NAME

linuxcnc − LinuxCNC (The Enhanced Machine Controller)

SYNOPSIS

linuxcnc [*-v*] [*-d*] [*INIFILE*]

DESCRIPTION

linuxcnc is used to start LinuxCNC (The Enhanced Machine Controller). It starts the realtime system and then initializes a number of LinuxCNC components (IO, Motion, GUI, HAL, etc). The most important parameter is *INIFILE*, which specifies the configuration name you would like to run. If *INIFILE* is not specified, the **linuxcnc** script presents a graphical wizard to let you choose one.

OPTIONS

−v Be a little bit verbose. This causes the script to print information as it works.

−d Print lots of debug information. All executed commands are echoed to the screen. This mode is useful when something is not working as it should.

INIFILE

The ini file is the main piece of an LinuxCNC configuration. It is not the entire configuration; there are various other files that go with it (NML files, HAL files, TBL files, VAR files). It is, however, the most important one, because it is the file that holds the configuration together. It can adjust a lot of parameters itself, but it also tells **linuxcnc** which other files to load and use.

There are several ways to specify which config to use:

Specify the absolute path to an ini, e.g.
linuxcnc */usr/local/linuxcnc/configs/sim/sim.ini*

Specify a relative path from the current directory, e.g.
linuxcnc *configs/sim/sim.ini*

Otherwise, in the case where the **INIFILE** is not specified, the behavior will depend on whether you configured linuxcnc with **--enable-run-in-place**. If so, the linuxcnc config chooser will search only the configs directory in your source tree. If not (or if you are using a packaged version of linuxcnc), it may search several directories. The config chooser is currently set to search the path:

~/linuxcnc/configs:/home/buildslave/emc2-buildbot/wheezy-amd64-clang/docs/build/configs

EXAMPLES

linuxcnc

linuxcnc *configs/sim/sim.ini*

linuxcnc */etc/linuxcnc/sample-configs/stepper/stepper_mm.ini*

SEE ALSO

halcmd(1)

Much more information about LinuxCNC and HAL is available in the LinuxCNC and HAL User Manuals, found at /usr/share/doc/linuxcnc/.

HISTORY

BUGS

None known at this time.

AUTHOR

This man page written by Alex Joni, as part of the LinuxCNC Enhanced Machine Controller project.

REPORTING BUGS

Report bugs to alex_joni AT users DOT sourceforge DOT net

COPYRIGHT

NAME

axis−remote − AXIS Remote Interface

SYNOPSIS

axis−remote *OPTIONS|FILENAME*

DESCRIPTION

axis−remote is a small script that triggers commands in a running AXIS GUI. Use **axis−remote −−help** for further information.

OPTIONS

−−ping, **−p**
: Check whether AXIS is running.

−−reload, **−r**
: Make AXIS reload the currently loaded file.

−−clear, **−c**
: Make AXIS clear the backplot.

−−quit, **−q**
: Make AXIS quit.

−−help, **−h**, **−?**
: Display a list of valid parameters for **axis−remote**.

−−mdi COMMAND, **−m COMMAND**
: Run the MDI command **COMMAND**.

FILENAME
: Load the G-code file **FILENAME**.

SEE ALSO

axis(1)

Much more information about LinuxCNC and HAL is available in the LinuxCNC and HAL User Manuals, found at /usr/share/doc/linuxcnc/.

HISTORY

BUGS

None known at this time.

AUTHOR

This man page written by Alex Joni, as part of the LinuxCNC project.

REPORTING BUGS

Report bugs to alex_joni AT users DOT sourceforge DOT net

COPYRIGHT

NAME

axis − AXIS LinuxCNC Graphical User Interface

SYNOPSIS

axis −*ini INIFILE*

DESCRIPTION

axis is one of the Graphical User Interfaces (GUI) for LinuxCNC It gets run by the runscript usually.

OPTIONS

INIFILE

The ini file is the main piece of an LinuxCNC configuration. It is not the entire configuration; there are various other files that go with it (NML files, HAL files, TBL files, VAR files). It is, however, the most important one, because it is the file that holds the configuration together. It can adjust a lot of parameters itself, but it also tells **LinuxCNC** which other files to load and use.

SEE ALSO

LinuxCNC(1)

Much more information about LinuxCNC and HAL is available in the LinuxCNC and HAL User Manuals, found at /usr/share/doc/LinuxCNC/.

HISTORY

BUGS

None known at this time.

AUTHOR

This man page written by Alex Joni, as part of the LinuxCNC project.

REPORTING BUGS

Report bugs to alex_joni AT users DOT sourceforge DOT net

COPYRIGHT

NAME

elbpcom − Communicate with Mesa ethernet cards

SYNOPSIS

Common options:

elbpcom [−−ip=*IP*] [−−**port**=*PORT*] [−−**timeout**=*TIMEOUT*]

Reading data:

elbpcom [*common options***] −−space**=*SPACE* **[−−info] −−address**=*ADDRESS* −−**read**=*LENGTH*

Writing data:

elbpcom [*common options***] −−space**=*SPACE* −−**address**=*ADDRESS* −−**write**=*HEXDATA*

Sending arbitrary packets:

elbpcom [*common options***]** *HEXDATA*

DESCRIPTION

Read or write data from a Mesa ethernet card that uses the LBP16 protocol, such as the 7i80. This can be useful for performing certain low-level tasks.

For more information about the meaning of each address space, see the card documentation. Incorrect use of this utility can have negative effects such as changing the board's IP address or even corrupting the FPGA bitfile in the eeprom. For some tasks, such as updating FPGA bitfiles and setting IP addresses, **mesaflash**(1) is a more appropriate tool.

If not specified, the default values are

−−**ip**=*192.168.1.121* −−**port**=*27181* −−**timeout**=*.2*

This example demonstrates reading the HOSTMOT2 identifying string from the IDROM in space 0:

```
$ elbpcom −−space 0 −−address 0x104 −−read 8
> 82420401
< 484f53544d4f5432
    HOSTMOT2
```

First the request is shown in hex. Then the response (if any) is shown in hex. Finally, the response is shown in ASCII, with "." replacing any non-ASCII characters. This is similar to the following invocations of mesaflash:

```
$ ./mesaflash  −−device 7i80 −−rpo 0x104
54534F48
$ ./mesaflash  −−device 7i80 −−rpo 0x108
32544F4D
```

but notice its different treatment of byte order.

SEE ALSO

mesaflash(1), **hostmot2**(9), **hm2_eth**(9), Mesa's documentation for the Anything I/O boards ⟨http://www.mesanet.com⟩.

NAME

gladevcp − Virtual Control Panel for LinuxCNC based on Glade, Gtk and HAL widgets

SYNOPSIS

gladevcp [−g *WxH+X+Y*] [−c *component-name*] [−u *handler*] [−U *useroption*] [−H *halfile*] [−d] *myfile.ui*

OPTIONS

−g *WxH+X+Y*

This sets the initial geometry of the root window. Use 'WxH' for just size, '+X+Y' for just position, or 'WxH+X+Y' for both. Size / position use pixel units. Position is referenced from top left.

−c *component-name*

Use *component-name* as the HAL component name. If the component name is not specified, the basename of the ui file is used.

−u *handler*

Instructs gladevcp to inspect the Python script *handler* for event handlers, and connect them to signals in the ui file.

−U *useroption*

gladevcp collects all *useroption* strings and passes them to the handler init() method as a list of strings without further inspection.

−x *XID* Reparent gladevcp into an existing window *XID* instead of creating a new top level window.

−H *halfile*

gladevcp runs *halfile* - a list of HAL commands - by executing *halcmd −c halfile* after the HAL component is finalized.

−d enable debug output.

−R *gtkrcfile*

explicitly load a gtkrc file.

−t *THEME*

set gtk theme. Default is *system* theme. Different panels can have different themes.

−m *MAXIMUM*

force panel window to maxumize. Together with the *−g geometry* option one can move the panel to a second monitor and force it to use all of the screen

−R explicitly deactivate workaround for a gtk bug which makes matches of widget and widget_class matches in gtk theme and gtkrc files fail. Normally not needed.

SEE ALSO

GladeVCP in the LinuxCNC documentation for a description of gladevcp's capabilities and the associated HAL widget set, along with examples

NAME

gs2_vfd − HAL userspace component for Automation Direct GS2 VFD's

SYNOPSIS

gs2_vfd [OPTIONS]

DESCRIPTION

This manual page explains the **gs2_vfd** component. This component reads and writes to the GS2 via a modbus connection.

gs2_vfd is for use with LinuxCNC

OPTIONS

−b, −−bits <n>
(default 8) Set number of data bits to <n>, where n must be from 5 to 8 inclusive

−d, −−device <path>
(default /dev/ttyS0) Set the name of the serial device node to use.

−v, −−verbose
Turn on verbose mode.

−g, −−debug
Turn on debug messages. Note that if there are serial errors, this may become annoying. Debug mode will cause all modbus messages to be printed in hex on the terminal.

−n, −−name <string>
(default gs2_vfd) Set the name of the HAL module. The HAL comp name will be set to <string>, and all pin and parameter names will begin with <string>.

−p, −−parity [even,odd,none]
(default odd) Set serial parity to even, odd, or none.

−r, −−rate <n>
(default 38400) Set baud rate to <n>. It is an error if the rate is not one of the following: 110, 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200

−s, −−stopbits [1,2]
(default 1) Set serial stop bits to 1 or 2

−t, −−target <n>
(default 1) Set MODBUS target (slave) number. This must match the device number you set on the GS2.

−A, −−accel−seconds <n>
(default 10.0) Seconds to accelerate the spindle from 0 to Max RPM.

−D, −−decel−seconds <n>
(default 0.0) Seconds to decelerate the spindle from Max RPM to 0. If set to 0.0 the spindle will be allowed to coast to a stop without controlled deceleration.

−R, −−braking−resistor
This argument should be used when a braking resistor is installed on the GS2 VFD (see Appendix A of the GS2 manual). It disables deceleration over-voltage stall prevention (see GS2 modbus Parameter 6.05), allowing the VFD to keep braking even in situations where the motor is regenerating high voltage. The regenerated voltage gets safely dumped into the braking resistor.

PINS

<name>.DC−bus−volts (float, out)
from the VFD

<name>.at−speed (bit, out)
when drive is at commanded speed

<name>.err−reset (bit, in)
reset errors sent to VFD

<name>.firmware−revision (s32, out)
from the VFD

<name>.frequency−command (float, out)
from the VFD

<name>.frequency−out (float, out)
from the VFD

<name>.is−stopped (bit, out)
when the VFD reports 0 Hz output

<name>.load−percentage (float, out)
from the VFD

<name>.motor−RPM (float, out)
from the VFD

<name>.output−current (float, out)
from the VFD

<name>.output−voltage (float, out)
from the VFD

<name>.power−factor (float, out)
from the VFD

<name>.scale−frequency (float, out)
from the VFD

<name>.speed−command (float, in)
speed sent to VFD in RPM It is an error to send a speed faster than the Motor Max RPM as set in the VFD

<name>.spindle−fwd (bit, in)
1 for FWD and 0 for REV sent to VFD

<name>.spindle−on (bit, in)
1 for ON and 0 for OFF sent to VFD, only on when running

<name>.spindle−rev (bit, in)
1 for ON and 0 for OFF, only on when running

<name>.status−1 (s32, out)
Drive Status of the VFD (see the GS2 manual)

<name>.status−2 (s32, out)
Drive Status of the VFD (see the GS2 manual) Note that the value is a sum of all the bits that are on. So a 163 which means the drive is in the run mode is the sum of 3 (run) + 32 (freq set by serial) + 128 (operation set by serial).

PARAMETERS

<name>.error−count (s32, RW)

<name>.loop−time (float, RW)
how often the modbus is polled (default 0.1)

<name>.nameplate−HZ (float, RW)
Nameplate Hz of motor (default 60)

<name>.nameplate−RPM (float, RW)
Nameplate RPM of motor (default 1730)

<name>.retval (s32, RW)
the return value of an error in HAL

<name>.tolerance (float, RW)
speed tolerance (default 0.01)

<name>.ack−delay (s32, RW)
number of read/write cycles before checking at−speed (default 2)

SEE ALSO

GS2 Driver in the LinuxCNC documentation for a full description of the **GS2** syntax

GS2 Examples in the LinuxCNC documentation for examples using the **GS2** component

BUGS

AUTHOR

John Thornton

LICENSE

GPL

NAME

hal_input − control HAL pins with any Linux input device, including USB HID devices

SYNOPSIS

loadusr **hal_input** *[−KRAL] inputspec ...*

DESCRIPTION

hal_input is an interface between HAL and any Linux input device, including USB HID devices. For each device named, **hal_input** creates pins corresponding to its keys, absolute axes, and LEDs. At a fixed rate of approximately 10ms, it synchronizes the device and the HAL pins.

INPUT SPECIFICATION

The *inputspec* may be in one of several forms:

A string *S*

A substring or shell-style pattern match will be tested against the "name" of the device, the "phys" (which gives information about how it is connected), and the "id", which is a string of the form "Bus=... Vendor=... Product=... Version=...". You can view the name, phys, and id of attached devices by executing **less /proc/bus/input/devices**. Examples:

SpaceBall
"Vendor=001f Product=0001"
serio*/input0

A number *N*

This opens **/dev/input/event***N*. Except for devices that are always attached to the system, this number may change over reboots or when the device is removed. For this reason, using an integer is not recommended.

When several devices are identified by the same string, add "**:***N*" where *N* is the index of the desired device. For example, if **Mouse** matches **input3** and **input10**, then **Mouse** and **Mouse:0** select **input3**. Specifying **mouse:1** selects input10.

For devices that appear as multiple entries in /dev/input, these indices are likely to stay the same every time. For multiple identical devices, these indices are likely to depend on the insertion order, but stay the same across reboots as long as the devices are not moved to different ports or unplugged while the machine is booted.

If the first character of the *inputspec* is a "+", then **hal_input** requests exclusive access to the device. The first device matching an *inputspec* is used. Any number of *inputspec*s may be used.

A *subset option may precede each inputspec*. The subset option begins with a dash. Each letter in the subset option specifies a device feature to **include**. Features that are not specified are excluded. For instance, to export keyboard LEDs to HAL without exporting keys, use

hal_input −L *keyboard ...*

DEVICE FEATURES SUPPORTED

- EV_KEY (buttons and keys). Subset −K
- EV_ABS (absolute analog inputs). Subset −A
- EV_REL (relative analog inputs). Subset −R
- EV_LED (LED outputs). Subset −L

HAL PINS AND PARAMETERS

For buttons

input.*N***.btn−***name* bit out
input.*N***.btn−***name***−not** bit out

Created for each button on the device.

For keys

input.*N*.key−*name*
input.*N*.key−*name*−not
Created for each key on the device.

For absolute axes

input.*N*.abs−*name*−counts s32 out
input.*N*.abs−*name*−position float out
input.*N*.abs−*name*−scale parameter float rw
input.*N*.abs−*name*−offset parameter float rw
input.*N*.abs−*name*−fuzz parameter s32 rw
input.*N*.abs−*name*−flat parameter s32 rw
input.*N*.abs−*name*−min parameter s32 r
input.*N*.abs−*name*−max parameter s32 r
Created for each absolute axis on the device. Device positions closer than **flat** to **offset** are reported as **offset** in **counts**, and **counts** does not change until the device position changes by at least **fuzz**. The position is computed as **position** = (**counts** − **offset**) / **scale**. The default value of **scale** and **offset** map the range of the axis reported by the operating system to [−1,1]. The default values of **fuzz** and **flat** are those reported by the operating system. The values of **min** and **max** are those reported by the operating system.

For relative axes

input.*N*.rel−*name*−counts s32 out
input.*N*.rel−*name*−position float out
input.*N*.rel−*name*−reset bit in
input.*N*.rel−*name*−scale parameter float rw
input.*N*.rel−*name*−absolute parameter s32 rw
input.*N*.rel−*name*−precision parameter s32 rw
input.*N*.rel−*name*−last parameter s32 rw
Created for each relative axis on the device. As long as **reset** is true, **counts** is reset to zero regardless of any past or current axis movement. Otherwise, **counts** increases or decreases according to the motion of the axis. **counts** is divided by position−scale to give **position**. The default value of **position** is 1. There are some devices, notably scroll wheels, which return signed values with less resolution than 32 bits. The default value of **precision** is 32. **precision** can be set to 8 for a device that returns signed 8 bit values, or any other value from 1 to 32. **absolute**, when set true, ignores duplicate events with the same value. This allows for devices that repeat events without any user action to work correctly. **last** shows the most recent count value returned by the device, and is used in the implementation of **absolute**.

For LEDs

input.*N*.led−*name* bit out
input.*N*.led−*name*−invert parameter bit rw
Created for each LED on the device.

PERMISSIONS AND UDEV

By default, the input devices may not be accessible to regular users--**hal_input** requires read-write access, even if the device has no outputs.

Different versions of udev have slightly different, incompatible syntaxes. For this reason, it is not possible for this manual page to give an accurate example. The **udev(7)** manual page documents the syntax used on your Linux distribution. To view it in a terminal, the command is **man 7 udev**.

BUGS

The initial state of keys, buttons, and absolute axes are erroneously reported as FALSE or 0 until an event is received for that key, button, or axis.

SEE ALSO

udev(8), **udev(7)**

NAME

hal_manualtoolchange − HAL userspace component to enable manual tool changes.

SYNOPSIS

loadusr hal_manualtoolchange

DESCRIPTION

hal_manualtoolchange is a LinuxCNC userspace component that allows users with machines lacking automatic tool changers to make manual tool changes. In use when a M6 tool change is encountered, the motion component will stop the spindle and pause the program. The hal_manualtoolchange component will then receive a signal from the motion component causing it to display a tool change window prompting the user which tool number to load based on the last T− number programmed. The dialog will stay active until the "continue" button is pressed. When the "continue" button is pressed, hal_manualtoolchange will then signal the motion component that the tool change is complete thus allowing motion to turn the spindle back on and resume program execution.

Additionally, The hal_manualtoolchange component includes a hal pin for a button that can be connected to a physical button to complete the tool change and remove the window prompt (hal_manual-toolchange.change_button).

hal_manualtoolchange can be used even when AXIS is not used as the GUI. This component is most useful if you have presettable tools and you use the tool table.

PINS

hal_manualtoolchange.number s32 in
Receives last programmed T− number.

hal_manualtoolchange.change bit in
Receives signal to do tool change.

hal_manualtoolchange.changed bit out
Signifies that the tool change is complete.

hal_manualtoolchange.change_button bit in
Pin to allow an external switch to signify that the tool change is complete.

USAGE

Normal usage is to load the component in your HAL file and net the appropriate pins from the *motion* and *io* components. The following lines are typical in a HAL file when using the hal_manualtoolchange userspace component.

loadusr −W hal_manualtoolchange
This will load the hal_manualtoolchange userspace component waiting for the component to be ready before continuing.

net tool−change iocontrol.0.tool−change => hal_manualtoolchange.change
When an M6 code is run, motion sets *iocontrol.0.tool−change* to high indicating a tool change. This pin should be netted to *hal_manualtoolchange.change*. This causes the Tool change dialog to be displayed on screen and wait for the user to either click the continue button on the dialog or press an externally connected button.

net tool−changed iocontrol.0.tool−changed <= hal_manualtoolchange.changed
When the Tool change dialog's continue button is pressed, it will set the *hal_manual-toolchange.changed* pin to high, this should be netted to the *iocontrol.0.tool−changed* pin, indicating to the motion controller that the tool change has been completed and can continue with the execution of the G-code program.

net tool−number iocontrol.0.tool−prep−number => hal_manualtoolchange.number
When a T− command is executed in a G-code program, the tool number will held in the *iocontrol.0.tool−prep−number*. This pin should be netted to *hal_manualtoolchange.number*. The value of this pin, the tool number is displayed in the Tool change dialog to let the user know which tool should be loaded.

net tool−prepare−loopback iocontrol.0.tool−prepare => iocontrol.0.tool−prepared

The *iocontrol.0.tool−prepare* pin will go true when a Tn tool prepare is requested. Since there is not automated tool changer this pin should be netted to *iocontrol.0.tool−prepared* to indocate that the tool has been prepared.

If you wish to use an external button to signal the hal_manualtoolchange component that the tool change is complete simply bring the button into HAL (via a parport input pin or a hostmot2 gpio input or similar), and wire it directly to the *hal_manualtoolchange.change_button* pin. For Example:

net tool−changed−btn hal_manualtoolchange.change_button <= parport.0.pin−15−in

SEE ALSO

motion(1) iocontrol(1) halcmd(1)

NAME

hal_parport − Realtime HAL component to communicate with one or more pc parallel ports.

SYNOPSIS

loadrt hal_parport cfg="*port_addr* [*type*] [[*port_addr* [*type*] ...]**"**

DESCRIPTION

The hal_parport component is a realtime component that provides connections from HAL via halpins to the physical pins of one or more parallel ports. It provides a read and write function to send and receive data to the attached parallel port(s).

The hal_parport component supports up to **8** physical parallel ports.

OPTIONS

cfg="port_addr [type] [[port_addr [type] ...]"

The cfg string tells hal_parport the address(es) of the parallel port(s) and whether the port(s) is/are used as an input or output port(s). Up to eight parallel ports are supported by the component.

The **port_addr** parameter of the configuration string may be either the physical base address of a parallel port or specified as the detected parallel port via Linux parport_pc driver. In which case, a **port_addr** of *0* is the first parallel port detected on the system, *1* is the next, and so on.

The **type** parameter of the configuration string determines how the I/O bits of the port are used. There are four possible options and if none is specified will default to out.

in − Sets the 8 bits of the data port to input. In this mode the parallel port has a total of 13 input pins and 4 output pins.

out − Sets the 8 bits of the data port to output. In this mode the parallel port has a total of 5 input pins and 12 output pins.

epp − This option is the same as setting to out, but can cause the computer to change the electrical characteristics of the port. (*See USAGE below*.)

x − The option allows ports with open collectorts on the control group pins to be configured as inputs resulting in 8 output pins and 9 input pins. (*See USAGE below*.)

PINS

The pins created by the hal_parport component depends on how it is configured in the **cfg=""** string passed to it. (*See OPTIONS*.)

parport.<p>.pin−<n>−out (bit) Drives a physical output pin.

parport.<p>.pin−<n>−in (bit) Tracks a physical input pin.

parport.<p>.pin−<n>−in−not (bit) Tracks a physical input pin, but inverted.

For each pin created, **<p>** is the port number, and **<n>** is the physical pin number in the 25 pin D−shell connector.

For each physical output pin, the driver creates a single HAL pin, for example: **parport.0.pin−14−out**.

For each physical input pin, the driver creates two HAL pins, for example: **parport.0.pin−12−in** and **parport.0.pin−12−in−not**.

The **−in** HAL pin is TRUE if the physical pin is high, and FALSE if the physical pin is low. The **−in−not** HAL pin is inverted and is FALSE if the physical pin is high.

The following lists the input and output pins by the type setting used in the cfg="" string.

in: Pins 2,3,4,5,6,7,8,9,10,11,12,13,15 are input pins and pins 1,14,16 and 17 are output pins.

out/epp: Pins 10,11,12,13 and 15 are input pins and pins 1,2,3,4,5,6,7,8,9,14,16 and 17 are output pins.

x: Pins 1,10,11,12,13,14,15,16 and 17 are input pins and pins 2,3,4,5,6,7,8,9 are output pins. (*See USAGE section*.)

PARAMETERS

parport.<p>.pin−<n>−out−invert (bit)
Inverts an output pin.

parport.<p>.pin−<n>−out−reset (bit)
(only for out pins) TRUE if this pin should be reset when the .reset function is executed.

parport.<p>.reset−time' (U32)
The time (in nanoseconds) between a pin is set by write and reset by the reset function if it is enabled.

FUNCTIONS

parport.<p>.read(funct)
Reads physical input pins of port <portnum> and updates HAL −in and −in−not pins.

parport.read−all (funct)
Reads physical input pins of all ports and updates HAL −in and −in−not pins.

parport.<p>.write (funct)
Reads HAL −out pins of port <p> and updates that portâs physical output pins.

parport.write−all (funct)
Reads HAL −out pins of all ports and updates all physical output pins.

parport.<p>.reset (funct)
Waits until *reset−time* has elapsed since the associated write, then resets pins to values indicated by *−out−reset* and *−out−invert* settings. reset must be later in the same thread as write. 'If '*−out−reset* is TRUE, then the reset function will set the pin to the value of *−out−invert*. This can be used in conjunction with stepgenâs doublefreq to produce one step per period. The stepgen stepspace for that pin must be set to 0 to enable doublefreq.

USAGE

The hal_parport component is a driver for the traditional PC parallel port. The port has a total of 25 physical pins of which 17 are used for signals. The original parallel port divided those pins into three groups: data, control, and status. The data group consists of 8 output pins, the control group consists of 4 output pins, and the status group consists of 5 input pins.

In the early 1990âs, the bidirectional parallel port was introduced, which allows the data group to be used for output or input. The HAL driver supports the bidirectional port, and allows the user to set the data group as either input or output. If configured as *out*, a port provides a total of 12 outputs and 5 inputs. If configured as *in*, it provides 4 outputs and 13 inputs.

In some parallel ports, the control group pins are open collectors, which may also be driven low by an external gate. On a board with open collector control pins, if configured as *x*, it provides 8 outputs, and 9 inputs.

In some parallel ports, the control group has push-pull drivers and cannot be used as an input.

Note: HAL and Open Collectors

HAL cannot automatically determine if the x mode bidirectional pins are actually open collectors (OC). If they are not, they cannot be used as inputs, and attempting to drive them LOW from an external source can damage the hardware.

To determine whether your port has open collector pins, load hal_parport in x mode. With no device attached, HAL should read the pin as TRUE. Next, insert a 470 ohm resistor from one of the control pins to GND. If the resulting voltage on the control pin is close to 0V, and HAL now reads the pin as FALSE, then you have an OC port. If the resulting voltage is far from 0V, or HAL does not read the pin as FALSE, then your port cannot be used in x mode.

The external hardware that drives the control pins should also use open collector gates (e.g., 74LS05).

On some computers, BIOS settings may affect whether x mode can be used. SPP mode is most likely to work.

No other combinations are supported, and a port cannot be changed from input to output once the driver is installed.

The parport driver can control up to 8 ports (defined by MAX_PORTS in hal_parport.c). The ports are numbered starting at zero.

Loading the hal_parport component

The hal_parport driver is a real time component so it must be loaded into the real time thread with loadrt. The configuration string describes the parallel ports to be used, and (optionally) their types. If the configuration string does not describe at least one port, it is an error.

loadrt hal_parport cfg="port [type] [port [type] ...]"

Specifying the Port

Numbers below 16 refer to parallel ports detected by the system. This is the simplest way to configure the hal_parport driver, and cooperates with the Linux parport_pc driver if it is loaded. A port of 0 is the first parallel port detected on the system, 1 is the next, and so on.

Basic configuration

This will use the first parallel port Linux detects:

loadrt hal_parport cfg="0"

Using the Port Address

Instead, the port address may be specified using the hex notation 0x then the address.

loadrt hal_parport cfg="0x378"

Specifying a port Type

For each parallel port handled by the hal_parport driver, a type can optionally be specified. The type is one of in, out, epp, or x.

If the type is not specified, the default is out.

A type of epp is the same as out, but the hal_parport driver requests that the port switch into EPP mode. The hal_parport driver does not use the EPP bus protocol, but on some systems EPP mode

changes the electrical characteristics of the port in a way that may make some marginal hardware work better. The Gecko G540âs charge pump is known to require this on some parallel ports.

See the Note above about mode x.

Example with two parallel ports

This will enable two system-detected parallel ports, the first in output mode and the second in input mode:

loadrt hal_parport cfg="0 out 1 in"

Functions single port

You must also direct LinuxCNC to run the read and write functions.

addf parport.read−all base−thread
addf parport.write−all base−thread

Functions multiple ports

You can direct LinuxCNC to ruin the read and write functions for all the attached ports.

addf parport.0.read base−thread
addf parport.0.write base−thread

The individual functions are provided for situations where one port needs to be updated in a very fast thread, but other ports can be updated in a slower thread to save CPU time. It is probably not a good idea to use both an −all function and an individual function at the same time.

SEE ALSO

Parallel Port Driver (Hardware Drivers Section of LinuxCNC Docs) PCI Parallel Port Example (Hardware Examples Section of LinuxCNC Docs)

AUTHOR

This man page written by Joe Hildreth as part of the LinuxCNC project. Most of this information was taken from the parallel-port docs located in the Hardware Drivers section of the documentation. To the best of my knowledge that documentation was written by Sebastian Kuzminsky and Chris Radek.

NAME

halcmd − manipulate the LinuxCNC HAL from the command line

SYNOPSIS

halcmd [*OPTIONS*] [*COMMAND* [*ARG*]]

DESCRIPTION

halcmd is used to manipulate the HAL (Hardware Abstraction Layer) from the command line. **halcmd** can optionally read commands from a file, allowing complex HAL configurations to be set up with a single command.

If the **readline** library is available when LinuxCNC is compiled, then **halcmd** offers commandline editing and completion when running interactively. Use the up arrow to recall previous commands, and press tab to complete the names of items such as pins and signals.

OPTIONS

−I Before tearing down the realtime environment, run an interactive halcmd. **halrun** only. If **−I** is used, it must precede all other commandline arguments.

\-f [*file*] Ignore commands on command line, take input from *file* instead. If *file* is not specified, take input from *stdin*.

−i *inifile*
Use variables from *inifile* for substitutions. See **SUBSTITUTION** below.

\-k Keep going after failed command(s). The default is to stop and return failure if any command fails.

\-q display errors only (default)

\-Q display nothing, execute commands silently

\-s Script-friendly mode. In this mode, *show* will not output titles for the items shown. Also, module names will be printed instead of ID codes in pin, param, and funct listings. Threads are printed on a single line, with the thread period, FP usage and name first, followed by all of the functions in the thread, in execution order. Signals are printed on a single line, with the type, value, and signal name first, followed by a list of pins connected to the signal, showing both the direction and the pin name.

−R Release the HAL mutex. This is useful for recovering when a HAL component has crashed while holding the HAL mutex.

\-v display results of each command

\-V display lots of debugging junk

\-h [*command*]
display a help screen and exit, displays extended help on *command* if specified

COMMANDS

Commands tell **halcmd** what to do. Normally **halcmd** reads a single command from the command line and executes it. If the '**−f**' option is used to read commands from a file, **halcmd** reads each line of the file as a new command. Anything following '**#**' on a line is a comment.

loadrt *modname*
(*load r*eal*t*ime module) Loads a realtime HAL module called *modname*. **halcmd** looks for the module in a directory specified at compile time.

In systems with realtime, **halcmd** calls the **linuxcnc_module_helper** to load realtime modules. **linuxcnc_module_helper** is a setuid program and is compiled with a whitelist of modules it is allowed to load. This is currently just a list of **LinuxCNC**-related modules. The **linuxcnc_module_helper** execs insmod, so return codes and error messages are those from insmod. Administrators who wish to restrict which users can load these **LinuxCNC**-related kernel modules can do this

by setting the permissions and group on **linuxcnc_module_helper** appropriately.

In systems without realtime **halcmd** calls the **rtapi_app** which creates the simulated realtime environment if it did not yet exist, and then loads the requested component with a call to **dlopen(3)**.

unloadrt *modname*
(*unload r*eal*t*ime module) Unloads a realtime HAL module called *modname*. If *modname* is "all", it will unload all currently loaded realtime HAL modules. **unloadrt** also works by execing **linuxcnc_module_helper** or **rtapi_app**, just like **loadrt**.

loadusr *[flags] unix-command*
(*load Us*erspace component) Executes the given *unix-command*, usually to load a userspace component. *[flags]* may be one or more of:

- **−W** to wait for the component to become ready. The component is assumed to have the same name as the first argument of the command.
- **−Wn name** to wait for the component, which will have the given name.
- **−w** to wait for the program to exit
- **−i** to ignore the program return value (with −w)

waitusr *name*
(*wait* for *Us*erspace component) Waits for user space component *name* to disconnect from HAL (usually on exit). The component must already be loaded. Useful near the end of a HAL file to wait until the user closes some user interface component before cleaning up and exiting.

unloadusr *compname*
(*unload Us*erspace component) Unloads a userspace component called *compname*. If *compname* is "all", it will unload all userspace components. **unloadusr** works by sending SIGTERM to all userspace components.

unload *compname*
Unloads a userspace component or realtime module. If *compname* is "all", it will unload all userspace components and realtime modules.

newsig *signame type*
(OBSOLETE - use **net** instead) (*new sig*nal) Creates a new HAL signal called *signame* that may later be used to connect two or more HAL component pins. *type* is the data type of the new signal, and must be one of "**bit**", "**s32**", "**u32**", or "**float**". Fails if a signal of the same name already exists.

delsig *signame*
(*del*ete *sig*nal) Deletes HAL signal *signame*. Any pins currently linked to the signal will be unlinked. Fails if *signame* does not exist.

sets *signame value*
(*set* signal) Sets the value of signal *signame* to *value*. Fails if *signame* does not exist, if it already has a writer, or if *value* is not a legal value. Legal values depend on the signals's type.

stype *name*
(signal type) Gets the type of signal *name*. Fails if *name* does not exist as a signal.

gets *signame*
(*get* signal) Gets the value of signal *signame*. Fails if *signame* does not exist.

linkps *pinname* [*arrow*] *signame*
(OBSOLETE - use **net** instead) (*link p*in to signal) Establishs a link between a HAL component pin *pinname* and a HAL signal *signame*. Any previous link to *pinname* will be broken. *arrow* can be "=>", "<=", "<=>", or omitted. **halcmd** ignores arrows, but they can be useful in command files to document the direction of data flow. Arrows should not be used on the command line since

the shell might try to interpret them. Fails if either *pinname* or *signame* does not exist, or if they are not the same type type.

linksp *signame* [*arrow*] *pinname*
(OBSOLETE - use **net** instead) (*link s*ignal to *p*in) Works like **linkps** but reverses the order of the arguments. **halcmd** treats both link commands exactly the same. Use whichever you prefer.

linkpp *pinname1* [*arrow*] *pinname2*
(OBSOLETE - use **net** instead) (*link p*in to *p*in) Shortcut for **linkps** that creates the signal (named like the first pin), then links them both to that signal. **halcmd** treats this just as if it were:
halcmd newsig pinname1
halcmd linksp pinname1 pinname1
halcmd linksp pinname1 pinname2

net *signame pinname ...*
Create *signname* to match the type of *pinname* if it does not yet exist. Then, link *signame* to each *pinname* in turn. Arrows may be used as in **linkps**. When linking a pin to a signal for the first time, the signal value will inherit the pin's default value.

unlinkp *pinname*
(*unlink p*in) Breaks any previous link to *pinname*. Fails if *pinname* does not exist. An unlinked pin will retain the last value of the signal it was linked to.

setp *name value*
(*set p*arameter or *p*in) Sets the value of parameter or pin *name* to *value*. Fails if *name* does not exist as a pin or parameter, if it is a parameter that is not writable, if it is a pin that is an output, if it is a pin that is already attached to a signal, or if *value* is not a legal value. Legal values depend on the type of the pin or parameter. If a pin and a parameter both exist with the given name, the parameter is acted on.

paramname **=** *value*

pinname **=** *value*
Identical to **setp**. This alternate form of the command may be more convenient and readable when used in a file.

ptype *name*
(*p*arameter or *p*in *type*) Gets the type of parameter or pin *name*. Fails if *name* does not exist as a pin or parameter. If a pin and a parameter both exist with the given name, the parameter is acted on.

getp *name*
(*get p*arameter or *p*in) Gets the value of parameter or pin *name*. Fails if *name* does not exist as a pin or parameter. If a pin and a parameter both exist with the given name, the parameter is acted on.

addf *functname threadname*
(*add f*unction) Adds function *functname* to realtime thread *threadname*. *functname* will run after any functions that were previously added to the thread. Fails if either *functname* or *threadname* does not exist, or if they are incompatible.

delf *functname threadname*
(*del*ete *f*unction) Removes function *functname* from realtime thread *threadname*. Fails if either *functname* or *threadname* does not exist, or if *functname* is not currently part of *threadname*.

start Starts execution of realtime threads. Each thread periodically calls all of the functions that were added to it with the **addf** command, in the order in which they were added.

stop Stops execution of realtime threads. The threads will no longer call their functions.

show [*item*]

Prints HAL items to *stdout* in human readable format. *item* can be one of "**comp**" (components), "**pin**", "**sig**" (signals), "**param**" (parameters), "**funct**" (functions), "**thread**", or "**alias**". The type "**all**" can be used to show matching items of all the preceding types. If *item* is omitted, **show** will print everything.

item This is equivalent to **show all [item]**.

save [*item*]

Prints HAL items to *stdout* in the form of HAL commands. These commands can be redirected to a file and later executed using **halcmd −f** to restore the saved configuration. *item* can be one of the following:

"**comp**" generates a **loadrt** command for realtime component.

"**alias**" generates an **alias** command for each pin or parameter alias pairing

"**sig**" (or "**signal**") generates a **newsig** command for each signal, and "**sigu**" generates a **newsig** command for each unlinked signal (for use with **netl** and **netla**).

"**link**" and "**linka**" both generate **linkps** commands for each link. (**linka** includes arrows, while **link** does not.)

"**net**" and "**neta**" both generate one **newsig** command for each signal, followed by **linksp** commands for each pin linked to that signal. (**neta** includes arrows.)

"**netl**" generates one **net** command for each linked signal, and "**netla**" (or "**netal**") generates a similar command using arrows.

"**param**" (or "**parameter**) "generates one **setp** command for each parameter.

"**thread**" generates one **addf** command for each function in each realtime thread.

"**unconnectedinpins** generates a setp command for each unconnected hal input pin.

If *item* is **allu**), **save** does the equivalent of **comp**, **alias**, **sigu**, **netla**, **param**, **thread**, and **unconnectedinpins**.

If *item* is omitted (or **all**), **save** does the equivalent of **comp**, **alias**, **sigu**, **netla**, **param**, and **thread**.

source *filename.hal*

Execute the commands from *filename.hal*.

alias *type name alias*

Assigns "**alias**" as a second name for the pin or parameter "name". For most operations, an alias provides a second name that can be used to refer to a pin or parameter, both the original name and the alias will work.
"type" must be **pin** or **param**.
"name" must be an existing name or **alias** of the specified type.

unalias *type alias*

Removes any alias from the pin or parameter alias.
"type" must be **pin** or **param**
"alias" must be an existing name or **alias** of the specified type.

list *type* [*pattern*]
Prints the names of HAL items of the specified type.
'type' is '**comp**', '**pin**', '**sig**', '**param**', '**funct**', or '**thread**'. If 'pattern' is specified it prints only those names that match the pattern, which may be a 'shell glob'.
For '**sig**', '**pin**' and '**param**', the first pattern may be −t**datatype** where datatype is the data type (e.g., 'float') in this case, the listed pins, signals, or parameters are restricted to the given data type
Names are printed on a single line, space separated.

lock [*all*|*tune*|*none*]
Locks HAL to some degree.
none - no locking done.
tune - some tuning is possible (**setp** & such).
all - HAL completely locked.

unlock [*all*|*tune*]
Unlocks HAL to some degree.
tune - some tuning is possible (**setp** & such).
all - HAL completely unlocked.

status [*type*]
Prints status info about HAL.
'type' is '**lock**', '**mem**', or '**all**'.
If 'type' is omitted, it assumes '**all**'.

help [*command*]
Give help information for command.
If 'command' is omitted, list command and brief description

SUBSTITUTION

After a command is read but before it is executed, several types of variable substitution take place.

Environment Variables

Environment variables have the following formats:

$ENVVAR followed by end-of-line or whitespace

$(ENVVAR)

Inifile Variables

Inifile variables are available only when an inifile was specified with the halcmd **−i** flag. They have the following formats:

[SECTION]VAR followed by end-of-line or whitespace

[SECTION](VAR)

LINE CONTINUATION

The backslash character (\) may be used to indicate the line is extended to the next line. The backslash character must be the last character before the newline.

EXAMPLES

HISTORY

BUGS

None known at this time.

AUTHOR

Original version by John Kasunich, as part of the LinuxCNC project. Now includes major contributions by several members of the project.

REPORTING BUGS

Report bugs to the LinuxCNC bug tracker ⟨`http://sf.net/p/emc/bugs/`⟩.

COPYRIGHT

SEE ALSO

halrun(1) -- a convenience script to start a realtime environment, process a .hal or a .tcl file, and optionally start an interactive command session using **halcmd** (described here) or **haltcl**(1).

NAME

halcompile − Build, compile and install LinuxCNC HAL components

SYNOPSIS

halcompile [**−−compile**|**−−preprocess**|**−−document**|**−−view−doc**] compfile...
sudo **halcompile** [**−−install**|**−−install−doc**] compfile...
halcompile −−compile −−userspace cfile...
sudo **halcompile −−install −−userspace** cfile...
sudo **halcompile −−install −−userspace** pyfile...

When personalities are used in a comp file, hal instances are exported sequentially (typically by the mutually exclusive count= or names= parameters). If the number of exports excedes the maximum number of personalities, subsequent personalities are assigned modulo the maximum number of personalities allowed.

By default, the maximum number of personalities is 64. To alter this limit, use the **--personalities=** option with halcompile. For example, to set the maximum of personality items to 4:
[sudo] **halcompile --personalities=4** --install ...

DESCRIPTION

halcompile performs many different functions:

- Compile **.comp** and **.c** files into **.so** or **.ko** HAL realtime components (the **−−compile** flag)
- Compile **.comp** and **.c** files into HAL userspace components (the **−−compile −−userspace** flag)
- Preprocess **.comp** files into **.c** files (the **−−preprocess** flag)
- Extract documentation from **.comp** files into **.9** manpage files (the **−−document** flag)
- Display documentation from **.comp** files onscreen (the **−−view−doc** flag)
- Compile and install **.comp** and **.c** files into the proper directory for HAL realtime components (the **−−install** flag), which may require *sudo* to write to system directories.
- Install **.c** and **.py** files into the proper directory for HAL userspace components (the **−−install −−userspace** flag), which may require *sudo* to write to system directories.
- Extract documentation from **.comp** files into **.9** manpage files in the proper system directory (the **−−install** flag), which may require *sudo* to write to system directories.
- Preprocess **.comp** files into **.c** files (the **−−preprocess** flag)

SEE ALSO

Halcompile HAL Component Generator in the LinuxCNC documentation for a full description of the **.comp** syntax, along with examples

pydoc hal and *Creating Userspace Python Components* in the LinuxCNC documentation for documentation on the Python interface to HAL components

NAME

halmeter − observe HAL pins, signals, and parameters

SYNOPSIS

halmeter [**−s**] [**pin**|**sig**|**param** *name*] [**−g** *X-positon Y-position [Width]*]

DESCRIPTION

halmeter is used to observe HAL (Hardware Abstraction Layer) pins, signals, or parameters. It serves the same purpose as a multimeter does when working on physical systems.

OPTIONS

pin *name*
: display the HAL pin *name*.

sig *name*
: display the HAL signal *name*.

param *name*
: display the HAL parameter *name*.

If neither **pin**, **sig**, or **param** are specified, the
: window starts out blank and the user must select an item to observe.

\-s small window. Non-interactive, must be used with **pin**, **sig**, or **param** to select the item to display. The item name is displayed in the title bar instead of the window, and there are no "Select" or "Exit" buttons. Handy when you want a lot of meters in a small space.

\-g geometry position. allows one to specify the initial starting position and optionally the width of the meter. Referenced from top left of screen in pixel units. Handy when you want to load a lot of meters in a script with out them displaying on top of each other.

USAGE

Unless **\-s** is specified, there are two buttons, "Select" and "Exit". "Select" opens a dialog box to select the item (pin, signal, or parameter) to be observed. "Exit" does what you expect.

The selection dialog has "OK" "Apply", and "Cancel" buttons. OK displays the selected item and closes the dialog. "Apply" displays the selected item but keeps the selection dialog open. "Cancel" closes the dialog without changing the displayed item.

EXAMPLES

halmeter
: Opens a meter window, with nothing initially displayed. Use the "Select" button to choose an item to observe. Does not return until the window is closed.

halmeter &
: Open a meter window, with nothing initially displayed. Use the "Select" button to choose an item. Runs in the background leaving the shell free for other commands.

halmeter pin *parport.0.pin−03−out* **&**
: Open a meter window, initially displaying HAL pin *parport.0.pin−03−out*. The "Select" button can be used to display other items. Runs in background.

halmeter −s pin *parport.0.pin−03−out* **&**
: Open a small meter window, displaying HAL pin *parport.0.pin−03−out*. The displayed item cannot be changed. Runs in background.

halmeter −s pin *parport.0.pin−03−out* **−g** *100 500* **&**
: Open a small meter window, displaying HAL pin *parport.0.pin−03−out*. places it 100 pixels to the left and 500 pixels down from top of screen. The displayed item cannot be changed. Runs in background.

halmeter −s pin *parport.0.pin−03−out* **−g** *100 500 400* **&**

Open a small meter window, displaying HAL pin *parport.0.pin−03−out*. places it 100 pixels to the left and 500 pixels down from top of screen. The width will be 400 pixels (270 is default) The displayed item cannot be changed. Runs in background.

SEE ALSO

HISTORY

BUGS

AUTHOR

Original version by John Kasunich, as part of the LinuxCNC project. Improvements by several other members of the LinuxCNC development team.

REPORTING BUGS

Report bugs to jmkasunich AT users DOT sourceforge DOT net

COPYRIGHT

NAME

halrun − manipulate the LinuxCNC HAL from the command line

SYNOPSIS

halrun −*h*

halrun [−*I*] [*halcmd_opts*] [*filename[.hal|.tcl]*]

halrun −*T* [*halcmd_opts*] [*filename[.hal|.tcl]*]

halrun −*U*

DESCRIPTION

halrun is a convenience script used to manipulate the HAL (Hardware Abstraction Layer) from the command line. When invoked, **halrun**:

Sets up the realtime environment.
Executes a command interpreter (**halcmd** or **haltcl**).
(Optionally) runs an interactive session.
Tears down the realtime environment.

If no filename is specified, an interactive session is started.
The session will use **halcmd**(1) unless −T is specified in
which case **haltcl**(1) will be used.

If a filename is specified and neither the −I nor the −T option
is included, the filename will be processed by the command
interpreter corresponding to the filename extension (**halcmd**
or **haltcl**). After processing, the realtime environment
will be torn down.

If a filename is specified and the −I or −T option is included,
the file is processed by the appropriate command interpreter and
then an interactive session is started for **halcmd** or
haltcl according to the −I or −T option.

OPTIONS

halcmd_opts

When a .hal file is specified, the **halcmd_opts** are passed to **halcmd**. See the man page for **halcmd**(1). When a .tcl file is specified, the only valid options are:
−i inifile
−f filename[.tcl|.hal] (alternate means of specifying a file)

−I Run an interactive **halcmd** session

−T Run an interactive **haltcl** session.

−U Forcibly cause the realtime environment to exit. It releases the HAL mutex, requests that all HAL components unload, and stops the realtime system. **−U** must be the only commandline argument.

\-h display a brief help screen and exit

EXAMPLES

HISTORY

BUGS

None known at this time.

AUTHOR

Original version by John Kasunich, as part of the LinuxCNC Enhanced Machine Controller project. Now includes major contributions by several members of the project.

REPORTING BUGS

Report bugs to the LinuxCNC bug tracker ⟨URL: http://sf.net/p/emc/bugs/ ⟩.

COPYRIGHT

SEE ALSO

halcmd(1), **haltcl**(1)

NAME

halsampler − sample data from HAL in realtime

SYNOPSIS

halsampler [*options*]

DESCRIPTION

sampler(9) and **halsampler** are used together to sample HAL data in real time and store it in a file. **sampler** is a realtime HAL component that exports HAL pins and creates a FIFO in shared memory. It then begins sampling data from the HAL and storing it to the FIFO. **halsampler** is a user space program that copies data from the FIFO to stdout, where it can be redirected to a file or piped to some other program.

OPTIONS

−c *CHAN*

instructs **halsampler** to read from FIFO *CHAN*. FIFOs are numbered from zero, and the default value is zero, so this option is not needed unless multiple FIFOs have been created.

−n *COUNT*

instructs **halsampler** to read *COUNT* samples from the FIFO, then exit. If **−n** is not specified, **halsampler** will read continuously until it is killed.

−t instructs **halsampler** to tag each line by printing the sample number in the first column.

FILENAME

instructs **halsampler** to write to **FILENAME** instead of to stdout.

USAGE

A FIFO must first be created by loading **sampler**(9) with **halcmd loadrt** or a **loadrt** command in a .hal file. Then **halsampler** can be invoked to begin printing data from the FIFO to stdout.

Data is printed one line per sample. If **−t** was specified, the sample number is printed first. The data follows, in the order that the pins were defined in the config string. For example, if the **sampler** config string was "ffbs" then a typical line of output (without **−t**) would look like:

123.55 33.4 0 −12

halsampler prints data as fast as possible until the FIFO is empty, then it retries at regular intervals, until it is either killed or has printed *COUNT* samples as requested by **−n**. Usually, but not always, data printed by **halsampler** will be redirected to a file or piped to some other program.

The FIFO size should be chosen to absorb samples captured during any momentary disruptions in the flow of data, such as disk seeks, terminal scrolling, or the processing limitations of subsequent program in a pipeline. If the FIFO gets full and **sampler** is forced to overwrite old data, **halsampler** will print 'overrun' on a line by itself to mark each gap in the sampled data. If **−t** was specified, gaps in the sequential sample numbers in the first column can be used to determine exactly how many samples were lost.

The data format for **halsampler** output is the same as for **halstreamer**(1) input, so 'waveforms' captured with **halsampler** can be replayed using **halstreamer**. The **−t** option should not be used in this case.

EXIT STATUS

If a problem is encountered during initialization, **halsampler** prints a message to stderr and returns failure.

Upon printing *COUNT* samples (if **−n** was specified) it will shut down and return success. If it is terminated before printing the specified number of samples, it returns failure. This means that when **−n** is not specified, it will always return failure when terminated.

SEE ALSO

sampler(9) **streamer**(9) **halstreamer**(1)

HISTORY

BUGS

AUTHOR

Original version by John Kasunich, as part of the LinuxCNC project. Improvements by several other members of the LinuxCNC development team.

REPORTING BUGS

Report bugs to jmkasunich AT users DOT sourceforge DOT net

COPYRIGHT

NAME

halstreamer − stream file data into HAL in real time

SYNOPSIS

halstreamer [*options*]

DESCRIPTION

streamer(9) and **halstreamer** are used together to stream data from a file into the HAL in real time. **streamer** is a realtime HAL component that exports HAL pins and creates a FIFO in shared memory. **hal_streamer** is a user space program that copies data from stdin into the FIFO, so that **streamer** can write it to the HAL pins.

OPTIONS

−c *CHAN*

Instructs **halstreamer** to write to FIFO *CHAN*. FIFOs are numbered from zero, and the default value is zero, so this option is not needed unless multiple FIFOs have been created.

FILENAME

Instructs **halsampler** to read from *FILENAME* instead of from stdin.

USAGE

A FIFO must first be created by loading **streamer**(9) with **halcmd loadrt** or a **loadrt** command in a .hal file. Then **halstreamer** can be invoked to begin writing data into the FIFO.

Data is read from stdin, and is almost always either redirected from a file or piped from some other program, since keyboard input would be unable to keep up with even slow streaming rates.

Each line of input must match the pins that are attached to the FIFO, for example, if the **streamer** config string was "ffbs" then each line of input must consist of two floats, a bit, and a signed integer, in that order and separated by whitespace. Floats must be formatted as required by **strtod**(3), signed and unsigned integers must be formated as required by **strtol**(3) and **strtoul**(3), and bits must be either *0* or *1*.

Input lines that begin with # will be treated as comments and silently skipped.

halstreamer transfers data to the FIFO as fast as possible until the FIFO is full, then it retries at regular intervals, until it is either killed or reads EOF from stdin. Data can be redirected from a file or piped from some other program.

The FIFO size should be chosen to ride through any momentary disruptions in the flow of data, such as disk seeks. If the FIFO is big enough, **halstreamer** can be restarted with the same or a new file before the FIFO empties, resulting in a continuous stream of data.

The data format for **halstreamer** input is the same as for **halsampler**(1) output, so *waveforms* captured with **halsampler** can be replayed using **halstreamer**.

EXIT STATUS

If a problem is encountered during initialization, **halstreamer** prints a message to stderr and returns failure.

If a badly formatted line is encountered while writing to the FIFO, it prints a message to stderr, skips the line, and continues (this behavior may be revised in the future).

Upon reading EOF from the input, it returns success. If it is terminated before the input ends, it returns failure.

SEE ALSO

streamer(9) **sampler**(9) **halsampler**(1)

AUTHOR

Original version by John Kasunich, as part of the LinuxCNC project. Improvements by several other members of the LinuxCNC development team.

REPORTING BUGS

Report bugs to jmkasunich AT users DOT sourceforge DOT net

COPYRIGHT

NAME

haltcl − manipulate the LinuxCNC HAL from the command line using a tcl interpreter.

SYNOPSIS

haltcl [−*i inifile*] [*filename*]

DESCRIPTION

haltcl is used to manipulate the HAL (Hardware Abstraction Layer) from the command line using a tcl interpreter. **haltcl** can optionally read commands from a file (filename), allowing complex HAL configurations to be set up with a single command.

OPTIONS

−i *inifile*

If specified, the inifile is read and used to create tcl global variable arrays. An array is created for each SECTION of the inifile with elements for each ITEM in the section.

For example, if the inifile contains:
[SECTION_A]ITEM_1 = 1
[SECTION_A]ITEM_2 = 2
[SECTION_B]ITEM_1 = 10

The corresponding tcl variables are:
SECTION_A(ITEM_1) = 1
SECTION_A(ITEM_2) = 2
SECTION_B(ITEM_1) = 10

−ini *inifile* -- declining usage, use **−i** *inifile*

filename

If specified, the tcl commands of **filename** are executed. If no filename is specified, haltcl opens an interactive session.

COMMANDS

haltcl includes the commands of a tcl interpreter augmented with commands for the hal language as described for **halcmd**(1). The augmented commands can be listed with the command:

haltcl: hal −−commands

addf alias delf delsig getp gets ptype stype help linkpp linkps linksp list loadrt loadusr lock net newsig save setexact_for_test_suite_only setp sets show source start status stop unalias unlinkp unload unloadrt unloadusr unlock waitusr

Two of the augmented commands, 'list' and 'gets', require special treatment to avoid conflict with tcl built-in commands having the same names. To use these commands, precede them with the keyword 'hal':

hal list
hal gets

REPORTING BUGS

Report bugs to the LinuxCNC bug tracker ⟨URL: http://sf.net/p/emc/bugs/ ⟩.

COPYRIGHT

SEE ALSO

halcmd(1), **halrun**(1)

NAME

halui − observe HAL pins and command LinuxCNC through NML

SYNOPSIS

halui [**−ini <path-to-ini>**]

DESCRIPTION

halui is used to build a User Interface using hardware knobs and switches. It exports a big number of pins, and acts accordingly when these change.

OPTIONS

−ini name

use the *name* as the configuration file. Note: halui must find the nml file specified in the ini, usually that file is in the same folder as the ini, so it makes sense to run halui from that folder.

USAGE

When run, **halui** will export a large number of pins. A user can connect those to his physical knobs & switches & leds, and when a change is noticed halui triggers an appropriate event.

halui expects the signals to be debounced, so if needed (bad knob contact) connect the physical button to a HAL debounce filter first.

PINS

abort

halui.abort bit in
pin for clearing most errors

tool

halui.tool.length−offset.a float out
current applied tool length offset for the A axis

halui.tool.length−offset.b float out
current applied tool length offset for the B axis

halui.tool.length−offset.c float out
current applied tool length offset for the C axis

halui.tool.length−offset.u float out
current applied tool length offset for the U axis

halui.tool.length−offset.v float out
current applied tool length offset for the V axis

halui.tool.length−offset.w float out
current applied tool length offset for the W axis

halui.tool.length−offset.x float out
current applied tool length offset for the X axis

halui.tool.length−offset.y float out
current applied tool length offset for the Y axis

halui.tool.length−offset.z float out
current applied tool length offset for the Z axis

halui.tool.diameter float out
Current tool diameter, or 0 if no tool is loaded.

halui.tool.number u32 out
current selected tool

spindle

halui.spindle.N.brake−is−on bit out
status pin that tells us if brake is on

halui.spindle.N.brake−off bit in
pin for deactivating the spindle brake

halui.spindle.N.brake−on bit in
pin for activating the spindle brake

halui.spindle.N.decrease bit in
a rising edge on this pin decreases the current spindle speed by 100

halui.spindle.N.forward bit in
a rising edge on this pin makes the spindle go forward

halui.spindle.N.increase bit in
a rising edge on this pin increases the current spindle speed by 100

halui.spindle.N.is−on bit out
status pin telling if the spindle is on

halui.spindle.N.reverse bit in
a rising edge on this pin makes the spindle go reverse

halui.spindle.N.runs−backward bit out
status pin telling if the spindle is running backward

halui.spindle.N.runs−forward bit out
status pin telling if the spindle is running forward

halui.spindle.N.start bit in
a rising edge on this pin starts the spindle

halui.spindle.N.stop bit in
a rising edge on this pin stops the spindle

spindle override

halui.spindle.N.override.count−enable bit in (default: **TRUE**)
When TRUE, modify spindle override when counts changes.

halui.spindle.N.override.counts s32 in
counts X scale = spindle override percentage

halui.spindle.N.override.decrease bit in
pin for decreasing the SO (−=scale)

halui.spindle.N.override.direct−value bit in
pin to enable direct spindle override value input

halui.spindle.N.override.increase bit in
pin for increasing the SO (+=scale)

halui.spindle.N.override.scale float in
pin for setting the scale of counts for SO

halui.spindle.N.override.value float out
current FO value

program

halui.program.block−delete.is−on bit out
status pin telling that block delete is on

halui.program.block−delete.off bit in
pin for requesting that block delete is off

halui.program.block−delete.on bit in
pin for requesting that block delete is on

halui.program.is−idle bit out
status pin telling that no program is running

halui.program.is−paused bit out
status pin telling that a program is paused

halui.program.is−running bit out
status pin telling that a program is running

halui.program.optional−stop.is−on bit out
status pin telling that the optional stop is on

halui.program.optional−stop.off bit in
pin requesting that the optional stop is off

halui.program.optional−stop.on bit in
pin requesting that the optional stop is on

halui.program.pause bit in
pin for pausing a program

halui.program.resume bit in
pin for resuming a program

halui.program.run bit in
pin for running a program

halui.program.step bit in
pin for stepping in a program

halui.program.stop bit in
pin for stopping a program (note: this pin does the same thing as halui.abort)

mode

halui.mode.auto bit in
pin for requesting auto mode

halui.mode.is−auto bit out
pin for auto mode is on

halui.mode.is−joint bit out
pin showing joint by joint jog mode is on

halui.mode.is−manual bit out
pin for manual mode is on

halui.mode.is−mdi bit out
pin for mdi mode is on

halui.mode.is−teleop bit out
pin showing coordinated jog mode is on

halui.mode.joint bit in
pin for requesting joint by joint jog mode

halui.mode.manual bit in
pin for requesting manual mode

halui.mode.mdi bit in
pin for requesting mdi mode

halui.mode.teleop bit in
pin for requesting coordinated jog mode

mdi (optional)
halui.mdi−command−XX bit in
halui looks for ini variables named [HALUI]MDI_COMMAND, and exports a pin for each command it finds. When the pin is driven TRUE, **halui** runs the specified MDI command. XX is a two digit number starting at 00. If no [HALUI]MDI_COMMAND variables are set in the ini file, no halui.mdi−command−XX pins will be exported by halui.

mist
halui.mist.is−on bit out
pin for mist is on

halui.mist.off bit in
pin for stopping mist

halui.mist.on bit in
pin for starting mist

max−velocity
halui.max−velocity.count−enable bit in (default: **TRUE**)
When True, modify max velocity when halui.max−velocity.counts changes.

halui.max−velocity.counts s32 in
When .count−enable is True, halui changes the max velocity in response to changes to this pin. It's usually connected to an MPG encoder on an operator's panel or jog pendant. When .count−enable is False, halui ignores this pin.

halui.max−velocity.direct−value bit in
When this pin is True, halui commands the max velocity directly to (.counts * .scale). When this pin is False, halui commands the max velocity in a relative way: change max velocity by an amount equal to (change in .counts * .scale).

halui.max−velocity.increase bit in
A positive edge (a False to True transition) on this pin increases the max velocity by the value of the .scale pin. (Note that halui always responds to this pin, independent of the .count−enable pin.)

halui.max−velocity.decrease bit in
A positive edge (a False to True transition) on this pin decreases the max velocity by the value of the .scale pin. (Note that halui always responds to this pin, independent of the .count−enable pin.)

halui.max−velocity.scale float in
This pin controls the scale of changes to the max velocity. Each unit change in .counts, and each positive edge on .increase and .decrease, changes the max velocity by .scale. The units of the .scale pin are machine−units per second.

halui.max−velocity.value float out
Current value for maximum velocity, in machine−units per second.

machine
halui.machine.units−per−mm float out
pin for machine units−per−mm (inch:1/25.4, mm:1) according to inifile setting: [TRAJ]LINEAR_UNITS

halui.machine.is−on bit out
pin for machine is On/Off

halui.machine.off bit in
pin for setting machine Off

halui.machine.on bit in
pin for setting machine On

lube

halui.lube.is−on bit out
pin for lube is on

halui.lube.off bit in
pin for stopping lube

halui.lube.on bit in
pin for starting lube

joint (**N** = joint number (0 ... num_joints−1))

halui.joint.N.select bit in
pin for selecting joint N

halui.joint.N.is−selected bit out
status pin that joint N is selected

halui.joint.N.has−fault bit out
status pin telling that joint N has a fault

halui.joint.N.home bit in
pin for homing joint N

halui.joint.N.is−homed bit out
status pin telling that joint N is homed

halui.joint.N.on−hard−max−limit bit out
status pin telling that joint N is on the positive hardware limit

halui.joint.N.on−hard−min−limit bit out
status pin telling that joint N is on the negative hardware limit

halui.joint.N.on−soft−max−limit bit out
status pin telling that joint N is on the positive software limit

halui.joint.N.on−soft−min−limit bit out
status pin telling that joint N is on the negative software limit

halui.joint.N.override−limits bit out
status pin telling that joint N’s limits are temporarily overridden

halui.joint.N.unhome bit in
pin for unhoming joint N

halui.joint.selected u32 out
selected joint number (0 ... num_joints−1)

halui.joint.selected.has−fault bit out
status pin selected joint is faulted

halui.joint.selected.home bit in
pin for homing the selected joint

halui.joint.selected.is−homed bit out
status pin telling that the selected joint is homed

halui.joint.selected.on−hard−max−limit bit out
status pin telling that the selected joint is on the positive hardware limit

halui.joint.selected.on−hard−min−limit bit out
status pin telling that the selected joint is on the negative hardware limit

halui.joint.selected.on−soft−max−limit bit out
status pin telling that the selected joint is on the positive software limit

halui.joint.selected.on−soft−min−limit bit out
status pin telling that the selected joint is on the negative software limit

halui.joint.selected.override−limits bit out
status pin telling that the selected joint's limits are temporarily overridden

halui.joint.selected.unhome bit in
pin for unhoming the selected joint

joint jogging (**N** = joint number (0 ... num_joints−1))

halui.joint.jog−deadband float in pin for setting jog analog deadband (jog analog inputs smaller/slower than this (in absolute value) are ignored)

halui.joint.jog−speed float in
pin for setting jog speed for plus/minus jogging.

halui.joint.N.analog float in
pin for jogging the joint N using an float value (e.g. joystick). The value, typically set between 0.0 and ±1.0, is used as a jog−speed multiplier.

halui.joint.N.increment float in
pin for setting the jog increment for joint N when using increment−plus/minus

halui.joint.N.increment−minus bit in
a rising edge will will make joint N jog in the negative direction by the increment amount

halui.joint.N.increment−plus bit in
a rising edge will will make joint N jog in the positive direction by the increment amount

halui.joint.N.minus bit in
pin for jogging joint N in negative direction at the halui.joint.jog−speed velocity

halui.joint.N.plus bit in
pin for jogging joint N in positive direction at the halui.joint.jog−speed velocity

halui.joint.selected.increment float in
pin for setting the jog increment for the selected joint when using increment−plus/minus

halui.joint.selected.increment−minus bit in
a rising edge will will make the selected joint jog in the negative direction by the increment amount

halui.joint.selected.increment−plus bit in
a rising edge will will make the selected joint jog in the positive direction by the increment amount

halui.joint.selected.minus bit in
pin for jogging the selected joint in negative direction at the halui.joint.jog−speed velocity

halui.joint.selected.plus
pin for jogging the selected joint bit in in positive direction at the halui.joint.jog−speed velocity

axis (L = axis index (0:x 1:y 2:z 3:a 4:b 5:c 6:u 7:v 8:w))

halui.axis.L.select bit in
pin for selecting axis by index

halui.axis.L.is−selected bit out
status pin that axis L is selected

halui.axis.L.pos−commanded float out float out
Commanded axis position in machine coordinates

halui.axis.L.pos−feedback float out float out
Feedback axis position in machine coordinates

halui.axis.L.pos−relative float out float out
Commanded axis position in relative coordinates

axis jogging (**L** = axis index (0:x 1:y 2:z 3:a 4:b 5:c 6:u 7:v 8:w)

halui.axis.jog−deadband float in
pin for setting jog analog deadband (jog analog inputs smaller/slower than this (in absolute value) are ignored)

halui.axis.jog−speed float in
pin for setting jog speed for plus/minus jogging.

halui.axis.L.analog float in
pin for jogging the axis L using an float value (e.g. joystick). The value, typically set between 0.0 and ±1.0, is used as a jog−speed multiplier.

halui.axis.L.increment float in
pin for setting the jog increment for axis L when using increment−plus/minus

halui.axis.L.increment−minus bit in
a rising edge will will make axis L jog in the negative direction by the increment amount

halui.axis.L.increment−plus bit in
a rising edge will will make axis L jog in the positive direction by the increment amount

halui.axis.L.minus bit in
pin for jogging axis L in negative direction at the halui.axis.jog−speed velocity

halui.axis.L.plus bit in
pin for jogging axis L in positive direction at the halui.axis.jog−speed velocity

halui.axis.selected u32 out
selected axis (by index: 0:x 1:y 2:z 3:a 4:b 5:cr 6:u 7:v 8:w)

halui.axis.selected.increment float in
pin for setting the jog increment for the selected axis when using increment−plus/minus

halui.axis.selected.increment−minus bit in
a rising edge will will make the selected axis jog in the negative direction by the increment amount

halui.axis.selected.increment−plus bit in
a rising edge will will make the selected axis jog in the positive direction by the increment amount

halui.axis.selected.minus bit in
pin for jogging the selected axis in negative direction at the halui.axis.jog−speed velocity

halui.axis.selected.plus
pin for jogging the selected axis bit in in positive direction at the halui.axis.jog−speed velocity

flood

halui.flood.is−on bit out
pin for flood is on

halui.flood.off bit in
pin for stopping flood

halui.flood.on bit in
pin for starting flood

feed override

halui.feed−override.count−enable bit in (default: **TRUE**)
When TRUE, modify feed override when counts changes.

halui.feed−override.counts s32 in
counts X scale = feed override percentage

halui.feed−override.decrease bit in
pin for decreasing the FO (−=scale)

halui.feed−override.direct−value bit in
pin to enable direct value feed override input

halui.feed−override.increase bit in
pin for increasing the FO (+=scale)

halui.feed−override.scale float in
pin for setting the scale on changing the FO

halui.feed−override.value float out
current Feed Override value

rapid override

halui.rapid−override.count−enable bit in (default: **TRUE**)
When TRUE, modify Rapid Override when counts changes.

halui.rapid−override.counts s32 in
counts X scale = Rapid Override percentage

halui.rapid−override.decrease bit in
pin for decreasing the Rapid Override (−=scale)

halui.rapid−override.direct−value bit in
pin to enable direct value Rapid Override input

halui.rapid−override.increase bit in
pin for increasing the Rapid Override (+=scale)

halui.rapid−override.scale float in
pin for setting the scale on changing the Rapid Override

halui.rapid−override.value float out
current Rapid Override value

estop

halui.estop.activate bit in
pin for setting Estop (LinuxCNC internal) On

halui.estop.is−activated bit out
pin for displaying Estop state (LinuxCNC internal) On/Off

halui.estop.reset bit in
pin for resetting Estop (LinuxCNC internal) Off

home

halui.home−all bit in

pin for requesting home-all (only available when a valid homing sequence is specified)

SEE ALSO

HISTORY

BUGS

none known at this time.

AUTHOR

Written by Alex Joni, as part of the LinuxCNC project. Updated by John Thornton

REPORTING BUGS

Report bugs to alex_joni AT users DOT sourceforge DOT net

COPYRIGHT

NAME

hy_gt_vfd − HAL userspace component for Huanyang GT−series VFDs

SYNOPSIS

hy_gt_vfd [*OPTIONS*]

DESCRIPTION

The hy_gt_vfd component interfaces a Huanyang GT−series VFD to the LinuxCNC HAL. The VFD is connected via RS−485 serial to the LinuxCNC computer.

HARDWARE SETUP

At least some Huanyang GT VFDs must be physically modified to enable Modbus communication.

The circuit board location marked "SW1" is identified in the manual as "Switch of terminal resistor for RS485 communication". On the only VFD I have experience with, the circuit board contained no switch at that location, instead holding a pair of crossed jumper wires (top−left pad connected to bottom−right pad, top−right to bottom−left). In this configuration, no Modbus communication is possible. We had to desolder the two crossed jumper wires and re−solder them parallel to each other (top−left to bottom−left, top−right to bottom−right).

FIRMWARE SETUP

The Huanyang GT VFD must be configure via the faceplate to talk Modbus with LinuxCNC. Consult the Operation section of the Huanyang GT−series Inverter Manual for details. Set the following parameters:

P0.01 = 2
: Set Run Command Source to Modbus serial port.

P0.03
: Set Maximum Frequency to the maximum frequency you want the VFD to output, in Hz.

P0.04
: Set Upper Frequence Limit to the maximum frequency you want the VFD to output, in Hz. This should be the same as the value in P0.03.

P0.05
: Set Lower Frequency Limit to the minimum frequency you want the VFD to output, in Hz.

P0.07 = 7
: Set Frequency A Command Source to Modbus serial port.

P2.01 = ???
: Set Motor Rated Power to the motor’s power rating in kW.

P2.02 = ???
: Set Motor Rated Frequency to the motor’s max frequency in Hz.

P2.03 = ???
: Set Motor Rated Speed to the motor’s speed in RPM at its rated maximum frequence.

P2.04 = ???
: Set Motor Rated Voltage to the motor’s maximum voltage, in Volts.

P2.05 = ???
: Set Motor Rated Current to the motor’s maximum current, in Amps.

PC.00 = 1
: Set Local Address to 1. This matches the default in the hy_gt_vfd driver, change this if your setup has special needs.

PC.01 = 5
: Set Baud Rate Selection to 5 (38400 bps). This matches the default in the hy_gt_vfd driver, change this if your setup has special needs.

  0 = 1200

1 = 2400
2 = 4800
3 = 9600
4 = 19200
5 = 38400

PC.02 = 0
Set Data Format (8n1 RTU). This matches the default in the hy_gt_vfd driver, change this if your setup has special needs.

PC.03 = 1
Set Communication Delay Time to 1 ms. This is expected by the hy_gt_vfd driver.

OPTIONS

−b, **−−bits** *N*
(default 8) For Modbus communication. Set number of data bits to *N*. *N* must be between 5 and 8 inclusive.

−p, **−−parity** [Even,Odd,None]

(default None) For Modbus communication. Set serial parity to Even, Odd, or None.

−r, **−−rate** *N*
(default 38400) For Modbus communication. Set baud rate to *N*. It is an error if the rate is not one of the following: 1200, 2400, 4800, 9600, 19200, 38400

−s, **−−stopbits** [1,2]
(default 1) For Modbus communication. Set serial stop bits to 1 or 2.

−t, **−−target** *N*
(default 1) For Modbus communication. Set Modbus target (slave) number. This must match the device number you set on the Huanyang GT VFD.

−d, **−−device** *PATH*
(default /dev/ttyS0) For Modbus communication. Set the name of the serial device node to use.

−v, **−−verbose**
Turn on verbose mode.

−S, **−−motor−max−speed** *RPM*
The motor's max speed in RPM. This must match the motor speed value configured in VFD register P2.03.

−F, **−−max−frequency** *HZ*
This is the maximum output frequency of the VFD in Hz. It should correspond to the motor's rated max frequency, and to the maximum and upper limit output frequency configured in VFD register P0.03 and P0.04.

−f, **−−min−frequency** *HZ*
This is the minimum output frequency of the VFD in Hz. It should correspond to the minimum output frequency configured in VFD register P0.05.

PINS

hy_gt_vfd.period (float, in)
The period for the driver's update cycle, in seconds. This is how frequently the driver will wake up, check its HAL pins, and communicate with the VFD. Must be between 0.001 and 2.000 seconds. Default: 0.1 seconds.

hy_gt_vfd.speed−cmd (float, in)
The requested motor speed, in RPM.

hy_gt_vfd.speed−fb (float, out)

The motor's current speed, in RPM, reported by the VFD.

hy_gt_vfd.at−speed (bit, out)
True when the drive is on and at the commanded speed (within 2%), False otherwise.

hy_gt_vfd.freq−cmd (float, out)
The requested output frequency, in Hz. This is set from the .speed−cmd value, and is just shown for debugging purposes.

hy_gt_vfd.freq−fb (float, out)
The current output frequency of the VFD, in Hz. This is reported from the VFD to the driver.

hy_gt_vfd.spindle−on (bit, in)
Set this pin True to command the spindle on, at the speed requested on the .speed−cmd pin. Set this pin False to command the spindle off.

hy_gt_vfd.output−voltage (float, out)
The voltage that the VFD is current providing to the motor, in Volts.

hy_gt_vfd.output−current (float, out)
The current that the motor is currently drawing from the VFD, in Amperes.

hy_gt_vfd.output−power (float, out)
The power that the motor is currently drawing from the VFD, in Watts.

hy_gt_vfd.dc−bus−volts (float, out)
The current voltage of the VFD's internal DC power supply, in Volts.

hy_gt_vfd.modbus−errors (u32, out)
A count of the number of modbus communication errors between the driver and the VFD. The driver is resilient against communication errors, but a large or growing number here indicates a problem that should be investigated.

hy_gt_vfd.input−terminal (float, out)
The VFD's input terminal register.

hy_gt_vfd.output−terminal (float, out)
The VFD's output terminal register.

hy_gt_vfd.AI1 (float, out)
The VFD's AI1 register.

hy_gt_vfd.AI2 (float, out)
The VFD's AI2 register.

hy_gt_vfd.HDI−frequency (float, out)
The VFD's HDI−frequency register.

hy_gt_vfd.external−counter (float, out)
The VFD's external counter register.

hy_gt_vfd.fault−info (float, out)
The VFD's fault info register.

ISSUES

The VFD produces the output frequency that it sends to the motor by adding a manually specified offset to the frequency command it gets over modbus.

The manual offset is controlled by pressing the Up/Down arrows on the faceplate while the VFD is turning the motor.

If you command a speed on the .speed−cmd pin and get a different speed reported on the .speed−fb pin, first verify that the VFD registers listed in the FIRMWARE SETUP section above and the driver's command−line arguments all agree with the info on the motor's name plate. If you still aren't getting the speed you expect, zero the VFD's frequency offset by starting the motor running, then pressing the

Up/Down buttons to zero the offset.

NAME

hy_vfd − HAL userspace component for Huanyang VFDs

SYNOPSIS

hy_vfd [OPTIONS]

DESCRIPTION

This component connects the Huanyang VFD to the LinuxCNC HAL via a serial (RS-485) connection.

The Huanyang VFD must be configured via the face plate user interface to accept serial communications:

PD001 = 2
: Set register PD001 (source of run commands) to 2 (communication port).

PD002 = 2
: Set register PD002 (source of operating frequency) to 2 (communication port).

PD004
: Set register PD004 (Base Frequency) according to motor specs. This is the rated frequency of the motor from the motor's name plate, in Hz.

PD005
: Set register PD005 (max frequency) according to motor specs. This is the maximum frequency of the motor's power supply, in Hz.

PD011
: Set register PD011 (min frequency) according to motor specs. This is the minimum frequency of the motor's power supply, in Hz.

PD141
: Set register PD141 (rated motor voltage) according to motor name plate. This is the motor's maximum voltage, in Volts.

PD142
: Set register PD142 (rated motor current) according to motor name plate. This is the motor's maximum current, in Amps.

PD143
: Set register PD143 (Number of Motor Poles) according to motor name plate.

PD144
: Set register PD144 (rated motor revolutions) according to motor name plate. This is the motor's speed in RPM at 50 Hz. Note: This is not the motor's max speed (unless the max motor frequency happens to be 50 Hz)!

PD163 = 1
: Set register PD163 (communication address) to 1. This matches the default in the hy_vfd driver, change this if your setup has special needs.

PD164 = 2
: Set register PD164 (baud rate) to 2 (19200 bps). This matches the default in the hy_vfd driver, change this if your setup has special needs.

PD165 = 3
: Set register PD165 (communication data method) to 3 (8n1 RTU). This matches the default in the hy_vfd driver, change this if your setup has special needs. Note that the hy_vfd driver only supports RTU communication, not ASCII.

Consult the Huanyang instruction manual for details on using the face plate to program the VFDs registers, and alternative values for the above registers.

OPTIONS

−d, −−device <path>
(default /dev/ttyS0) Set the name of the serial device node to use.

−g, −−debug
Turn on debug messages. Note that if there are serial errors, this may become annoying. Debug mode will cause all serial communication messages to be printed in hex on the terminal.

−n, −−name <string>
(default hy_vfd) Set the name of the HAL module. The HAL comp name will be set to <string>, and all pin and parameter names will begin with <string>.

−b, −−bits <n>
(default 8) Set number of data bits to <n>, where n must be from 5 to 8 inclusive. This must match the setting in register PD165 of the Huanyang VFD.

−p, −−parity [even,odd,none]
(default odd) Set serial parity to even, odd, or none. This must match the setting in register PD165 of the Huanyang VFD.

−r, −−rate <n>
(default 38400) Set baud rate to <n>. It is an error if the rate is not one of the following: 110, 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200. This must match the setting in register PD164 of the Huanyang VFD.

−s, −−stopbits [1,2]
(default 1) Set serial stop bits to 1 or 2. This must match the setting in register PD165 of the HuanyangVFD.

−t, −−target <n>
(default 1) Set HYCOMM target (slave) number. This must match the device number you set on the Hyanyang VFD in register PD163.

−F, −−max−frequency <n>
(default: read from VFD) If specified, program register PD005 of the VFD with the specified max frequency of <n> Hz (and use the same max frequency in the hy_vfd driver). If not specified, read the max frequency to use from register PD005 of the VFD.

−f, −−min−frequency <n>
(default: read from VFD) If specified, program register PD011 of the VFD with the specified minimum frequency of <n> Hz (and use the same minimum frequency in the hy_vfd driver). If not specified, read the minimum frequency to use from register PD011 of the VFD.

−V, −−motor−voltage <n>
(default: read from VFD) If specified, program register PD141 of the VFD with the specified max motor voltage of <n> Volts. If not specified, read the max motor voltage from register PD141 of the VFD.

−I, −−motor−current <n>
(default: read from VFD) If specified, program register PD142 of the VFD with the specified max motor current of <n> Amps. If not specified, read the max motor current from register PD142 of the VFD.

−S, −−motor−speed <n>
(default: compute from value read from VFD P144) This command-line argument is the motor's max speed. If specified, compute the motor's speed at 50 Hz from this argument and from the motor's max frequency (from the −−max−frequency argument or from P011 if −−max−frequency is not specified) and program register PD144 of the VFD. If not specified, read the motor's speed at 50 Hz from register P144 of the VFD, and use that and the max frequency to compute the motor's max speed.

−P, −−motor−poles <n>
(default: read value from VFD P143) This command-line argument is the number of poles in the motor. If specified, this value is sent to the VFD's register PD143. If not specified, the value is read from PD143 and reported on the corresponding HAL pin.

PINS

<name>.enable
(bit, in) Enable communication from the hy_vfd driver to the VFD.

<name>.SetF
(float, out)

<name>.OutF
(float, out)

<name>.OutA
(float, out)

<name>.Rott
(float, out)

<name>.DCV
(float, out)

<name>.ACV
(float, out)

<name>.Cont
(float, out)

<name>.Tmp
(float, out)

<name>.spindle−forward
(bit, in)

<name>.spindle−reverse
(bin, in)

<name>.spindle−on
(bin, in)

<name>.CNTR
(float, out)

<name>.CNST
(float, out)

<name>.CNST−run
(bit, out)

<name>.CNST−jog
(bit, out)

<name>.CNST−command−rf
(bit, out)

<name>.CNST−running
(bit, out)

<name>.CNST−jogging
(bit, out)

<name>.CNST−running−rf
(bit, out)

<name>.CNST−bracking
(bit, out)

<name>.CNST−track−start
(bit, out)

<name>.speed−command
(float, in)

<name>.spindle−speed−fb
(float, out) Current spindle speed as reported by Huanyang VFD.

<name>.spindle−at−speed−tolerance
(float, in) Spindle speed error tolerance. If the actual spindle speed is within .spindle−at−speed−tolerance of the commanded speed, then the .spindle−at−speed pin will go True. The default .spindle−at−speed−tolerance is 0.02, which means the actual speed must be within 2% of the commanded spindle speed.

<name>.spindle−at−speed
(bit, out) True when the current spindle speed is within .spindle−at−speed−tolerance of the commanded speed.

<name>.frequency−command
(float, out)

<name>.max−freq
(float, out)

<name>.base−freq
(float, out)

<name>.freq−lower−limit
(float, out)

<name>.rated−motor−voltage
(float, out)

<name>.rated−motor−current
(float, out)

<name>.rated−motor−rev
(float, out)

<name>.motor−poles
(u32, out)

<name>.hycomm−ok
(bit, out)

PARAMETERS

<name>.error−count
(s32, RW)

<name>.retval
(float, RW)

AUTHOR

Sebastian Kuzminsky

LICENSE

GPL

NAME

iocontrol − accepts NML I/O commands, interacts with HAL in userspace

SYNOPSIS

loadusr io [−ini *inifile***]**

DESCRIPTION

These pins are created by the userspace IO controller, usually found in $LINUXCNC_HOME/bin/io

The signals are turned on and off in userspace - if you have strict timing requirements or simply need more i/o, consider using the realtime synchronized i/o provided by **motion**(9) instead.

The inifile is searched for in the directory from which halcmd was run, unless an absolute path is specified.

PINS

iocontrol.0.coolant−flood
(Bit, Out) TRUE when flood coolant is requested

iocontrol.0.coolant−mist
(Bit, Out) TRUE when mist coolant is requested

iocontrol.0.emc−enable−in
(Bit, In) Should be driven FALSE when an external estop condition exists.

iocontrol.0.lube
(Bit, Out) TRUE when lube is requested. This pin gets driven True when the controller comes out of E-stop, and when the "Lube On" command gets sent to the controller. It gets driven False when the controller goes into E-stop, and when the "Lube Off" command gets sent to the controller.

iocontrol.0.lube_level
(Bit, In) Should be driven FALSE when lubrication tank is empty.

iocontrol.0.tool−change
(Bit, Out) TRUE when a tool change is requested

iocontrol.0.tool−changed
(Bit, In) Should be driven TRUE when a tool change is completed.

iocontrol.0.tool−number
(s32, Out) Current tool number

iocontrol.0.tool−prep−number
(s32, Out) The number of the next tool, from the RS274NGC T-word

iocontrol.0.tool−prep−pocket
(s32, Out) This is the pocket number (location in the tool storage mechanism) of the tool requested by the most recent T-word.

iocontrol.0.tool−prepare
(Bit, Out) TRUE when a T*n* tool prepare is requested

iocontrol.0.tool−prepared
(Bit, In) Should be driven TRUE when a tool prepare is completed.

iocontrol.0.user−enable−out
(Bit, Out) FALSE when an internal estop condition exists

iocontrol.0.user−request−enable
(Bit, Out) TRUE when the user has requested that estop be cleared

PARAMETERS

iocontrol.0.tool−prep−index
(s32, RO) IO's internal array index of the prepped tool requested by the most recent T-word. 0 if no tool is prepped. On Random toolchanger machines this is tool's pocket number (ie, the same as the tool−prep−pocket pin), on Non-random toolchanger machines this is a small integer corresponding to the tool's location in the internal representation of the tool table. This parameter returns to 0 after a successful tool change (M6).

SEE ALSO

motion(9)

NAME

linuxcncrsh − text-mode interface for commanding LinuxCNC over the network

SYNOPSIS

linuxcncrsh [OPTIONS] [−− LINUXCNC_OPTIONS]

DESCRIPTION

linuxcncrsh is a user interface for LinuxCNC. Instead of popping up a GUI window like axis(1) and touchy(1) do, it processes text-mode commands that it receives via the network. A human (or a program) can interface with **linuxcncrsh** using telnet(1) or nc(1) or similar programs.

All features of LinuxCNC are available via the **linuxcncrsh** interface.

OPTIONS

−p,−−port PORT_NUMBER
Specify the port for linuxcncrsh to listen on. Defaults to 5007 if omitted.

−n,−−name SERVER_NAME
Sets the server name that linuxcncrsh will use to identify itself during handshaking with a new client. Defaults to EMCNETSVR if omitted.

−w,−−connectpw PASSWORD
Specify the connection password to use during handshaking with a new client. Note that the password is sent in the clear, so it can be read by anyone who can read packets on the network between the server and the client. Defaults to EMC if omitted.

−e,−−enablepw PASSWORD
Specify the password required to enable LinuxCNC via linuxcncrsh. Note that the password is sent in the clear, so it can be read by anyone who can read packets on the network between the server and the client. Defaults to EMCTOO if omitted.

−s,−−sessions MAX_SESSIONS
Specify the maximum number of simultaneous connections. Defaults to −1 (no limit) if not specified.

In addition to the options listed above, linuxcncrsh accepts an optional special LINUXCNC_OPTION at the end:

−ini LINUXCNC_INI_FILE
LinuxCNC .ini file to use. The −ini option **must** be preceded by two dashes: "−−". Defaults to emc.ini if omitted.

Starting linuxcncrsh

To use linuxcncrsh instead of a normal LinuxCNC GUI like axis or touch, specify it in your .ini file like this:

[DISPLAY]

DISPLAY=linuxcncrsh

To use linuxcncrsh in addition to a normal GUI, you can either start it at the end of your .hal file, or run it by hand in a terminal window.

To start it from hal, add a line like this to the end of your .hal file:

loadusr linuxcncrsh [OPTIONS] [−− LINUXCNC_OPTIONS]

To start it from the terminal, run linuxcncrsh manually like this:

linuxcncrsh [OPTIONS] [−− LINUXCNC_OPTIONS]

Connecting

Once LinuxCNC is up and linuxcncrsh is running, you can connect to it using **telnet** or **nc** or similar:

telnet HOST PORT
HOST is the hostname or IP address of the computer running linuxcncrsh, and PORT is

the port it's listening on (5007 if you did not give linuxcncrsh the −−port option).

Network protocol

linuxcncrsh accepts TCP connections on the port specified by the −−port option, or 5007 if not specified.

The client sends requests, and the linuxcncrsh server returns replies. Requests consist of a command word followed by optional command-specific parameters. Requests and most request parameters are case insensitive. The exceptions are passwords, file paths and text strings.

Requests to linuxcncrsh are terminated with line endings, any combination of one or more '\r' and '\n' characters. Replies from linuxcncrsh are terminated with the sequence ´\r\n´.

The supported commands are as follows:

hello <password> <client> <version>

<password> must match linuxcncrsh's connect password, or "EMC" if no −−connectpw was supplied. The three arguments may not contain whitespace. If a valid password was entered the server will respond with:

HELLO ACK <ServerName> <ServerVersion>

If an invalid password or any other syntax error occurs then the server responds with:

HELLO NAK

get <subcommand> [<parameters>]

The get command takes one of the LinuxCNC sub-commands (described in the section **LinuxCNC Subcommands**, below) and zero or more additional subcommand-specific parameters.

set <subcommand> <parameters>

The set command takes one of the LinuxCNC sub-commands (described in the section **LinuxCNC Subcommands**, below) and one or more additional parameters.

quit

The quit command disconnects the associated socket connection.

shutdown

The shutdown command tells LinuxCNC to shutdown and disconnect the session. This command may only be issued if the Hello has been successfully negotiated and the connection has control of the CNC (see **enable** subcommand in the **LinuxCNC Subcommands** section, below).

help

The help command will return help information in text format over the connection. If no parameters are specified, it will itemize the available commands. If a command is specified, it will provide usage information for the specified command. Help will respond regardless of whether a "Hello" has been successsfully negotiated.

LinuxCNC Subcommands

Subcommands for **get** and **set** are:

echo {on|off}

With get, any on/off parameter is ignored and the current echo state is returned. With set, sets the echo state as specified. Echo defaults to on when the connection is first established. When echo is on, all commands will be echoed upon receipt. This state is local to each connection.

verbose {on|off}

With get, any on/off parameter is ignored and the current verbose state is returned. With set, sets the verbose state as specified. When verbose mode is on, all set commands return positive acknowledgement in the form SET <COMMAND> ACK, and text error messages will be issued (FIXME: I don't know what this means). The verbose state is local to each connection, and starts out OFF on new connections.

enable {<passwd>|off}

The session's enable state indicates whether the current connection is enabled to perform control functions. With get, any parameter is ignored, and the current enable state is returned. With set and a valid password matching linuxcncrsh's −−enablepw (EMCTOO if not specified), the current connection is enabled for control functions. "OFF" may not be used as a password and disables control functions for this connection.

config [TBD]
Unused, ignore for now.

comm_mode {ascii|binary}
With get, any parameter is ignored and the current communications mode is returned. With set, will set the communications mode to the specified mode. The ascii mode is the text request/reply mode, the binary protocol is not currently designed or implemented.

comm_prot <version>
With get, any parameter is ignored and the current protocol version used by the server is returned. With set, sets the server to use the specified protocol version, provided it is lower than or equal to the highest version number supported by the server implementation.

inifile
Not currently implemented! With get, returns the string "emc.ini". Should return the full path and file name of the current configuration inifile. Setting this does nothing.

plat
With get, returns the string "Linux".

ini <var> <section>
Not currently implemented, do not use! Should return the string value of <var> in section <section> of the ini file.

debug <value>
With get, any parameter is ignored and the current integer value of EMC_DEBUG is returned. Note that the value of EMC_DEBUG returned is the from the UI's ini file, which may be different than emc's ini file. With set, sends a command to the EMC to set the new debug level, and sets the EMC_DEBUG global here to the same value. This will make the two values the same, since they really ought to be the same.

set_wait {received|done}
The set_wait setting controls the wait after receiving a command. It can be "received" (after the command was sent and received) or "done" (after the command was done). With get, any parameter is ignored and the current set_wait setting is returned. With set, set the set_wait setting to the specified value.

wait {received|done}
With set, force a wait for the previous command to be received, or done.

set_timeout <timeout>
With set, set the timeout for commands to return to <timeout> seconds. Timeout is a real number. If it's <= 0.0, it means wait forever. Default is 0.0, wait forever.

update {none|auto}
The update mode controls whether to return fresh or stale values for "get" requests. When the update mode is "none" it returns stale values, when it's "auto" it returns fresh values. Defaults to "auto" for new connections. Set this to "none" if you like to be confused.

error
With get, returns the current error string, or "ok" if no error.

operator_display
With get, returns the current operator display string, or "ok" if none.

operator_text
With get, returns the current operator text string, or "ok" if none.

time
With get, returns the time, in seconds, from the start of the epoch. This starting time depends on the platform.

estop {on|off}
With get, ignores any parameters and returns the current estop setting as "on" or "off". With set, sets the estop as specified. Estop "on" means the machine is in the estop state and won't run.

machine {on|off}
With get, ignores any parameters and returns the current machine power setting as "on" or "off". With set, sets the machine on or off as specified.

mode {manual|auto|mdi}
With get, ignores any parameters and returns the current machine mode. With set, sets the machine mode as specified.

mist {on|off}
With get, ignores any parameters and returns the current mist coolant setting. With set, sets the mist setting as specified.

flood {on|off}
With get, ignores any parameters and returns the current flood coolant setting. With set, sets the flood setting as specified.

lube {on|off}
With get, ignores any parameters and returns the current lube pump setting. With set, sets the lube pump setting as specified.

lube_level
With get, returns the lubricant level sensor reading as "ok" or "low". With set, mocks you for wishful thinking.

spindle {forward|reverse|increase|decrease|constant|off}
With get, any parameter is ignored and the current spindle state is returned as "forward", "reverse", "increase", "decrease", or "off". With set, sets the spindle as specified. Note that "increase" and "decrease" will cause a speed change in the corresponding direction until a "constant" command is sent.

brake {on|off}
With get, any parameter is ignored and the current brake setting is returned. With set, the brake is set as specified.

tool
With get, returns the id of the currently loaded tool.

tool_offset
With get, returns the currently applied tool length offset.

load_tool_table <file>
With set, loads the tool table specified by <file>.

home {0|1|2|...} | -1
With set, homes the indicated joint or if -1, Home All joints

jog_stop joint_number|axis_letter
With set, stop any in-progress jog on the specified joint or axis. If TELEOP_ENABLE is NO, use joint_number; If TELEOP_ENABLE is YES, use axis_letter.

jog joint_number|axis_letter <speed>
With set, jog the specified joint or axis at <speed>; sign of speed is direction. If TELEOP_ENABLE is NO, use joint_number; If TELEOP_ENABLE is YES, use axis_letter.

jog_incr jog_number|axis_letter <speed> <incr>
With set, jog the indicated joint or axis by increment <incr> at the <speed>; sign of speed is

direction. If TELEOP_ENABLE is NO, use joint_number; If TELEOP_ENABLE is YES, use axis_letter.

feed_override <percent>
With get, any parameter is ignored and the current feed override is returns (as a percentage of commanded feed). With set, sets the feed override as specified.

spindle_override <percent>
With get, any parameter is ignored and the current spindle override is returned (as a percentage of commanded speed). With set, sets the spindle override as specified.

abs_cmd_pos [{0|1|...}]
With get, returns the specified axis' commanded position in absolute coordinates. If no axis is specified, returns all axes' commanded absolute position.

abs_act_pos [{0|1|...}]
With get, returns the specified axis' actual position in absolute coordinates. If no axis is specified, returns all axes' actual absolute position.

rel_cmd_pos [{0|1|...}]
With get, returns the specified axis' commanded position in relative coordinates, including tool length offset. If no axis is specified, returns all axes' commanded relative position.

rel_act_pos [{0|1|...}]
With get, returns the specified axis' actual position in relative coordinates, including tool length offset. If no axis is specified, returns all axes' actual relative position.

joint_pos [{0|1|...}]
With get, returns the specified joint's actual position in absolute coordinates, excluding tool length offset. If no joint is specified, returns all joints' actual absolute position.

pos_offset [{X|Y|Z|R|P|W}]
With get, returns the position offset associated with the world coordinate provided.

joint_limit [{0|1|...}]
With get, returns limit status of the specified joint as "ok", "minsoft", "minhard", "maxsoft", or "maxhard". If no joint number is specified, returns the limit status of all joints.

joint_fault [{0|1|...}]
With get, returns the fault status of the specified joint as "ok" or "fault". If no joint number is specified, returns the fault status of all joints.

joint_homed [{0|1|...}]
With get, returns the homed status of the specified joint as "homed" or "not". If no joint number is specified, returns the homed status of all joints.

mdi <string>
With set, sends <string> as an MDI command.

task_plan_init
With set, initializes the program interpreter.

open <filename>
With set, opens the named file. The <filename> is opened by linuxcnc, so it should either be an absolute path or a relative path starting in the linuxcnc working directory (the directory of the active .ini file).

run [<StartLine>]
With set, runs the opened program. If no StartLine is specified, runs from the beginning. If a StartLine is specified, start line, runs from that line. A start line of −1 runs in verify mode.

pause
With set, pause program execution.

resume

With set, resume program execution.

abort
With set, abort program or MDI execution.

step
With set, step the program one line.

program
With get, returns the name of the currently opened program, or "none".

program_line
With get, returns the currently executing line of the program.

program_status
With get, returns "idle", "running", or "paused".

program_codes
With get, returns the string for the currently active program codes.

joint_type [<joint>]
With get, returns "linear", "angular", or "custom" for the type of the specified joint (or for all joints if none is specified).

joint_units [<joint>]
With get, returns "inch", "mm", "cm", or "deg", "rad", "grad", or "custom", for the corresponding native units of the specified joint (or for all joints if none is specified). The type of the axis (linear or angular) is used to resolve which type of units are returned. The units are obtained heuristically, based on the EMC_AXIS_STAT::units numerical value of user units per mm or deg. For linear joints, something close to 0.03937 is deemed "inch", 1.000 is "mm", 0.1 is "cm", otherwise it's "custom". For angular joints, something close to 1.000 is deemed "deg", PI/180 is "rad", 100/90 is "grad", otherwise it's "custom".

program_units
Synonym for program_linear_units.

program_linear_units
With get, returns "inch", "mm", "cm", or "none", for the corresponding linear units that are active in the program interpreter.

program_angular_units
With get, returns "deg", "rad", "grad", or "none" for the corresponding angular units that are active in the program interpreter.

user_linear_units
With get, returns "inch", "mm", "cm", or "custom", for the corresponding native user linear units of the LinuxCNC trajectory level. This is obtained heuristically, based on the EMC_TRAJ_STAT::linearUnits numerical value of user units per mm. Something close to 0.03937 is deemed "inch", 1.000 is "mm", 0.1 is "cm", otherwise it's "custom".

user_angular_units
Returns "deg", "rad", "grad", or "custom" for the corresponding native user angular units of the LinuxCNC trajectory level. Like with linear units, this is obtained heuristically.

display_linear_units
With get, returns "inch", "mm", "cm", or "custom", for the linear units that are active in the display. This is effectively the value of linearUnitConversion.

display_angular_units
With get, returns "deg", "rad", "grad", or "custom", for the angular units that are active in the display. This is effectively the value of angularUnitConversion.

linear_unit_conversion {inch|mm|cm|auto}
With get, any parameter is ignored and the active unit conversion is returned. With set, sets the

unit to be displayed. If it's "auto", the units to be displayed match the program units.

angular_unit_conversion {deg|rad|grad|auto}
With get, any parameter is ignored and the active unit conversion is returned. With set, sets the units to be displayed. If it's "auto", the units to be displayed match the program units.

probe_clear
With set, clear the probe tripped flag.

probe_tripped
With get, return the probe state - has the probe tripped since the last clear?

probe_value
With get, return the current value of the probe signal.

probe
With set, move toward a certain location. If the probe is tripped on the way stop motion, record the position and raise the probe tripped flag.

teleop_enable [on|off]
With get, any parameter is ignored and the current teleop mode is returned. With set, sets the teleop mode as specified.

kinematics_type
With get, returns the type of kinematics functions used (identity=1, serial=2, parallel=3, custom=4).

override_limits {on|off}
With get, any parameter is ignored and the override_limits setting is returned. With set, the override_limits parameter is set as specified. If override_limits is on, disables end of travel hardware limits to allow jogging off of a limit. If parameters is off, then hardware limits are enabled.

optional_stop {0|1}
With get, any parameter is ignored and the current "optional stop on M1" setting is returned. With set, the setting is set as specified.

Example Session

This section shows an example session to the local machine (**localhost**). Bold items are typed by you, non-bold is machine output. Default values are shown for --port PORT_NUMBER (**5007**), --conectpw PASSWORD (**EMC**), and --enablepw PASSWORD (**EMCTOO**).

The user connects to linuxcncrsh, handshakes with the server (hello), enables machine commanding from this session (set enable), brings the machine out of estop (set estop off) and turns it on (set machine on), homes all the axes, switches the machine to mdi mode, sends an MDI g-code command, then disconnects and shuts down LinuxCNC.

> **telnet localhost 5007**
Trying 127.0.0.1...
Connected to 127.0.0.1
Escape character is '^]'.
hello EMC user-typing-at-telnet 1.0
HELLO ACK EMCNETSVR 1.1
set enable EMCTOO
set enable EMCTOO
set mode manual
set mode manual
set estop off
set estop off
set machine on
set machine on
set home 0

set home 0
set home 1
set home 1
set home 2
set home 2
set mode mdi
set mode mdi
set mdi g0x1
set mdi g0x1
help
help
Available commands:
  Hello <password> <client name> <protocol version>
  Get <emc command>
  Set <emc command>
  Shutdown
  Help <command>
help get
help get
Usage: Get <emc command>
  Get commands require that a hello has been successfully negotiated.
  Emc command may be one of:
    Abs_act_pos
    Abs_cmd_pos
 ...
shutdown
shutdown
Connection closed by foreign host.

NAME

mb2hal - HAL userspace component for Modbus

SYNOPSIS

mb2hal [OPTIONS]

DESCRIPTION

MB2HAL is a generic userspace HAL component to communicate with one or more Modbus devices.

See the Documents for more information on mb2hal

AUTHOR

John Thornton

LICENSE

GPL

NAME

milltask − Userspace task controller for LinuxCNC

DESCRIPTION

milltask is an internal process of LinuxCNC. It is generally not invoked directly but by an inifile setting: **[TASK]TASK=milltask**. The **milltask** process creates the **ini.*** hal pins listed below and owned by the **inihal** user component. These pins may be modified while LinuxCnC is running to alter values that are typically specified in an inifile.

The **inihal** pins are sampled in every task cycle, however, commands affected by their values typically use the value present at the time when the command is processed. Such commands include all codes handled by the interpreter (**Gcode** programs and **MDI** commands) and NML **jogging** commands issued by a GUI (including **halui**). **Wheel jogging** is implemented in the realtime motion module so **inihal** pin changes (e.g., ini.*.max_velocity, ini.*.max_acceleration) may be honored as soon as altered values are propagated to the motion module.

PINS

Per-joint pins (N == joint number)

ini.*N*.backlash
Allows adjustment of **[JOINT_*N*]BACKLASH**

ini.*N*.ferror
Allows adjustment of **[JOINT_*N*]FERROR**

ini.*N*.min_ferror
Allows adjustment of **[JOINT_*N*]MIN_FERROR**

ini.*N*.min_limit
Allows adjustment of **[JOINT_*N*]MIN_LIMIT**

ini.*N*.max_limit
Allows adjustment of **[JOINT_*N*]MAX_LIMIT**

ini.*N*.max_velocity
Allows adjustment of **[JOINT_*N*]MAX_VELOCITY**

ini.*N*.max_acceleration
Allows adjustment of **[JOINT_*N*]MAX_ACCELERATION**

ini.*N*.home
Allows adjustment of **[JOINT_*N*]HOME**

ini.*N*.home_offset
Allows adjustment of **[JOINT_*N*]HOME_OFFSET**

ini.*N*.home_offset
Allows adjustment of **[JOINT_*N*]HOME_SEQUENCE**

Per-axis pins (L == axis letter)

ini.*L*.min_limit
Allows adjustment of **[AXIS_*L*]MIN_LIMIT**

ini.*L*.max_limit
Allows adjustment of **[AXIS_*L*]MAX_LIMIT**

ini.*L*.max_velocity
Allows adjustment of **[AXIS_*L*]MAX_VELOCITY**

ini.*L*.max_acceleration
Allows adjustment of **[AXIS_*L*]MAX_ACCELERATION**

Global pins

ini.traj_default_acceleration
Allows adjustment of **[TRAJ]DEFAULT_ACCELERATION**

ini.traj_default_velocity
Allows adjustment of **[TRAJ]DEFAULT_VELOCITY**

ini.traj_max_acceleration
Allows adjustment of **[TRAJ]MAX_ACCELERATION**

ini.traj_max_velocity
Allows adjustment of **[TRAJ]MAX_VELOCITY**

Global pins (arc_blend trajectory planner)

ini.traj_arc_blend_enable
Allows adjustment of **[TRAJ]ARC_BLEND_ENABLE**

ini.traj_arc_blend_fallback_enable
Allows adjustment of **[TRAJ]ARC_BLEND_FALLBACK_ENABLE**

ini.traj_arc_blend_gap_cycles
Allows adjustment of **[TRAJ]ARC_OPTIMIZATION_DEPTH**

ini.traj_arc_blend_optimization_depth
Allows adjustment of **[TRAJ]ARC_BLEND_GAP_CYCLES**

ini.traj_arc_blend_ramp_freq
Allows adjustment of **[TRAJ]ARC_BLEND_RAMP_FREQ**

NOTES

The **inihal** pins cannot be linked or set in a halfile that is specified by an inifile **[HAL]HALFILE** item because they are not created until **milltask** is started. The **inihal** pin values can be altered by independent halcmd programs specified by **[APPLICATION]APP** items or by GUIs that support a **[HAL]POSTGUI_HALFILE**.

The inifile is not automatically updated with values altered by **inihal** pin settings but can be updated using the calibration program (emccalib.tcl) when using a **[HAL]POSTGUI_HALFILE**.

NAME

mitsub_vfd - HAL userspace component for Mitsubishi A500 F500 E500 A500 D700 E700 F700-series VFDs (others may work)

SYNOPSIS

loadrt mitsub_vfd [--baud 4800] [--port /dev/ttyUSB0] name1=number1[,name2=numer2...]
name1 is user selectable (usually a description of the controlled device).
number1 is the slave number that was set on the VFD. must be two digits (Parameter 117)
name=number can be repeated for multiple VFD's connected together
--baud is optional as it defaults to 9600
all networked vfds must be set to the same baudrate
--port is optional as it defaults to ttyS0

DESCRIPTION

The mitsub_vfd component interfaces a Mitsubishi VFD to LinuxCNC. The VFD is connected via RS-485 serial to the computer's USB or serial port using a RS-232/RS-485 converter

HARDWARE SETUP

reference manual 'communication option reference manual' and A500 technical manual for 500 series. Fr-A700 F700 E700 D700 technical manual for the 700 series
The inverter must be set manually for communication
(you may have to set PR 77 to 1 to unlock PR modifcation)
You must power cycle the inverter for some of these. (eg 79)

VFD INTERNAL PARAMETERS:

PARAMETER 79 - 1 or 0

PARAMETER 117 station number - 1
(can be optionally set 0 - 31) if component is also set

PARAMETER 118 communication speed 96
(can be optionally set 48,96,192 if component is also set)

PARAMETER 119 stop bit/data length - 0
(8 bits, two stop - don't change)

PARAMETER 120 parity - 0
(no parity - don't change)

PARAMETER 121 COM tries - 10
(if maximuim 10 COM errors then inverter faults- can change)

PARAMETER 122 COM check time interval 9999
(never check - if communication is lost inverter will not know (can change)

PARAMETER 123 wait time - 9999
no wait time is added to the serial data frame (don't change)

PARAMETER 124 CR selection - 0
don't change

This driver assumes certain other VFD settings:
-That the motor frequency status is set to show herts.
-That the status bit 3 is up to speed
-That the status bit 7 is alarm

some models (eg E500) cannot monitor status.
You must set set the monitor pin to false.
In this case pins such as up-to-speed, amps, alarm and status bits are not useful.

PINS

[VFD NAME].fwd (bit, in)::
forward/reverse pin
[VFD NAME].run (bit, in)::
run/stop pin
[VFD NAME].debug (bit, in)::
set debug mode pin
This will print many messages to the terminal
[VFD NAME].monitor (bit, in)::
set monitor mode pin
If false request-status command will not be sent to vfd.
Status, amps, power, motor-feedback, and alarm would then not be useful.
[VFD NAME].estop (bit, in)::
set estop mode pin
This will stop the VFD.
Restarting requires the run pin to cycle.

[VFD NAME].fwd (bit, out)::
up-to-speed status pin
Motor is at requested speed within VFD's settings tolerance.
[VFD NAME].alarm (bit, out)::
alarm status pin

[VFD NAME].motor-cmd (float, in)::
The requested motor speed, is Hertz

[VFD NAME].motor-fb (float, out)::
The motor feedback speed (from vfd) in hertz
[VFD NAME].motor-amps (float, out)::
The motor current, in amps
[VFD NAME].motor-power (float, out)::
The motor power

[VFD NAME].scale-cmd (float, in)::
Motor command's scale setting defaults to 1
[VFD NAME].scale-cmd (float, in)::
Motor command's scale setting defaults to 1
[VFD NAME].scale-cmd (float, in)::
Motor command's scale setting defaults to 1

[VFD NAME].stat-bit-0 (bit, out)::
raw status bit

[VFD NAME].stat-bit-1 (bit, out)::
raw status bit
[VFD NAME].stat-bit-2 (bit, out)::
raw status bit
[VFD NAME].stat-bit-3 (bit, out)::
raw status bit
set the VFD so this is motor-at-speed status
[VFD NAME].stat-bit-4 (bit, out)::
raw status bit
[VFD NAME].stat-bit-5 (bit, out)::
raw status bit
[VFD NAME].stat-bit-6 (bit, out)::
raw status bit
[VFD NAME].stat-bit-7 (bit, out)::
raw status bit
Set the VFD so this in the alarm bit

SAMPLE HAL

```
loadusr -Wn coolant mitsub_vfd --port /dev/ttyUSB0 spindle=02 coolant=01
# ***************** Spindle VFD setup slave 2 *****************
net spindle-vel-cmd             spindle.motor-cmd
net spindle-cw                  spindle.fwd
net spindle-on                  spindle.run
net spindle-at-speed            spindle.up-to-speed
net estop-out                   spindle.estop
#       cmd scaled to RPM (belt/gearbox driven)
setp spindle.scale-cmd .135
#       feedback is in rpm (recipicale of command)
setp spindle.scale-fb 7.411
#       turn on monitoring so feedback works
setp spindle.monitor 1
net spindle-speed-indicator spindle.motor-fb
# ***************** Coolant vfd setup slave 1 ******************
net coolant-flood                   coolant.run
net coolant-is-on           coolant.up-to-speed
#       cmd and feedback scaled to hertz
setp coolant.scale-cmd 1
setp coolant.scale-fb 1
#       command full speed
setp coolant.motor-cmd 60
#       allows us to see status
setp coolant.monitor 1
net estop-out                   coolant.estop
```

ISSUES

some models (eg E500) cannot monitor status, so set the monitor pin to false In this case pins such as up-to-speed, amps, alarm and status bits are not useful.

NAME

moveoff_gui − a gui for the moveoff component

SYNOPSIS

moveoff_gui [−−help | −− −h | −?]

moveoff_gui [options]

DESCRIPTION

Moveoff_gui is a sample graphical user interface (GUI) for controlling a Hal moveoff component to implement Hal-only offsets. See the manpage (man moveoff) for **IMPORTANT limitations and warnings**.

Supported configurations must use a known kinematics module with **KINEMATICS_TYPE = KINEMATICS_IDENTITY**. The modules currently supported are:
trivkins

OPTIONS

−−help | −? | −− −h
Show options and exit

−mode onpause | always
onpause: popup gui to control offsets when program paused
always: show gui to control offsets always
Default: **onpause**

−axes axisnames
Letters from set of {x y z a b c u v w}
Examples: −axes x, −axes xyz, −axes xz (no spaces)
Default: **xyz**

−inc incrementvalue
Specify one increment value per −inc (up to 4)
Defaults: **0.001 0.01 0.10 1.0**

−size integer
Overall gui size is based on font size, typically 8 - 20
Default: **14**

−loc center | +x+y
Initial location on screen
Examples: −loc center, −loc +20+100
Default: **center**

−autoresume
Resume program when move-enable deasserted
Default: notused

−delay delay secs
Delay for autoresume (allow time to restore spindle speed etc) Default: **5**

OTHER OPTIONS

These options are available for special cases:

−noentry
Disables creation of entry widgets
Default: notused

−no_resume_inhibit
Disable use of resume−inhibit to controlling gui
Default: notused

−no_pause_requirement
Disable check for halui.program.is−paused
Default: notused

−no_cancel_autoresume
Useful for retracting offsets with simple external controls
Default: notused

−no_display
Use when both external controls and and external displays are in use
Default: notused

NOTES

LinuxCNC must be running.

Halui must be loaded, typical ini file setting:
[HAL]HALUI = halui.

The moveoff component must be loaded with the name 'mv' as:
loadrt moveoff names=mv personality=number_of_axes

If the pin mv.motion−enable is **not** connected when moveoff_gui is started, **controls will be provided** to enable offsets and set offset values. If the pin **is** connected, **only a display** of offsets is shown and control must be made by **external** Hal connections.

If a pin named *.resume−inhibit exists and is not connected, it will be set while offsets are applied. This pin may be provided by the controlling linuxcnc gui in use. Use of the pin may be disabled with the option −no_resume_inhibit.

The −autoresume option uses halui.program.resume to automatically resume program execution when the move−enable pin is deactivated and all offsets are removed. The resume pin is not activated until an additional interval (−delay delay_secs) elapses. This delay interval may be useful for restarting related equipment (a spindle motor for example) While timing the delay, a popup is offered to cancel the automatic program resumption.

USAGE

The ini file in the configuration directory must provide HALFILEs to loadrt the moveoff component, connect its pins, and addf its read and write functions in the proper order. These steps can be done at runtime using an existing configuration ini file and specifying a system library HALFILE **hookup_moveoff.tcl** as illustrated below:

[HAL]
HALUI = halui
HALFILE = user_halfile_1

etc ...
HALFILE = user_halfile_n
HALFILE = LIB:hookup_moveoff.tcl

The **hookup_moveoff.tcl** halfile will use ini file settings for the moveoff component control pins:

[OFFSET]
EPSILON =
WAYPOINT_SAMPLE_SECS =
WAYPOINT_THRESHOLD =
BACKTRACK_ENABLE =

The **hookup_moveoff.tcl** will use ini file settings for the moveoff per-axis limits:

[AXIS_m]
OFFSET_MAX_VELOCITY =
OFFSET_MAX_ACCELERATION =
OFFSET_MAX_LIMIT =
OFFSET_MIN_LIMIT =

The moveoff_gui program should be specified in the APPLICATIONS stanza of the ini file, for example:

[APPLICATIONS]
DELAY = delay_in_secs_to_allow_hal_connections
APP = moveoff_gui −option1 −option2 ...

SEE ALSO

Simulation configurations that demonstrate the moveoff_gui and the moveoff component are located in:

configs/sim/axis/moveoff (axis-ui)
configs/sim/touchy/ngcgui (touchy-ui)

man page for the moveoff component:**moveoff**(9)

NAME

pyvcp − Virtual Control Panel for LinuxCNC

SYNOPSIS

pyvcp [−g *WxH+X+Y*] [−c *component−name*] *myfile.xml*

OPTIONS

−g *WxH+X+Y*

This sets the initial geometry of the root window. Use 'WxH' for just size, '+X+Y' for just position, or 'WxH+X+Y' for both. Size / position use pixel units. Position is referenced from top left.

−c *component-name*

Use *component-name* as the HAL component name. If the component name is not specified, the basename of the xml file is used.

SEE ALSO

Python Virtual Control Panel in the LinuxCNC documentation for a description of the xml syntax, along with examples

NAME

shuttle − control HAL pins with the ShuttleXpress or ShuttlePRO device made by Contour Design

SYNOPSIS

loadusr **shuttle** *[DEVICE ...]*

DESCRIPTION

shuttle is a non-realtime HAL component that interfaces Contour Design's ShuttleXpress and ShuttlePRO devices with LinuxCNC's HAL.

If the driver is started without command-line arguments, it will probe all /dev/hidraw* device files for Shuttle devices, and use all devices found. If it is started with command-line arguments, it will only probe the devices specified.

The ShuttleXpress has five momentary buttons, a 10 counts/revolution jog wheel with detents, and a 15-position spring-loaded outer wheel that returns to center when released.

The ShuttlePRO has 13 momentary buttons, a 10 counts/revolution jog wheel with detents, and a 15-position spring-loaded outer wheel that returns to center when released.

UDEV

The shuttle driver needs read permission to the Shuttle devices' /dev/hidraw* device files. This can be accomplished by adding a file **/etc/udev/rules.d/99-shuttle.rules**, with the following contents:

SUBSYSTEM=="hidraw", ATTRS{idVendor}=="0b33", ATTRS{idProduct}=="0020", MODE="0444"

SUBSYSTEM=="hidraw", ATTRS{idVendor}=="05f3", ATTRS{idProduct}=="0240", MODE="0444"

The LinuxCNC Debian package installs an appropriate udev file automatically, but if you are building LinuxCNC from source and are not using the Debian packaging, you'll need to install this file by hand.

A warning about the Jog Wheel

The Shuttle devices have an internal 8-bit counter for the current jog-wheel position. The shuttle driver can not know this value until the Shuttle device sends its first event. When the first event comes into the driver, the driver uses the device's reported jog-wheel position to initialize counts to 0.

This means that if the first event is generated by a jog-wheel move, that first move will be lost.

Any user interaction with the Shuttle device will generate an event, informing the driver of the jog-wheel position. So if you (for example) push one of the buttons at startup, the jog-wheel will work fine and notice the first click.

Pins

All HAL pin names are prefixed with the type of device followed by the index of the device (the order in which the driver found them), for example "shuttlexpress.0" or "shuttlepro.2".

(bit out) *(prefix).button-(number)*

(bit out) *(prefix).button-(number)-not*

The momentary buttons. "(number)" identifies which button corresponds to the HAL pin. The "button-(number)" pins are True when the button is pushed, the "button-(number)-not" pins are True when the button

is not pushed.

(s32 out) *(prefix).counts*

Accumulated counts from the jog wheel (the inner wheel).

(s32 out) *(prefix).spring-wheel-s32*

The current deflection of the spring-wheel (the outer wheel). It's 0 at rest, and ranges from -7 at the counter-clockwise extreme to +7 at the clockwise extreme.

(float out) *(prefix).spring-wheel-f*

The current deflection of the spring-wheel (the outer wheel). It's 0.0 at rest, -1.0 at the counter-clockwise extreme, and +1.0 at the clockwise extreme. (The Shuttle devices report the spring-wheel position as an integer from -7 to +7, so this pin reports only 15 discrete values in its range.)

NAME

sim_pin − gui for displaying and setting one or more Hal inputs

SYNOPSIS

sim_pin *[Options] name1* [*name2* [*name3* ...]]

Options:
−−**help** (shows help text)
−−**title title_string**

For bit items, the name may include a /mode= specifier:
namei/**mode=**[**pulse** | **toggle** | **hold**]
(default is toggle)

DESCRIPTION

Hal boolean items (bit) and numerical items (u32, s32, float) are supported.

If the named input is a numerical type, the gui displays:

Entry Entry widget for value or a valid Tcl expression.
Set Pushbutton to set new value from Entry (or use <RETURN>)
Reset Pushbutton to reset to the value present on initiation

If the input is a **bit** type, the gui shows a single pushbutton that is controlled by radio−button selectors:

mode=**pulse** Pulse input to 1 for each pushbutton press
mode=**toggle** Toggle input for each pushbutton press
mode=**hold** Set input to 1 while pushbutton pressed

If the bit item mode begins with an uppercase letter, the radio buttons for selecting other modes are not shown

NOTE

LinuxCNC or a standalone Hal application must be running

A named item can specify a **pin**, **param**, or **signal**. The named item must be writable:

pin IN or I/O (and not connected to a signal with a writer)
param RW
signal connected to a writable pin

USAGE

sim_pin can be used interactively from a shell command line or started automatically from a configuration ini file.

EXAMPLE

Example for ini file usage:

```
[APPLICATIONS]
DELAY = 5
APP = sim_pin \
    halui.machine.off/mode=pulse \
    ini.traj_arc_blend_enable \
    motion−command−handler−tmax
```

NAME

thermistor − compute temperature indicated by a thermistor

SYNOPSIS

thermistor

DESCRIPTION

This component computes the temperature indicated by a thermistor in a voltage-divider ladder. It uses the Beta-parameter variant of the Steinhart-Hart equation, described here:

http://en.wikipedia.org/wiki/Thermistor

PINS

thermistor.*N*.t0-c
float in Reference temperature of the thermistor, in degrees Celsius (typically 25 C). This must be set before the component can compute the thermistor temperature. The reference temperature information is supplied by the thermistor manufacturer.

thermistor.*N*.r0
float in Resistance of the thermistor at the reference temperature. This must be set before the component can compute the thermistor temperature. The reference resistance information is supplied by the thermistor manufacturer.

thermistor.*N*.beta
float in Beta parameter of the thermistor (sometimes just called B). This must be set before the component can compute the thermistor temperature. The Beta parameter is supplied by the thermistor manufacturer.

thermistor.*N*.r-other
float in Resistance of the other resistor in the voltage-divider ladder. This must be set before the component can compute the thermistor temperature.

thermistor.*N*.v-total
float in Supply voltage of the voltage-divider ladder.

thermistor.*N*.v-thermistor
float in Voltage drop across the termistor.

thermistor.*N*.temperature-c
float out Temperature sensed by the thermistor, in degrees Celsius.

thermistor.*N*.temperature-k
float out Temperature sensed by the thermistor, in Kelvins.

thermistor.*N*.temperature-f
float out Temperature sensed by the thermistor, in degrees Fahrenheit.

thermistor.*N*.resistance
float out Computed resistance of the thermistor.

LICENSE

GPL

NAME

vfdb_vfd - HAL userspace component for Delta VFD-B Variable Frequency Drives

SYNOPSIS

vfdb_vfd [OPTIONS]

DESCRIPTION

This manual page explains the **vfdb_vfd** component. This component reads and writes to the VFD-B device via a Modbus connection.

vfdb_vfd is for use with LinuxCNC.

QUICK START

The VFD-B ships in a configuration that can not talk to this driver. The VFD-B must be reconfigured via the face plate by the integrator before it will work. This section gives a brief description of what changes need to be made, consult your Delta VFD-B manual for more details.

Switch the VFD-B to Modbus RTU frame format:

Switch parameter 09-04 from the factory default of 0 (Ascii framing) to 3, 4, or 5 (RTU framing). The setting you choose will determine several serial parameters in addition to the Modbus framing protocol.

Set the frequency control source to be Modbus, not the keypad:

Switch parameter 02-00 from factory default of 00 (keypad control) to 5 (control from RS-485).

Set the run/stop control source to be Modbus, not the keypad:

Switch parameter 02-01 from the factory default of 0 (control from keypad) to 3 (control from Modbus, with Stop enabled on the keypad).

OPTIONS

−n −−name <halname>

set the HAL component name

−d −−debug

Turn on debugging messages. Also toggled by sending a USR1 signal to the vfdb_vfd process.

−m −−modbus−debug

Turn on Modbus debugging messages. This will cause all Modbus messages to be printed in hex on the terminal. Also toggled by sending a USR2 signal to the vfdb_vfd process.

−I −−ini <inifilename>

take configuration from this ini file. Defaults to environment variable INI_FILE_NAME. Most vfdb_vfd configuration comes from the ini file, not from command-line arguments.

−S −−section <section name>

take configuration from this section in the ini file. Defaults to 'VFD-B'.

−r −−report−device

report device propertiers on console at startup

INI CONFIG VARIABLES

DEBUG

Set to a non-zero value to enable general debug output from the VFD-B driver. Optional.

MODBUS_DEBUG

Set to a non-zero value to enable modbus debug output from the VFD-B driver. Optional.

DEVICE
Serial port device file to use for Modbus communication with the VFD-B. Defaults to '/dev/ttyS0'.

BAUD Modbus baud rate. Defaults to 19200.

BITS Modbus data bits. Defaults to 8.

PARITY
Modbus parity. Defaults to Even. Accepts 'Even', 'Odd', or 'None'.

STOPBITS
Modbus stop bits. Defaults to 1.

TARGET
Modbus target number of the VFD-B to speak to. Defaults to 1.

POLLCYCLES
Only read the less important variables from the VFD-B once in this many poll cycles. Defaults to 10.

RECONNECT_DELAY
If the connection to the VFD-B is broken, wait this many seconds before reconnecting. Defaults to 1.

MOTOR_HZ, MOTOR_RPM
The frequency of the motor (in Hz) and the corresponding speed of the motor (in RPM). This information is provided by the motor manufacturer, and is generally printed on the motor's name plate.

PINS

<name>.at−speed (bit, out)
True when drive is at commanded speed (see *speed−tolerance* below)

<name>.enable (bit, in)
Enable the VFD. If False, all operating parameters are still read but control is released and panel control is enabled (subject to VFD setup).

<name>.frequency−command (float, out)
Current target frequency in HZ as set through speed−command (which is in RPM), from the VFD.

<name>.frequency−out (float, out)
Current output frequency of the VFD.

<name>.inverter−load−percentage (float, out)
Current load report from VFD.

<name>.is−e−stopped (bit, out)
The VFD is in emergency stop status (blinking "E" on panel).

<name>.is−stopped (bit, out)
True when the VFD reports 0 Hz output.

<name>.jog−mode (bit, in)
1 for ON and 0 for OFF, enables the VFD-B 'jog mode'. Speed control is disabled. This might be useful for spindle orientation.

<name>.max−rpm (float, out)
Actual RPM limit based on maximum frequency the VFD may generate, and the motors nameplate values. For instance, if *nameplate−HZ* is 50, and *nameplate−RPM* is 1410, but the VFD may generate up to 80Hz, then *max−rpm* would read as 2256 (80*1410/50). The frequency limit is read from the VFD at startup. To increase the upper frequency limit, the UL and FH parameters must be changed on the panel. See the VFD-B manual for instructions how to set the maximum frequency.

<name>.modbus−ok (bit, out)
True when the Modbus session is successfully established and the last 10 transactions returned without error.

<name>.motor−RPM (float, out)
Estimated current RPM value, from the VFD.

<name>.motor−RPS (float, out)
Estimated current RPS value, from the VFD.

<name>.output−voltage (float, out)
From the VFD.

<name>.output−current (float, out)
From the VFD.

<name>.speed−command (float, in)
Speed sent to VFD in RPM. It is an error to send a speed faster than the Motor Max RPM as set in the VFD.

<name>.spindle−on (bit, in)
1 for ON and 0 for OFF sent to VFD, only on when running.

<name>.max−speed (bit, in)
Ignore the loop-time parameter and run Modbus at maximum speed, at the expense of higher CPU usage. Suggested use during spindle positioning.

<name>.status (s32, out)
Drive Status of the VFD (see the VFD manual). A bitmap.

<name>.error−count (s32, out)
Total number of transactions returning a Modbus error.

<name>.error−code (s32, out)
Most recent Error Code from VFD.

<name>.frequency−limit (float, out)
Upper limit read from VFD setup.

PARAMETERS

<name>.loop−time (float, RW)
How often the Modbus is polled (default interval 0.1 seconds).

<name>.nameplate−HZ (float, RW)
Nameplate Hz of motor (default 50). Used to calculate target frequency (together with *nameplate−RPM*) for a target RPM value as given by speed−command.

<name>.nameplate−RPM (float, RW)
Nameplate RPM of motor (default 1410)

<name>.rpm−limit (float, RW)
Do-not-exceed soft limit for motor RPM (defaults to *nameplate−RPM*).

<name>.tolerance (float, RW)
Speed tolerance (default 0.01) for determining wether spindle is at speed (0.01 meaning: output frequency is within 1% of target frequency).

USAGE

The vfdb_vfd driver takes precedence over panel control while it is enabled (see *.enable* pin), effectively disabling the panel. Clearing the *.enable* pin re-enables the panel. Pins and parameters can still be set, but will not be written to the VFD untile the .enable pin is set. Operating parameters are still read while bus control is disabled.

Exiting the vfdb_vfd driver in a controlled way will release the VFD from the bus and restore panel control.

See the LinuxCNC Integrators Manual for more information. For a detailed register description of the Delta VFD-B, see the VFD manual.

AUTHOR

Yishin Li; based on vfd11_vfd by Michael Haberler.

LICENSE

GPL

NAME

vfs11_vfd - HAL userspace component for Toshiba-Schneider VF-S11 Variable Frequency Drives

SYNOPSIS

vfs11_vfd [OPTIONS]

DESCRIPTION

This manual page explains the **vfs11_vfd** component. This component reads and writes to the vfs11 via a Modbus connection.

vfs11_vfd is for use with LinuxCNC.

OPTIONS

−n −−name <halname>
set the HAL component name

−d −−debug
Turn on debugging messages. Also toggled by sending a USR1 signal to the vfs11_vfd process.

−m −−modbus−debug
Turn on Modbus debugging messages. This will cause all Modbus messages to be printed in hex on the terminal. Also toggled by sending a USR2 signal to the vfs11_vfd process.

−I −−ini <inifilename>
take configuration from this ini file. Defaults to environment variable INI_FILE_NAME.

−S −−section <section name>
take configuration from this section in the ini file. Defaults to 'VFS11'.

−r −−report−device
report device propertiers on console at startup

PINS

<name>.acceleration−pattern (bit, in)
when true, set acceleration and deceleration times as defined in registers F500 and F501 respecitvely. Used in PID loops to choose shorter ramp times to avoid oscillation.

<name>.alarm−code (s32, out)
non-zero if drive is in alarmed state. Bitmap describing alarm information (see register FC91 description). Use *err−reset* (see below) to clear the alarm.

<name>.at−speed (bit, out)
when drive is at commanded speed (see *speed−tolerance* below)

<name>.current−load−percentage (float, out)
reported from the VFD

<name>.dc−brake (bit, in)
engage the DC brake. Also turns off spindle−on.

<name>.enable (bit, in)
enable the VFD. If false, all operating parameters are still read but control is released and panel control is enabled (subject to VFD setup).

<name>.err−reset (bit, in)
reset errors (alarms a.k.a Trip and e-stop status). Resetting the VFD may cause a 2-second delay until it's rebooted and Modbus is up again.

<name>.estop (bit, in)
put the VFD into emergency-stopped status. No operation possible until cleared with *err−reset* or powercycling.

<name>.frequency−command (float, out)
current target frequency in HZ as set through speed−command (which is in RPM), from the VFD

<name>.frequency−out (float, out)
current output frequency of the VFD

<name>.inverter−load−percentage (float, out)
current load report from VFD

<name>.is−e−stopped (bit, out)
the VFD is in emergency stop status (blinking "E" on panel). Use *err−reset* to reboot the VFD and clear the e−stop status.

<name>.is−stopped (bit, out)
true when the VFD reports 0 Hz output

<name>.jog−mode (bit, in)
1 for ON and 0 for OFF, enables the VF-S11 'jog mode'. Speed control is disabled, and the output frequency is determined by register F262 (preset to 5Hz). This might be useful for spindle orientation.

<name>.max−rpm (float, R)
actual RPM limit based on maximum frequency the VFD may generate, and the motors nameplate values. For instance, if *nameplate−HZ* is 50, and *nameplate−RPM_* is 1410, but the VFD may generate up to 80Hz, then *max−rpm* would read as 2256 (80*1410/50). The frequency limit is read from the VFD at startup. To increase the upper frequency limit, the UL and FH parameters must be changed on the panel. See the VF−S11 manual for instructions how to set the maximum frequency.

<name>.modbus−ok (bit, out)
true when the Modbus session is successfully established and the last 10 transactions returned without error.

<name>.motor−RPM (float, out)
estimated current RPM value, from the VFD

<name>.output−current−percentage (float, out)
from the VFD

<name>.output−voltage−percentage (float, out)
from the VFD

<name>.output−voltage (float, out)
from the VFD

<name>.speed−command (float, in)
speed sent to VFD in RPM. It is an error to send a speed faster than the Motor Max RPM as set in the VFD

<name>.spindle−fwd (bit, in)
1 for FWD and 0 for REV, sent to VFD

<name>.spindle−on (bit, in)
1 for ON and 0 for OFF sent to VFD, only on when running

<name>.spindle−rev (bit, in)
1 for ON and 0 for OFF, only on when running

<name>.max−speed (bit, in)
ignore the loop−time parameter and run Modbus at maximum speed, at the expense of higher CPU usage. Suggested use during spindle positioning.

<name>.status (s32, out)
Drive Status of the VFD (see the TOSVERT VF-S11 Communications Function Instruction Manual, register FD01). A bitmap.

<name>.trip−code (s32, out)
trip code if VF-S11 is in tripped state.

<name>.error−count (s32, RW)
total number of transactions returning a Modbus error

PARAMETERS

<name>.frequency−limit (float, RO)
upper limit read from VFD setup.

<name>.loop−time (float, RW)
how often the Modbus is polled (default interval 0.1 seconds)

<name>.nameplate−HZ (float, RW)
Nameplate Hz of motor (default 50). Used to calculate target frequency (together with *nameplate−RPM*) for a target RPM value as given by speed−command.

<name>.nameplate−RPM (float, RW)
Nameplate RPM of motor (default 1410)

<name>.rpm−limit (float, RW)
do-not-exceed soft limit for motor RPM (defaults to *nameplate−RPM*).

<name>.tolerance (float, RW)
speed tolerance (default 0.01) for determining wether spindle is at speed (0.01 meaning: output frequency is within 1% of target frequency)

USAGE

The vfs11_vfd driver takes precedence over panel control while it is enabled (see *.enable* pin), effectively disabling the panel. Clearing the *.enable* pin re-enableds the panel. Pins and parameters can still be set, but will not be written to the VFD untile the .enable pin is set. Operating parameters are still read while bus control is disabled.

Exiting the vfs11_vfd driver in a controlled will release the VFD from the bus and restore panel control.

See the LinuxCNC Integrators Manual for more information. For a detailed register description of the Toshiba VFD’s, see the "TOSVERT VF-S11 Communications Function Instruction Manual" (Toshiba document number E6581222) and the "TOSVERT VF-S11 Instruction manual" (Toshiba document number E6581158).

AUTHOR

Michael Haberler; based on gs2_vfd by Steve Padnos and John Thornton.

LICENSE

GPL

NAME

xhc−hb04 − User-space HAL component for the xhc-hb04 pendant.

DESCRIPTION

The xhc-hb04 component supports a common USB pendant that provides a number of pushbuttons, a manual pulse generator (mpg or jog wheel), and a selector switch for the wheel.

There are at least two hardware versions -- one with 16 buttons and a more common one with 18 buttons. The information herein is based on the 18 button device with a USB Vendor:Product code of 10CE:EB70.

In addition to buttons, the pendant provides an LCD display for the current stepsize multiplier (from a set of available integer values), position (absolute and relative, labeled MC and WC respectively), feedrate (override percent and value in units per minute), and spindle speed (override percent and value in revolutions per minute (RPM)). The display is managed by a rotary switch that selects one of four axes for wheel positioning, feed override, spindle override, or OFF.

The pendant display, its rotary selector switch, and the component pin names use designators x,y,z,a. While this arrangement presumes a machine configured as XYZA, the pins can be assigned independently as required in a HAL configuration.

UDEV

The xhc−hb04 executable needs permission for reading the pendant's USB device. Debian package installs (debs) handle this automatically but Run-In-Place (RIP) builds may need a udev rules file. This file should be created (using sudo and a text editor) as:

/etc/udev/rules.d/99−xhc−hb04.rules with the single line:

ATTR{idProduct}=="eb70", ATTR{idVendor}=="10ce", MODE="0666", OWNER="root", GROUP="plugdev"

Standalone Usage

The xhc-hb04 program can be run from the command line without LinuxCNC to test a pendant in a simulation mode. This standalone mode is used to identify the button codes produced for each button press and to verify proper counting of the jog wheel. The identified button codes can be used to create a **button−cfg−file**. When a **button−cfg−file** exists, pendant operation can be verified using the −I option to specify the file.

Usage:

$ xhc−hb04 [options]

Options

−h list command line options and exit

−I button−cfg−file (see below for file format)

−H run in real-time HAL mode (simulation mode is default)

−x wait for pendant detection before creating HAL pins.

−s n n is one of the following stepsize sequences

1: 1,10,100,1000 (default)
2: 1,5,10,20
3: 1,10,100
4: 1,5,10,20,50,100
5: 1,10,50,100,1000
The stepsize selected is always multiplied by 0.001

button−cfg−file format

Standard configuration files are provided in the distribution for known button configurations:
/usr/share/linuxcnc/hallib/xhc−hb04−layout1.cfg
/usr/share/linuxcnc/hallib/xhc−hb04−layout2.cfg
or for a RIP build:
rip_base_dir/lib/hallib/xhc−hb04−layout1.cfg
rip_base_dir/lib/hallib/xhc−hb04−layout2.cfg

layout1 describes the 16 button pendant, layout2 describes the more common 18 button pendant.

The button configuration file follows the same format as ini files but should use a file suffix of .cfg.

File format:

```
[XHC−HB04]
BUTTON=X1:button−thename1
BUTTON=X2:button−thename2
BUTTON=X3:button−thename3
etc.
```

XN is the code reported for a button press and button−thenameN is the name to be assigned to the pin created for the button.

Hal Usage

Use the −H option to specify HAL mode and other options as required:

loadusr −W **xhc−hb04** *−H [Options]*

Example: *loadusr −W* **xhc−hb04** *−H −I path_to_cfg_file −s 2*

Input Pins (Control)

(bit in) *xhc−hb04.stepsize−up* A 1 pulse on this pin changes the
stepsize to the next higher stepsize in the stepsize sequence specified in the xhc−hb04 (loadusr) command.

(bit in) *xhc−hb04.stepsize−down* A 1 pulse on this pin changes the
stepsize to the next lower stepsize in the stepsize sequence specified in the xhc−hb04 (loadusr) command.

Input Pins (to the pendant LCD display)

(float in) *xhc−hb04.[xyza].pos−absolute* Absolule position display.
(typically connect to: halui.axis.N.pos−feedback). The LCD display for pos−absolute is fixed format with a sign, 4 number digits and 3 fraction digits (+XXXX.XXX), require: −9999.999 <= value <= 9999.999.

(float in) *xhc−hb04.[xyza].pos−relative* Relative position display.
(typically connect to: halui.axis.N.pos−relative). The LCD display for pos−relative is fixed format with a sign, 4 number digits and 3 fraction digits (+XXXX.XXX), require: −9999.999 <= value <= 9999.999.

(float in) *xhc−hb04.feed−override* Feed−override value.
The float value is converted to a 16 bit integer and multiplied by 100 in order to display as percent, require: 0 <= pinvalue <= 655 (typically connect to: halui.feed−override.value)

(float in) *xhc−hb04.feed−value* Current Feed-value (units/sec).
The float value is converted to a 16 bit integer and multiplied by 60 in order to display as units-per-minute, require: 0 <= pinvalue <= 1092 (65520 units-per-minute) (typically connect to: motion.current−vel)

(float in) *xhc−hb04.spindle−override* Spindle−override value.
The float value is converted to a 16 bit integer and multiplied by 100 in order to display as percent, require: 0 <= pinvalue <= 655) (typically connect to: halui.spindle−override.value)

(float in) *xhc−hb04.spindle−rps* Spindle speed in rps.
(revolutions per second). The float value is converted to a 16 bit integer and multiplied by 60 in order to display as RPMs, require: 0 <= pinvalue <= 1092 (65520 RPM) (typically connect to: spindle.N.speed−out−rps−abs)

(bit in) *xhc−hb04.inch−icon* Use inch icon (default is mm)

Output Pins (Status)

(bit out) *xhc−hb04.sleeping* True when the driver receives a pendant inactive (sleeping) message.

(bit out) *xhc−hb04.jog.enable−off* True when the pendant rotary selector switch is in the OFF position or when the pendant is sleeping.

(bit out) *xhc−hb04.enable−[xyza]* True when the pendant rotary selector switch is in the [xyza] position and not sleeping.

(bit out) *xhc−hb04.enable−spindle−override* True when the pendant rotary selector switch is in the Spindle position and not sleeping. (typically connect to: halui.spindle−override−count−enable)

(bit out) *xhc−hb04.enable−feed−override* True when the pendant rotary selector switch is in the Feed position and not sleeping. (typically connect to: halui.feed−override−count−enable)

(bit out) *xhc−hb04.connected* True when connection to the pendant is established over the USB interface.

(bit out) *xhc−hb04.require_pendant* True if driver started with the −x option.

(s32 out) *xhc−hb04.stepsize* Current stepsize in the stepsize sequence as controlled by the stepsize−up and/or stepsize−down pins.

Output Pins (for jogging using axis.N.jog−counts)

(s32 out) *xhc−hb04.jog.counts* Number of counts of the wheel since start−up (50 counts per wheel revolution). (typically connect to axis.N.jog−counts (lowpass filtering may be helpful))

(s32 out) *xhc−hb04.jog.counts−neg* The value of the xhc−hb04.jog.counts multipled by −1.

(float out) *xhc−hb04.jog.scale* Value is the current stepsize multipled by 0.001. (typically connect to axis.N.jog−scale)

Experimental: Pins for halui plus/minus jogging

These pins provide some support for non−trivkins, world mode jogging.

(float in) *xhc−hb04.jog.max−velocity* Connect to halui.max−velocity.value

(float out) *xhc−hb04.jog.velocity* Connect to halui.jog−speed

(bit out) *xhc−hb04.jog.plus−[xyza]* Connect to halui.jog.N.plus

(bit out) *xhc−hb04.jog.minus−[xyza]* Connect to halui.jog.N.minus

(float out) *xhc−hb04.jog.increment* Debug pin -- abs(delta_pos)

Button output pins (for the 18 button, layout2 pendant)

The output bit type pins are TRUE when the button is pressed.

ROW 1
(bit out) xhc−hb04.button−reset
(bit out) xhc−hb04.button−stop

ROW 2
(bit out) xhc−hb04.button−goto−zero
(bit out) xhc−hb04.button−rewind
(bit out) xhc−hb04.button−start−pause
(bit out) xhc−hb04.button−probe−z

ROW 3
(bit out) xhc−hb04.button−spindle
(bit out) xhc−hb04.button−half
(bit out) xhc−hb04.button−zero
(bit out) xhc−hb04.button−safe−z

ROW 4
(bit out) xhc−hb04.button−home
(bit out) xhc−hb04.button−macro−1
(bit out) xhc−hb04.button−macro−2
(bit out) xhc−hb04.button−macro−3

ROW 5
(bit out) xhc−hb04.button−step
(bit out) xhc−hb04.button−mode
(bit out) xhc−hb04.button−macro−6
(bit out) xhc−hb04.button−macro−7

Synthesized button pins

Additional buttons are synthesized for buttons named **zero**, **goto−zero**, and **half**. These synthesized buttons are active when the button is pressed AND the selector−switch is set to the corresponding axis [xyza].

(bit out) xhc−hb04.button−zero−[xyza]
(bit out) xhc−hb04.button−goto−zero−[xyza]
(bit out) xhc−hb04.button−half−[xyza]

DEBUGGING

For debugging USB activity, use environmental variable LIBUSB_DEBUG:

export LIBUSB_DEBUG=[2 | 3 | 4]; xhc−hb04 [options]
2:warning, 3:info, 4:debug

Sim Configs

The distribution includes several simulation configurations in the directory:
/usr/share/doc/linuxcnc/examples/sample−configs/sim/axis/xhc−hb04/
or for a RIP build:
rip_base_dir/configs/sim/axis/xhc−hb04/

These configurations use a distribution-provided script (xhc−hb04.tcl) to configure the pendant and make necessary HAL connections according to a number of ini file settings. The script uses an additional HAL component (xhc_hb04_util) to provide common functionality and includes support for a standard method for the start-pause button.

The settings available include:
1) specify button−cfg−file for standard layout1 or layout2
2) select axes (up to 4 axes from set of x y z a b c u v w)
3) implement per-axis filtering coeficients
4) implement per-axis acceleration for mpg jogging
5) implement per-axis scale settings
6) select normal or velocity based jog modes
7) select stepsize sequence
8) option to initialize pin for inch or mm display icon
9) option to require pendant on startup

The sim configs illustrate button connections that:
1) connect pendant stepsize−up button to the step input pin.
2) connect buttons to halui.* pins
3) connect buttons to motion.* pins

Another script is included to monitor the pendant and report loss of USB connectivity. See the README and .txt files in the above directory for usage.

Note: The sim configs use the axis gui but the scripts are available with any HAL configuration or gui. The same scripts can be used to adapt the xhc−hb04 to existing configurations provided that the halui, motion, and axis.N pins needed are not otherwise claimed. Instructions are included in README file in the directory named above.

Use halcmd to display the pins and signals used by the xhc−hb04.tcl script:
halcmd show pin xhc−hb04 (show all xhc−hb04 pins)
halcmd show pin pendant_util (show all pendant_util pins)
halcmd show sig pendant: (show all pendant signals)

Author

Frederick Rible (frible@teaser.fr)

NAME

hal − Introduction to the HAL API

DESCRIPTION

HAL stands for Hardware Abstraction Layer, and is used by LinuxCNC to transfer realtime data to and from I/O devices and other low-level modules.

hal.h defines the API and data structures used by the HAL. This file is included in both realtime and non-realtime HAL components. HAL uses the RTPAI real time interface, and the #define symbols RTAPI and ULAPI are used to distinguish between realtime and non-realtime code. The API defined in this file is implemented in hal_lib.c and can be compiled for linking to either realtime or user space HAL components.

The HAL is a very modular approach to the low level parts of a motion control system. The goal of the HAL is to allow a systems integrator to connect a group of software components together to meet whatever I/O requirements he (or she) needs. This includes realtime and non-realtime I/O, as well as basic motor control up to and including a PID position loop. What these functions have in common is that they all process signals. In general, a signal is a data item that is updated at regular intervals. For example, a PID loop gets position command and feedback signals, and produces a velocity command signal.

HAL is based on the approach used to design electronic circuits. In electronics, off-the-shelf components like integrated circuits are placed on a circuit board and their pins are interconnected to build whatever overall function is needed. The individual components may be as simple as an op-amp, or as complex as a digital signal processor. Each component can be individually tested, to make sure it works as designed. After the components are placed in a larger circuit, the signals connecting them can still be monitored for testing and troubleshooting.

Like electronic components, HAL components have pins, and the pins can be interconnected by signals.

In the HAL, a *signal* contains the actual data value that passes from one pin to another. When a signal is created, space is allocated for the data value. A *pin* on the other hand, is a pointer, not a data value. When a pin is connected to a signal, the pin's pointer is set to point at the signal's data value. This allows the component to access the signal with very little run-time overhead. (If a pin is not linked to any signal, the pointer points to a dummy location, so the realtime code doesn't have to deal with null pointers or treat unlinked variables as a special case in any way.)

There are three approaches to writing a HAL component. Those that do not require hard realtime performance can be written as a single user mode process. Components that need hard realtime performance but have simple configuration and init requirements can be done as a single kernel module, using either pre-defined init info, or insmod-time parameters. Finally, complex components may use both a kernel module for the realtime part, and a user space process to handle ini file access, user interface (possibly including GUI features), and other details.

HAL uses the RTAPI/ULAPI interface. If RTAPI is #defined hal_lib.c would generate a kernel module hal_lib.o that is insmoded and provides the functions for all kernel module based components. The same source file compiled with the ULAPI #define would make a user space hal_lib.o that is staticlly linked to user space code to make user space executables. The variable lists and link information are stored in a block of shared memory and protected with mutexes, so that kernel modules and any of several user mode programs can access the data.

REALTIME CONSIDERATIONS

For an explanation of realtime considerations, see **intro(3rtapi)**.

HAL STATUS CODES

Except as noted in specific manual pages, HAL returns negative errno values for errors, and nonnegative values for success.

SEE ALSO

intro(3rtapi)

NAME

hal_add_funct_to_thread − cause a function to be executed at regular intervals

SYNTAX

int hal_add_funct_to_thread(const char *_funct_name_, const char *_thread_name_,
int position)

int hal_del_funct_from_thread(const char *_funct_name_, const char *_thread_name_)

ARGUMENTS

funct_name
The name of the function

thread_name
The name of the thread

position
The desired location within the thread. This determines when the function will run, in relation to other functions in the thread. A positive number indicates the desired location as measured from the beginning of the thread, and a negative is measured from the end. So +1 means this function will become the first one to run, +5 means it will be the fifth one to run, −2 means it will be next to last, and −1 means it will be last. Zero is illegal.

DESCRIPTION

hal_add_funct_to_thread adds a function exported by a realtime HAL component to a realtime thread. This determines how often and in what order functions are executed.

hal_del_funct_from_thread removes a function from a thread.

RETURN VALUE

Returns a HAL status code.

REALTIME CONSIDERATIONS

Call only from realtime init code, not from user space or realtime code.

SEE ALSO

hal_thread_new(3hal), **hal_export_funct(3hal)**

NAME

hal_create_thread − Create a HAL thread

SYNTAX

int hal_create_thread(const char *_name_, unsigned long _period_, int _uses_fp_)

int hal_thread_delete(const char *_name_)

ARGUMENTS

name The name of the thread

period The interval, in nanoseconds, between iterations of the thread

uses_fp Must be nonzero if a function which uses floating-point will be attached to this thread.

DESCRIPTION

hal_create_thread establishes a realtime thread that will execute one or more HAL functions periodically.

All thread periods are rounded to integer multiples of the hardware timer period, and the timer period is based on the first thread created. Threads must be created in order, from the fastest to the slowest. HAL assigns decreasing priorities to threads that are created later, so creating them from fastest to slowest results in rate monotonic priority scheduling.

hal_delete_thread deletes a previously created thread.

REALTIME CONSIDERATIONS

Call only from realtime init code, not from user space or realtime code.

RETURN VALUE

Returns a HAL status code.

SEE ALSO

hal_export_funct(3hal)

NAME

hal_exit − Shut down HAL

SYNTAX

int hal_exit(int *comp_id*)

ARGUMENTS

comp_id

A HAL component identifier returned by an earlier call to **hal_init**.

DESCRIPTION

hal_exit shuts down and cleans up HAL and RTAPI. It must be called prior to exit by any module that called **hal_init**.

REALTIME CONSIDERATIONS

Call only from within user or init/cleanup code, not from realtime tasks.

RETURN VALUE

Returns a HAL status code.

NAME

hal_export_funct − create a realtime function callable from a thread

SYNTAX

typedef void(*hal_funct_t)(void * *arg*, long *period*)

int hal_export_funct(const char **name*, hal_funct_t *funct*, void **arg*, int *uses_fp*, int *reentrant*, int *comp_id*)

ARGUMENTS

name The name of the function.

funct The pointer to the function

arg The argument to be passed as the first parameter of *funct*

uses_fp Nonzero if the function uses floating-point operations, including assignment of floating point values with "=".

reentrant
If reentrant is non-zero, the function may be preempted and called again before the first call completes. Otherwise, it may only be added to one thread.

comp_id
A HAL component identifier returned by an earlier call to **hal_init**.

DESCRIPTION

hal_export_funct makes a realtime function provided by a component available to the system. A subsequent call to **hal_add_funct_to_thread** can be used to schedule the execution of the function as needed by the system.

When this function is placed on a HAL thread, and HAL threads are started, *funct* is called repeatedly with two arguments: *void *arg* is the same value that was given to **hal_export_funct**, and *long period* is the interval between calls in nanoseconds.

Each call to the function should do a small amount of work and return.

RETURN VALUE

Returns a HAL status code.

SEE ALSO

hal_create_thread(3hal), **hal_add_funct_to_thread(3hal)**

NAME

hal_init − Sets up HAL and RTAPI

SYNTAX

int hal_init(const char **modname*)

ARGUMENTS

modname

The name of this hal module

DESCRIPTION

hal_init sets up HAL and RTAPI. It must be called by any module that intends to use the API, before any other RTAPI calls.

modname must point to a string that identifies the module. The string may be no longer than **HAL_NAME_LEN** characters.

REALTIME CONSIDERATIONS

Call only from within user or init/cleanup code, not from relatime tasks.

RETURN VALUE

On success, returns a positive integer module ID, which is used for subsequent calls to hal and rtapi APIs. On failure, returns a HAL error code.

NAME

hal_malloc − Allocate space in the HAL shared memory area

SYNTAX

void *hal_malloc(long int *size*)

ARGUMENTS

size Gives the size, in bytes, of the block

DESCRIPTION

hal_malloc allocates a block of memory from the main HAL shared memory area. It should be used by all components to allocate memory for HAL pins and parameters. It allocates ‘size’ bytes, and returns a pointer to the allocated space, or NULL (0) on error. The returned pointer will be properly aligned for any type HAL supports. A component should allocate during initialization all the memory it needs.

The allocator is very simple, and there is no ‘free’. The entire HAL shared memory area is freed when the last component calls **hal_exit**. This means that if you continuously install and remove one component while other components are present, you eventually will fill up the shared memory and an install will fail. Removing all components completely clears memory and you start fresh.

RETURN VALUE

A pointer to the allocated space, which is properly aligned for any variable HAL supports. Returns NULL on error.

NAME

hal_param_alias − create an alternate name for a param

SYNTAX

int **hal_param_alias**(const char ***original_name**, const char ***alias**);

ARGUMENTS

original_name
: The original name of the param

alias
: The alternate name that may be used to refer to the param, or NULL to remove any alternate name.

DESCRIPTION

A param may have two names: the original name (the one that was passed to a **hal_param_new** function) and an alias.

Usually, aliases are for the convenience of users and should be created and destroyed via halcmd. However, in some cases it is sensible to create aliases directly in a component. These cases include the case where a param is renamed, to preserve compatibility with old versions.

RETURN VALUE

Returns a HAL status code.

SEE ALSO

hal_pin_alias(3)

NAME

hal_param_new − Create a HAL parameter

SYNTAX

int hal_param_bit_new(const char *_name_, hal_param_dir_t _dir_, hal_bit_t * _data_addr_, int _comp_id_)

int hal_param_float_new(const char *_name_, hal_param_dir_t _dir_, hal_float_t * _data_addr_, int _comp_id_)

int hal_param_u32_new(const char *_name_, hal_param_dir_t _dir_, hal_u32_t * _data_addr_, int _comp_id_)

int hal_param_s32_new(const char *_name_, hal_param_dir_t _dir_, hal_s32_t * _data_addr_, int _comp_id_)

int hal_param_bit_newf(hal_param_dir_t _dir_, hal_bit_t * _data_addr_, int _comp_id_, const char *_fmt_, ...)

int hal_param_float_newf(hal_param_dir_t _dir_, hal_float_t * _data_addr_, int _comp_id_, const char *_fmt_, ...)

int hal_param_u32_newf(hal_param_dir_t _dir_, hal_u32_t * _data_addr_, int _comp_id_, const char *_fmt_, ...)

int hal_param_s32_newf(hal_param_dir_t _dir_, hal_s32_t * _data_addr_, int _comp_id_, const char *_fmt_, ...)

int hal_param_new(const char *_name_, hal_type_t _type_, hal_param_dir_t _dir_, void *_data_addr_, int _comp_id_)

ARGUMENTS

name The name to give to the created parameter

dir The direction of the parameter, from the viewpoint of the component. It may be one of **HAL_RO**, or **HAL_RW** A component may assign a value to any parameter, but other programs (such as halcmd) may only assign a value to a parameter that is **HAL_RW**.

data_addr
The address of the data, which must lie within memory allocated by **hal_malloc**.

comp_id
: A HAL component identifier returned by an earlier call to **hal_init**.

fmt, ... A printf-style format string and arguments

type The type of the parameter, as specified in **hal_type_t(3hal)**.

DESCRIPTION

The **hal_param_new** family of functions create a new *param* object.

There are functions for each of the data types that the HAL supports. Pins may only be linked to signals of the same type.

RETURN VALUE

Returns a HAL status code.

SEE ALSO

hal_type_t(3hal)

NAME

hal_parport − portable access to PC-style parallel ports

SYNTAX

#include "hal_parport.h"

int **hal_parport_get**(int *comp_id*, hal_parport_t **port*, unsigned short *base*, unsigned short *base_hi*, unsigned int *modes*)

void **hal_parport_release**(hal_parport_t **port*)

ARGUMENTS

comp_id
A HAL component identifier returned by an earlier call to **hal_init**.

port A pointer to a hal_parport_t structure

base The base address of the port (if port >= 16) or the linux port number of the port (if port < 16)

base_hi
The "high" address of the port (location of the ECP registers), 0 to use a probed high address, or −1 to disable the high address

modes Advise the driver of the desired port modes, from <linux/parport.h>. If a linux-detected port does not provide the requested modes, a warning is printed with rtapi_print_msg. This does not make the port request fail, because unfortunately, many systems that have working EPP parports are not detected as such by Linux.

DESCRIPTION

hal_parport_get allocates a parallel port for exclusive use of the named hal component. The port must be released with **hal_parport_release** before the component exits with **hal_exit**.

HIGH ADDRESS PROBING

If the port is a parallel port known to Linux, and Linux detected a high I/O address, this value is used. Otherwise, if base+0x400 is not registered to any device, it is used. Otherwise, no address is used. If no high address is detected, port−>base_hi is 0.

PARPORT STRUCTURE

```
typedef struct
{
   unsigned short base;
   unsigned short base_hi;
   .... // and further unspecified fields
} hal_parport_t;
```

RETURN VALUE

hal_parport_get returns a HAL status code. On success, *port* is filled out with information about the allocated port. On failure, the contents of *port* are undefined except that it is safe (but not required) to pass this port to **hal_parport_release**.

hal_parport_release does not return a value. It always succeeds.

NOTES

In new code, prefer use of rtapi_parport to hal_parport.

NAME

hal_pin_alias − create an alternate name for a pin

SYNTAX

int **hal_pin_alias**(const char ***original_name**, const char ***alias**);

ARGUMENTS

original_name
The original name of the pin

alias The alternate name that may be used to refer to the pin, or NULL to remove any alternate name.

DESCRIPTION

A pin may have two names: the original name (the one that was passed to a **hal_pin_new** function) and an alias.

Usually, aliases are for the convenience of users and should be created and destroyed via halcmd. However, in some cases it is sensible to create aliases directly in a component. These cases include the case where a pin is renamed, to preserve compatibility with old versions.

RETURN VALUE

Returns a HAL status code.

SEE ALSO

hal_param_alias(3)

NAME

hal_pin_new − Create a HAL pin

SYNTAX

int hal_pin_bit_new(const char *_name_, hal_pin_dir_t _dir_, hal_bit_t ** _data_ptr_addr_, int _comp_id_)

int hal_pin_float_new(const char *_name_, hal_pin_dir_t _dir_, hal_float_t ** _data_ptr_addr_, int _comp_id_)

int hal_pin_u32_new(const char *_name_, hal_pin_dir_t _dir_, hal_u32_t ** _data_ptr_addr_, int _comp_id_)

int hal_pin_s32_new(const char *_name_, hal_pin_dir_t _dir_, hal_s32_t ** _data_ptr_addr_, int _comp_id_)

int hal_pin_bit_newf(hal_pin_dir_t _dir_, hal_bit_t ** _data_ptr_addr_, int _comp_id_, const char *_fmt_, ...)

int hal_pin_float_newf(hal_pin_dir_t _dir_, hal_float_t ** _data_ptr_addr_, int _comp_id_, const char *_fmt_, ...)

int hal_pin_u32_newf(hal_pin_dir_t _dir_, hal_u32_t ** _data_ptr_addr_, int _comp_id_, const char *_fmt_, ...)

int hal_pin_s32_newf(hal_pin_dir_t _dir_, hal_s32_t ** _data_ptr_addr_, int _comp_id_, const char *_fmt_, ...)

int hal_pin_new(const char *_name_, hal_type_t _type_, hal_pin_dir_t _dir_, void **_data_ptr_addr_, int _comp_id_)

ARGUMENTS

name The name of the pin

dir

The direction of the pin, from the viewpoint of the component. It may be one of **HAL_IN**, **HAL_OUT**, or **HAL_IO**. Any number of **HAL_IN** or **HAL_IO** pins may be connected to the same signal, but at most one **HAL_OUT** pin is permitted. A component may assign a value to a pin that is **HAL_OUT** or **HAL_IO**, but may not assign a value to a pin that is **HAL_IN**.

data_ptr_addr
The address of the pointer-to-data, which must lie within memory allocated by **hal_malloc**.

comp_id
A HAL component identifier returned by an earlier call to **hal_init**.

fmt,
A printf-style format string and arguments

type
The type of the param, as specified in **hal_type_t(3hal)**.

DESCRIPTION

The **hal_pin_new** family of functions create a new *pin* object. Once a pin has been created, it can be linked to a signal object using **hal_link**. A pin contains a pointer, and the component that owns the pin can dereference the pointer to access whatever signal is linked to the pin. (If no signal is linked, it points to a dummy signal.)

There are functions for each of the data types that the HAL supports. Pins may only be linked to signals of the same type.

RETURN VALUE

Returns 0 on success, or a negative errno value on failure.

SEE ALSO

hal_type_t(3hal), **hal_link(3hal)**

NAME

hal_ready − indicates that this component is ready

SYNTAX

hal_ready(int *comp_id*)

ARGUMENTS

comp_id

A HAL component identifier returned by an earlier call to **hal_init**.

DESCRIPTION

hal_ready indicates that this component is ready (has created all its pins, parameters, and functions). This must be called in any realtime HAL component before its **rtapi_app_init** exits, and in any userspace component before it enters its main loop.

RETURN VALUE

Returns a HAL status code.

NAME

hal_set_constructor − Set the constructor function for this component

SYNTAX

typedef int (*hal_constructor_t)(const char *prefix, const char *arg); int hal_set_constructor(int *comp_id*, hal_constructor_t *constructor*)

ARGUMENTS

comp_id A HAL component identifier returned by an earlier call to **hal_init**.

prefix The prefix to be given to the pins, parameters, and functions in the new instance

arg An argument that may be used by the component to customize this istance.

DESCRIPTION

As an experimental feature in HAL 2.1, components may be *constructable*. Such a component may create pins and parameters not only at the time the module is loaded, but it may create additional pins and parameters, and functions on demand.

RETURN VALUE

Returns a HAL status code.

SEE ALSO

halcmd(1)

NAME

hal_set_lock, hal_get_lock − Set or get the HAL lock level

SYNTAX

int hal_set_lock(unsigned char *lock_type*)

int hal_get_lock()

ARGUMENTS

lock_type

The desired lock type, which may be a bitwise combination of: **HAL_LOCK_LOAD**, **HAL_LOCK_CONFIG**, **HAL_LOCK_PARAMS**, or **HAL_LOCK_PARAMS**. **HAL_LOCK_NONE** or 0 locks nothing, and **HAL_LOCK_ALL locks everything.**

DESCRIPTION

RETURN VALUE

hal_set_lock Returns a HAL status code. **hal_get_lock** returns the current HAL lock level or a HAL status code.

NAME

hal_signal_new, hal_signal_delete, hal_link, hal_unlink − Manipulate HAL signals

SYNTAX

int hal_signal_new(const char *_signal_name_, hal_type_t _type_)

int hal_signal_delete(const char *_signal_name_)

int hal_link(const char *_pin_name_, const char *_signal_name_)

int hal_unlink(const char *_pin_name_)

ARGUMENTS

signal_name
: The name of the signal

pin_name
: The name of the pin

type The type of the signal, as specified in **hal_type_t(3hal)**.

DESCRIPTION

hal_signal_new creates a new signal object. Once a signal has been created, pins can be linked to it with **hal_link**. The signal object contains the actual storage for the signal data. Pin objects linked to the signal have pointers that point to the data. 'name' is the name of the new signal. It may be no longer than HAL_NAME_LEN characters. If there is already a signal with the same name the call will fail.

hal_link links a pin to a signal. If the pin is already linked to the desired signal, the command succeeds. If the pin is already linked to some other signal, it is an error. In either case, the existing connection is not modified. (Use 'hal_unlink' to break an existing connection.) If the signal already has other pins linked to it, they are unaffected - one signal can be linked to many pins, but a pin can be linked to only one signal.

hal_unlink unlinks any signal from the specified pin.

hal_signal_delete deletes a signal object. Any pins linked to the object are unlinked.

RETURN VALUE

Returns a HAL status code.

SEE ALSO

hal_type_t(3hal)

NAME

hal_start_threads − Allow HAL threads to begin executing

SYNTAX

int hal_start_threads()

int hal_stop_threads()

ARGUMENTS

DESCRIPTION

hal_start_threads starts all threads that have been created. This is the point at which realtime functions start being called.

hal_stop_threads stops all threads that were previously started by **hal_start_threads**. It should be called before any component that is part of a system exits.

RETURN VALUE

Returns a HAL status code.

SEE ALSO

hal_export_funct(3hal), **hal_create_thread(3hal)**, **hal_add_funct_to_thread(3hal)**

NAME

hal_stream − non-blocking realtime streams

SYNOPSIS

#include <hal.h>

int hal_stream_create(hal_stream_t *stream, int comp_id, int key, int depth, const char *typestring);
void hal_stream_destroy(hal_stream_t *stream);
int hal_stream_attach(hal_stream_t *stream, int comp_id, int key, const char *typestring);
int hal_stream_detach(hal_stream_t *stream);

int hal_stream_element_count(hal_stream_t *stream);
hal_type_t hal_stream_element_type(hal_stream_t *stream, int idx);
int hal_stream_depth(hal_stream_t *stream);
int hal_stream_maxdepth(hal_stream_t *stream);
int hal_stream_num_underruns(hal_stream_t *stream);
int hal_stream_num_overruns(hal_stream_t *stream);

int hal_stream_read(hal_stream_t *stream, union hal_stream_data *buf, unsigned *sampleno);
bool hal_stream_readable(hal_stream_t *stream);

int hal_stream_write(hal_stream_t *stream, union hal_stream_data *buf);
bool hal_stream_writable(hal_stream_t *stream);

#ifdef ULAPI
void hal_stream_wait_writable(hal_stream_t *stream, sig_atomic_t *stop);
void hal_stream_wait_readable(hal_stream_t *stream, sig_atomic_t *stop);
#endif

DESCRIPTION

A HAL stream provides a limited ability for two components to communicate data which does not fit within the model of HAL pins. A reader and a writer must agree on a *key* (32-bit integer identifier) and a data structure specified by *typestring* will **hal_stream_create** the stream, and wich component (the second one loaded) will **hal_stream_attach** to the already-created stream.

The userspace part can be **halstreamer** or **halsampler**. In the case of **halstreamer** the key is 0x48535430 plus the channel number. In the case of **halsampler** the key is 0x48534130 plus the channel number.

hal_stream_create

Create the given stream, initializing the *stream* which is passed by reference. If is an undiagnosed error if a stream has already been created with the same *key*.

hal_stream_destroy

Destroy the given stream. It is an undiagnosed error if the stream is still attached by another component. It is an undiagnosed error if the stream was attached with **hal_stream_attach** rather than created with **hal_stream_create**. It is an undiagnosed error if the call to **hal_stream_destroy** is omitted.

hal_stream_attach
Attach the given stream, which was already created by **hal_stream_create**. If the typestring is specified, this call fails if it does not match the typestring the stream was created with. If the typestring argument is NULL, then any typestring is accepted.

hal_stream_detach
Detach the given stream. It is an undiagnosed error if the stream was created with **hal_stream_create** rather than attached with **hal_stream_attach**. It is an undiagnosed error if the call to **hal_stream_detach** is omitted.

hal_stream_element_count
Returns the number of pins.

hal_stream_element_type
Returns the type of the given pin number.

hal_stream_readable
Returns true if the stream has at least one sample to read

hal_stream_read
If the stream has one sample to read, stores it in buf.

hal_stream_writable
Returns true if the stream has room for at least one sample to be written.

hal_stream_depth
Returns the number of samples waiting to be read.

hal_stream_maxdepth
Returns the **depth** argument that the stream was created with.

hal_stream_num_overruns
Returns a number which is incremented each time **hal_stream_write** is called without space available.

hal_stream_num_underruns
Returns a number which is incremented each time **hal_stream_read** is called without a sample available.

hal_stream_wait_readable
Waits until the stream is readable or the stop flag is set.

hal_stream_wait_writable
Waits until the stream is writable or the stop flag is set.

hal_stream_read
Reads a record from stream. If successful, it is stored in the given buffer. Optionally, the sample number can be retrieved. If no sample is available, *num_underruns* is incremented. It is an undetected error if more than one component or real-time function calls **hal_stream_read** concurrently.

hal_stream_write
Writes a record to the stream. If successful, it copied from the given buffer. If no room is available, *num_overruns* is incremented. In either case, the internal *sampleno* value is incremented.
It is an undetected error if more than one component or real-time function calls **hal_stream_write** concurrently.

ARGUMENTS

stream A pointer to a stream object. In the case of **hal_stream_create** and **hal_stream_attach** this is an uninitialized stream; in other cases, it must be a stream created or attached by an earlier call and not yet detached or destroyed.

hal_id An HAL component identifier returned by an earlier call to **hal_init**.

key The key for the shared memory segment.

depth The number of samples that can be unread before any samples are lost (overrun)

typestring

A typestring is a case-insensitive string which consists of one or more of the following type characters:

- B for bool / hal_bit_t
- S for int32_t / hal_s32_t
- U for uint32_t / hal_u32_t
- F for real_t / hal_float_t

A typestring is limited to 16 characters.

buf A buffer big enough to hold all the data in one sample.

sampleno

If non-NULL, the last sample number is stored here. Gaps in this sequence indicate that an overrun occured between the previous read and this one. May be NULL, in which case the sample number is not retrieved.

stop A pointer to a value which is monitored while waiting. If it is nonzero, the wait operation returns early. This allows a wait call to be safely terminated in the case of a signal.

SAMPLE CODE

In the source tree under *src/hal/components*, **sampler.c** and **streamer.c** are realtime components that read and write hal streams.

REALTIME CONSIDERATIONS

hal_stream_read, **hal_stream_readable**, **hal_stream_write**, **hal_stream_writable**, **hal_stream_element_count**, **hal_tream_pin_type**, **hal_stream_depth**, **hal_stream_maxdepth**, **hal_stream_num_underruns**, **hal_stream_number_overruns** may be called from realtime code.

hal_stream_wait_writable, **hal_stream_wait_writable** may be called from ULAPI code.

Other functions may be called in any context, including realtime contexts.

RETURN VALUE

hal_stream_create , **hal_stream_attach** , **hal_stream_read** , **hal_stream_write** , **hal_stream_detach** and **hal_stream_destroy** return an RTAPI status code. Other functions' return values are explained above.

BUGS

The memory overhead of a stream can be large. Each element in a record uses 8 bytes, and the implicit sample number also uses 8 bytes. As a result, a stream which is used to transport 8-bit values uses 94% of

its memory as overhead. However, for modest stream sizes this overhead is not important. (this memory is part of its own shared memory region and does not count against the HAL shared memory region used for pins, parameters and signals)

SEE ALSO

sampler(9), **streamer**(9), **halsampler**(1), **halstreamer**(1)

NAME

hal_type_t − typedefs for HAL datatypes

DESRCIPTION

typedef ... **hal_bool;**
A type which may have a value of 0 or nonzero.

typedef ... **hal_bit_t;**
A volatile type which may have a value of 0 or nonzero.

typedef ... **hal_s32_t**;
A volatile type which may have a value from −2147483648 to 2147483647.

typedef ... **hal_u32_t**;
A volatile type which may have a value from 0 to 4294967295.

typedef ... **hal_float_t**;
A volatile floating-point type, which typically has the same precision and range as the C type **double**.

typedef ... **real_t**;
A nonvolatile floating-point type with at least as much precision as **hal_float_t**.

typedef ... **ireal_t**;
A nonvolatile unsigned integral type the same size as **hal_float_t**.

typedef enum **hal_type_t**;

HAL_BIT
Corresponds to the type **hal_bit_t**.

HAL_FLOAT
Corresponds to the type **hal_float_t**.

HAL_S32
Corresponds to the type **hal_s32_t**.

HAL_U32
Corresponds to the type **hal_u32_t**.

NOTES

hal_bit_t is typically a typedef to an integer type whose range is larger than just 0 and 1. When testing the value of a **hal_bit_t**, never compare it to 1. Prefer one of the following:

- if(b)
- if(b != 0)

It is often useful to refer to a type that can represent all the values as a hal type, but without the volatile qualifier. The following types correspond with the hal types:

hal_bit_t	int
hal_s32_t	__s32
hal_u32_t	__u32
hal_float_t	hal_real_t

Take care not to use the types **s32** and **u32**. These will compile in kernel modules but not in userspace, and not for "realtime components" when using simulated (userspace) realtime.

SEE ALSO

hal_pin_new(3hal), **hal_param_new(3hal)**

NAME

undocumented − undocumented functions in HAL

SEE ALSO

The header file *hal.h*. Most hal functions have documentation in that file.

NAME

rtapi − Introduction to the RTAPI API

DESCRIPTION

RTAPI is a library providing a uniform API for several real time operating systems. As of LinuxCNC 2.7, POSIX threads and RTAI are supported.

HEADER FILES

rtapi.h

The file **rtapi.h** defines the RTAPI for both realtime and non-realtime code. This is a change from Rev 2, where the non-realtime (user space) API was defined in ulapi.h and used different function names. The symbols RTAPI and ULAPI are used to determine which mode is being compiled, RTAPI for realtime and ULAPI for non-realtime.

rtapi_math.h

The file rtapi_math.h defines floating-point functions and constants. It should be used instead of <math.h> in rtapi real-time components.

rtapi_string.h

The file rtapi_string.h defines string-related functions. It should be used instead of <string.h> in rtapi real-time components.

rtapi_byteorder.h

This file defines the preprocessor macros RTAPI_BIG_ENDIAN, RTAPI_LITTLE_ENDIAN, and RTAPI_FLOAT_BIG_ENDIAN as true or false depending on the characteristics of the target system. It should be used instead of **<endian.h>** (userspace) or **<linux/byteorder.h>** (kernel space).

rtapi_limits.h

This file defines the minimum and maximum value of some fundamental integral types, such as INT_MIN and INT_MAX. This should be used instead of **<limits.h>** because that header file is not available to kernel modules.

REALTIME CONSIDERATIONS

Userspace code

Certain functions are not available in userspace code. This includes functions that perform direct device access such as **rtapi_inb(3)**.

Init/cleanup code

Certain functions may only be called from realtime init/cleanup code. This includes functions that perform memory allocation, such as **rtapi_shmem_new(3)**.

Realtime code

Only a few functions may be called from realtime code. This includes functions that perform direct device access such as **rtapi_inb(3)**. It excludes most Linux kernel APIs such as do_gettimeofday(3) and many rtapi APIs such as rtapi_shmem_new(3).

Simulator

For an RTAPI module to be buildable in the "sim" environment (fake realtime system without special privileges), it must not use **any** linux kernel APIs, and must not use the RTAPI APIs for direct device

access such as **rtapi_inb(3)**. This automatically includes any hardware device drivers, and also devices which use Linux kernel APIs to do things like create special devices or entries in the **/proc** filesystem.

RTAPI STATUS CODES

Except as noted in specific manual pages, RTAPI returns negative errno values for errors, and nonnegative values for success.

NAME

rtapi_app_exit − User-provided function to shut down a component

SYNTAX

#include <rtapi_app.h>

void rtapi_app_exit(void) {...**}**

ARGUMENTS

None

DESCRIPTION

The body of **rtapi_app_exit**, which is provided by the component author, generally consists of a call to rtapi_exit or hal_exit, preceded by other component-specific shutdown code.

This code is called when unloading a component which successfully initialized (i.e., returned zero from its **rtapi_app_main**). It is not called when the component did not successfully initialize.

RETURN CODE

None.

REALTIME CONSIDERATIONS

Called automatically by the rtapi infrastructure in an initialization (not realtime) context.

SEE ALSO

rtapi_app_main(3rtapi), **rtapi_exit(3rtapi)**, **hal_exit(3hal)**

NAME

rtapi_app_main − User-provided function to initialize a component

SYNTAX

#include <rtapi_app.h>

int rtapi_app_main(void) {...**}**

ARGUMENTS

None

DESCRIPTION

The body of **rtapi_app_main**, which is provided by the component author, generally consists of a call to rtapi_init or hal_init, followed by other component-specific initialization code.

RETURN VALUE

Return 0 for success. Return a negative errno value (e.g., −EINVAL) on error. Existing code also returns RTAPI or HAL error values, but using negative errno values gives better diagnostics from insmod.

REALTIME CONSIDERATIONS

Called automatically by the rtapi infrastructure in an initialization (not realtime) context.

SEE ALSO

rtapi_app_exit(3rtapi), **rtapi_init(3rtapi)**, **hal_init(3hal)**

NAME

rtapi_atomic − subset of C11 <stdatomic.h>

SYNTAX

#include <rtapi_atomic.h>

enum memory_order { ... };

#define atomic_store(obj, desired)...

#define atomic_store_explicit(obj, desired, order)...

#define atomic_load(obj)...

#define atomic_load_explicit(obj, order)...

ARGUMENTS

volatile A* *obj*

A pointer to a volatile object that is the destination of the store or the source of the load. The pointer must have an appropriate type and alignment such that the underlying store or load operation itself is atomic; at a minimum, a properly aligned "int" may be assumed to be such a type. Improper size or alignment are undiagnosed errors.

C *desired*

The value to be stored in the object. "*obj = desired" must be well-formed.

memory_order order

The required memory ordering semantic.

DESCRIPTION

This header provides at least the subset of C11's <stdatomic.h> given above. When there is an ordering requirement for multiple values read or written in RTAPI shared memory areas by other threads of execution, including the values of HAL pins and parameters, these functions (or function-like macros) are the only way to ensure the ordering requirement is obeyed. Otherwise, according to architecture-specific rules, loads and stores may be reordered from their normal source code order.

For example, to leave a message in a shared memory area from one thread and retrieve it from another, the writer must use an atomic store for the "message is complete" variable, and the reader must use an atomic load when checking that variable:

```
// producer
*message = 42;
atomic_store_explicit(message_ready, 1, memory_order_release);

// consumer
while(atomic_load_explicit(message_ready, memory_order_acquire) == 0) sched_yi
printf("message was %d\n", *message); // must print 42
```

REALTIME CONSIDERATIONS

May be called from any code.

RETURN VALUE

atomic_load and **atomic_load_explicit** return the value pointed to by the *obj* argument.

atomic_store and **atomic_store_explicit** have no return value.

SEE ALSO

<stdatomic.h> (C11), **<rtapi_bitops.h>** (for other atomic memory operations supported by rtapi)

NAME

rtapi_bool.h − RTAPI wrappers for linux kernel functionality

SYNTAX

#include <rtapi_bool.h>

DESCRIPTION

Includes either <stdbool.h> or <linux/types.h> as appropriate, to obtain suitable declarations of "bool", "true" and "false".

REALTIME CONSIDERATIONS

None.

NOTES

Also permitted in C++ programs, where including it has no effect.

NAME

rtapi_byteorder.h − RTAPI wrappers for linux kernel functionality

SYNTAX

#include <rtapi_byteorder.h>

RTAPI_BIG_ENDIAN
: Defined to 1 if the platform is big-endian, 0 otherwise

RTAPI_LITTLE_ENDIAN
: Defined to 1 if the platform is little-endian, 0 otherwise

RTAPI_FLOAT_BIG_ENDIAN
: Defined to 1 if the platform double-precision value is big-endian, 0 otherwise.

DESCRIPTION

In kernel space, each rtapi_xxx or RTAPI_XXX identifier is mapped to the underlying kernel functionality, if available.

In userspace, or in kernels where the underlying functionality is not provided by a kernel, generally another implementation--possibly with reduced functionality--is provided. (For example, the userspace implementation for rtapi_byteorder_register always succeeds)

REALTIME CONSIDERATIONS

May be used at any time.

RETURN VALUE

As in Linux.

SEE ALSO

NAME

rtapi_clock_set_period − set the basic time interval for realtime tasks

SYNTAX

rtapi_clock_set_period(long int *nsec*)

ARGUMENTS

nsec The desired basic time interval for realtime tasks.

DESCRIPTION

rtapi_clock_set_period sets the basic time interval for realtime tasks. All periodic tasks will run at an integer multiple of this period. The first call to **rtapi_clock_set_period** with *nsec* greater than zero will start the clock, using *nsec* as the clock period in nano-seconds. Due to hardware and RTOS limitations, the actual period may not be exactly what was requested. On success, the function will return the actual clock period if it is available, otherwise it returns the requested period. If the requested period is outside the limits imposed by the hardware or RTOS, it returns **−EINVAL** and does not start the clock. Once the clock is started, subsequent calls with non-zero *nsec* return **−EINVAL** and have no effect. Calling **rtapi_clock_set_period** with *nsec* set to zero queries the clock, returning the current clock period, or zero if the clock has not yet been started.

REALTIME CONSIDERATIONS

Call only from within init/cleanup code, not from realtime tasks. This function is not available from user (non-realtime) code.

RETURN VALUE

The actual period provided by the RTOS, which may be different than the requested period, or a RTAPI status code.

NAME

rtapi_delay − Busy-loop for short delays

SYNTAX

void rtapi_delay(long int *nsec*)

void rtapi_delay_max()

ARGUMENTS

nsec The desired delay length in nanoseconds

DESCRIPTION

rtapi_delay is a simple delay. It is intended only for short delays, since it simply loops, wasting CPU cycles.

rtapi_delay_max returns the max delay permitted (usually approximately 1/4 of the clock period). Any call to **rtapi_delay** requesting a delay longer than the max will delay for the max time only.

rtapi_delay_max should be called before using **rtapi_delay** to make sure the required delays can be achieved. The actual resolution of the delay may be as good as one nano-second, or as bad as a several microseconds.

REALTIME CONSIDERATIONS

May be called from init/cleanup code, and from within realtime tasks.

RETURN VALUE

rtapi_delay_max returns the maximum delay permitted.

SEE ALSO

rtapi_clock_set_period(3rtapi)

NAME

rtapi_device.h − RTAPI wrappers for linux kernel functionality

SYNTAX

```
#include <rtapi_device.h>

struct rtapi_device;

int rtapi_dev_set_name(struct rtapi_device *dev, const char *name, ...);

int rtapi_device_register(struct rtapi_device *dev);

int rtapi_device_unregister(struct rtapi_device *dev);
```

DESCRIPTION

In kernel space, each rtapi_xxx or RTAPI_XXX identifier is mapped to the underlying kernel functionality, if available.

In userspace, or in kernels where the underlying functionality is not provided by a kernel, generally another implementation--possibly with reduced functionality--is provided. (For example, the userspace implementation for rtapi_device_register always succeeds)

REALTIME CONSIDERATIONS

Typically, these functions may be called from realtime init/cleanup code.

RETURN VALUE

As in Linux.

SEE ALSO

NAME

rtapi_div_u64 − unsigned division of a 64-bit number by a 32-bit number

SYNTAX

__u64 rtapi_div_u64_rem(__u64 *dividend*, __u32 *divisor*, __u32 **remainder*)

__u64 rtapi_div_u64(__u64 *dividend*, __u32 *divisor*)

__s64 rtapi_div_s64(__s64 *dividend*, __s32 *divisor*)

__s64 rtapi_div_s64_rem(__s64 *dividend*, __s32 *divisor*, __s32 **remainder*)

ARGUMENTS

dividend
: The value to be divided

divisor
: The value to divide by

remainder
: Pointer to the location to store the remainder. This may not be a NULL pointer. If the remainder is not desired, call **rtapi_div_u64** or **rtapi_div_s64**.

DESCRIPTION

Perform integer division (and optionally compute the remainder) with a 64-bit dividend and 32-bit divisor.

RETURN VALUE

The result of integer division of *dividend / divisor*. In versions with the *remainder* argument, the remainder is stored in the pointed-to location.

NOTES

If the result of the division does not fit in the return type, the result is undefined.

This function exists because in kernel space the use of the division operator on a 64-bit type can lead to an undefined symbol such as __umoddi3 when the module is loaded.

REALTIME CONSIDERATIONS

May be called from init/cleanup code and from within realtime tasks. Available in userspace components.

NAME

rtapi_exit − Shut down RTAPI

SYNTAX

int rtapi_exit(int *module_id*)

ARGUMENTS

module_id

An rtapi module identifier returned by an earlier call to **rtapi_init**.

DESCRIPTION

rtapi_exit shuts down and cleans up the RTAPI. It must be called prior to exit by any module that called **rtapi_init**.

REALTIME CONSIDERATIONS

Call only from within user or init/cleanup code, not from relatime tasks.

RETURN VALUE

Returns a RTAPI status code.

NAME

rtapi_firmware.h − RTAPI wrappers for linux kernel functionality

SYNTAX

```
#include <rtapi_firmware.h>

struct rtapi_firmware;

int rtapi_request_firmware(const struct rtapi_firmware **fw,
        const char *name, struct rtapi_device *device);

void rtapi_release_firmware(const struct rtapi_firmware *fw);
```

DESCRIPTION

In kernel space, each rtapi_xxx or RTAPI_XXX identifier is mapped to the underlying kernel functionality, if available.

In userspace, or in kernels where the underlying functionality is not provided by a kernel, generally another implementation--possibly with reduced functionality--is provided. (For example, the userspace implementation for rtapi_device_register always succeeds)

REALTIME CONSIDERATIONS

Typically, these functions may be called from realtime init/cleanup code.

RETURN VALUE

As in Linux.

SEE ALSO

NAME

rtapi_get_time − get the current time

SYNTAX

long long rtapi_get_time()

long long rtapi_get_clocks()

DESCRIPTION

rtapi_get_time returns the current time in nanoseconds. Depending on the RTOS, this may be time since boot, or time since the clock period was set, or some other time. Its absolute value means nothing, but it is monotonically increasing and can be used to schedule future events, or to time the duration of some activity. Returns a 64 bit value. The resolution of the returned value may be as good as one nano-second, or as poor as several microseconds. May be called from init/cleanup code, and from within realtime tasks.

rtapi_get_clocks returns the current time in CPU clocks. It is fast, since it just reads the TSC in the CPU instead of calling a kernel or RTOS function. Of course, times measured in CPU clocks are not as convenient, but for relative measurements this works fine. Its absolute value means nothing, but it is monotonically increasing and can be used to schedule future events, or to time the duration of some activity. (on SMP machines, the two TSC's may get out of sync, so if a task reads the TSC, gets swapped to the other CPU, and reads again, the value may decrease. RTAPI tries to force all RT tasks to run on one CPU.) Returns a 64 bit value. The resolution of the returned value is one CPU clock, which is usually a few nanoseconds to a fraction of a nanosecond.

Note that *long long* math may be poorly supported on some platforms, especially in kernel space. Also note that rtapi_print() will NOT print *long long*s. Most time measurements are relative, and should be done like this:

```
deltat = (long int)(end_time − start_time);
```

where end_time and start_time are longlong values returned from rtapi_get_time, and deltat is an ordinary long int (32 bits). This will work for times up to a second or so, depending on the CPU clock frequency. It is best used for millisecond and microsecond scale measurements though.

RETURN VALUE

Returns the current time in nanoseconds or CPU clocks.

NOTES

Certain versions of the Linux kernel provide a global variable **cpu_khz**. Computing

```
deltat = (end_clocks − start_clocks) / cpu_khz:
```

gives the duration measured in milliseconds. Computing

```
deltat = (end_clocks − start_clocks) * 1000000 / cpu_khz:
```

gives the duration measured in nanoseconds for deltas less than about 9 trillion clocks (e.g., 3000 seconds at 3GHz).

REALTIME CONSIDERATIONS

May be called from init/cleanup code and from within realtime tasks. Not available in userspace components.

NAME

rtapi_gfp.h − RTAPI wrappers for linux kernel functionality

SYNTAX

#include <rtapi_gfp.h>

enum rtapi_gfp_e;

RTAPI_GFP_xxx

typedef ... rtapi_gfp_t;

DESCRIPTION

In kernel space, each rtapi_xxx or RTAPI_XXX identifier is mapped to the underlying kernel functionality, if available.

In userspace, or in kernels where the underlying functionality is not provided by a kernel, generally another implementation--possibly with reduced functionality--is provided. (For example, the userspace implementation for rtapi_device_register always succeeds)

REALTIME CONSIDERATIONS

Typically, these functions may be called from realtime init/cleanup code.

RETURN VALUE

As in Linux.

SEE ALSO

NAME

rtapi_init − Sets up RTAPI

SYNTAX

int rtapi_init(const char **modname*)

ARGUMENTS

modname

The name of this rtapi module

DESCRIPTION

rtapi_init sets up the RTAPI. It must be called by any module that intends to use the API, before any other RTAPI calls.

modname can optionally point to a string that identifies the module. The string will be truncated at **RTAPI_NAME_LEN** characters. If *modname* is **NULL**, the system will assign a name.

REALTIME CONSIDERATIONS

Call only from within user or init/cleanup code, not from relatime tasks.

RETURN VALUE

On success, returns a positive integer module ID, which is used for subsequent calls to rtapi_xxx_new, rtapi_xxx_delete, and rtapi_exit. On failure, returns an RTAPI error code.

NAME

rtapi_io.h − RTAPI wrappers for linux kernel functionality

SYNTAX

#include <rtapi_io.h>

unsigned char rtapi_inb(unsigned short int port);

unsigned short rtapi_inw(unsigned short int port);

unsigned int rtapi_inl(unsigned short int port);

unsigned void rtapi_inb(unsigned char value, unsigned short int port);

unsigned void rtapi_inw(unsigned short value, unsigned short int port);

unsigned void rtapi_inl(unsigned int value, unsigned short int port);

DESCRIPTION

In kernel space, each rtapi_xxx or RTAPI_XXX identifier is mapped to the underlying kernel functionality, if available.

In userspace, or in kernels where the underlying functionality is not provided by a kernel, generally another implementation--possibly with reduced functionality--is provided. (For example, the userspace implementation for rtapi_device_register always succeeds)

REALTIME CONSIDERATIONS

Call from init/cleanup code and from realtime tasks. These functions will cause illegal instruction exceptions in userspace components, as well as in uspace rtapi_app when it is not setuid root.

RETURN VALUE

As in Linux.

SEE ALSO

NAME

rtapi_is − details of rtapi configuration

SYNTAX

int rtapi_is_kernelspace()

int rtapi_is_realtime()

DESCRIPTION

rtapi_is_kernelspace() returns nonzero when rtapi modules run in kernel space (e.g., under rtai) and zero when they run in userpace (e.g., under uspace).

rtapi_is_realtime() returns nonzero when capable of running with realtime guarantees. For rtai, this always returns nonzero (but actually loading realtime modules will fail if not running under the appropriate kernel). For uspace, this returns nonzero when the running kernel indicates it is capable of realtime performance. If **rtapi_app** is not setuid root, this returns nonzero even though **rtapi_app** will not be able to obtain realtime scheduling or hardware access, so e.g., attempting to **loadrt** a hardware driver will fail.

REALTIME CONSIDERATIONS

May be called from userspace or from realtime setup code. **rtapi_is_realtime()** may perform filesystem I/O.

RETURN VALUE

Zero for false, nonzero for true.

NAME

rtapi_list.h − RTAPI wrappers for linux kernel functionality

SYNTAX

#include <rtapi_list.h>

struct rtapi_list_head;

void rtapi_list_add(struct rtapi_list_head *new_, struct rtapi_list_head *head);

void rtapi_list_add_tail(struct rtapi_list_head *new_, struct rtapi_list_head *head);

void rtapi_list_del(struct rtapi_list_head *entry);

void RTAPI_INIT_LIST_HEAD(struct rtapi_list_head *entry);

rtapi_list_for_each(pos, head) { ... }

rtapi_list_entry(ptr, type, member)

DESCRIPTION

In kernel space, each rtapi_xxx or RTAPI_XXX identifier is mapped to the underlying kernel functionality, if available.

In userspace, or in kernels where the underlying functionality is not provided by a kernel, generally another implementation--possibly with reduced functionality--is provided. (For example, the userspace implementation for rtapi_device_register always succeeds)

REALTIME CONSIDERATIONS

Call from init/cleanup code and from realtime tasks. These functions will cause illegal instruction exceptions in userspace components, as well as in uspace rtapi_app when it is not setuid root.

RETURN VALUE

As in Linux.

SEE ALSO

NAME

rtapi_module_param − Specifying module parameters

SYNTAX

RTAPI_MP_INT(*var*, *description*)

RTAPI_MP_LONG(*var*, *description*)

RTAPI_MP_STRING(*var*, *description*)

RTAPI_MP_ARRAY_INT(*var*, *num*, *description*)

RTAPI_MP_ARRAY_LONG(*var*, *num*, *description*)

RTAPI_MP_ARRAY_STRING(*var*, *num*, *description*)

MODULE_LICENSE(*license*)

MODULE_AUTHOR(*author*)

MODULE_DESCRIPTION(*description*)

EXPORT_FUNCTION(*function*)

ARGUMENTS

var The variable where the parameter should be stored

description
A short description of the parameter or module

num The maximum number of values for an array parameter

license The license of the module, for instance "GPL"

author The author of the module

function
The pointer to the function to be exported

DESCRIPTION

These macros are portable ways to declare kernel module parameters. They must be used in the global scope, and are not followed by a terminating semicolon. They must be used after the associated variable or function has been defined.

NOTES

EXPORT_FUNCTION makes a symbol available for use by a subsequently loaded component. It is unrelated to hal functions, which are described in hal_export_funct(3hal)

Interpretation of license strings

MODULE_LICENSE follows the kernel's definition of license strings. Notably, "GPL" indicates "GNU General Public License v2 *or later*". (emphasis ours).

"GPL"
GNU General Public License v2 or later

"GPL v2"
GNU General Public License v2

"GPL and additional rights"
GNU General Public License v2 rights and more

"Dual BSD/GPL"
GNU General Public License v2 or BSD license choice

"Dual MIT/GPL"
GNU General Public License v2 or MIT license choice

"Dual MPL/GPL"
GNU General Public License v2 or Mozilla license choice

"Proprietary"
Non-free products

It is still good practice to include a license block which indicates the author, copyright date, and disclaimer of warranty as recommended by the GNU GPL.

REALTIME CONSIDERATIONS

Not available in userspace code.

NAME

rtapi_mutex − Mutex-related functions

SYNTAX

#include <rtapi_mutex.h>

int rtapi_mutex_try(unsigned long ****mutex*);**
int rtapi_mutex_get(unsigned long ****mutex*);**
int rtapi_mutex_give(unsigned long ****mutex*);**

ARGUMENTS

mutex A pointer to the mutex.

DESCRIPTION

rtapi_mutex_try makes a non-blocking attempt to get the mutex. If the mutex is available, it returns 0, and the mutex is no longer available. Otherwise, it returns a nonzero value.

rtapi_mutex_get blocks until the mutex is available.

rtapi_mutex_give releases a mutex acquired by **rtapi_mutex_try** or **rtapi_mutex_get**.

REALTIME CONSIDERATIONS

rtapi_mutex_give and **rtapi_mutex_try** may be used from user, init/cleanup, and realtime code.

rtapi_mutex_get may not be used from realtime code.

RETURN VALUE

rtapi_mutex_try returns 0 for if the mutex was claimed, and nonzero otherwise.

rtapi_mutex_get and **rtapi_mutex_gif** have no return value.

NAME

rtapi_open_as_root − Open a file with "root" privilege

SYNTAX

#include <rtapi.h>

int rtapi_open_as_root(const char **filename***, int** *flags)*

ARGUMENTS

filename

The filename to open, as in **open(2)**. Note that rtapi has no well-defined "current directory", so this should be an absolute path, but this is not enforced.

flags The open flags, as in **open(2)**. Should never include bits that open or create files (e.g., O_CREAT, O_APPEND, etc) as this API is not intended for creating or writing files, but this is not enforced.

DESCRIPTION

In "uspace" realtime, root privileges are dropped whenever possible. This API temporarily switches on root priveleges to open a file, and switches them off before returning. This can be useful for example when accessing device nodes or memory-mapped I/O.

In the case of PCI devices on x86 and x86-64 systems, prefer the linux-style PCI interfaces provided in **<rtapi_pci.h>**.

RETURN VALUE

In case of success, the nonnegative file descriptor opened. If the caller does not close it, it remains open until rtapi_app exits.

In case of failure, a negative errno value.

REALTIME CONSIDERATIONS

Call only from realtime initcode in "uspace" realtime.

SEE ALSO

open(2), **rtapi_pci(3)**

NAME

rtapi_outb, rtapi_inb − Perform hardware I/O

SYNTAX

void rtapi_outb(unsigned char *byte*, unsigned int *port*)

unsigned char rtapi_inb(unsigned int *port*)

ARGUMENTS

port The address of the I/O port

byte The byte to be written to the port

DESCRIPTION

rtapi_outb writes a byte to a hardware I/O port. **rtapi_inb** reads a byte from a hardware I/O port.

REALTIME CONSIDERATIONS

May be called from init/cleanup code and from within realtime tasks. Not available in userspace components.

RETURN VALUE

rtapi_inb returns the byte read from the given I/O port

NOTES

The I/O address should be within a region previously allocated by **rtapi_request_region**. Otherwise, another real-time module or the Linux kernel might attempt to access the I/O region at the same time.

SEE ALSO

rtapi_region(3rtapi)

NAME

rtapi_parport − portable access to PC-style parallel ports

SYNTAX

#include "rtapi_parport.h"

int **rtapi_parport_get**(const char **module_name*, rtapi_parport_t **port*, unsigned short *base*, unsigned short *base_hi*, unsigned int *modes*)

void **rtapi_parport_release**(rtapi_parport_t **port*)

ARGUMENTS

module_name
By convention, the name of the RTAPI module or HAL component using the parport.

port A pointer to a rtapi_parport_t structure

base The base address of the port (if port >= 16) or the linux port number of the port (if port < 16)

base_hi
The "high" address of the port (location of the ECP registers), 0 to use a probed high address, or −1 to disable the high address

modes Advise the driver of the desired port modes, from <linux/parport.h>. If a linux-detected port does not provide the requested modes, a warning is printed with rtapi_print_msg. This does not make the port request fail, because unfortunately, many systems that have working EPP parports are not detected as such by Linux.

DESCRIPTION

rtapi_parport_get allocates a parallel port for exclusive use of the named hal component. If successful, access the port with I/O calls such as rtapi_inb at address based at the **base** or **base_hi** addresses. The port must be released with **rtapi_parport_release** before the component exits with **rtapi_exit**.

HIGH ADDRESS PROBING

If the port is a parallel port known to Linux, and Linux detected a high I/O address, this value is used. Otherwise, if base+0x400 is not registered to any device, it is used. Otherwise, no address is used. If no high address is detected, port−>base_hi is 0.

PARPORT STRUCTURE

```
typedef struct
{
   unsigned short base;
   unsigned short base_hi;
   .... // and further unspecified fields
} rtapi_parport_t;
```

RETURN VALUE

rtapi_parport_get returns a HAL status code. On success, *port* is filled out with information about the allocated port. On failure, the contents of *port* are undefined except that it is safe (but not required) to pass this port to **rtapi_parport_release**.

rtapi_parport_release does not return a value. It always succeeds.

NOTES

In new code, prefer use of rtapi_parport to rtapi_parport.

NAME

rtapi_pci.h − RTAPI wrappers for linux kernel functionality

SYNTAX

```
#include <rtapi_pci.h>

struct rtapi_pci_device_id { ... };

struct rtapi_pci_resource { ... };

struct rtapi_pci_dev { ... };

struct rtapi_pci_driver { ... };

const char *rtapi_pci_name(const struct rtapi_pci_dev *pdev);

int rtapi_pci_enable_device(struct rtapi_pci_dev *dev);

void rtapi__iomem *rtapi_pci_ioremap_bar(struct rtapi_pci_dev *pdev, int bar);

int rtapi_pci_register_driver(struct rtapi_pci_driver *driver);

void rtapi_pci_unregister_driver(struct rtapi_pci_driver *driver);

int rtapi_pci_enable_device(struct rtapi_pci_dev *dev);

int rtapi_pci_disable_device(struct rtapi_pci_dev *dev);

#define rtapi_pci_resource_start(dev, bar) ...

#define rtapi_pci_resource_end(dev, bar) ...

#define rtapi_pci_resource_flags(dev, bar) ...

#define rtapi_pci_resource_len(dev,bar) ....

void rtapi_pci_set_drvdata(struct rtapi_pci_dev *pdev, void *data)

void rtapi_pci_set_drvdata(struct rtapi_pci_dev *pdev, void *data)

void rtapi_iounmap(volatile void *addr);

struct rtapi_pci;
```

DESCRIPTION

In kernel space, each rtapi_xxx or RTAPI_XXX identifier is mapped to the underlying kernel functionality, if available.

In userspace, or in kernels where the underlying functionality is not provided by a kernel, generally another implementation--possibly with reduced functionality--is provided. (For example, the userspace implementation for rtapi_pci_register always succeeds)

REALTIME CONSIDERATIONS

Typically, these functions may be called from realtime init/cleanup code.

RETURN VALUE

As in Linux.

SEE ALSO

NAME

rtapi_print, rtapi_print_msg − print diagnostic messages

SYNTAX

void rtapi_print(const char *_fmt_, ...)

void rtapi_print_msg(int level, const char *_fmt_, ...)

typedef void(*__rtapi_msg_handler_t__)(msg_level_t _level_, const char *_msg_);

void **rtapi_set_msg_handler**(rtapi_msg_handler_t _handler_);

rtapi_msg_handler_t **rtapi_get_msg_handler**(void);

ARGUMENTS

level A message level: One of **RTAPI_MSG_ERR**, **RTAPI_MSG_WARN**, **RTAPI_MSG_INFO**, or **RTAPI_MSG_DBG**.

handler
A function to call from **rtapi_print** or **rtapi_print_msg** to actually output the message.

fmt, ... Other arguments are as for *rtapi_vsnprintf(3rtapi)*.

DESCRIPTION

rtapi_print and **rtapi_print_msg** work like the standard C printf functions, except that a reduced set of formatting operations are supported. Notably, formatting long-long values is not supported, and formatting floating-point values has different behavior than standard printf.

Depending on the RTOS, the default may be to print the message to stdout, stderr, a kernel log, etc. In RTAPI code, the action may be changed by a call to **rtapi_set_msg_handler**. A **NULL** argument to **rtapi_set_msg_handler** restores the default handler. **rtapi_msg_get_handler** returns the current handler. When the message came from **rtapi_print**, *level* is RTAPI_MSG_ALL.

rtapi_print_msg works like rtapi_print but only prints if *level* is less than or equal to the current message level.

REALTIME CONSIDERATIONS

rtapi_print and **rtapi_print_msg** May be called from user, init/cleanup, and realtime code. **rtapi_get_msg_handler** and **rtapi_set_msg_handler** may be called from realtime init/cleanup code. A message handler passed to **rtapi_set_msg_handler** may only call functions that can be called from real-time code.

RETURN VALUE

None.

SEE ALSO

rtapi_set_msg_level(3rtapi), **rtapi_get_msg_level(3rtapi)**, **rtapi_vsnprintf(3rtapi)**

NAME

rtapi_prio − thread priority functions

SYNTAX

int rtapi_prio_highest()

int rtapi_prio_lowest()

int rtapi_prio_next_higher(int *prio*)

int rtapi_prio_next_lower(int *prio*)

ARGUMENTS

prio A value returned by a prior **rtapi_prio_xxx** call

DESCRIPTION

The **rtapi_prio_xxxx** functions provide a portable way to set task priority. The mapping of actual priority to priority number depends on the RTOS. Priorities range from **rtapi_prio_lowest** to **rtapi_prio_highest**, inclusive. To use this API, use one of two methods:

1) Set your lowest priority task to **rtapi_prio_lowest**, and for each task of the next lowest priority, set their priorities to **rtapi_prio_next_higher(previous)**.

2) Set your highest priority task to **rtapi_prio_highest**, and for each task of the next highest priority, set their priorities to **rtapi_prio_next_lower(previous)**.

N.B. A high priority task will pre-empt or interrupt a lower priority task. Linux is always the lowest priority!

REALTIME CONSIDERATIONS

Call these functions only from within init/cleanup code, not from realtime tasks.

RETURN VALUE

Returns an opaque real-time priority number.

SEE ALSO

rtapi_task_new(3rtapi)

NAME

rtapi_region − functions to manage I/O memory regions

SYNTAX

void *rtapi_request_region(unsigned long *base*, unsigned long int *size*, const char **name*)

void rtapi_release_region(unsigned long *base*, unsigned long int *size*)

ARGUMENTS

base The base address of the I/O region

size The size of the I/O region

name The name to be shown in /proc/ioports

DESCRIPTION

rtapi_request_region reserves I/O memory starting at *base* and going for *size* bytes.

REALTIME CONSIDERATIONS

May be called from realtime init/cleanup code only.

RETURN VALUE

rtapi_request_region returns NULL if the allocation fails, and a non-NULL value otherwise.

rtapi_release_region has no return value.

NAME

rtapi_get_msg_level, rtapi_set_msg_level − Get or set the logging level

SYNTAX

int rtapi_set_msg_level(int *level*)

int rtapi_get_msg_level()

ARGUMENTS

level The desired logging level

DESCRIPTION

Get or set the RTAPI message level used by **rtapi_print_msg**. Depending on the RTOS, this level may apply to a single RTAPI module, or it may apply to a group of modules.

REALTIME CONSIDERATIONS

May be called from user, init/cleanup, and realtime code.

RETURN VALUE

rtapi_set_msg_level returns a status code, and **rtapi_get_msg_level** returns the current level.

SEE ALSO

rtapi_print_msg(3rtapi)

NAME

rtapi_shmem − Functions for managing shared memory blocks

SYNTAX

int rtapi_shmem_new(int *key*, int *module_id*, unsigned long int *size*)

int rtapi_shmem_delete(int *shmem_id*, int *module_id*)

int rtapi_shmem_getptr(int *shmem_id*, void ** *ptr*)

ARGUMENTS

key Identifies the memory block. Key must be nonzero. All modules wishing to use the same memory must use the same key.

module_id
Module identifier returned by a prior call to **rtapi_init**.

size The desired size of the shared memory block, in bytes

ptr The pointer to the shared memory block. Note that the block may be mapped at a different address for different modules.

DESCRIPTION

rtapi_shmem_new allocates a block of shared memory. *key* identifies the memory block, and must be non-zero. All modules wishing to access the same memory must use the same key. *module_id* is the ID of the module that is making the call (see rtapi_init). The block will be at least *size* bytes, and may be rounded up. Allocating many small blocks may be very wasteful. When a particular block is allocated for the first time, the first 4 bytes are zeroed. Subsequent allocations of the same block by other modules or processes will not touch the contents of the block. Applications can use those bytes to see if they need to initialize the block, or if another module already did so. On success, it returns a positive integer ID, which is used for all subsequent calls dealing with the block. On failure it returns a negative error code.

rtapi_shmem_delete frees the shared memory block associated with *shmem_id*. *module_id* is the ID of the calling module. Returns a status code.

rtapi_shmem_getptr sets **ptr* to point to shared memory block associated with *shmem_id*.

REALTIME CONSIDERATIONS

rtapi_shmem_getptr may be called from user code, init/cleanup code, or realtime tasks.

rtapi_shmem_new and **rtapi_shmem_dete** may not be called from realtime tasks.

RETURN VALUE

NAME

rtapi_slab.h − RTAPI wrappers for linux kernel functionality

SYNTAX

#include <rtapi_slab.h>

void *rtapi_kmalloc(size_t size, gfp_t g);

void *rtapi_kzalloc(size_t size, gfp_t g);

void *rtapi_krealloc(size_t size, gfp_t g);

void rtapi_kfree(void *);

DESCRIPTION

In kernel space, each rtapi_xxx or RTAPI_XXX identifier is mapped to the underlying kernel functionality, if available.

In userspace, or in kernels where the underlying functionality is not provided by a kernel, generally another implementation--possibly with reduced functionality--is provided. (For example, the userspace implementation for rtapi_device_register always succeeds)

REALTIME CONSIDERATIONS

Call only from within init/cleanup code, not from realtime tasks. This function is not available from user (non-realtime) code.

RETURN VALUE

As in Linux.

SEE ALSO

NAME

rtapi_snprintf, rtapi_vsnprintf − Perform snprintf-like string formatting

SYNTAX

int rtapi_snprintf(char *_buf_, unsigned long int _size_, const char *_fmt_, ...)

int rtapi_vsnprintf(char *_buf_, unsigned long int _size_, const char *_fmt_, va_list _apfB)_

ARGUMENTS

As for *snprintf(3)* or *vsnprintf(3)*.

DESCRIPTION

These functions work like the standard C printf functions, except that a reduced set of formatting operations are supported.

In particular: formatting of long long values is not supported. Formatting of floating-point values is done as though with %A even when other formats like %f are specified.

REALTIME CONSIDERATIONS

May be called from user, init/cleanup, and realtime code.

RETURN VALUE

The number of characters written to *buf*.

SEE ALSO

printf(3)

NAME

rtapi_stdint.h − RTAPI wrappers for linux kernel functionality

SYNTAX

#include <rtapi_stdint.h>

typedef ... rtapi_s8;

typedef ... rtapi_s16;

typedef ... rtapi_s32;

typedef ... rtapi_s64;

typedef ... rtapi_intptr_t;

typedef ... rtapi_u8;

typedef ... rtapi_u16;

typedef ... rtapi_u32;

typedef ... rtapi_u64;

typedef ... rtapi_uintptr_t;

#define RTAPI_INT*xx*_MIN ...

#define RTAPI_INT*xx*_MAX ...

#define RTAPI_UINT*xx*_MAX ...

DESCRIPTION

In kernel space, each rtapi_xxx or RTAPI_XXX identifier is mapped to the underlying kernel functionality, if available.

In userspace, or in kernels where the underlying functionality is not provided by a kernel, generally another implementation--possibly with reduced functionality--is provided. (For example, the userspace implementation for rtapi_device_register always succeeds)

REALTIME CONSIDERATIONS

None.

RETURN VALUE

As in Linux.

SEE ALSO

NAME

rtapi_string.h − RTAPI wrappers for linux kernel functionality

SYNTAX

#include <rtapi_string.h>

char **rtapi_argv_split(rtapi_gfp_t g, const char *argstr, int *argc);

void rtapi_argv_free(char **argv);

char *rtapi_kstrdup(const char *s, rtapi_gfp_t t);

DESCRIPTION

In kernel space, each rtapi_xxx or RTAPI_XXX identifier is mapped to the underlying kernel functionality, if available.

In userspace, or in kernels where the underlying functionality is not provided by a kernel, generally another implementation--possibly with reduced functionality--is provided. (For example, the userspace implementation for rtapi_device_register always succeeds)

REALTIME CONSIDERATIONS

Call only from within init/cleanup code, not from realtime tasks. This function is not available from user (non-realtime) code.

RETURN VALUE

As in Linux.

SEE ALSO

NAME

rtapi_task_new − create a realtime task

SYNTAX

int rtapi_task_new(void (**taskcode*)(void*), void ***arg*, int *prio*, unsigned long *stacksize*, int *uses_fp*)

int rtapi_task_delete(int *task_id*)

ARGUMENTS

taskcode
: A pointer to the function to be called when the task is started

arg
: An argument to be passed to the *taskcode* function when the task is started

prio
: A task priority value returned by **rtapi_prio_xxxx**

uses_fp
: A flag that tells the OS whether the task uses floating point or not.

task_id
: A task ID returned by a previous call to **rtapi_task_new**

DESCRIPTION

rtapi_task_new creates but does not start a realtime task. The task is created in the "paused" state. To start it, call either **rtapi_task_start** for periodic tasks, or **rtapi_task_resume** for free-running tasks.

REALTIME CONSIDERATIONS

Call only from within init/cleanup code, not from realtime tasks.

RETURN VALUE

On success, returns a positive integer task ID. This ID is used for all subsequent calls that need to act on the task. On failure, returns an RTAPI status code.

SEE ALSO

rtapi_prio(3rtapi), **rtapi_task_start(3rtapi)**, **rtapi_task_wait(3rtapi)**, **rtapi_task_resume(3rtapi)**

NAME

rtapi_task_pause, rtapi_task_resume − pause and resume real-time tasks

SYNTAX

void rtapi_task_pause(int *task_id*)

void rtapi_task_resume(int *task_id*)

ARGUMENTS

task_id An RTAPI task identifier returned by an earlier call to **rtapi_task_new**.

DESCRIPTION

rtapi_task_resume starts a task in free-running mode. The task must be in the "paused" state.

A free running task runs continuously until either:

1) It is prempted by a higher priority task. It will resume as soon as the higher priority task releases the CPU.

2) It calls a blocking function, like **rtapi_sem_take**. It will resume when the function unblocks.

3) It is returned to the "paused" state by **rtapi_task_pause**. May be called from init/cleanup code, and from within realtime tasks.

rtapi_task_pause causes a task to stop execution and change to the "paused" state. The task can be free-running or periodic. Note that **rtapi_task_pause** may called from any task, or from init or cleanup code, not just from the task that is to be paused. The task will resume execution when either **rtapi_task_resume** or **rtapi_task_start** (depending on whether this is a free-running or periodic task) is called.

REALTIME CONSIDERATIONS

May be called from init/cleanup code, and from within realtime tasks.

RETURN VALUE

An RTAPI status code.

SEE ALSO

rtapi_task_new(3rtapi), **rtapi_task_start(3rtapi)**

NAME

rtapi_task_self − Retrieve ID of current task

SYNTAX

void rtapi_task_self()

DESCRIPTION

rtapi_task_self retrieves the current task, or −EINVAL if not in a realtime task (e.g., in startup or shutdown code).

REALTIME CONSIDERATIONS

May be called from init/cleanup code, and from within realtime tasks.

RETURN VALUE

The task number previously returned by **rtapi_task_new** or −EINVAL.

SEE ALSO

rtapi_task_new(3rtapi)

NAME

rtapi_task_start − start a realtime task in periodic mode

SYNTAX

int rtapi_task_start(int *task_id*, unsigned long *period_nsec*)

ARGUMENTS

task_id A task ID returned by a previous call to **rtapi_task_new**

period_nsec

The clock period in nanoseconds between iterations of a periodic task

DESCRIPTION

rtapi_task_start starts a task in periodic mode. The task must be in the *paused* state.

REALTIME CONSIDERATIONS

Call only from within init/cleanup code, not from realtime tasks.

RETURN VALUE

Returns an RTAPI status code.

SEE ALSO

rtapi_task_new(3rtapi), **rtapi_task_pause(3rtapi)**, **rtapi_task_resume(3rtapi)**

NAME

rtapi_task_wait − suspend execution of this periodic task

SYNTAX

void rtapi_task_wait()

DESCRIPTION

rtapi_task_wait suspends execution of the current task until the next period. The task must be periodic. If not, the result is undefined.

REALTIME CONSIDERATIONS

Call only from within a periodic realtime task

RETURN VALUE

None

SEE ALSO

rtapi_task_start(3rtapi), **rtapi_task_pause(3rtapi)**

NAME

undocumented − undocumented functions in RTAPI

SEE ALSO

The header file *rtapi.h*. Most rtapi functions have documentation in that file.

NAME

abs − Compute the absolute value and sign of the input signal

SYNOPSIS

loadrt abs [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

abs.*N* (requires a floating-point thread)

PINS

abs.*N***.in**
float in Analog input value

abs.*N***.out**
float out Analog output value, always positive

abs.*N***.sign**
bit out Sign of input, false for positive, true for negative

abs.*N***.is-positive**
bit out TRUE if input is positive, FALSE if input is 0 or negative

abs.*N***.is-negative**
bit out TRUE if input is negative, FALSE if input is 0 or positive

LICENSE

GPL

NAME

abs_s32 − Compute the absolute value and sign of the input signal

SYNOPSIS

loadrt abs_s32 [count=*N***|names=***name1***[,***name2...***]]**

FUNCTIONS

abs-s32.*N*

PINS

abs-s32.*N***.in**
s32 in input value

abs-s32.*N***.out**
s32 out output value, always non-negative

abs-s32.*N***.sign**
bit out Sign of input, false for positive, true for negative

abs-s32.*N***.is-positive**
bit out TRUE if input is positive, FALSE if input is 0 or negative

abs-s32.*N***.is-negative**
bit out TRUE if input is negative, FALSE if input is 0 or positive

LICENSE

GPL

NAME

and2 − Two-input AND gate

SYNOPSIS

loadrt and2 [count=*N***|names=***name1***[,***name2...***]]**

FUNCTIONS

and2.*N*

PINS

and2.*N***.in0**
bit in

and2.*N***.in1**
bit in

and2.*N***.out**
bit out **out** is computed from the value of **in0** and **in1** according to the following rule:

in0=TRUE in1=TRUE
out=TRUE

Otherwise,
out=FALSE

LICENSE

GPL

NAME

at_pid − proportional/integral/derivative controller with auto tuning

SYNOPSIS

loadrt at_pid [num_chan=*num* **| names=***name1***[,***name2...***]]**

DESCRIPTION

at_pid is a classic Proportional/Integral/Derivative controller, used to control position or speed feedback loops for servo motors and other closed-loop applications.

at_pid supports a maximum of sixteen controllers. The number that are actually loaded is set by the **num_chan** argument when the module is loaded. Alternatively, specify **names=** and unique names separated by commas.

The **num_chan=** and **names=** specifiers are mutually exclusive. If neither **num_chan=** nor **names=** are specified, the default value is three.

If **debug** is set to 1 (the default is 0), some additional HAL parameters will be exported, which might be useful for tuning, but are otherwise unnecessary.

at_pid has a built in auto tune mode. It works by setting up a limit cycle to characterize the process. From this, **Pgain/Igain/Dgain** or **Pgain/Igain/FF1** can be determined using Ziegler-Nichols. When using **FF1**, scaling must be set so that **output** is in user units per second.

During auto tuning, the **command** input should not change. The limit cycle is setup around the commanded position. No initial tuning values are required to start auto tuning. Only **tune−cycles**, **tune−effort** and **tune−mode** need be set before starting auto tuning. When auto tuning completes, the tuning parameters will be set. If running from LinuxCNC, the FERROR setting for the axis being tuned may need to be loosened up as it must be larger than the limit cycle amplitude in order to avoid a following error.

To perform auto tuning, take the following steps. Move the axis to be tuned, to somewhere near the center of it's travel. Set **tune−cycles** (the default value should be fine in most cases) and **tune−mode**. Set **tune−effort** to a small value. Set **enable** to true. Set **tune−mode** to true. Set **tune−start** to true. If no oscillation occurs, or the oscillation is too small, slowly increase **tune−effort**. Auto tuning can be aborted at any time by setting **enable** or **tune−mode** to false.

NAMING

The names for pins, parameters, and functions are prefixed as:
pid.N. for N=0,1,...,num−1 when using **num_chan=num**
nameN. for nameN=name1,name2,... when using **names=name1,name2,...**

The **pid.N.** format is shown in the following descriptions.

FUNCTIONS

pid.*N*.do−pid−calcs (uses floating-point)
Does the PID calculations for control loop *N*.

PINS

pid.*N*.command float in
The desired (commanded) value for the control loop.

pid.*N*.feedback float in
The actual (feedback) value, from some sensor such as an encoder.

pid.*N*.error float out
The difference between command and feedback.

pid.*N*.output float out
The output of the PID loop, which goes to some actuator such as a motor.

pid.*N*.enable bit in
When true, enables the PID calculations. When false, **output** is zero, and all internal integrators, etc, are reset.

pid.*N*.tune−mode bit in
When true, enables auto tune mode. When false, normal PID calculations are performed.

pid.*N*.tune−start bit io
When set to true, starts auto tuning. Cleared when the auto tuning completes.

PARAMETERS

pid.*N*.Pgain float rw
Proportional gain. Results in a contribution to the output that is the error multiplied by **Pgain**.

pid.*N*.Igain float rw
Integral gain. Results in a contribution to the output that is the integral of the error multiplied by **Igain**. For example an error of 0.02 that lasted 10 seconds would result in an integrated error (**errorI**) of 0.2, and if **Igain** is 20, the integral term would add 4.0 to the output.

pid.*N*.Dgain float rw
Derivative gain. Results in a contribution to the output that is the rate of change (derivative) of the error multiplied by **Dgain**. For example an error that changed from 0.02 to 0.03 over 0.2 seconds would result in an error derivative (**errorD**) of of 0.05, and if **Dgain** is 5, the derivative term would add 0.25 to the output.

pid.*N*.bias float rw
bias is a constant amount that is added to the output. In most cases it should be left at zero. However, it can sometimes be useful to compensate for offsets in servo amplifiers, or to balance the weight of an object that moves vertically. **bias** is turned off when the PID loop is disabled, just like all other components of the output. If a non-zero output is needed even when the PID loop is disabled, it should be added with an external HAL sum2 block.

pid.*N*.FF0 float rw
Zero order feed-forward term. Produces a contribution to the output that is **FF0** multiplied by the commanded value. For position loops, it should usually be left at zero. For velocity loops, **FF0** can compensate for friction or motor counter-EMF and may permit better tuning if used properly.

pid.*N*.FF1 float rw
First order feed-forward term. Produces a contribution to the output that **FF1** multiplied by the derivative of the commanded value. For position loops, the contribution is proportional to speed, and can be used to compensate for friction or motor CEMF. For velocity loops, it is proportional to acceleration and can compensate for inertia. In both cases, it can result in better tuning if used properly.

pid.*N*.FF2 float rw
Second order feed-forward term. Produces a contribution to the output that is **FF2** multiplied by the second derivative of the commanded value. For position loops, the contribution is proportional to acceleration, and can be used to compensate for inertia. For velocity loops, it should usually be left at zero.

pid.*N*.deadband float rw
Defines a range of "acceptable" error. If the absolute value of **error** is less than **deadband**, it will be treated as if the error is zero. When using feedback devices such as encoders that are inherently quantized, the deadband should be set slightly more than one-half count, to prevent the control loop from hunting back and forth if the command is between two adjacent encoder values. When

the absolute value of the error is greater than the deadband, the deadband value is subtracted from the error before performing the loop calculations, to prevent a step in the transfer function at the edge of the deadband. (See **BUGS**.)

pid.*N*.maxoutput float rw
Output limit. The absolute value of the output will not be permitted to exceed **maxoutput**, unless **maxoutput** is zero. When the output is limited, the error integrator will hold instead of integrating, to prevent windup and overshoot.

pid.*N*.maxerror float rw
Limit on the internal error variable used for P, I, and D. Can be used to prevent high **Pgain** values from generating large outputs under conditions when the error is large (for example, when the command makes a step change). Not normally needed, but can be useful when tuning non-linear systems.

pid.*N*.maxerrorD float rw
Limit on the error derivative. The rate of change of error used by the **Dgain** term will be limited to this value, unless the value is zero. Can be used to limit the effect of **Dgain** and prevent large output spikes due to steps on the command and/or feedback. Not normally needed.

pid.*N*.maxerrorI float rw
Limit on error integrator. The error integrator used by the **Igain** term will be limited to this value, unless it is zero. Can be used to prevent integrator windup and the resulting overshoot during/after sustained errors. Not normally needed.

pid.*N*.maxcmdD float rw
Limit on command derivative. The command derivative used by **FF1** will be limited to this value, unless the value is zero. Can be used to prevent **FF1** from producing large output spikes if there is a step change on the command. Not normally needed.

pid.*N*.maxcmdDD float rw
Limit on command second derivative. The command second derivative used by **FF2** will be limited to this value, unless the value is zero. Can be used to prevent **FF2** from producing large output spikes if there is a step change on the command. Not normally needed.

pid.*N*.tune−type u32 rw
When set to 0, **Pgain/Igain/Dgain** are caclulated. When set to 1, **Pgain/Igain/FF1** are calculated.

pid.*N*.tune−cycles u32 rw
Determines the number of cycles to run to characterize the process. **tune−cycles** actually sets the number of half cycles. More cycles results in a more accurate characterization as the average of all cycles is used.

pid.*N*.tune−effort float rw
Determines the effor used in setting up the limit cycle in the process. **tune−effort** should be set to a positive value less than **maxoutput**. Start with something small and work up to a value that results in a good portion of the maximum motor current being used. The smaller the value, the smaller the amplitude of the limit cycle.

pid.*N*.errorI float ro (only if debug=1)
Integral of error. This is the value that is multiplied by **Igain** to produce the Integral term of the output.

pid.*N*.errorD float ro (only if debug=1)
Derivative of error. This is the value that is multiplied by **Dgain** to produce the Derivative term of the output.

pid.*N*.commandD float ro (only if debug=1)
Derivative of command. This is the value that is multiplied by **FF1** to produce the first order feedforward term of the output.

pid.*N*.commandDD float ro (only if debug=1)
Second derivative of command. This is the value that is multiplied by **FF2** to produce the second order feed-forward term of the output.

pid.*N*.ultimate−gain float ro (only if debug=1)
Determined from process characterization. **ultimate−gain** is the ratio of **tune−effort** to the limit cycle amplitude multipled by 4.0 divided by Pi. **pid.*N*.ultimate−period** float ro (only if debug=1)
Determined from process characterization. **ultimate−period** is the period of the limit cycle.

BUGS

Some people would argue that deadband should be implemented such that error is treated as zero if it is within the deadband, and be unmodified if it is outside the deadband. This was not done because it would cause a step in the transfer function equal to the size of the deadband. People who prefer that behavior are welcome to add a parameter that will change the behavior, or to write their own version of **at_pid**. However, the default behavior should not be changed.

NAME

axistest − Used to allow testing of an axis. Used IN PNCconf

SYNOPSIS

loadrt axistest [count=*N***|names=***name1***[,***name2...***]]**

FUNCTIONS

axistest.*N***.update**
(requires a floating-point thread)

PINS

axistest.*N***.jog-minus**
bit in Drive TRUE to jog the axis in its minus direction

axistest.*N***.jog-plus**
bit in Drive TRUE to jog the axis in its positive direction

axistest.*N***.run**
bit in Drive TRUE to run the axis near its current position_fb with a trapezoidal velocity profile

axistest.*N***.maxvel**
float in Maximum velocity

axistest.*N***.amplitude**
float in Approximate amplitude of positions to command during 'run'

axistest.*N***.dir**
s32 in Direction from central point to test: 0 = both, 1 = positive, 2 = negative

axistest.*N***.position-cmd**
float out

axistest.*N***.position-fb**
float in

axistest.*N***.running**
bit out

axistest.*N***.run-target**
float out

axistest.*N***.run-start**
float out

axistest.*N***.run-low**
float out

axistest.*N***.run-high**
float out

axistest.*N***.pause**
s32 in (default: *0*) pause time for each end of run in seconds

PARAMETERS

axistest.*N***.epsilon**
float rw (default: *.001*)

axistest.*N***.elapsed**
float r Current value of the internal timer

LICENSE

GPL

NAME

bin2gray − convert a number to the gray-code representation

SYNOPSIS

loadrt bin2gray [count=*N***|names=***name1***[,***name2***...]]**

DESCRIPTION

Converts a number into gray-code

FUNCTIONS

bin2gray.*N*

PINS

bin2gray.*N***.in**
u32 in binary code in

bin2gray.*N***.out**
u32 out gray code out

AUTHOR

andy pugh

LICENSE

GPL

NAME

biquad − Biquad IIR filter

SYNOPSIS

loadrt biquad [count=*N***|names=***name1***[,***name2***...]]**

DESCRIPTION

Biquad IIR filter. Implements the following transfer function: H(z) = (n0 + n1z-1 + n2z-2) / (1+ d1z-1 + d2z-2)

FUNCTIONS

biquad.*N*

(requires a floating-point thread)

PINS

biquad.*N***.in**

float in Filter input.

biquad.*N***.out**

float out Filter output.

biquad.*N***.enable**

bit in (default: *0*) Filter enable. When false, the **in** pin is passed to the **out** pin without any filtering. A **transition from false to true** causes filter coefficients to be calculated according to the current **type** and the describing pin and parameter settings

biquad.*N***.valid**

bit out (default: *0*) When false, indicates an error occurred when calculating filter coefficients (require 2>**Q**>0.5 and **f0**>sampleRate/2)

biquad.*N***.type**

u32 in (default: *0*) Filter type determines the type of filter coefficients calculated. When 0, coefficients must be loaded directly from the **n0,n1,n2,d1** params. When 1, a low pass filter is created specified by the **f0,Q** pins. When 2, a notch filter is created specified by the **f0,Q** pins.

biquad.*N***.f0**

float in (default: *250.0*) The corner frequency of the filter.

biquad.*N***.Q**

float in (default: *0.7071*) The Q of the filter.

biquad.*N***.s1**

float out (default: *0.0*) 1st-delayed internal state (for debug only)

biquad.*N***.s2**

float out (default: *0.0*) 2nd-delayed internal state (for debug only)

PARAMETERS

biquad.*N***.d1**

float rw (default: *0.0*) 1st-delayed denominator coef

biquad.*N***.d2**

float rw (default: *0.0*) 2nd-delayed denominator coef

biquad.*N***.n0**

float rw (default: *1.0*) non-delayed numerator coef

biquad.*N***.n1**

float rw (default: *0.0*) 1st-delayed numerator coef

biquad.*N***.n2**

float rw (default: *0.0*) 2nd-delayed numerator coef

LICENSE

GPL

NAME

bitslice − Converts an unsigned-32 input into individual bits

SYNOPSIS

loadrt bitslice [count=*N***|names=***name1***[,***name2...***]] [personality=***P,P,...***]**

DESCRIPTION

This component creates individual bit-outputs for each bit of an unsigned-32 input. The number of bits can be limited by the "personality" modparam. The inverse process can be performed by the weighted_sum HAL component.

FUNCTIONS

bitslice.*N*

PINS

bitslice.*N***.in**
u32 in The input value

bitslice.*N***.out-***MM*
bit out
(MM=00..personality)

AUTHOR

Andy Pugh

LICENSE

GPL2+

NAME

bitwise − Computes various bitwise operations on the two input values

SYNOPSIS

loadrt bitwise [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

bitwise.*N*

PINS

bitwise.*N***.in0**
u32 in First input value

bitwise.*N***.in1**
u32 in Second input value

bitwise.*N***.out-and**
u32 out The bitwise AND of the two inputs

bitwise.*N***.out-or**
u32 out The bitwise OR of the two inputs

bitwise.*N***.out-xor**
u32 out The bitwise XOR of the two inputs

bitwise.*N***.out-nand**
u32 out The inverse of the bitwise AND

bitwise.*N***.out-nor**
u32 out The inverse of the bitwise OR

bitwise.*N***.out-xnor**
u32 out The inverse of the bitwise XOR

AUTHOR

Andy Pugh

LICENSE

GPL 2+

NAME

bldc − BLDC and AC-servo control component

SYNOPSIS

loadrt bldc personality=*P*

DESCRIPTION

This component is designed as an interface between the most common forms of three-phase motor feedback devices and the corresponding types of drive. However there is no requirement that the motor and drive should necessarily be of inherently compatible types.

SYNOPSIS

(ignore the auto-generated SYNOPSIS above)

loadrt bldc cfg=qi6,aH

Each instance of the component is defined by a group of letters describing the input and output types. A comma separates individual instances of the component.

Tags

Input type definitions are all lower-case.

n No motor feedback. This mode could be used to drive AC induction motors, but is also potentially useful for creating free-running motor simulators for drive testing.

h Hall sensor input. Brushless DC motors (electronically commutated permanent magnet 3-phase motors) typically use a set of three Hall sensors to measure the angular position of the rotor. A lower-case **h** in the cfg string indicates that these should be used.

a Absolute encoder input. (Also possibly used by some forms of Resolver conversion hardware). The presence of this tag over-rides all other inputs. Note that the component still requires to be be connected to the **rawcounts** encoder pin to prevent loss of commutation on index-reset.

q Incremental (quadrature) encoder input. If this input is used then the rotor will need to be homed before the motor can be run.

i Use the index of an incremental encoder as a home reference.

f Use a 4-bit Gray-scale patttern to determine rotor alignment. This scheme is only used on the Fanuc "Red Cap" motors. This mode could be used to control one of these motors using a non-Fanuc drive.

Output type descriptions are all upper-case.

Defaults The component will always calculate rotor angle, phase angle and the absolute value of the input **value** for interfacing with drives such as the Mesa 8i20. It will also default to three individual, bipolar phase output values if no other output type modifiers are used.

B Bit level outputs. Either 3 or 6 logic-level outputs indicating which high or low gate drivers on an external drive should be used.

6 Create 6 rather than the default 3 outputs. In the case of numeric value outputs these are separate positive and negative drive amplitudes. Both have positive magnitude.

H Emulated Hall sensor output. This mode can be used to control a drive which expects 3x Hall signals, or to convert between a motor with one hall pattern and a drive which expects a different one.

F Emulated Fanuc Red Cap Gray-code encoder output. This mode might be used to drive a non-Fanuc motor using a Fanuc drive intended for the "Red-Cap" motors.

T Force Trapezoidal mode.

OPERATING MODES

The component can control a drive in either Trapezoidal or Sinusoidal mode, but will always default to sinusoidal if the input and output modes allow it. This can be over-ridden by the **T** tag. Sinusoidal commutation is significantly smoother (trapezoidal commutation induces 13% torque ripple).

ROTOR HOMING.

To use an encoder for commutation a reference 0-degrees point must be found. The component uses the convention that motor zero is the point that an unloaded motor aligns to with a positive voltage on the A (or U) terminal and the B & C (or V and W) terminals connected together and to −ve voltage. There will be two such positions on a 4-pole motor, 3 on a 6-pole and so on. They are all functionally equivalent as far as driving the motor is concerned. If the motor has Hall sensors then the motor can be started in trapezoidal commutation mode, and will switch to sinusoidal commutation when an alignment is found. If the mode is **qh** then the first Hall state-transition will be used. If the mode is **qhi** then the encoder index will be used. This gives a more accurate homing position if the distance in encoder counts between motor zero and encoder index is known. To force homing to the Hall edges instead simply omit the **i**.

Motors without Hall sensors may be homed in synchronous/direct mode. The better of these options is to home to the encoder zero using the **iq** config parameter. When the **init** pin goes high the motor will rotate (in a direction determined by the **rev** pin) until the encoder indicates an index-latch (the servo thread runs too slowly to rely on detecting an encoder index directly). If there is no encoder index or its location relative to motor zero can not be found, then an alternative is to use *magnetic* homing using the **q** config. In this mode the motor will go through an alignment sequence ending at motor zero when the init pin goes high It will then set the final position as motor zero. Unfortunately the motor is rather *springy* in this mode and so alignment is likely to be fairly sensitive to load.

FUNCTIONS

bldc.*N* (requires a floating-point thread)

PINS

bldc.*N*.hall1
bit in
[if personality & 0x01] Hall sensor signal 1

bldc.*N*.hall2
bit in
[if personality & 0x01] Hall sensor signal 2

bldc.*N*.hall3
bit in
[if personality & 0x01] Hall sensor signal 3

bldc.*N*.hall-error
bit out
[if personality & 0x01] Indicates that the selected hall pattern gives inconsistent rotor position data. This can be due to the pattern being wrong for the motor, or one or more sensors being unconnected or broken. A consistent pattern is not neceesarily valid, but an inconsistent one can never be valid.

bldc.*N*.C1
bit in
[if (personality & 0x10)] Fanuc Gray-code bit 0 input

bldc.*N*.C2
bit in
[if (personality & 0x10)] Fanuc Gray-code bit 1 input

bldc.*N*.C4
bit in
[if (personality & 0x10)] Fanuc Gray-code bit 2 input

bldc.*N*.C8
bit in
[if (personality & 0x10)] Fanuc Gray-code bit 3 input

bldc.*N*.value
float in PWM master amplitude input

bldc.*N*.lead-angle
float in
[if personality & 0x06] (default: *90*) The phase lead between the electrical vector and the rotor position in degrees

bldc.*N*.rev
bit in Set this pin true to reverse the motor. Negative PWM amplitudes will also reverse the motor and there will generally be a Hall pattern that runs the motor in each direction too.

bldc.*N*.frequency
float in
[if (personality & 0x0F) == 0] Frequency input for motors with no feedback at all, or those with only an index (which is ignored)

bldc.*N*.initvalue
float in
[if personality & 0x04] (default: *0.2*) The current to be used for the homing sequence in applications where an incremental encoder is used with no hall-sensor feedback

bldc.*N*.rawcounts
s32 in
[if personality & 0x06] (default: *0*) Encoder counts input. This must be linked to the encoder rawcounts pin or encoder index resets will cause the motor commutation to fail

bldc.*N*.index-enable
bit io
[if personality & 0x08] This pin should be connected to the associated encoder index-enable pin to zero the encoder when it passes index This is only used indicate to the bldc control component that an index has been seen

bldc.*N*.init
bit in
[if (personality & 0x05) == 4] A rising edge on this pin starts the motor alignment sequence. This pin should be connected in such a way that the motors re-align any time that encoder monitoring has been interrupted. Typically this will only be at machine power-off. The alignment process involves powering the motor phases in such a way as to put the motor in a known position. The encoder counts are then stored in the **offset** parameter. The alignment process will tend to cause a following error if it is triggered while the axis is enabled, so should be set before the matching axis.N.enable pin. The complementary **init-done** pin can be used to handle the required sequencing.

Both pins can be ignored if the encoder offset is known explicitly, such as is the case with an

absolute encoder. In that case the **offset** parameter can be set directly in the HAL file

bldc.*N*.init-done
bit out
[if (personality & 0x05) == 4] (default: *0*) Indicates homing sequence complete

bldc.*N*.A-value
float out
[if (personality & 0xF00) == 0] Output amplitude for phase A

bldc.*N*.B-value
float out
[if (personality & 0xF00) == 0] Output amplitude for phase B

bldc.*N*.C-value
float out
[if (personality & 0xF00) == 0] Output amplitude for phase C

bldc.*N*.A-on
bit out
[if (personality & 0xF00) == 0x100] Output bit for phase A

bldc.*N*.B-on
bit out
[if (personality & 0xF00) == 0x100] Output bit for phase B

bldc.*N*.C-on
bit out
[if (personality & 0xF00) == 0x100] Output bit for phase C

bldc.*N*.A-high
float out
[if (personality & 0xF00) == 0x200] High-side driver for phase A

bldc.*N*.B-high
float out
[if (personality & 0xF00) == 0x200] High-side driver for phase B

bldc.*N*.C-high
float out
[if (personality & 0xF00) == 0x200] High-side driver for phase C

bldc.*N*.A-low
float out
[if (personality & 0xF00) == 0x200] Low-side driver for phase A

bldc.*N*.B-low
float out
[if (personality & 0xF00) == 0x200] Low-side driver for phase B

bldc.*N*.C-low
float out
[if (personality & 0xF00) == 0x200] Low-side driver for phase C

bldc.*N*.A-high-on
bit out
[if (personality & 0xF00) == 0x300] High-side driver for phase A

bldc.*N*.B-high-on
bit out
[if (personality & 0xF00) == 0x300] High-side driver for phase B

bldc.*N*.C-high-on
bit out
[if (personality & 0xF00) == 0x300] High-side driver for phase C

bldc.*N*.A-low-on
bit out
[if (personality & 0xF00) == 0x300] Low-side driver for phase A

bldc.*N*.B-low-on
bit out
[if (personality & 0xF00) == 0x300] Low-side driver for phase B

bldc.*N*.C-low-on
bit out
[if (personality & 0xF00) == 0x300] Low-side driver for phase C

bldc.*N*.hall1-out
bit out
[if (personality & 0x400)] Hall 1 output

bldc.*N*.hall2-out
bit out
[if (personality & 0x400)] Hall 2 output

bldc.*N*.hall3-out
bit out
[if (personality & 0x400)] Hall 3 output

bldc.*N*.C1-out
bit out
[if (personality & 0x800)] Fanuc Gray-code bit 0 output

bldc.*N*.C2-out
bit out
[if (personality & 0x800)] Fanuc Gray-code bit 1 output

bldc.*N*.C4-out
bit out
[if (personality & 0x800)] Fanuc Gray-code bit 2 output

bldc.*N*.C8-out
bit out
[if (personality & 0x800)] Fanuc Gray-code bit 3 output

bldc.*N*.phase-angle
float out (default: *0*) Phase angle including lead/lag angle after encoder zeroing etc. Useful for angle/current drives. This value has a range of 0 to 1 and measures electrical revolutions. It will have two zeros for a 4 pole motor, three for a 6-pole etc

bldc.*N*.rotor-angle
float out (default: *0*) Rotor angle after encoder zeroing etc. Useful for angle/current drives which add their own phase offset such as the 8i20. This value has a range of 0 to 1 and measures electrical revolutions. It will have two zeros for a 4 pole motor, three for a 6-pole etc

bldc.*N*.out
float out Current output, including the effect of the dir pin and the alignment sequence

bldc.*N*.out-dir
bit out Direction output, high if /fBvalue/fR is negative XOR /fBrev/fR is true.

bldc.*N*.out-abs
float out Absolute value of the input value

PARAMETERS

bldc.*N*.in-type
s32 r (default: *-1*) state machine output, will probably hide after debug

bldc.*N*.out-type
s32 r (default: *-1*) state machine output, will probably hide after debug

bldc.*N*.scale
s32 rw
[if personality & 0x06] (default: *512*) The number of encoder counts per rotor revolution.

bldc.*N*.poles
s32 rw
[if personality & 0x06] (default: *4*) The number of motor poles. The encoder scale will be divided by this value to determine the number of encoder counts per electrical revolution

bldc.*N*.encoder-offset
s32 rw
[if personality & 0x0A] (default: *0*) The offset, in encoder counts, between the motor electrical zero and the encoder zero modulo the number of counts per electrical revolution

bldc.*N*.offset-measured
s32 r
[if personality & 0x04] (default: *0*) The encoder offset measured by the homing sequence (in certain modes)

bldc.*N*.drive-offset
float rw (default: *0*) The angle, in degrees, applied to the commanded angle by the drive in degrees. This value is only used during the homing sequence of drives with incremental encoder feedback. It is used to back-calculate from commanded angle to actual phase angle. It is only relevant to drives which expect rotor-angle input rather than phase-angle demand. Should be 0 for most drives.

bldc.*N*.output-pattern
u32 rw
[if personality & 0x400] (default: *25*) Commutation pattern to be output in Hall Signal translation mode. See the description of /fBpattern/fR for details

bldc.*N*.pattern
u32 rw
[if personality & 0x01] (default: *25*) Commutation pattern to use, from 0 to 47. Default is type 25. Every plausible combination is included. The table shows the excitation pattern along the top, and the pattern code on the left hand side. The table entries are the hall patterns in H1, H2, H3 order. Common patterns are: 0 (30 degree commutation) and 26, its reverse. 17 (120 degree). 18 (alternate 60 degree). 21 (300 degree, Bodine). 22 (240 degree). 25 (60 degree commutation).

Note that a number of incorrect commutations will have non-zero net torque which might look as if they work, but don't really.

If your motor lacks documentation it might be worth trying every pattern.

Phases, Source - Sink						
pat	**B-A**	**C-A**	**C-B**	**A-B**	**A-C**	**B-C**
0	000	001	011	111	110	100
1	001	000	010	110	111	101
2	000	010	011	111	101	100
3	001	011	010	110	100	101
4	010	011	001	101	100	110
5	011	010	000	100	101	111
6	010	000	001	101	111	110
7	011	001	000	100	110	111
8	000	001	101	111	110	010
9	001	000	100	110	111	011
10	000	010	110	111	101	001
11	001	011	111	110	100	000
12	010	011	111	101	100	000
13	011	010	110	100	101	001
14	010	000	100	101	111	011
15	011	001	101	100	110	010
16	000	100	101	111	011	010
17	001	101	100	110	010	011
18	000	100	110	111	011	001
19	001	101	111	110	010	000
20	010	110	111	101	001	000
21	011	111	110	100	000	001
22	010	110	100	101	001	011
23	011	111	101	100	000	010
24	100	101	111	011	010	000
25	101	100	110	010	011	001
26	100	110	111	011	001	000
27	101	111	110	010	000	001
28	110	111	101	001	000	010
29	111	110	100	000	001	011
30	110	100	101	001	011	010
31	111	101	100	000	010	011
32	100	101	001	011	010	110
33	101	100	000	010	011	111
34	100	110	010	011	001	101
35	101	111	011	010	000	100
36	110	111	011	001	000	100
37	111	110	010	000	001	101
38	110	100	000	001	011	111
39	111	101	001	000	010	110
40	100	000	001	011	111	110
41	101	001	000	010	110	111
42	100	000	010	011	111	101
43	101	001	011	010	110	100
44	110	010	011	001	101	100
45	111	011	010	000	100	101
46	110	010	000	001	101	111
47	111	011	001	000	100	110

AUTHOR

Andy Pugh

LICENSE

GPL

NAME

bldc_hall3 − 3-wire BLDC motor driver using Hall sensors and trapezoidal commutation.

SYNOPSIS

The functionality of this component is now included in the generic "bldc" component. This component is likely to be removed in a future release

DESCRIPTION

This component produces a 3-wire bipolar output. This suits upstream drivers that interpret a negative input as a low-side drive and positive as a high-side drive. This includes the Hostmot2 3pwmgen function, which is likely to be the most common application of this component.

FUNCTIONS

bldc-hall3.*N*

(requires a floating-point thread) Interpret Hall sensor patterns and set 3-phase amplitudes

PINS

bldc-hall3.*N***.hall1**

bit in Hall sensor signal 1

bldc-hall3.*N***.hall2**

bit in Hall sensor signal 2

bldc-hall3.*N***.hall3**

bit in Hall sensor signal 3

bldc-hall3.*N***.value**

float in PWM master amplitude input

bldc-hall3.*N***.dir**

bit in Forwards / reverse selection. Negative PWM amplitudes will also reverse the motor and there will generally be a pattern that runs the motor in each direction too.

bldc-hall3.*N***.A-value**

float out Output amplitude for phase A

bldc-hall3.*N***.B-value**

float out Output amplitude for phase B

bldc-hall3.*N***.C-value**

float out Output amplitude for phase C

PARAMETERS

bldc-hall3.*N***.pattern**

u32 rw (default: *25*) Commutation pattern to use, from 0 to 47. Default is type 25. Every plausible combination is included. The table shows the excitation pattern along the top, and the pattern code on the left hand side. The table entries are the hall patterns in H1, H2, H3 order. Common patterns are: 0 (30 degree commutation) and 26, its reverse. 17 (120 degree). 18 (alternate 60 degree). 21 (300 degree, Bodine). 22 (240 degree). 25 (60 degree commutation).

Note that a number of incorrect commutations will have non-zero net torque which might look as if they work, but don’t really.

If your motor lacks documentation it might be worth trying every pattern.

Phases, Source - Sink						
pat	**B-A**	**C-A**	**C-B**	**A-B**	**A-C**	**B-C**
0	000	001	011	111	110	100
1	001	000	010	110	111	101
2	000	010	011	111	101	100
3	001	011	010	110	100	101
4	010	011	001	101	100	110
5	011	010	000	100	101	111
6	010	000	001	101	111	110
7	011	001	000	100	110	111
8	000	001	101	111	110	010
9	001	000	100	110	111	011
10	000	010	110	111	101	001
11	001	011	111	110	100	000
12	010	011	111	101	100	000
13	011	010	110	100	101	001
14	010	000	100	101	111	011
15	011	001	101	100	110	010
16	000	100	101	111	011	010
17	001	101	100	110	010	011
18	000	100	110	111	011	001
19	001	101	111	110	010	000
20	010	110	111	101	001	000
21	011	111	110	100	000	001
22	010	110	100	101	001	011
23	011	111	101	100	000	010
24	100	101	111	011	010	000
25	101	100	110	010	011	001
26	100	110	111	011	001	000
27	101	111	110	010	000	001
28	110	111	101	001	000	010
29	111	110	100	000	001	011
30	110	100	101	001	011	010
31	111	101	100	000	010	011
32	100	101	001	011	010	110
33	101	100	000	010	011	111
34	100	110	010	011	001	101
35	101	111	011	010	000	100
36	110	111	011	001	000	100
37	111	110	010	000	001	101
38	110	100	000	001	011	111
39	111	101	001	000	010	110
40	100	000	001	011	111	110
41	101	001	000	010	110	111
42	100	000	010	011	111	101
43	101	001	011	010	110	100
44	110	010	011	001	101	100
45	111	011	010	000	100	101
46	110	010	000	001	101	111
47	111	011	001	000	100	110

SEE ALSO

bldc_hall6 6-wire unipolar driver for BLDC motors.

AUTHOR

Andy Pugh

LICENSE

GPL

NAME

blend − Perform linear interpolation between two values

SYNOPSIS

loadrt blend [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

blend.*N*

(requires a floating-point thread)

PINS

blend.*N***.in1**

float in First input. If select is equal to 1.0, the output is equal to in1

blend.*N***.in2**

float in Second input. If select is equal to 0.0, the output is equal to in2

blend.*N***.select**

float in Select input. For values between 0.0 and 1.0, the output changes linearly from in2 to in1

blend.*N***.out**

float out Output value.

PARAMETERS

blend.*N***.open**

bit rw If true, select values outside the range 0.0 to 1.0 give values outside the range in2 to in1. If false, outputs are clamped to the the range in2 to in1

LICENSE

GPL

NAME

carousel − Orient a toolchanger carousel using various encoding schemes

SYNOPSIS

loadrt carousel pockets=*N*[,*N*] **encoding=***ssss*[,*sss*] **num_sense=***N*[,*N*] **dir=***N*[,*N]*

pockets The number of pockets in each toolchanger.
Use up to 8 numbers separated by commas to create multiple carousel components.

encoding The position encoding.
gray, binary, bcd, index, edge or single. Default = 'gray'

num_sense The number of position sense pins.
Default = 4.

dir Set to 1 for unidirectional or 2 for bidirectional operation.
Default = bidirectional

parity Set to 1 for odd parity, 0 for even parity checking.
Default = 0 (even)

DESCRIPTION

This component is intended to help operate various types of carousel-type toolchangers. The component can be configured to operate with binary, binary-coded decimal (BCD) or gray-coded position feedback, with an individual sensor for each tool position or with a sensor at each tool position and a separate index.

Both unidirectional and bidirectional systems are supported and those that reverse against a stop when in position.

The number of carousel component instances created depends on the number of entries in the 'pockets' modparam. For example

loadrt carousel pockets=10,10,8

Would create 3 carousel instances with 10, 10 and 8 pockets. The other parameters are optional. If absent then defaults will be used. Any missing entry will assume the previous value.

When the enable pin is set to true the component will immediately set the "active" pin to true and then (for a bidirectional instance) calculate the shortest path to the requested pocket number. The appropriate motor direction output pins will then be set. Bit outputs for forward and reverse are provided as well as a three-state velocity output for driving a DC motor PWM or a velocity-mode stepgen.

The component will monitor the carousel position and, when the correct position is reached, set the motor-control pins to 0, set "active" to 0 and set "ready" to 1.

In index mode the behaviour is slightly different. The first time that the "enable" pin is set; the carousel will rotate forwards until both the index and pulse inputs are true. If there is no pulse line at the index position then a HAL "or2" function can be used to allow the index sensor to toggle both inputs. Setting "enable" low does not halt the homing move, so if homing on first tool change is not needed then the enable pin can be toggled by an axis homing pin or a script. **edge** is a special case of index mode for tool changers with pockets on both the rising and falling edges of the position sensor. (Seen on at least one Denford Orac.)

For tool changers which lock the carousel against a stop the **rev-pulse** pin can be set to a non-zero value. The motor-rev pin will then be set for this many seconds at the completion of the tool search and at the same time the reverse duty/cycle velocity value will be sent to the motor-vel pin.

FUNCTIONS

carousel.*N*

(requires a floating-point thread)

PINS

carousel.*N***.pocket-number**

s32 in The pocket to move to when the .enable pin goes high. If the value passed is gigher than the number of pockests specified in the "pockets" modparam then modulo arithmetic is used. This is intended to allow the use of multiple tools in the same holder, as is sometimes useful with lathes.

carousel.*N***.enable**

bit in Set this pin high to start movement. Setting it low will stop movement

carousel.*N***.active**

bit out indicates that the component is active

carousel.*N***.ready**

bit out This pin goes high when the carousel is in-position

carousel.*N***.strobe**

bit in (default: *1*) Use this pin to indicate that the position feedback is valid. Often provided by binary encoders

carousel.*N***.parity**

bit in Some encoders supply a parity bit, if this is connected then the parity-error output bit will indicate parity errors

carousel.*N***.sense-***M*

bit in

(M=0..personality) Carousel position feedback pins. In 'index' mode there will be only 2 pins. sense-0 is the index and sense-1 is the pocket sensor.

carousel.*N***.rev-pulse**

float in The duration in seconds for which a ratchet changer (Boxford, Emco) should pulse the reverse pin to lock the holder

carousel.*N***.fwd-dc**

float in Velocity or duty cycle when forwards rotation is desired

carousel.*N***.rev-dc**

float in

Velocity or duty cycle when reverse rotation is desired

carousel.*N***.hold-dc**

float in Duty cycle when carousel is in-position (to hold against stop)

carousel.*N***.jog-fwd**

bit in Jog the carousel forwards one tool position

carousel.*N***.jog-rev**

bit in Jog the carousel in reverse (only if dir = 2). It is very important that these pins should be debounced and should probably also be interlocked to only operate when the machine is idle.

carousel.*N***.motor-fwd**

bit out Indicates the motor should run forwards (bigger numbers)

carousel.*N***.motor-rev**

bit out Indicates the motor should run reverse.

carousel.*N***.parity-error**

bit out Indicates a parity error

carousel.*N*.current-position
s32 out This pin indicates the current position feedback

carousel.*N*.motor-vel
float out The duty-cycle or velocity to drive a DC motor or stepgen

PARAMETERS

carousel.*N*.state
s32 r (default: *0*) Current component state

carousel.*N*.homing
bit r (default: *0*) Shows that homing is in progress. Only used for index mode

carousel.*N*.homed
bit r (default: *0*) Shows that homing is complete. Only used in index and edge modes

carousel.*N*.timer
float r Shows the value of the internal timer

AUTHOR

andy pugh

LICENSE

GPL

NAME

charge_pump − Create a square-wave for the ’charge pump’ input of some controller boards

SYNOPSIS

loadrt charge_pump

DESCRIPTION

The ’Charge Pump’ should be added to the base thread function. When enabled the output is on for one period and off for one period. To calculate the frequency of the output 1/(period time in seconds x 2) = hz. For example if you have a base period of 100,000ns that is 0.0001 seconds and the formula would be 1/(0.0001 x 2) = 5,000 hz or 5 Khz. Two additional outputs are provided that run a factor of 2 and 4 slower for hardware that requires a lower frequency.

FUNCTIONS

charge-pump

Toggle the output bit (if enabled)

PINS

charge-pump.out
bit out Square wave if ’enable’ is TRUE or unconnected, low if ’enable’ is FALSE

charge-pump.out-2
bit out Square wave at half the frequency of ’out’

charge-pump.out-4
bit out Square wave at a quarter of the frequency of ’out’

charge-pump.enable
bit in (default: *TRUE*) If FALSE, forces all ’out’ pins to be low

LICENSE

GPL

NAME

clarke2 − Two input version of Clarke transform

SYNOPSIS

loadrt clarke2 [count=*N***|names=***name1***[,***name2...***]]**

DESCRIPTION

The Clarke transform can be used to translate a vector quantity from a three phase system (three components 120 degrees apart) to a two phase Cartesian system.

clarke2 implements a special case of the Clarke transform, which only needs two of the three input phases. In a three wire three phase system, the sum of the three phase currents or voltages must always be zero. As a result only two of the three are needed to completely define the current or voltage. **clarke2** assumes that the sum is zero, so it only uses phases A and B of the input. Since the H (homopolar) output will always be zero in this case, it is not generated.

FUNCTIONS

clarke2.*N*

(requires a floating-point thread)

PINS

clarke2.*N***.a**

float in

clarke2.*N***.b**

float in first two phases of three phase input

clarke2.*N***.x**

float out

clarke2.*N***.y**

float out cartesian components of output

SEE ALSO

clarke3 for the general case, **clarkeinv** for the inverse transform.

LICENSE

GPL

NAME

clarke3 − Clarke (3 phase to cartesian) transform

SYNOPSIS

loadrt clarke3 [count=*N***|names=***name1***[,***name2...***]]**

DESCRIPTION

The Clarke transform can be used to translate a vector quantity from a three phase system (three components 120 degrees apart) to a two phase Cartesian system (plus a homopolar component if the three phases don't sum to zero).

clarke3 implements the general case of the transform, using all three phases. If the three phases are known to sum to zero, see **clarke2** for a simpler version.

FUNCTIONS

clarke3.*N*

(requires a floating-point thread)

PINS

clarke3.*N***.a**

float in

clarke3.*N***.b**

float in

clarke3.*N***.c**

float in three phase input vector

clarke3.*N***.x**

float out

clarke3.*N***.y**

float out cartesian components of output

clarke3.*N***.h**

float out homopolar component of output

SEE ALSO

clarke2 for the 'a+b+c=0' case, **clarkeinv** for the inverse transform.

LICENSE

GPL

NAME

clarkeinv − Inverse Clarke transform

SYNOPSIS

loadrt clarkeinv [count=*N***|names=***name1***[,***name2***...]]**

DESCRIPTION

The inverse Clarke transform can be used rotate a vector quantity and then translate it from Cartesian coordinate system to a three phase system (three components 120 degrees apart).

FUNCTIONS

clarkeinv.*N*

(requires a floating-point thread)

PINS

clarkeinv.*N***.x**

float in

clarkeinv.*N***.y**

float in cartesian components of input

clarkeinv.*N***.h**

float in homopolar component of input (usually zero)

clarkeinv.*N***.theta**

float in rotation angle: 0.00 to 1.00 = 0 to 360 degrees

clarkeinv.*N***.a**

float out

clarkeinv.*N***.b**

float out

clarkeinv.*N***.c**

float out three phase output vector

SEE ALSO

clarke2 and **clarke3** for the forward transform.

LICENSE

GPL

NAME

classicladder − realtime software plc based on ladder logic

SYNOPSIS

loadrt classicladder_rt [numRungs=*N***] [numBits=***N***] [numWords=***N***] [numTimers=***N***] [numMonostables=***N***] [numCounters=***N***] [numPhysInputs=***N***] [numPhysOutputs=***N***] [numArithmExpr=***N***] [numSections=***N***] [numSymbols=***N***] [numS32in=***N***] [numS32out=***N***] [numFloatIn=***N***] [numFloatOut=***N***]**

DESCRIPTION

These pins and parameters are created by the realtime **classicladder_rt** module. Each period (minimum 1000000 ns), classicladder reads the inputs, evaluates the ladder logic defined in the GUI, and then writes the outputs.

PINS

classicladder.0.in−*NN* IN bit
: These bit signal pins map to **%I***NN* variables in classicladder

classicladder.0.out−*NN* OUT bit
: These bit signal pins map to **%Q***NN* variables in classicladder Output from classicladder

classicladder.0.s32in−*NN* IN s32
: Integer input from classicladder These s32 signal pins map to **%IW***NN* variables in classicladder

classicladder.0.s32out−*NN* OUT s32
: Integer output from classicladder These s32 signal pins map to **%QW***NN* variables in classicladder

classicladder.0.floatin−*NN* IN float
: Integer input from classicladder These float signal pins map to **%IF***NN* variables in classicladder These are truncated to S32 values internally. eg 7.5 will be 7

classicladder.0.floatout−*NN* OUT float
: Float output from classicladder These float signal pins map to **%QF***NN* variables in classicladder

classicladder.0.hide_gui IN bit
: This bit pin hides the classicladder window, while still having the userspace code run. This is usually desirable when modbus is used, as modbus requires the userspace code to run.

PARAMETERS

classicladder.0.refresh.time RO s32
: Tells you how long the last refresh took

classicladder.0.refresh.tmax RW s32
: Tells you how long the longest refresh took

classicladder.0.ladder−state RO s32
: Tells you if the program is running or not

FUNCTIONS

classicladder.0.refresh FP

The rung update rate. Add this to the servo thread. You can added it to a faster thread but it Will update no faster than once every 1 millisecond (1000000 ns).

BUGS

See http://wiki.linuxcnc.org/cgi−bin/wiki.pl?ClassicLadder_Ver_7.124 for the latest.

SEE ALSO

Classicladder chapters in the LinuxCNC documentation for a full description of the **Classicladder** syntax and examples

http://wiki.linuxcnc.org/cgi−bin/wiki.pl?ClassicLadder_Ver_7.124

NAME

comp − Two input comparator with hysteresis

SYNOPSIS

loadrt comp [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

comp.*N*

(requires a floating-point thread) Update the comparator

PINS

comp.*N***.in0**

float in Inverting input to the comparator

comp.*N***.in1**

float in Non-inverting input to the comparator

comp.*N***.out**

bit out Normal output. True when **in1** > **in0** (see parameter **hyst** for details)

comp.*N***.equal**

bit out Match output. True when difference between **in1** and **in0** is less than **hyst**/2

PARAMETERS

comp.*N***.hyst**

float rw (default: *0.0*) Hysteresis of the comparator (default 0.0)

With zero hysteresis, the output is true when **in1** > **in0**. With nonzero hysteresis, the output switches on and off at two different values, separated by distance **hyst** around the point where **in1** = **in0**. Keep in mind that floating point calculations are never absolute and it is wise to always set **hyst** if you intend to use equal

LICENSE

GPL

NAME

constant − Use a parameter to set the value of a pin

SYNOPSIS

loadrt constant [count=*N***|names=***name1***[,***name2...***]]**

FUNCTIONS

constant.*N*

(requires a floating-point thread)

PINS

constant.*N***.out**

float out

PARAMETERS

constant.*N***.value**

float rw

LICENSE

GPL

NAME

conv_bit_float − Convert a value from bit to float

SYNOPSIS

loadrt conv_bit_float [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

conv-bit-float.*N*

(requires a floating-point thread) Update ’out’ based on ’in’

PINS

conv-bit-float.*N***.in**

bit in

conv-bit-float.*N***.out**

float out

LICENSE

GPL

NAME

conv_bit_s32 − Convert a value from bit to s32

SYNOPSIS

loadrt conv_bit_s32 [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

conv-bit-s32.*N*

Update ’out’ based on ’in’

PINS

conv-bit-s32.*N***.in**
bit in

conv-bit-s32.*N***.out**
s32 out

LICENSE

GPL

NAME

conv_bit_u32 − Convert a value from bit to u32

SYNOPSIS

loadrt conv_bit_u32 [count=*N***|names=***name1***[,***name2...***]]**

FUNCTIONS

conv-bit-u32.*N*

Update ’out’ based on ’in’

PINS

conv-bit-u32.*N***.in**
bit in

conv-bit-u32.*N***.out**
u32 out

LICENSE

GPL

NAME

conv_float_s32 − Convert a value from float to s32

SYNOPSIS

loadrt conv_float_s32 [count=*N***|names=***name1***[,***name2...***]]**

FUNCTIONS

conv-float-s32.*N*

(requires a floating-point thread) Update ’out’ based on ’in’

PINS

conv-float-s32.*N***.in**

float in

conv-float-s32.*N***.out**

s32 out

conv-float-s32.*N***.out-of-range**

bit out TRUE when ’in’ is not in the range of s32

PARAMETERS

conv-float-s32.*N***.clamp**

bit rw If TRUE, then clamp to the range of s32. If FALSE, then allow the value to "wrap around".

LICENSE

GPL

NAME

conv_float_u32 − Convert a value from float to u32

SYNOPSIS

loadrt conv_float_u32 [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

conv-float-u32.*N*

(requires a floating-point thread) Update ’out’ based on ’in’

PINS

conv-float-u32.*N***.in**

float in

conv-float-u32.*N***.out**

u32 out

conv-float-u32.*N***.out-of-range**

bit out TRUE when ’in’ is not in the range of u32

PARAMETERS

conv-float-u32.*N***.clamp**

bit rw If TRUE, then clamp to the range of u32. If FALSE, then allow the value to "wrap around".

LICENSE

GPL

NAME

conv_s32_bit − Convert a value from s32 to bit

SYNOPSIS

loadrt conv_s32_bit [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

conv-s32-bit.*N*

Update ’out’ based on ’in’

PINS

conv-s32-bit.*N***.in**
s32 in

conv-s32-bit.*N***.out**
bit out

conv-s32-bit.*N***.out-of-range**
bit out TRUE when ’in’ is not in the range of bit

PARAMETERS

conv-s32-bit.*N***.clamp**
bit rw If TRUE, then clamp to the range of bit. If FALSE, then allow the value to "wrap around".

LICENSE

GPL

NAME

conv_s32_float − Convert a value from s32 to float

SYNOPSIS

loadrt conv_s32_float [count=*N***|names=***name1***[,***name2...***]]**

FUNCTIONS

conv-s32-float.*N*

(requires a floating-point thread) Update ’out’ based on ’in’

PINS

conv-s32-float.*N***.in**

s32 in

conv-s32-float.*N***.out**

float out

LICENSE

GPL

NAME

conv_s32_u32 − Convert a value from s32 to u32

SYNOPSIS

loadrt conv_s32_u32 [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

conv-s32-u32.*N*

Update ’out’ based on ’in’

PINS

conv-s32-u32.*N***.in**
s32 in

conv-s32-u32.*N***.out**
u32 out

conv-s32-u32.*N***.out-of-range**
bit out TRUE when ’in’ is not in the range of u32

PARAMETERS

conv-s32-u32.*N***.clamp**
bit rw If TRUE, then clamp to the range of u32. If FALSE, then allow the value to "wrap around".

LICENSE

GPL

NAME

conv_u32_bit − Convert a value from u32 to bit

SYNOPSIS

loadrt conv_u32_bit [count=*N***|names=***name1***[,***name2...***]]**

FUNCTIONS

conv-u32-bit.*N*

Update ’out’ based on ’in’

PINS

conv-u32-bit.*N***.in**
u32 in

conv-u32-bit.*N***.out**
bit out

conv-u32-bit.*N***.out-of-range**
bit out TRUE when ’in’ is not in the range of bit

PARAMETERS

conv-u32-bit.*N***.clamp**
bit rw If TRUE, then clamp to the range of bit. If FALSE, then allow the value to "wrap around".

LICENSE

GPL

NAME

conv_u32_float − Convert a value from u32 to float

SYNOPSIS

loadrt conv_u32_float [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

conv-u32-float.*N*

(requires a floating-point thread) Update ’out’ based on ’in’

PINS

conv-u32-float.*N***.in**

u32 in

conv-u32-float.*N***.out**

float out

LICENSE

GPL

NAME

conv_u32_s32 − Convert a value from u32 to s32

SYNOPSIS

loadrt conv_u32_s32 [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

conv-u32-s32.*N*

Update ’out’ based on ’in’

PINS

conv-u32-s32.*N***.in**
u32 in

conv-u32-s32.*N***.out**
s32 out

conv-u32-s32.*N***.out-of-range**
bit out TRUE when ’in’ is not in the range of s32

PARAMETERS

conv-u32-s32.*N***.clamp**
bit rw If TRUE, then clamp to the range of s32. If FALSE, then allow the value to "wrap around".

LICENSE

GPL

NAME

counter − counts input pulses **(DEPRECATED)**

SYNOPSIS

loadrt counter [num_chan=*N*]

DESCRIPTION

counter is a deprecated HAL component and will be removed in a future release. Use the **encoder** component with encoder.X.counter−mode set to TRUE.

counter is a HAL component that provides software- based counting that is useful for spindle position sensing and maybe other things. Instead of using a real encoder that outputs quadrature, some lathes have a sensor that generates a simple pulse stream as the spindle turns and an index pulse once per revolution. This component simply counts up when a "count" pulse (phase−A) is received, and if reset is enabled, resets when the "index" (phase−Z) pulse is received.

This is of course only useful for a unidirectional spindle, as it is not possible to sense the direction of rotation.

counter conforms to the "canonical encoder" interface described in the HAL manual.

FUNCTIONS

counter.capture−position (uses floating-point)
Updates the counts, position and velocity outputs based on internal counters.

counter.update−counters
Samples the phase−A and phase−Z inputs and updates internal counters.

PINS

counter.*N*.phase−A bit in
The primary input signal. The internal counter is incremented on each rising edge.

counter.*N*.phase−Z bit in
The index input signal. When the **index−enable** pin is TRUE and a rising edge on **phase−Z** is seen, **index−enable** is set to FALSE and the internal counter is reset to zero.

counter.*N*.index−enable bit io
counter.*N*.reset bit io
counter.*N*.counts signed out
counter.*N*.position float out
counter.*N*.velocity float out
These pins function according to the canonical digital encoder interface.

counter.*N*.position−scale float rw
This parameter functions according to the canonical digital encoder interface.

counter.*N*.rawcounts signed ro
The internal counts value, updated from **update−counters** and reflected in the output pins at the next call to **capture−position**.

SEE ALSO

encoder(9). in the LinuxCNC documentation.

NAME

ddt − Compute the derivative of the input function

SYNOPSIS

loadrt ddt [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

ddt.*N* (requires a floating-point thread)

PINS

ddt.*N***.in**
: float in

ddt.*N***.out**
: float out

LICENSE

GPL

NAME

deadzone − Return the center if within the threshold

SYNOPSIS

loadrt deadzone [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

deadzone.*N*

(requires a floating-point thread) Update **out** based on **in** and the parameters.

PINS

deadzone.*N***.in**

float in

deadzone.*N***.out**

float out

PARAMETERS

deadzone.*N***.center**

float rw (default: *0.0*) The center of the dead zone

deadzone.*N***.threshhold**

float rw (default: *1.0*) The dead zone is **center** ± (**threshhold**/2)

LICENSE

GPL

NAME

debounce − filter noisy digital inputs

SYNOPSIS

loadrt debounce cfg=*size[,size,...]*

Creates debounce groups with the number of filters specified by (*size*). Every filter in the same group has the same sample rate and delay. For example cfg=2,3 creates two filter groups with 2 filters in the first group and 3 filters in the second group.

DESCRIPTION

The debounce filter works by incrementing a counter whenever the input is true, and decrementing the counter when it is false. If the counter decrements to zero, the output is set false and the counter ignores further decrements. If the counter increments up to a threshold, the output is set true and the counter ignores further increments. If the counter is between zero and the threshold, the output retains its previous state. The threshold determines the amount of filtering: a threshold of 1 does no filtering at all, and a threshold of N requires a signal to be present for N samples before the output changes state.

FUNCTIONS

debounce.*G*

Sample all the input pins in group G and update the output pins.

PINS

debounce.*G***.***F***.in** bit in

The F’th input pin in group G.

debounce.*G***.***F***.out** bit out

The F’th output pin in group G. Reflects the last "stable" input seen on the corresponding input pin.

debounce.*G***.delay** signed rw

Sets the amount of filtering for all pins in group G.

NAME

demux − Select one of several output pins selected either by

SYNOPSIS

an integer input or individual bits. Or even both

DESCRIPTION

This component creates a number of output bits defined by the "personality" command-line parameter. One of these bits will be set based on interpreting the bit-inputs as a binary number and then adding on the integer input. Most uses will use only one or the other, but it is possible to use the bits as a ""shift"" if required. An optional operating mode is enabled by setting the "bargraph" parameter to true, in this case all bits up to the selected bit will be set, as might be required for an LED bargraph display

FUNCTIONS

demux.*N*

(requires a floating-point thread)

PINS

demux.*N***.sel-bit-***MM*

bit in

(MM=00..04) Binary-number bit selectors

demux.*N***.sel-u32**

u32 in Integer selection input

demux.*N***.out-***MM*

bit out

(MM=00..personality) The set of output bits

PARAMETERS

demux.*N***.bargraph**

bit rw (default: *0*)

AUTHOR

andypugh

LICENSE

GPL 2+

NAME

differential − kinematics for a differential transmission

SYNOPSIS

loadrt differential [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

differential.*N*

(requires a floating-point thread)

PINS

differential.*N***.roll-cmd**
float in position command for roll (in degrees)

differential.*N***.pitch-cmd**
float in position command for pitch (in degrees)

differential.*N***.roll-fb**
float out position feedback for roll (in degrees)

differential.*N***.pitch-fb**
float out position feedback for pitch (in degrees)

differential.*N***.motor0-cmd**
float out position command to motor0 (based on roll & pitch inputs)

differential.*N***.motor1-cmd**
float out position command to motor1 (based on roll & pitch inputs)

differential.*N***.motor0-fb**
float in position feedback from motor0

differential.*N***.motor1-fb**
float in position feedback from motor1

LICENSE

GPL

NAME

edge − Edge detector

SYNOPSIS

loadrt edge [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

edge.*N*

Produce output pulses from input edges

PINS

edge.*N***.in**
bit in

edge.*N***.out**
bit out Goes high when the desired edge is seen on ’in’

edge.*N***.out-invert**
bit out Goes low when the desired edge is seen on ’in’

PARAMETERS

edge.*N***.both**
bit rw (default: *FALSE*) If TRUE, selects both edges. Otherwise, selects one edge according to in-edge

edge.*N***.in-edge**
bit rw (default: *TRUE*) If both is FALSE, selects the one desired edge: TRUE means falling, FALSE means rising

edge.*N***.out-width-ns**
s32 rw (default: *0*) Time in nanoseconds of the output pulse

edge.*N***.time-left-ns**
s32 r Time left in this output pulse

edge.*N***.last-in**
bit r Previous input value

LICENSE

GPL

NAME

encoder − software counting of quadrature encoder signals

SYNOPSIS

loadrt encoder [num_chan=*num* **| names=***name1***[,***name2...***]]**

DESCRIPTION

encoder is used to measure position by counting the pulses generated by a quadrature encoder. As a software-based implementation it is much less expensive than hardware, but has a limited maximum count rate. The limit is in the range of 10KHz to 50KHz, depending on the computer speed and other factors. If better performance is needed, a hardware encoder counter is a better choice. Some hardware-based systems can count at MHz rates.

encoder supports a maximum of eight channels. The number of channels actually loaded is set by the **num_chan** argument when the module is loaded. Alternatively, specify names= and unique names separated by commas.

The **num_chan=** and **names=** specifiers are mutually exclusive. If neither **num_chan=** nor **names=** are specified, or if **num_chan=0** is specified, the default value is three.

encoder has a one-phase, unidirectional mode called *counter*. In this mode, the **phase−B** input is ignored; the counts increase on each rising edge of **phase−A**. This mode may be useful for counting a unidirectional spindle with a single input line, though the noise-resistant characteristics of quadrature are lost.

FUNCTIONS

encoder.update−counters (no floating-point)

Does the actual counting, by sampling the encoder signals and decoding the quadrature waveforms. Must be called as frequently as possible, preferably twice as fast as the maximum desired count rate. Operates on all channels at once.

encoder.capture−position (uses floating point)

Captures the raw counts from **update−counters** and performs scaling and other necessary conversion, handles counter rollover, etc. Can (and should) be called less frequently than **update−counters**. Operates on all channels at once.

NAMING

The names for pins and parameters are prefixed as:
encoder.N. for N=0,1,...,num−1 when using **num_chan=num**
nameN. for nameN=name1,name2,... when using **names=name1,name2,...**

The **encoder.N.** format is shown in the following descriptions.

PINS

encoder.*N*.counter−mode bit i/o

Enables counter mode. When true, the counter counts each rising edge of the phase−A input, ignoring the value on phase−B. This is useful for counting the output of a single channel (non-quadrature) sensor. When false (the default), it counts in quadrature mode.

encoder.*N*.counts s32 out

Position in encoder counts.

encoder.*N*.index−enable bit i/o

When true, **counts** and **position** are reset to zero on the next rising edge of **Phase−Z**. At the same time, **index−enable** is reset to zero to indicate that the rising edge has occurred.

encoder.*N*.min−speed−estimate float in (default: 1.0)
Determine the minimum speed at which **velocity** will be estimated as nonzero and **position−interpolated** will be interpolated. The units of **min−speed−estimate** are the same as the units of **velocity**. Setting this parameter too low will cause it to take a long time for **velocity** to go to 0 after encoder pulses have stopped arriving.

encoder.*N*.phase−A bit in
Quadrature input for encoder channel *N*.

encoder.*N*.phase−B bit in
Quadrature input.

encoder.*N*.phase−Z bit in
Index pulse input.

encoder.*N*.position float out
Position in scaled units (see **position−scale**)

encoder.*N*.position−interpolated float out
Position in scaled units, interpolated between encoder counts. Only valid when velocity is approximately constant and above **min−speed−estimate**. Do not use for position control.

encoder.*N*.position−scale float i/o
Scale factor, in counts per length unit. For example, if **position−scale** is 500, then 1000 counts of the encoder will be reported as a position of 2.0 units.

encoder.*N*.rawcounts s32 out
The raw count, as determined by **update−counters**. This value is updated more frequently than **counts** and **position**. It is also unaffected by **reset** or the index pulse.

encoder.*N*.reset bit in
When true, **counts** and **position** are reset to zero immediately.

encoder.*N*.velocity float out
Velocity in scaled units per second. **encoder** uses an algorithm that greatly reduces quantization noise as compared to simply differentiating the **position** output. When the magnitude of the true velocity is below min−speed−estimate, the velocity output is 0.

encoder.*N*.x4−mode bit i/o
Enables times−4 mode. When true (the default), the counter counts each edge of the quadrature waveform (four counts per full cycle). When false, it only counts once per full cycle. In **counter−mode**, this parameter is ignored.

encoder.*N*.latch−input bit in
encoder.*N*.latch−falling bit in (default: **TRUE**)
encoder.*N*.latch−rising bit in (default: **TRUE**)
encoder.*N*.counts−latched s32 out
encoder.*N*.position−latched float out
Update **counts−latched** and **position−latched** on the rising and/or falling edges of **latch−input** as indicated by **latch−rising** and **latch−falling**.

encoder.*N*.counter−mode bit rw
Enables counter mode. When true, the counter counts each rising edge of the phase−A input, ignoring the value on phase−B. This is useful for counting the output of a single channel (non-quadrature) sensor. When false (the default), it counts in quadrature mode. **encoder.*N*.capture−position.tmax** s32 rw Maximum number of CPU cycles it took to execute this function.

PARAMETERS

The encoder component has no HAL Parameters.

NAME

encoder_ratio − an electronic gear to synchronize two axes

SYNOPSIS

loadrt encoder_ratio [num_chan=*num* **| names=***name1***[,***name2***...]]**

DESCRIPTION

encoder_ratio can be used to synchronize two axes (like an "electronic gear"). It counts encoder pulses from both axes in software, and produces an error value that can be used with a PID loop to make the slave encoder track the master encoder with a specific ratio.

This module supports up to eight axis pairs. The number of pairs is set by the module parameter **num_chan**. Alternatively, specify **names=** and unique names separated by commas.

The **num_chan=** and **names=** specifiers are mutually exclusive. If neither **num_chan=** nor **names=** are specified, the default value is one.

FUNCTIONS

encoder−ratio.sample

Read all input pins. Must be called at twice the maximum desired count rate.

encoder−ratio.update (uses floating-point)

Updates all output pins. May be called from a slower thread.

NAMING

The names for pins and parameters are prefixed as:
encoder−ratio.N. for N=0,1,...,num−1 when using **num_chan=num**
nameN. for nameN=name1,name2,... when using **names=name1,name2,...**

The **encoder−ratio.N.** format is shown in the following descriptions.

PINS

encoder−ratio.*N*.master−A bit in
encoder−ratio.*N*.master−B bit in
encoder−ratio.*N*.slave−A bit in
encoder−ratio.*N*.slave−B bit in

The encoder channels of the master and slave axes

encoder−ratio.*N*.enable bit in

When the enable pin is FALSE, the error pin simply reports the slave axis position, in revolutions. As such, it would normally be connected to the feedback pin of a PID block for closed loop control of the slave axis. Normally the command input of the PID block is left unconnected (zero), so the slave axis simply sits still. However when the enable input goes TRUE, the error pin becomes the slave position minus the scaled master position. The scale factor is the ratio of master teeth to slave teeth. As the master moves, error becomes non-zero, and the PID loop will drive the slave axis to track the master.

encoder−ratio.*N*.error float out

The error in the position of the slave (in revolutions)

PARAMETERS

encoder−ratio.N.master−ppr unsigned rw
encoder−ratio.N.slave−ppr unsigned rw

The number of pulses per revolution of the master and slave axes

encoder−ratio.N.master−teeth unsigned rw
encoder−ratio.N.slave−teeth unsigned rw
The number of "teeth" on the master and slave gears.

SEE ALSO

encoder(9)

NAME

eoffset_per_angle − Compute External Offset Per Angle

SYNOPSIS

loadrt eoffset_per_angle [count=*N***|names=***name1***[,***name2***...]]**

DESCRIPTION

An offset is computed (from one of several functions) based on an input angle in degrees. The angle could be a rotary coordinate value or a spindle angle.

The computed offset is represented as an s32 **kcounts** output pin that is a compatible input to external offset pins like **axis.L.eoffset-counts** where **L** is the coordinate letter. Scaling of the s32 **kcounts** is controlled by the input (**k**) -- its reciprocal value is presented on an output pin (**kreciprocal**) for connection to **axis.L.eoffset-scale**. The default value for **k** should be suitable for most uses.

The built-in functions use pins **fmult** and **rfraction** to control the output frequency (or number of polygon sides) and amplitude respectively. The **rfraction** pin controls the offset amplitude as a fraction of the **radius-ref** pin.

One of the four built-in functions is specified by the **fnum** pin:
0: f0 inside polygon (requires **fmult** == nsides >= 3)
1: f1 outside polygon (requires **fmult** == nsides >= 3)
2: f2 sinusoid
3: f3 square wave

Unsupported **fnum** values default to use function f0.

NOTES:

radius-ref: The computed offsets are based on the **radius-ref** pin value. This pin may be set to a constant radius value or controlled by a user interface or by g code program (using **M68** and a **motion.analog-out-NN pin for instance).**

Stopping: When the **enable-in** pin is deasserted, the offset is returned to zero respecting the allocated acceleration and velocity limits. The allocations for coordinate **L** are typically controlled by an ini file setting: **[AXIS_L]OFFSET_AV_RATIO**.

NOTES: If unsupported parameters are supplied to a function (for instance a polygon with fewer than three sides), the current offset will be returned to zero (respecting velocity and acceleration constraints). After correcting the offending parameter, the **enable-in** pin must be toggled to resume offset computations.

EXAMPLE: An example simulation configuration is provided at: **configs/sim/axis/external_offsets/opa.ini**. A simulated XZC machine uses the **C** coordinate angle to offset the transverse **X** coordinate according to the selected **fnum** function.

FUNCTIONS

eoffset-per-angle.*N*
(requires a floating-point thread)

PINS

eoffset-per-angle.*N***.active**
bit in (default: *0*) From: motion.eoffset-active

eoffset-per-angle.*N*.is-on
bit in (default: *0*) From: halui.machine.is-on

eoffset-per-angle.*N*.enable-in
bit in (default: *0*) Enable Input

eoffset-per-angle.*N*.radius-ref
float in (default: *1*) Radius reference (see notes)

eoffset-per-angle.*N*.angle
float in (default: *0*) Input angle (in degrees)

eoffset-per-angle.*N*.start-angle
float in (default: *0*) Start angle (in degrees)

eoffset-per-angle.*N*.fnum
s32 in (default: *0*) Function selector (default 0)

eoffset-per-angle.*N*.rfraction
float in (default: *0.1*) Offset amplitude (+/- fraction of radius_ref)

eoffset-per-angle.*N*.fmult
float in (default: *6*) Offset frequency multiplier

eoffset-per-angle.*N*.k
u32 in (default: *10000*) Scaling Factor (if 0, use 10000)

eoffset-per-angle.*N*.is-off
bit out invert is_on (for convenience)

eoffset-per-angle.*N*.enable-out
bit out To: axis.L.eoffset-enable

eoffset-per-angle.*N*.clear
bit out To: axis.L.eoffset-clear

eoffset-per-angle.*N*.kcounts
s32 out To: axis.L.eoffset-counts

eoffset-per-angle.*N*.kreciprocal
float out To: axis.L.eoffset-scale (1/k)

eoffset-per-angle.*N*.eoffset-dbg
float out offset (debug pin--use kcounts & kreciprocal)

eoffset-per-angle.*N*.state-dbg
u32 out state (debug pin)

LICENSE

GPL

NAME

estop_latch − Software ESTOP latch

SYNOPSIS

loadrt estop_latch [count=*N***|names=***name1***[,***name2***...]]**

DESCRIPTION

This component can be used as a part of a simple software ESTOP chain.

It has two states: "OK" and "Faulted".

The initial state is "Faulted". When faulted, the **out-ok** output is false, the **fault-out** output is true, and the **watchdog** output is unchanging.

The state changes from "Faulted" to "OK" when **all** these conditions are true:

- **fault-in** is false
- **ok-in** is true
- **reset** changes from false to true

When "OK", the **out-ok** output is true, the **fault-out** output is false, and the **watchdog** output is toggling.

The state changes from "OK" to "Faulted" when **any** of the following are true:

- **fault-in** is true
- **ok-in** is false

To facilitate using only a single fault source, **ok-in** and **fault-en** are both set to the non-fault-causing value when no signal is connected. For estop-latch to ever be able to signal a fault, at least one of these inputs must be connected.

Typically, an external fault or estop input is connected to **fault-in**, **iocontrol.0.user-request-enable** is connected to **reset**, and **ok-out** is connected to **iocontrol.0.emc-enable-in.**

In more complex systems, it may be more appropriate to use classicladder to manage the software portion of the estop chain.

FUNCTIONS

estop-latch.*N*

PINS

estop-latch.*N***.ok-in**
bit in (default: *true*)
estop-latch.*N***.fault-in**
bit in (default: *false*)
estop-latch.*N***.reset**
bit in
estop-latch.*N***.ok-out**
bit out (default: *false*)
estop-latch.*N***.fault-out**
bit out (default: *true*)

estop-latch.*N*.watchdog
bit out

LICENSE

GPL

NAME

feedcomp − Multiply the input by the ratio of current velocity to the feed rate

SYNOPSIS

loadrt feedcomp [count=*N***|names=***name1***[,***name2...***]]**

FUNCTIONS

feedcomp.*N*

(requires a floating-point thread)

PINS

feedcomp.*N***.out**

float out Proportionate output value

feedcomp.*N***.in**

float in Reference value

feedcomp.*N***.enable**

bit in Turn compensation on or off

feedcomp.*N***.vel**

float in Current velocity

PARAMETERS

feedcomp.*N***.feed**

float rw Feed rate reference value

NOTES

Note that if enable is false, out = in

LICENSE

GPL

NAME

flipflop − D type flip-flop

SYNOPSIS

loadrt flipflop [count=*N***|names=***name1***[,***name2...***]]**

FUNCTIONS

flipflop.*N*

PINS

flipflop.*N***.data**
bit in data input

flipflop.*N***.clk**
bit in clock, rising edge writes data to out

flipflop.*N***.set**
bit in when true, force out true

flipflop.*N***.reset**
bit in when true, force out false; overrides set

flipflop.*N***.out**
bit io output

LICENSE

GPL

NAME

gantry − LinuxCNC HAL component for driving multiple joints from a single axis

SYNOPSIS

loadrt gantry [count=*N***|names=***name1***[,***name2***...]] [personality=***P,P,...***]**

DESCRIPTION

Drives multiple physical motors (joints) from a single axis input

The ‘personality’ value is the number of joints to control. Two is typical, but up to seven is supported (a three joint setup has been tested with hardware).

All controlled joints track the commanded position (with a per-joint offset) unless in the process of homing. Homing is when the commanded position is moving towards the homing switches (as determined by the sign of search-vel) and the joint home switches are not all in the same state. When the system is homing and a joint home switch activates, the command value sent to that joint is "frozen" and the joint offset value is updated instead. Once all home switches are active, there are no more adjustments made to the offset values and all joints run in lock-step once more.

For best results, set HOME_SEARCH_VEL and HOME_LATCH_VEL to the same direction and as slow as practical. When a joint home switch trips, the commanded velocity will drop immediately from HOME_SEARCH_VEL to zero, with no limit on acceleration.

FUNCTIONS

gantry.*N*.read
(requires a floating-point thread) Update position-fb and home/limit outputs based on joint values

gantry.*N*.write
(requires a floating-point thread) Update joint pos-cmd outputs based on position-cmd in

PINS

gantry.*N*.joint.*MM*.pos-cmd
float out
(MM=00..personality) Per-joint commanded position

gantry.*N*.joint.*MM*.pos-fb
float in
(MM=00..personality) Per-joint position feedback

gantry.*N*.joint.*MM*.home
bit in
(MM=00..personality) Per-joint home switch

gantry.*N*.joint.*MM*.offset
float out
(MM=00..personality) (debugging) Per-joint offset value, updated when homing

gantry.*N*.position-cmd
float in Commanded position from motion

gantry.*N*.position-fb
float out Position feedback to motion

gantry.*N*.home
bit out Combined home signal, true if all joint home inputs are true

gantry.*N*.limit
bit out Combined limit signal, true if any joint home input is true

gantry.*N*.search-vel
float in HOME_SEARCH_VEL from ini file

LICENSE

GPL

NAME

gantrykins − **Superseded** by the general purpose **trivkins** kinematics module.

To specify a gantry with non-identity kinematics: use trivkins with the kinstype parameter set for KINEMATICS_BOTH. Example:

loadrt trivkins coordinates=xyyz **kinstypes=BOTH**

For more information:

$ man −s 9 trivkins

NAME

gearchange − Select from one two speed ranges

SYNOPSIS

The output will be a value scaled for the selected gear, and clamped to the min/max values for that gear. The scale of gear 1 is assumed to be 1, so the output device scale should be chosen accordingly. The scale of gear 2 is relative to gear 1, so if gear 2 runs the spindle 2.5 times as fast as gear 1, scale2 should be set to 2.5.

FUNCTIONS

gearchange.*N*

(requires a floating-point thread)

PINS

gearchange.*N***.sel**

bit in Gear selection input

gearchange.*N***.speed-in**

float in Speed command input

gearchange.*N***.speed-out**

float out Speed command to DAC/PWM

gearchange.*N***.dir-in**

bit in Direction command input

gearchange.*N***.dir-out**

bit out Direction output - possibly inverted for second gear

PARAMETERS

gearchange.*N***.min1**

float rw (default: *0*) Minimum allowed speed in gear range 1

gearchange.*N***.max1**

float rw (default: *100000*) Maximum allowed speed in gear range 1

gearchange.*N***.min2**

float rw (default: *0*) Minimum allowed speed in gear range 2

gearchange.*N***.max2**

float rw (default: *100000*) Maximum allowed speed in gear range 2

gearchange.*N***.scale2**

float rw (default: *1.0*) Relative scale of gear 2 vs. gear 1 Since it is assumed that gear 2 is "high gear", **scale2** must be greater than 1, and will be reset to 1 if set lower.

gearchange.*N***.reverse**

bit rw (default: *0*) Set to 1 to reverse the spindle in second gear

LICENSE

GPL

NAME

gentrivkins − **Superseded** by the general purpose **trivkins** kinematics module.

For more information:

$ man -s 9 trivkins

NAME

gladevcp − displays Virtual control Panels built with GTK / GLADE

SYNOPSIS

loadusr gladevcp [−c componentname0x*N*] [−g WxH+Xoffset+Yoffset0x*N*] [−H halcmdfile] [−x windowid] gladefile.glade

DESCRIPTION

gladevcp parses a glade file and displays the widgets in a window. Then calls gladevcp_makepins which again parses the gladefile looking for specific HAL widgets then makes HAL pins and sets up updating for them. The HAL component name defaults to the basename of the glade file. The −x option directs gladevcp to reparent itself under this X window id instead of creating its own toplevel window. The −H option passes an input file for halcmd to be run after the gladevcp component is initialized. This is used in Axis when running gladevcp under a tab with the EMBED_TAB_NAME/EMBED_TAB_COMMAND ini file feature.

gladevcp supports gtkbuilder or libglade files though some widgets are not fully supported in gtkbuilder yet.

ISSUES

For now system links need to be added in the glade library folders to point to our new widgets and catalog files. look in lib/python/gladevcp/READ_ME for details

NAME

gray2bin − convert a gray-code input to binary

SYNOPSIS

loadrt gray2bin [count=*N***|names=***name1***[,***name2***...]]**

DESCRIPTION

Converts a gray-coded number into the corresponding binary value

FUNCTIONS

gray2bin.*N*

PINS

gray2bin.*N***.in**
u32 in gray code in

gray2bin.*N***.out**
u32 out binary code out

AUTHOR

andy pugh

LICENSE

GPL

NAME

hal_bb_gpio − Driver for beaglebone GPIO pins

SYNOPSIS

loadrt hal_bb_gpio *user_leds=#,... input_pins=#,... output_pins=#,...*

USER LEDS

The *user_leds* loadrt parameter controls which LEDs are available to HAL. Valid range: 0..3. These LEDs are next to the ethernet jack and the linuxcnc numbers match the silkscreen on beaglbone black. Empirically, these seem to be OR'd with whatever function is assigned to the LED in Linux.

PINS

bb_gpio.userled*N* bit in
bb_gpio.userled*N*-**invert** bit in
The associated LED is lit if **userled***N* xor **userled***N*-invert **is TRUE.**

INPUT PINS

The *input_pins* loadrt parameter controls which physical I/O pins are available to HAL as input pins. The numbering is "800+N" for pin N on connector P8, and "900+N" for pin N on connector P9. For example, "803" means connector P8 pin 3, which is also described in BeagleBone documentation as "gpmc_ad6".

Specifying pins that are otherwise in use by the system may have undesirable side effects, such as crashing rtapi_app or the whole system.

PINS

bb_gpio.p*N***.in-***NN* bit out
bb_gpio.p*N***.in-***NN*-**invert** bit in
in-*NN* is a snapshot of the value of the corresponding physical pin XOR the value of the corresponding **in-***NN*-**invert** pin.

OUTPUT PINS

The *input_pins* loadrt parameter controls which physical I/O pins are available to HAL as input pins. The numbering is "800+N" for pin N on connector P8, and "900+N" for pin N on connector P9.

Specifying pins that are otherwise in use by the system may have undesirable side effects, such as crashing rtapi_app or the whole system.

PINS

bb_gpio.p*N***.out-***NN* bit out
bb_gpio.p*N***.out-***NN*-**invert** bit in
The corresponding physical pin is driven with the result of **in-***NN* xor **in-***NN*-**invert**.

PARAMETERS

None

FUNCTIONS

bb_gpio.read
Update HAL pins from physical pins

bb_gpio.write
Update physical pins from HAL pins

LICENSE

GPL

NAME

histobins − histogram bins utility for scripts/hal-histogram

SYNOPSIS

Usage:
Read availablebins pin for the number of bins available.
Set the minvalue, binsize, and nbins pins.
Ensure nbins <= availablebins
For nbins = N, the bins are numbered: 0 ... N−1
Iterate:
Set index pin to a bin number: 0 <= index < nbins.
Read check pin and verify that check pin == index pin.
Read outputs: binvalue, pextra, nextra pins.
(binvalue is count for the indexed bin)
(pextra is count for all inputs > maxvalue)
(nextra is count for all bins < minvalue)

If index is out of range (index < 0 or index > maxbinnumber)
then binvalue == −1.
The input-error pin is set when input rules are violated
and updates cease.
The reset pin may be used to restart.
The input used is selected based on pintype:

pintype	inputpin
0	input
1	input-s32
2	input-u32
3	input-bit

Additional output statistics pins:
input-min
input-max
nsamples
variance
mean
The method input pin selects an alternate variance calculation.

Maintainers note: hardcoded for MAXBINNUMBER==200

FUNCTIONS

histobins.*N*
(requires a floating-point thread)

PINS

histobins.*N*.pintype
u32 in
histobins.*N*.input
float in
histobins.*N*.input-s32
s32 in
histobins.*N*.input-u32
u32 in

histobins.*N*.input-bit
bit in
histobins.*N*.nbins
u32 in (default: *20*)
histobins.*N*.binsize
float in (default: *1*)
histobins.*N*.minvalue
float in (default: *0*)
histobins.*N*.index
s32 in
histobins.*N*.check
s32 out
histobins.*N*.reset
bit in
histobins.*N*.method
bit in
histobins.*N*.input-error
bit out
histobins.*N*.binvalue
float out
histobins.*N*.pextra
float out
histobins.*N*.nextra
float out
histobins.*N*.input-min
float out
histobins.*N*.input-max
float out
histobins.*N*.nsamples
u32 out
histobins.*N*.variance
float out
histobins.*N*.mean
float out
histobins.*N*.availablebins
s32 out (default: *200*)

LICENSE

GPL

NAME

hm2_7i43 − LinuxCNC HAL driver for the Mesa Electronics 7i43 EPP Anything IO board with HostMot2 firmware.

SYNOPSIS

loadrt hm2_7i43 [ioaddr=*N*[,*N*...]] [ioaddr_hi=*N*[,*N*...]] [epp_wide=*N*[,*N*...]] [config=*"str[,str...]"*] [debug_epp=*N*[,*N*...]]

ioaddr [default: 0 (parport0)]
The base address of the parallel port.

The number of ioaddr indexes/addresses given is used by the driver to determine how many boards to search for.

ioaddr_hi [default: 0]
The secondary address of the parallel port, used to set EPP mode. 0 means to use ioaddr + 0x400.

epp_wide [default: 1]
Set to zero to disable the "wide EPP mode". "Wide" mode allows a 16- and 32-bit EPP transfers, which can reduce the time spent in the read and write functions. However, this may not work on all EPP parallel ports.

config [default: ""]
HostMot2 config strings, described in the hostmot2(9) manpage.

debug_epp [default: 0]
Developer/debug use only! Enable debug logging of most EPP transfers.

DESCRIPTION

hm2_7i43 is a device driver that interfaces the Mesa 7i43 board with the HostMot2 firmware to the LinuxCNC HAL. Both the 200K and the 400K FPGAs are supported.

The driver talks with the 7i43 over the parallel port, not over USB. USB can be used to power the 7i43, but not to talk to it. USB communication with the 7i43 will not be supported any time soon, since USB has poor real-time qualities.

The driver programs the board's FPGA with firmware when it registers the board with the hostmot2 driver. The firmware to load is specified in the **config** modparam, as described in the hostmot2(9) manpage, in the *config modparam* section.

Jumper settings

To send the FPGA configuration from the PC, the board must be configured to get its firmware from the EPP port. To do this, jumpers W4 and W5 must both be down, ie toward the USB connector.

The board must be configured to power on whether or not the USB interface is active. This is done by setting jumper W7 up, ie away from the edge of the board.

Communicating with the board

The 7i43 communicates with the LinuxCNC computer over EPP, the Enhanced Parallel Port. This provides about 1 MBps of throughput, and the communication latency is very predictable and reasonably low.

The parallel port must support EPP 1.7 or EPP 1.9. EPP 1.9 is prefered, but EPP 1.7 will work too. The EPP mode of the parallel port is sometimes a setting in the BIOS.

Note that the popular "NetMOS" aka "MosChip 9805" PCI parport cards **do not work**. They do not meet the EPP spec, and cannot be reliably used with the 7i43. You have to find another card, sorry.

EPP is very reliable under normal circumstances, but bad cabling or excessively long cabling runs may

cause communication timeouts. The driver exports a parameter named hm2_7i43.<BoardNum>.io_error to inform HAL of this condition. When the driver detects an EPP timeout, it sets io_error to True and stops communicating with the 7i43 board. Setting io_error back to False makes the driver start trying to communicate with the 7i43 again.

Access to the EPP bus is not threadsafe: only one realtime thread may access the EPP bus.

SEE ALSO

hostmot2(9)

LICENSE

GPL

NAME

hm2_7i90 − LinuxCNC HAL driver for the Mesa Electronics 7i90 EPP Anything IO board with HostMot2 firmware.

SYNOPSIS

loadrt hm2_7i90 [ioaddr=*N*[,*N*...]] [ioaddr_hi=*N*[,*N*...]] [epp_wide=*N*[,*N*...]] [debug_epp=*N*[,*N*...]]

ioaddr [default: 0 (parport0)]
: The base address of the parallel port.

  The number of ioaddr indexes/addresses given is used by the driver to determine how many boards to search for. Previously the number of config strings was used, but a blank config string is perfectly acceptable for 7i90.

ioaddr_hi [default: 0]
: The secondary address of the parallel port, used to set EPP mode. 0 means to use ioaddr + 0x400.

epp_wide [default: 1]
: Set to zero to disable the "wide EPP mode". "Wide" mode allows a 16- and 32-bit EPP transfers, which can reduce the time spent in the read and write functions. However, this may not work on all EPP parallel ports.

config [default: ""]
: HostMot2 config strings, described in the hostmot2(9) manpage.

debug_epp [default: 0]
: Developer/debug use only! Enable debug logging of most EPP transfers.

DESCRIPTION

hm2_7i90 is a device driver that interfaces the Mesa 7i90 board with the HostMot2 firmware to the LinuxCNC HAL.

The 7i90 firmware is stored on the 7i90 itself, it is not programmed by the driver at load time. The 7i90 firmware can be changed using the mesaflash program.

The driver talks with the 7i90 over the parallel port, via EPP.

Communicating with the board

The 7i90 communicates with the LinuxCNC computer over EPP, the Enhanced Parallel Port. This provides about 1 MBps of throughput, and the communication latency is very predictable and reasonably low.

The parallel port must support EPP 1.7 or EPP 1.9. EPP 1.9 is prefered, but EPP 1.7 will work too. The EPP mode of the parallel port is sometimes a setting in the BIOS.

Note that the popular "NetMOS" aka "MosChip 9805" PCI parport cards **do not work**. They do not meet the EPP spec, and cannot be reliably used with the 7i90. You have to find another card, sorry.

EPP is very reliable under normal circumstances, but bad cabling or excessively long cabling runs may cause communication timeouts. The driver exports a parameter named hm2_7i90.<BoardNum>.io_error to inform HAL of this condition. When the driver detects an EPP timeout, it sets io_error to True and stops communicating with the 7i90 board. Setting io_error back to False makes the driver start trying to communicate with the 7i90 again.

Access to the EPP bus is not threadsafe: only one realtime thread may access the EPP bus.

SEE ALSO

hostmot2(9)

LICENSE

GPL

NAME

hm2_eth − LinuxCNC HAL driver for the Mesa Electronics Ethernet Anything IO boards, with HostMot2 firmware.

SYNOPSIS

loadrt hm2_eth [config=*"str[,str...]"***] [board_ip=***ip[,ip...]***] [board_mac=***mac[,mac...]***]**

config [default: ""]
HostMot2 config strings, described in the hostmot2(9) manpage.

board_ip [default: ""]
The IP address of the board(s), separated by commas. As shipped, the board address is 192.168.1.121.

DESCRIPTION

hm2_eth is a device driver that interfaces Mesa's ethernet based Anything I/O boards (with the HostMot2 firmware) to the LinuxCNC HAL.

The supported boards are: 7i76E, 7I80DB, 7I80HD, 7i92, 7i93, 7i96.

The board must have its hardware loaded on the board by the mesaflash(1) program.

hm2_eth is only available when linuxcnc is configured with "uspace" realtime.

INTERFACE CONFIGURATION

hm2_eth should be used on a dedicated network interface, with only a cable between the PC and the board. Wireless and USB network interfaces are not suitable.

These instructions assume your dedicated network interface is "eth1", 192.168.1/24 is an unused private network, that the hostmot2 board is using the default address of 192.168.1.121, that you are using Debian 7 or similar, and that you do not otherwise use iptables. If any of these are false, you will need to modify the instructions accordingly. After following all the instructions, reboot so that the changes take effect.

It is particularly important to check that the network 192.168.1/24 is not already the private network used by your internet router, because this is a commonly-used value. If you use another network, you will also need to reconfigure the hostmot2 card to use an IP address on that network by using the mesaflash(1) utility and change jumper settings. Typically, you will choose one of the networks in the Private IPv4 address space. ⟨http://en.wikipedia.org/wiki/IPv4#Private_networks⟩ One common alternative is PC address 10.10.10.1, hostmot2 address 10.10.10.10.

Use of the dedicated ethernet interface while linuxcnc is running can cause violation of realtime guarantees. hm2_eth will automatically mitigate most accidental causes of interference.

Configure network with static address

Add these lines to the file /etc/network/interfaces to configure eth1 with a static address:

```
auto eth1
iface eth1 inet static
    address 192.168.1.1
    hardware-irq-coalesce-rx-usecs 0
```

PACKET LOSS

While ethernet is fairly resistant to electrical noise, many systems will not have 100% perfect packet reception. The hm2_eth driver has a limited ability to deal with lost packets. Packet loss is detected by transmitting an expected read or write packet count with each request, and checking the value with each read response. When a lost packet is detected, the **packet-error** pin is asserted in that cycle, the

packet−error−level pin is increased, and if it reaches a threshold then a permanent low-level I/O error is signaled.

However, not all hm2 special functions know how to properly recover from lost packets. For instance, the encoder special function does not properly manage the index feature when packets are lost. The author believes that this can lead to rare failures in home-to-index, which can have severe consequences.

On the other hand, pid-stepper systems will run properly for extended periods of time with packet loss on the order of .01%, as long as following error is increased enough that having stale position feedback does not trigger a following error. Altering the HAL configuration so that during transient packet loss the pid and motion feedback value is equal to the command value, instead of the stale feedback value, appears to improve tuning. This can be accomplished with a **mux2(9)** component for each feedback signal, using **packet−error** as the mux2 **sel** input.

PINS

In addition to the pins documented in **hostmot2(9)**, **hm2_eth(9)** creates additional pins:

(bit, out) hm2_<*BoardType*>.<*BoardNum*>.packet−error
: This pin is TRUE when the most recent cycle detected a read or write error, and FALSE at other times.

(s32, out) hm2_<*BoardType*>.<*BoardNum*>.packet−error−level
: This pin shows the current error level, with higher numbers indicating a greater number of recent detected errors. The error level is always in the range from 0 to packet−error−limit, inclusive.

(bit, out) hm2_<*BoardType*>.<*BoardNum*>.packet−error−exceeded
: This pin is TRUE when the current error level is equal to the maximum, and FALSE at other times.

PARAMETERS

In addition to the parameters documented in **hostmot2(9)**, **hm2_eth(9)** creates additional parameters:

(s32, rw) hm2_<*BoardType*>.<*BoardNum*>.packet−error−decrement
: The amount deducted from *packet−error−level* in a cycle without detected read or write errors, without going below zero.

(s32, rw) hm2_<*BoardType*>.<*BoardNum*>.packet−error−increment
: The amount added to *packet−error−level* in a cycle without detected read or write errors, without going above packet−error−limit.

(s32, rw) hm2_<*BoardType*>.<*BoardNum*>.packet−error−limit
: The level at which a detected read or write error is treated as a permament error. When this error level is reached, the board's *io−error* pin becomes TRUE and the condition must be manually reset.

(s32, rw) hm2_<*BoardType*>.<*BoardNum*>.packet−read−timeout
: The length of time that must pass before a read request times out. If the value is less than or equal to 0, it is interpreted as 80% of the thread period. If the value is less than 100, it is interpreted as a percentage of the thread period. Otherwise, it is interpreted as a time in nanoseconds. In any case, the timeout is never less than 100 microseconds.

  Setting this value too low can cause spurious read errors. Setting it too high can cause realtime delay errors.

NOTES

hm2_eth uses an iptables chain called "hm2−eth−rules−output" to control access to the network interface while hal is running. The chain is created if it does not exist, and a jump to it is inserted at the beginning of the OUTPUT chain if it is not there already. If you have an existing iptables setup, you can insert a direct jump from OUTPUT to hm2−eth−rules−output in an order appropriate to your local network.

At (normal) exit, hm2_eth will remove the rules. After a crash, you can manually clear the rules with **sudo iptables −F hm2−eth−rules−output**; the rules are also removed by a reboot.

"hardware−irq−coalesce−rx−usecs" decreases time waiting to receive a packet on most systems, but on at least some Marvel-chipset NICs it is harmful. If the line does not improve system performance, then remove it. A reboot is required for the value to be set back to its power-on default. This requires the eth-tool package to be installed.

BUGS

Some hostmot2 functions such uart are coded in a way that causes additional latency when used with hm2_eth.

On the 7i92, the HAL pins for the LEDs are called CR01..CR04, but the silkscreens are CR3..CR6. Depending on the FPGA firmware, the LEDs may initially be under control of the ethernet engine. This can be changed until power cycle with

```
elbpcom 01D914000000
```

Depending on firmware version, this driver may cause the hardware error LED to light even though the driver and hardware are functioning normally. This will reportedly be fixed in future bitfile updates from Mesa.

SEE ALSO

hostmot2(9), **elbpcom**(1)

LICENSE

GPL

NAME

hm2_pci − LinuxCNC HAL driver for the Mesa Electronics PCI-based Anything IO boards, with HostMot2 firmware.

SYNOPSIS

loadrt hm2_pci [config=*"str[,str...]"***]**

config [default: ""]
HostMot2 config strings, described in the hostmot2(9) manpage.

DESCRIPTION

hm2_pci is a device driver that interfaces Mesa's PCI and PC-104/Plus based Anything I/O boards (with the HostMot2 firmware) to the LinuxCNC HAL.

The supported boards are: the 5i20, 5i21, 5i22, 5i23, 5i24, and 5i25 (all on PCI); the 4i65, 4i68, and 4i69 (on PC-104/Plus), and the 3x20 (using a 6i68 or 7i68 carrier card) and 6i25 (on PCI Express).

The driver optionally programs the board's FPGA with firmware when it registers the board with the hostmot2 driver. The firmware to load is specified in the **config** modparam, as described in the hostmot2(9) manpage, in the *config modparam* section.

SEE ALSO

hostmot2(9)

LICENSE

GPL

NAME

hm2_rpspi − LinuxCNC HAL driver for the Mesa Electronics SPI Anything IO boards, with HostMot2 firmware.

SYNOPSIS

loadrt hm2_rpspi

config [default: ""]
HostMot2 config strings, described in the **hostmot2**(9) manpage.

spiclk_rate [default: 31250]
Specify the SPI clock rate in kHz. See **SPI CLOCK RATES** below.

spiclk_rate_rd [default: -1 (same as **spiclk_rate**)]
Specify the SPI read clock rate in kHz. Usually you read and write at the same speed. However, you may want to reduce the reading speed if the round-trip is too long (see **SPI CLOCK RATES** below).

spiclk_base [default: 400000000]
This is the SPI clock divider calculation fallback value. Usually, the base rate is read from */sys/kernel/debug/clk/vpu/clk_rate* and used in the divider calculation (for the Rpi3 it should be 250 MHz). The **spiclk_base** is *only* used as a fallback if the system's cannot be read. It is normally safe (and recommended) that you leave this parameter as is.
You should set this manually to 250000000 if your system does not provide access to the kernel clock settings. Otherwise, your SPI clock frequency will be only 62.5% of the requested value.

spi_pull_miso [default: 1 (pull−down)]

spi_pull_mosi [default: 1 (pull−down)]

spi_pull_sclk [default: 1 (pull−down)]
Enable or disable pull−up/pull-down on the SPI lines. A value of 0 disables any pull−up/down on the pin. A value of 1 means pull−down and 2 means pull−up. The chip enable line(s) are always pull−up enabled.

spi_probe [default: 1]
Probe SPI port and CE lines for a card. This is a bit−field indicating which combinations of SPI and CE should be probed:
− 1 = SPI0/CE0,
− 2 = SPI0/CE1,
− 4 = SPI1/CE0,
− 8 = SPI1/CE1,
− 16 = SPI1/CE2.

The probe is performed exactly in above order. Any boards found will be numbered 0...4 in the order found. See also **INTERFACE CONFGURATION** below.

It is an error if a probe fails and the driver will abort. The SPI0/SPI1 peripherals are located at gpio pins (with 40-pin I/O header pin−number in parentheses):
− SPI0: MOSI=10(19), MISO=9(21), SCLK=11(23), CE0=8(24), CE1=7(26)
− SPI1: MOSI=20(38), MISO=19(35), SCLK=21(40), CE0=18(12), CE1=17(11), CE2=16(36)

spi_debug [default: −1]
Set the message level of the running process. The message level is set if **spi_debug** is set to a positive value between 0 and 5, where 0 means no messages at all and 5 means everything. A value of −1 does not touch the current message level.

Caveat Emptor: changing the message level is process-wide and all modules within the process will spit out messages at the requested level. This may cause quite some clutter in your terminal.

DESCRIPTION

hm2_rpspi is a device driver for the Raspberry Pi 2/3 that interfaces Mesa's SPI based Anything I/O boards (with the HostMot2 firmware) to the LinuxCNC HAL. This driver is not based on the linux spidev driver, but on a dedicated BCM2835−SPI driver.

It is **strongly** recommended that you unload/disable the kernel's spidev driver by disabling it using **raspi-config**. Please note that having both kernel and user−space SPI drivers installed can result in unexpected interactions and system instabilities.

The supported boards are: 7I90HD.

The board must have a compatible firmware (ie.: 7i90_spi_svst4_8.bit) loaded on the board by the **mesaflash**(1) program.

hm2_rpspi is only available when linuxcnc is configured with "uspace" realtime. It works with Raspian and PREEMPT_RT kernel.

INTERFACE CONFIGURATION

Up to five devices (7i90 boards) are supported. Two on SPI0 and three on SPI1. It is recommended that you, at most, use two devices and each device connected to a separate SPI port. You can choose which CE lines you prefer or fit the design and setup the **spi_probe** parameter to instruct the driver where to search for the board(s).

REALTIME PERFORMANCE OF THE BCM2835-SPI DRIVER

TBD.

SPI CLOCK RATES

The maximum SPI clock of the BCM2835-SPI driver and the 7i90 is documented over 32MHz. The SPI driver can provide frequencies well beyond what is acceptable for the 7i90. A safe value to start with would be 12.5 MHz (spiclk_rate=12500) and then work your way up from there.

The SPI driver generates (very) discrete clock frequency values, especially in the MHz range because of a simple clock divider structure. The base frequency is 250 MHz and the divider for SPI0/SPI1 scales using discrete factors. The following list specifies the **spiclk_rate** setting and the discrete SPI clock frequency (250 MHz / (2n) for n > 1):

− 62500 − 62.500 MHz,
− 41667 − 41.667 MHz,
− 31250 − 31.250 MHz,
− 25000 − 25.000 MHz,
− 20834 − 20.833 MHz,
− 17858 − 17.857 MHz,
− 15625 − 15.625 MHz,
− 13889 − 13.889 MHz,
− 12500 − 12.500 MHz,
− 11364 − 11.364 MHz,
− 10417 − 10.417 MHz,
− 9616 − 9.615 MHz,
− ....

The lowest selectable SPI clock frequency is 30 kHz (spiclk_rate=30) for SPI0 and SPI1. Theoretically, the SPI0 port could go slower, but there is no point in doing so. You should not expect any real−time performance with such slow setting, unless your machine is located next to a black hole.

The highest SPI clock frequency is, theoretically, 125 MHz. However, you will not be able to build any reliable hardware interface at that frequency. The driver limits the clock to 62.5 MHz (cpiclk_rate=62500). The chances are rather slim that you get the interface to work reliably at this frequency. The 7i90 interface only supports frequencies up to 50 MHz and that is with perfect cabling and impedance matching (in write direction only).

Writing to the 7i90 may be done faster than reading. This is especially important if you have "long" wires or any buffers on the SPI−bus path. You can set the read clock frequency to a lower value (using **spiclk_rate_rd**) to counter the effects of the SPI−bus round-trip needed for read actions. For example, you can write at 41.67 MHz and read at 25.00 MHz.

It should be noted that the Rpi3 **must** have an adequate 5V power supply and the power should be properly decoupled right on the 40−pin I/O header. At high speeds and noise on the supply, there is the possibility of noise throwing off the SoC’s PLL(s), resulting in strange behaviour.

For optimal performance on the Rpi3, you must disable the "ondemand" CPU frequency governor. You may add the following to your /etc/rc.local file:
```
echo -n 1200000 > /sys/devices/system/cpu/cpufreq/policy0/scaling_min_freq
echo -n performance > /sys/devices/system/cpu/cpufreq/policy0/scaling_governor
```

Be sure to have a proper heatsink mounted on the SoC or it will get too warm and crash.

SEE ALSO

hostmot2(9)

LICENSE

GPL

NAME

hm2_spi − LinuxCNC HAL driver for the Mesa Electronics SPI Anything IO boards, with HostMot2 firmware.

SYNOPSIS

loadrt hm2_spi [config=*"str[,str...]"***] [spidev_path=path[,path...]] [spidev_rate=***rate[,rate...]***]**

config [default: ""]
HostMot2 config strings, described in the hostmot2(9) manpage.

spidev_path [default: "/dev/spidev1.0"]
The path to the spi device node, a character special device in /dev

spidev_rate [default: 24000]
The desired rate of the SPI clock in kHz. If the exact specified clock is not available, a lower clock is used. Due to shortcomings in the spidev API, it is not possible for hal to report the actual clock used.

DESCRIPTION

hm2_spi is a device driver that interfaces Mesa's SPI based Anything I/O boards (with the HostMot2 firmware) to the LinuxCNC HAL.

The supported boards are: 7I90HD.

The board must have a compatible firmware loaded on the board by the mesaflash(1) program.

hm2_spi is only available when linuxcnc is configured with "uspace" realtime.

INTERFACE CONFIGURATION

It is possible for one SPI bus to connect several devices; in this configuration, a master device has several chip select lines. In order to meet realtime deadlines, hm2_spi should be used on a dedicated SPI interface not shared with any other slaves.

REALTIME PERFORMANCE OF LINUX SPIDEV DRIVERS

As of kernel 3.8, most or all kernel SPI drivers do not achieve the high realtime response rate required for a typical linuxcnc configuration. The driver was tested with a modified version of the spi−s3c64xx SPI driver on the Odroid U3 platform. The patched kernel resides on github ⟨https://github.com/jepler/odroid−linux/tree/odroid−3.8.13−rt⟩.

SPI CLOCK RATES

The maximum SPI clock of the 7i90 is documented as 50MHz. Other elements of the data path between HAL and the 7i90 may impose other limitations.

SEE ALSO

hostmot2(9)

LICENSE

GPL

NAME

hostmot2 − LinuxCNC HAL driver for the Mesa Electronics HostMot2 firmware.

SYNOPSIS

See the config modparam section below for Mesa card configuration. Typically hostmot2 is loaded with no parameters unless debugging is required.

loadrt hostmot2 [debug_idrom=*N*] [debug_module_descriptors=*N*] [debug_pin_descriptors=*N*] [debug_modules=*N*]

debug_idrom [default: 0]
Developer/debug use only! Enable debug logging of the HostMot2 IDROM header.

debug_module_descriptors [default: 0]
Developer/debug use only! Enable debug logging of the HostMot2 Module Descriptors.

debug_pin_descriptors [default: 0]
Developer/debug use only! Enable debug logging of the HostMot2 Pin Descriptors.

debug_modules [default: 0]
Developer/debug use only! Enable debug logging of the HostMot2 Modules used.

use_serial_numbers [default: 0]
When creating HAL pins for smart-serial devices name the pins by the board serial number rather than which board and port they are connected to. With this option set to 1 pins will have names like **hm2_8i20.1234.current** rather than **hm2_5i23.0.8i20.0.1.current**. The identifier consists of the last 4 digits of the board serial number, which is normally on a sticker on the board. This will make configs less portable, but does mean that boards can be re-connected less carefully.

DESCRIPTION

hostmot2 is a device driver that interfaces the Mesa HostMot2 firmware to the LinuxCNC HAL. This driver by itself does nothing, the boards that actually run the firmware require their own drivers before anything can happen. Currently drivers are available for the 5i20, 5i22, 5i23, 5i25, 3x20, 4i65, and 4i68 (all using the hm2_pci module) and the 7i43 (using the hm2_7i43 module).

The HostMot2 firmware provides modules such as encoders, PWM generators, step/dir generators, and general purpose I/O pins (GPIOs). These things are called "Modules". The firmware is configured, at firmware compile time, to provide zero or more instances of each of these Modules.

Board I/O Pins

The HostMot2 firmware runs on an FPGA board. The board interfaces with the computer via PCI, PC-104/Plus, or EPP, and interfaces with motion control hardware such as servos and stepper motors via I/O pins on the board.

Each I/O pin can be configured, at board-driver load time, to serve one of two purposes: either as a particular I/O pin of a particular Module instance (encoder, pwmgen, stepgen etc), or as a general purpose digital I/O pin. By default all Module instances are enabled, and all the board's pins are used by the Module instances.

The user can disable Module instances at board-driver load time, by specifying a hostmot2 config string modparam. Any pins which belong to Module instances that have been disabled automatically become GPIOs.

All IO pins have some HAL presence, whether they belong to an active module instance or are full GPIOs. GPIOs can be changed (at run-time) between inputs, normal outputs, and open drains, and have a flexible HAL interface. IO pins that belong to active Module instances are constrained by the requirements of the owning Module, and have a more limited interface in HAL. This is described in the General Purpose I/O section below.

config modparam

All the board-driver modules (hm2_pci and hm2_7i43) accept a load-time modparam of type string array, named "config". This array has one config string for each board the driver should use. Each board's config string is passed to and parsed by the hostmot2 driver when the board-driver registers the board.

The config string can contain spaces, so it is usually a good idea to wrap the whole thing in double-quotes (the " character).

The comma character (,) separates members of the config array from each other.

For example, if your control computer has one 5i20 and one 5i23 you might load the hm2_pci driver with a HAL command (in halcmd) something like this:

loadrt hm2_pci config="firmware=hm2/5i20/SVST8_4.BIT num_encoders=3 num_pwmgens=3 num_stepgens=3,firmw

Note: this assumes that the hm2_pci driver detects the 5i20 first and the 5i23 second. If the detection order does not match the order of the config strings, the hostmot2 driver will refuse to load the firmware and the board-driver (hm2_pci or hm2_7i43) will fail to load. To the best of my knowledge, there is no way to predict the order in which PCI boards will be detected by the driver, but the detection order will be consistent as long as PCI boards are not moved around. Best to try loading it and see what the detection order is.

The valid entries in the format string are:

[firmware=*F***]**
[num_encoders=*N***]**
[ssi_chan_*N=abc%nq***]**
[biss_chan_*N=abc%nq***]**
[fanuc_chan_*N=abc%nq***]**
[num_resolvers=*N***]**
[num_pwmgens=*N***]**
[num_3pwmgens=*N***]**
[num_stepgens=*N***]**
[stepgen_width=*N***]**
[num_sserials=*N***]**
[sserial_port_*0=00000000***]**
[num_leds=*N***]**
[num_ssrs=*N***]**
[enable_raw]

firmware [*optional***]**

Load the firmware specified by F into the FPGA on this board. If no "**firmware=***F*" string is specified, the FPGA will not be re-programmed but may continue to run a previously downloaded firmware.

The requested firmware F is fetched by udev. udev searches for the firmware in the system's firmware search path, usually /lib/firmware. F typically has the form "hm2/<BoardType>/file.bit"; a typical value for F might be "hm2/5i20/SVST8_4.BIT". The hostmot2 firmware files are supplied by the hostmot2−firmware packages, available from linuxcnc.org and can normally be installed by entering the command "sudo apt−get install hostmot2−firmware−5i23" to install the support files for the 5i23 for example.

The 5i25 / 6i25 come pre-programmed with firmware and no "firmware=" string should be used with these cards. To change the firmware on a 5i25 or 6i25 the "mesaflash" utility should be used (available from Mesa). It is perfectly valid and reasonable to load these cards with no config string

at all.

num_dplls [optional, default: −1]
The hm2dpll is a phase-locked loop timer module which may be used to trigger certain types of encoder. This parameter can be used to disable the hm2dpll by setting the number to 0. There is only ever one module of this type, with 4 timer channels, so the other valid numbers are −1 (enable all) and 1, both of which end up meaning the same thing.

num_encoders [optional, default: −1]
Only enable the first N encoders. If N is −1, all encoders are enabled. If N is 0, no encoders are enabled. If N is greater than the number of encoders available in the firmware, the board will fail to register.

ssi_chan_N [optional, default: ""]
Specifies how the bit stream from a Synchronous Serial Interface device will be interpreted. There should be an entry for each device connected. Only channels with a format specifier will be enabled. (as the software can not guess data rates and bit lengths)

biss_chan_N [optional, default: ""]
As for ssi_chan_N, but for BiSS devices

fanuc_chan_N [optional, default: ""]
Specifies how the bit stream from a Fanuc absolute encoder will be interpreted. There should be an entry for each device connected. Only channels with a format specifier will be enabled. (as the software can not guess data rates and bit lengths)

num_resolvers [optional, default: −1]
Only enable the first N resolvers. If N = −1 then all resolvers are enabled. This module does not work with generic resolvers (unlike the encoder module which works with any encoder). At the time of writing the Hostmot2 Resolver function only works with the Mesa 7i49 card.

num_pwmgens [optional, default: −1]
Only enable the first N pwmgens. If N is −1, all pwmgens are enabled. If N is 0, no pwmgens are enabled. If N is greater than the number of pwmgens available in the firmware, the board will fail to register.

num_3pwmgens [optional, default: −1]
Only enable the first N Three-phase pwmgens. If N is −1, all 3pwmgens are enabled. If N is 0, no pwmgens are enabled. If N is greater than the number of pwmgens available in the firmware, the board will fail to register.

num_stepgens [optional, default: −1]
Only enable the first N stepgens. If N is −1, all stepgens are enabled. If N is 0, no stepgens are enabled. If N is greater than the number of stepgens available in the firmware, the board will fail to register.

stepgen_width [optional, default: 2]
Used to mask extra, unwanted, stepgen pins. Stepper drives typically require only two pins (step and dir) but the Hostmot2 stepgen can drive up to 8 output pins for specialised applications (depending on firmware). This parameter applies to all stepgen instances. Unused, masked pins will be available as GPIO.

num_sserials [optional, default: -1]
Only enable the first N of the Smart Serial modules on the FPGA board. If N is −1, then all Smart Serial modules will be enabled. If N=0 then no Smart Serial modules will be enabled.

sserial_port_N (N = 0 .. 3) [optional, default: 00000000 for all ports]
Up to 32 Smart Serial devices can be connected to a Mesa Anything IO board depending on the firmware used and the number of physical connections on the board. These are arranged in 1-4 ports of 1 to 8 channels.

Some Smart Serial (SSLBP) cards offer more than one load-time configuration, for example all inputs, or all outputs, or offering additional analogue input on some digital pins.

To set the modes for port 0 use, for example **sserial_port_0=0120xxxx**

A ’0’in the string sets the corresponding port to mode 0, 1 to mode 1, and so on up to mode 9. An "x" in any position disables that channel and makes the corresponding FPGA pins available as GPIO.

The string can be up to 8 characters long, and if it defines more modes than there are channels on the port then the extras are ignored. Channel numbering is left to right so the example above would set sserial device 0.0 to mode 0, 0.2 to mode2 and disable channels 0.4 onwards.

The sserial driver will auto-detect connected devices, no further configuration should be needed. Unconnected channels will default to GPIO, but the pin values will vary semi-randomly during boot when card-detection runs, to it is best to actively disable any channel that is to be used for GPIO.

num_bspis [optional, default: −1]

Only enable the first N Buffered SPI drivers. If N is −1 then all the drivers are enabled. Each BSPI driver can address 16 devices.

num_leds [optional, default: −1]

Only enable the first N of the LEDs on the FPGA board. If N is −1, then HAL pins for all the LEDs will be created. If N=0 then no pins will be added.

num_ssrs [optional, default: -1]

Only enable the first N of the SSR modules on the FPGA board. If N is −1, then HAL pins for all the SSR outputs will be created. If N=0 then no pins will be added.

enable_raw [optional]

If specified, this turns on a raw access mode, whereby a user can peek and poke the firmware from HAL. See Raw Mode below.

dpll

The hm2dpll module has pins like "hm2_<*BoardType*>.<*BoardNum*>.dpll" It is likely that the pin-count will decrease in the future and that some pins will become parameters. This module is a phase-locked loop that will synchronise itself with the thread in which the hostmot2 "read" function is installed and will trigger other functions that are allocated to it at a specified time before or after the "read" function runs. This can be applied to the three absolute encoder types, quadrature encoders and stepgen. In the case of the absolute encoders this allows the system to trigger a data transmission just prior to the time when the HAL driver reads the data. In the case of stepgens and quadrature encoders the timers can be used to reduce position sampling jitter. This is especially valuable with the ethernet-interfaced cards.

Pins:

(float, in) hm2_<*BoardType*>.<*BoardNum*>.dpll.NN.timer−us

This pin sets the triggering offset of the associated timer. There are 4 timers numbered 01 to 04, represented by the NN digits in the pin name. The units are micro-seconds. Generally the value will be negative, so that some action is undertaken by the fpga prior to the execution of the main hostmot2 read.

For stepgen and quadrature encoders, the value needs to be more than the maximum variation between read times. −100 will suffice for most systems, and −50 will work on systems with good performance and latency.

For serial encoders, the value also needs to include the time it takes to transfer the absolute encoder position. For instance, if 50 bits must be read at 500kHz then subtract an

additional 50/500kHz = 100uS to get a starting value of −200.

(float, in) hm2_<*BoardType*>.<*BoardNum*>.dpll.base−freq−khz
This pin sets the base frequency of the phase-locked loop. by default it will be set to the nominal frequency of the thread in which the PLL is running and wil not normally need to be changed.

(float, out) hm2_<*BoardType*>.<*BoardNum*>.dpll.phase−error−us
Indicates the phase eror of the DPLL. If the number cycles by a large amount it is likely that the PLL has failed to achieve lock and adjustments will need to be made.

(u32, in) hm2_<*BoardType*>.<*BoardNum*>.dpll.time−const
The filter time-constant for the PLL. The default value is a compromise between insensitivity to single-cycle variations and being resilient to changes to the Linux CLOCK_MONOTONIC timescale, which can instantly change by up to Â±500ppm from its nominal value, usually by timekeeping software like ntpd and ntpdate. Default 2000 (0x7d0)

(u32, in) hm2_<*BoardType*>.<*BoardNum*>.dpll.plimit
Sets the phase adjustment limit of the PLL. If the value is zero then the PLL will free-run at the base frequency independent of the servo thread rate. This is probably not what you want. Default 4194304 (0x400000) Units not known...

(u32, out) hm2_<*BoardType*>.<*BoardNum*>.dpll.ddsize
Used internally by the driver, likely to disappear.

(u32, in) hm2_<*BoardType*>.<*BoardNum*>.dpll.prescale
Prescale factor for the rate generator. Default 1.

encoder

Encoders have names like ""hm2_<*BoardType*>.<*BoardNum*>.encoder.<*Instance*>".". "Instance" is a two-digit number that corresponds to the HostMot2 encoder instance number. There are "num_encoders" instances, starting with 00.

So, for example, the HAL pin that has the current position of the second encoder of the first 5i20 board is: hm2_5i20.0.encoder.01.position (this assumes that the firmware in that board is configured so that this HAL object is available)

Each encoder uses three or four input IO pins, depending on how the firmware was compiled. Three-pin encoders use A, B, and Index (sometimes also known as Z). Four-pin encoders use A, B, Index, and Index-mask.

The hm2 encoder representation is similar to the one described by the Canonical Device Interface (in the HAL General Reference document), and to the software encoder component. Each encoder instance has the following pins and parameters:

Pins:

(s32 out) count
Number of encoder counts since the previous reset.

(float out) position
Encoder position in position units (count / scale).

(float out) velocity
Estimated encoder velocity in position units per second.

(bit in) reset
When this pin is TRUE, the count and position pins are set to 0. (The value of the velocity pin is not affected by this.) The driver does not reset this pin to FALSE after resetting the count to 0, that is the user's job.

(bit in/out) index−enable
When this pin is set to True, the count (and therefore also position) are reset to zero on the next Index (Phase−Z) pulse. At the same time, index−enable is reset to zero to indicate that the pulse has occurred.

(s32 out) rawcounts
Total number of encoder counts since the start, not adjusted for index or reset.

Parameters:

(float r/w) scale
Converts from 'count' units to 'position' units.

(bit r/w) index−invert
If set to True, the rising edge of the Index input pin triggers the Index event (if index−enable is True). If set to False, the falling edge triggers.

(bit r/w) index−mask
If set to True, the Index input pin only has an effect if the Index−Mask input pin is True (or False, depending on the index−mask−invert pin below).

(bit r/w) index−mask−invert
If set to True, Index−Mask must be False for Index to have an effect. If set to False, the Index−Mask pin must be True.

(bit r/w) counter−mode
Set to False (the default) for Quadrature. Set to True for Step/Dir (in which case Step is on the A pin and Dir is on the B pin).

(bit r/w) filter
If set to True (the default), the quadrature counter needs 15 clocks to register a change on any of the three input lines (any pulse shorter than this is rejected as noise). If set to False, the quadrature counter needs only 3 clocks to register a change. The encoder sample clock runs at 33 MHz on the PCI AnyIO cards and 50 MHz on the 7i43.

(float r/w) vel−timeout
When the encoder is moving slower than one pulse for each time that the driver reads the count from the FPGA (in the hm2_read() function), the velocity is harder to estimate. The driver can wait several iterations for the next pulse to arrive, all the while reporting the upper bound of the encoder velocity, which can be accurately guessed. This parameter specifies how long to wait for the next pulse, before reporting the encoder stopped. This parameter is in seconds.

(s32 r/w) hm2_XiXX.N.encoder.timer−number (default: −1)

Sets the hm2dpll timer instance to be used to latch encoder counts. A setting of −1 does not latch encoder counts. A setting of 0 latches at the same time as the main hostmot2 write. A setting of 1..4 uses a time offset from the main hostmot2 write according to the dpll's timer−us setting.

Typically, timer−us should be a negative number with a magnitude larger than the largest latency (e.g., −100 for a system with mediocre latency, −50 for a system with good latency).

If no DPLL module is present in the FPGA firmware, or if the encoder module does not support DPLL, then this pin is not created.

When available, this feature should typically be enabled. Doing so generally reduces following errors.

Synchronous Serial Interface (SSI)

(Not to be confused with the Smart Serial Interface)

One pin is created for each SSI instance regardless of data format: (bit, in) hm2_XiXX.NN.ssi.MM.data−incomplete This pin will be set "true" if the module was still transferring data when the value was read. When this problem exists there will also be a limited number of error messages printed to the UI. This pin should be used to monitor whether the problem has been addressed by config changes. Solutions to the problem dpend on whether the encoder read is being triggered by the hm2dpll phase-locked-loop timer (described above) or by the trigger−encoders function (described below).

The names of the pins created by the SSI module will depend entirely on the format string for each channel specified in the loadrt command line. A typical format string might be
ssi_chan_0=error%1bposition%24g

This would interpret the LSB of the bit-stream as a bit-type pin named "error" and the next 24 bits as a Gray-coded encoder counter. The encoder-related HAL pins would all begin with "position".

There should be no spaces in the format string, as this is used as a delimiter by the low-level code.

The format consists of a string of alphanumeric characters that will form the HAL pin names, followed by a % symbol, a bit-count and a data type. All bits in the packet must be defined, even if they are not used. There is a limit of 64 bits in total.

The valid format characters and the pins they create are:

p: (Pad). Does not create any pins, used to ignore sections of the bit stream that are not required.

b: (Boolean).

(bit, out) hm2_XiXX.N.ssi.MM.<name>. If any bits in the designated field width are non-zero then the HAL pin will be "true".

(bit, out) hm2_XiXX.N.ssi.MM.<name>−not. An inverted version of the above, the HAL pin will be "true" if all bits in the field are zero.

u: (Unsigned)

(float, out) hm2_XiXX.N.ssi.MM.<name>. The value of the bits interpeted as an unsigned integer then scaled such that the pin value will equal the scalemax parameter value when all bits are high. (for example if the field is 8 bits wide and the scalmax parameter was 20 then a value of 255 would return 20, and 0 would return 0.

s: (Signed)

(float, out) hm2_XiXX.N.ssi.MM.<name>. The value of the bits interpreted as a 2s complement signed number then scaled similarly to the unsigned variant, except symmetrical around zero.

f: (bitField)

(bit, out) hm2_XiXX.N.ssi.MM.<name>−NN. The value of each individual bit in the data field. NN starts at 00 up to the number of bits in the field.

(bit, out) hm2_XiXX.N.ssi.MM.<name>−NN−not. An inverted version of the individual bit values.

e: (Encoder)

(s32, out) hm2_XiXX.N.ssi.MM.<name>.count. The lower 32 bits of the total encoder counts. This value is reset both by the ...reset and the ...index−enable pins.

(s32, out) hm2_XiXX.N.ssi.MM.<name>.rawcounts. The lower 32 bits of the total encoder counts. The pin is not affected by reset and index.

(float, out) hm2_XiXX.N.ssi.MM.<name>.position. The encoder position in machine units. This is calculated from the full 64-bit buffers so will show a true value even after the counts pins have wrapped. It is zeroed by reset and index enable.

(bit, IO) hm2_XiXX.N.ssi.MM.<name>.index−enable. When this pin is set "true" the module will wait until the raw encoder counts next passes through an integer multiple of the number of counts specified by counts−per−rev parameter and then it will zero the counts and position pins, and set the index−enable pin back to "false" as a signal to the system that "index" has been passed. this pin is used for spindle-synchronised motion and index-homing.

(bit, in) (bit, out) hm2_XiXX.N.ssi.MM.<name>.reset. When this pin is set high the counts and position pins are zeroed.

h: (Split encoder, high-order bits)

Some encoders (Including Fanuc) place the encoder part-turn counts and full-turn counts in separate, non-contiguous fields. This tag defines the high-order bits of such an encoder module. There can be only one h and one l tag per channel, the behaviour with multiple such channels will be undefined.

l: (Split encoder, low-order bits)

Low order bits (see "h")

g: (Gray-code). This is a modifier that indicates that the following

format string is gray-code encoded. This is only valid for encoders (e, h l) and unsigned (u) data types.

m: (Multi-turn). This is a modifier that indicates that the following

format string is a multi-turn encoder. This is only valid for encoders (e, h l). A jump in encoder position of more than half the full scale is interpreted as a full turn and the counts are wrapped. With a multi-turn encoder this is only likely to be a data glitch and will lead to a permanent offset. This flag endures that such encoders will never wrap.

Parameters:

Two parameters is universally created for all SSI instances

(float r/w) hm2_XiXX.N.ssi.MM.frequency−khz

This parameter sets the SSI clock frequency. The units are kHz, so 500 will give a clock frequency of 500,000 Hz.

(s32 r/w) hm2_XiXX.N.ssi.timer-number−num

This parameter allocates the SSI module to a specific hm2dpll timer instance. This pin is only of use in firmwares which contain a hm2dpll function and will default to 1 in cases

where there is such a function, and 0 if there is not. The pin can be used to disable reads of the encoder, by setting to a nonexistent timer number, or to 0.

Other parameters depend on the data types specified in the config string.

p: (Pad) No Parameters.

b: (Boolean) No Parameters.

u: (Unsigned)
(float, r/w) hm2_XiXX.N.ssi.MM.<name>.scalemax. The scaling factor for the channel.

s: (Signed)
(float, r/w) hm2_XiXX.N.ssi.MM.<name>.scalemax. The scaling factor for the channel.

f: (bitField): No parameters.

e: (Encoder):
(float, r/w) hm2_XiXX.N.ssi.MM.<name>.scale: (float, r.w) The encoder scale in counts per machine unit.
(u32, r/w) hm2_XiXX.N.ssi.MM.<name>.counts−per−rev (u32, r/w) Used to emulate the index behaviour of an incemental+index encoder. This would normally be set to the actual counts per rev of the encoder, but can be any whole number of revs. Integer divisors or multimpilers of the true PPR might be useful for index-homing. Non-integer factors might be appropriate where there is a synchronous drive ratio between the encoder and the spindle or ballscrew.

BiSS

BiSS is a bidirectional variant of SSI. Currently only a single direction is supported by LinuxCNC (encoder to PC).

One pin is created for each BiSS instance regardless of data format:

(bit, in) hm2_XiXX.NN.biss.MM.data−incomplete This pin will be set "true" if the module was still transferring data when the value was read. When this problem exists there will also be a limited number of error messages printed to the UI. This pin should be used to monitor whether the problem has been addressed by config changes. Solutions to the problem dpend on whether the encoder read is being triggered by the hm2dpll phase-locked-loop timer (described above) or by the trigger−encoders function (described below)

The names of the pins created by the BiSS module will depend entirely on the format string for each channel specified in the loadrt command line and follow closely the format defined above for SSI. Currently data packets of up to 96 bits are supported by the LinuxCNC driver, although the Mesa Hostmot2 module can handle 512 bit packets. It should be possible to extend the number of packets supported by the driver if there is a requirement to do so.

Fanuc encoder.

The pins and format specifier for this module are identical to the SSI module described above, except that at least one pre-configured format is provided. A modparam of fanuc_chan_N=AA64 (case sensitive) will configure the channel for a Fanuc Aa64 encoder. The pins created are:

hm2_XiXX.N.fanuc.MM.batt	indicates battery state
hm2_XiXX.N.fanuc.MM.batt−not	inverted version of above
hm2_XiXX.N.fanuc.MM.comm	The 0-1023 absolute output for motor commutation
hm2_XXiX.N.fanuc.MM.crc	The CRC checksum. Currently HAL has no way to use this

hm2_XiXX.N.fanuc.MM.encoder.count Encoder counts
hm2_XiXX.N.fanuc.MM.encoder.index−enable Simulated index. Set by counts−per−rev parameter
hm2_XiXX.N.fanuc.MM.encoder.position Counts scaled by the ...scale parameter
hm2_XiXX.N.fanuc.MM.encoder.rawcounts Raw counts, unaffected by reset or index
hm2_XiXX.N.fanuc.MM.encoder.reset If high/true then counts and position = 0
hm2_XiXX.N.fanuc.MM.valid Indicates that the absolute position is valid
hm2_XiXX.N.fanuc.MM.valid−not Inverted version

resolver

Resolvers have names like hm2_<*BoardType*>.<*BoardNum*>.resolver.<*Instance*>. <Instance is a 2-digit number, which for the 7i49 board will be between 00 and 05. This function only works with the Mesa Resolver interface boards (of which the 7i49 is the only example at the time of writing). This board uses an SPI interface to the FPGA card, and will only work with the correct firmware. The pins allocated will be listed in the dmesg output, but are unlikely to be usefully probed with HAL tools.

Pins:

(float, out) angle
: This pin indicates the angular position of the resolver. It is a number between 0 and 1 for each electrical rotation.

(float, out) position
: Calculated from the number of complete and partial revolutions since startup, reset, or index−reset multiplied by the scale parameter.

(float, out) velocity
: Calculated from the rotational velocity and the velocity−scale parameter. The default scale is electrical rotations per second.

(s32, out) count
: This pins outputs a simulated encoder count at 2^24 counts per rev (16777216 counts).

(s32, out) rawcounts
: This is identical to the counts pin, except it is not reset by the 'index' or 'reset' pins. This is the pin which would be linked to the bldc HAL component if the resolver was being used to commutate a motor.

(bit, in) reset
: Resets the position and counts pins to zero immediately.

(bit, in) joint-pos-fb
: The Mesa resolver driver has the capability of emulating an absolute encoder using a position file (see the INI-config section of the manual) and the single-turn absolute operation of resolvers. At startup, and only if the **use-position-file** parameter is set to "true" the resolver driver will wait for a value to be written by the system to the axis.N.joint-pos-fb pin (which must be netted to this resolver pin) and will calculate the number of full turns that best matches the current reolver position. It will then pre-load the driver output with this offset. This should only be used on systems where axis movement in the unpowered state is unlikely. This feature will only work properly if the machine is

initially homed to "index" and if the axis home positions are exactly zero.

(bit, in/out) index−enable
When this pin is set high the position and counts pins will be reset the next time the resolver passes through the zero position. At the same time the pin is driven low to indicate to connected modules that the index has been seen, and that the counters have been reset.

(bit, out) error
Indicates an error in the particular channel. If this value is "true" then the reported position and velocity are invalid.

Parameters:

(float, read/write) scale
The position scale, in machine units per resolver electrical revolution.

(float, read/write) velocity−scale
The conversion factor between resolver rotation speed and machine velocity. A value of 1 will typically give motor speed in rps, a value of 0.01666667 will give (approximate) RPM.

(u32, read/write) index−divisor (default 1)
The resolver component emulates an index at a fixed point in the sin/cos cycle. Some resolvers have multiple cycles per rev (often related to the number of pole-pairs on the attached motor). LinuxCNC requires an index once per revolution for proper threading etc. This parameter should be set to the number of cycles per rev of the resolver. CAUTION: Which pseudo-index is used will not necessarily be consistent between LinuxCNC runs. Do not expect to re-start a thread after restarting LinuxCNC. It is not appropriate to use this parameter for index-homing of axis drives.

(float, read/write) excitation−khz
This pin sets the excitation frequency for the resolver. This pin is module-level rather than instance-level as all resolvers share the same excitation frequency.
Valid values are 10 (˜10kHz), 5 (˜5kHz) and 2.5 (˜2.5kHz). The actual frequency depends on the FPGA frequency, and they correspond to CLOCK_LOW/5000, CLOCK_LOW/10000 and CLOCK_LOW/20000 respectively. The parameter will be set to the closest available of the three frequencies.
A value of −1 (the default) indicates that the current setting should be retained.

(bit, read/write) use-position-file
In conjunction with **joint-pos-fb** (qv) emulate absolute encoders.

pwmgen

pwmgens have names like "hm2_<*BoardType*>.<*BoardNum*>.pwmgen.<*Instance*>". "Instance" is a two-digit number that corresponds to the HostMot2 pwmgen instance number. There are 'num_pwmgens' instances, starting with 00.

So, for example, the HAL pin that enables output from the fourth pwmgen of the first 7i43 board is: hm2_7i43.0.pwmgen.03.enable (this assumes that the firmware in that board is configured so

that this HAL object is available)

In HM2, each pwmgen uses three output IO pins: Not−Enable, Out0, and Out1.

The function of the Out0 and Out1 IO pins varies with output−type parameter (see below).

The hm2 pwmgen representation is similar to the software pwmgen component. Each pwmgen instance has the following pins and parameters:

Pins:

(bit input) enable
: If true, the pwmgen will set its Not−Enable pin false and output its pulses. If 'enable' is false, pwmgen will set its Not−Enable pin true and not output any signals.

(float input) value
: The current pwmgen command value, in arbitrary units.

Parameters:

(float rw) scale
: Scaling factor to convert 'value' from arbitrary units to duty cycle: dc = value / scale. Duty cycle has an effective range of −1.0 to +1.0 inclusive, anything outside that range gets clipped. The default scale is 1.0.

(s32 rw) output−type
: This emulates the output_type load-time argument to the software pwmgen component. This parameter may be changed at runtime, but most of the time you probably want to set it at startup and then leave it alone. Accepted values are 1 (PWM on Out0 and Direction on Out1), 2 (Up on Out0 and Down on Out1), 3 (PDM mode, PDM on Out0 and Dir on Out1), and 4 (Direction on Out0 and PWM on Out1, "for locked antiphase").

In addition to the per-instance HAL Parameters listed above, there are a couple of HAL Parameters that affect all the pwmgen instances:

(u32 rw) pwm_frequency
: This specifies the PWM frequency, in Hz, of all the pwmgen instances running in the PWM modes (modes 1 and 2). This is the frequency of the variable-duty-cycle wave. Its effective range is from 1 Hz up to 193 kHz. Note that the max frequency is determined by the ClockHigh frequency of the Anything IO board; the 5i20 and 7i43 both have a 100 MHz clock, resulting in a 193 kHz max PWM frequency. Other boards may have different clocks, resulting in different max PWM frequencies. If the user attempts to set the frequency too high, it will be clipped to the max supported frequency of the board. Frequencies below about 5 Hz are not terribly accurate, but above 5 Hz they're pretty close. The default pwm_frequency is 20,000 Hz (20 kHz).

(u32 rw) pdm_frequency
: This specifies the PDM frequency, in Hz, of all the pwmgen instances running in PDM mode (mode 3). This is the "pulse slot frequency"; the frequency at which the pdm generator in the AnyIO board chooses whether to emit a pulse or a space. Each pulse (and space) in the PDM pulse train has a duration of 1/pdm_frequency seconds. For example, setting the pdm_frequency to 2e6 (2 MHz) and the duty cycle to 50% results in a 1 MHz

square wave, identical to a 1 MHz PWM signal with 50% duty cycle. The effective range of this parameter is from about 1525 Hz up to just under 100 MHz. Note that the max frequency is determined by the ClockHigh frequency of the Anything IO board; the 5i20 and 7i43 both have a 100 MHz clock, resulting in a 100 Mhz max PDM frequency. Other boards may have different clocks, resulting in different max PDM frequencies. If the user attempts to set the frequency too high, it will be clipped to the max supported frequency of the board. The default pdm_frequency is 20,000 Hz (20 kHz).

3ppwmgen

Three-Phase PWM generators (3pwmgens) are intended for controlling the high-side and low-side gates in a 3-phase motor driver. The function is included to support the Mesa motor controller daughter-cards but can be used to control an IGBT or similar driver directly. 3pwmgens have names like "hm2_<*BoardType*>.<*BoardNum*>.3pwmgen.<*Instance*>" where <Instance> is a 2-digit number. There will be num_3pwmgens instances, starting at 00. Each instance allocates 7 output and one input pins on the Mesa card connectors. Outputs are: PWM A, PWM B, PWM C, /PWM A, /PWM B, /PWM C, Enable. The first three pins are the high side drivers, the second three are their complementary low-side drivers. The enable bit is intended to control the servo amplifier. The input bit is a fault bit, typically wired to over-current detection. When set the PWM generator is disabled. The three phase duty-cycles are individually controllable from −Scale to +Scale. Note that 0 corresponds to a 50% duty cycle and this is the inialization value.

Pins:

(float input) A−value, B−value, C−value: The PWM command value for each phase, limited to +/− "scale". Defaults to zero which is 50% duty cycle on high-side and low-sidepins (but see the "deadtime" parameter)

(bit input) enable

When high the PWM is enabled as long as the fault bit is not set by the external fault input pin. When low the PWM is disabled, with both high- side and low-side drivers low. This is not the same as 0 output (50% duty cycle on both sets of pins) or negative full scale (where the low side drivers are "on" 100% of the time)

(bit output) fault

Indicates the status of the fault bit. This output latches high once set by the physical fault pin until the "enable" pin is set to high.

Parameters:

(u32 rw) deadtime

Sets the dead-time between the high-side driver turning off and the low-side driver turning on and vice-versa. Deadtime is subtracted from on time and added to off time symmetrically. For example with 20 kHz PWM (50 uSec period), 50% duty cycle and zero dead time, the PWM and NPWM outputs would be square waves (NPWM being inverted from PWM) with high times of 25 uS. With the same settings but 1 uS of deadtime, the PWM and NPWM outputs would both have high times of 23 uS (25 − (2X 1 uS), 1 uS per edge). The value is specified in nS and defaults to a rather conservative 5000nS. Setting this parameter to too low a value could be both expensive and dangerous as if both gates are open at the same time there is effectively a short circuit accross the supply.

(float rw) scale
: Sets the half-scale of the specified 3-phase PWM generator. PWM values from −scale to +scale are valid. Default is +/− 1.0

(bit rw) fault−invert
: Sets the polarity of the fault input pin. A value of 1 means that a fault is triggered with the pin high, and 0 means that a fault it triggered when the pin is pulled low. Default 0, fault = low so that the PWM works with the fault pin unconnected.

(u32 rw) sample−time
: Sets the time during the cycle when an ADC pulse is generated. 0 = start of PWM cycle and 1 = end. Not currently useful to LinuxCNC. Default 0.5.

  In addition the per-instance parameters above there is the following parameter that affects all instances

(u32 rw) frequency
: Sets the master PWM frequency. Maximum is approx 48kHz, minimum is 1kHz. Defaults to 20kHz.

stepgen

stepgens have names like "hm2_<*BoardType*>.<*BoardNum*>.stepgen.<*Instance*>". "Instance" is a two-digit number that corresponds to the HostMot2 stepgen instance number. There are 'num_stepgens' instances, starting with 00.

So, for example, the HAL pin that has the current position feedback from the first stepgen of the second 5i22 board is: hm2_5i22.1.stepgen.00.position−fb (this assumes that the firmware in that board is configured so that this HAL object is available)

Each stepgen uses between 2 and 6 IO pins. The signals on these pins depends on the step_type parameter (described below).

The stepgen representation is modeled on the stepgen software component. Each stepgen instance has the following pins and parameters:

Pins:

(float input) position−cmd
: Target position of stepper motion, in arbitrary position units. This pin is only used when the stepgen is in position control mode (control−type=0).

(float input) velocity−cmd
: Target velocity of stepper motion, in arbitrary position units per second. This pin is only used when the stepgen is in velocity control mode (control−type=1).

(s32 output) counts
: Feedback position in counts (number of steps).

(float output) position−fb
Feedback position in arbitrary position units. This is similar to "counts/position_scale", but has finer than step resolution.

(float output) velocity−fb
Feedback velocity in arbitrary position units per second.

(bit input) enable
This pin enables the step generator instance. When True, the stepgen instance works as expected. When False, no steps are generated and velocity−fb goes immediately to 0. If the stepgen is moving when enable goes false it stops immediately, without obeying the maxaccel limit.

(bit input) control−type
Switches between position control mode (0) and velocity control mode (1). Defaults to position control (0).

Parameters:

(float r/w) position−scale
Converts from counts to position units. position = counts / position_scale

(float r/w) maxvel
Maximum speed, in position units per second. If set to 0, the driver will always use the maximum possible velocity based on the current step timings and position−scale. The max velocity will change if the step timings or position−scale changes. Defaults to 0.

(float r/w) maxaccel
Maximum acceleration, in position units per second per second. Defaults to 1.0. If set to 0, the driver will not limit its acceleration at all - this requires that the position−cmd or velocity−cmd pin is driven in a way that does not exceed the machine's capabilities. This is probably what you want if you're going to be using the LinuxCNC trajectory planner to jog or run G-code.

(u32 r/w) steplen
Duration of the step signal, in nanoseconds.

(u32 r/w) stepspace
Minimum interval between step signals, in nanoseconds.

(u32 r/w) dirsetup
Minimum duration of stable Direction signal before a step begins, in nanoseconds.

(u32 r/w) dirhold
Minimum duration of stable Direction signal after a step ends, in nanoseconds.

(u32 r/w) step_type
Output format, like the step_type modparam to the software stegen(9) component. 0 = Step/Dir, 1 = Up/Down, 2 = Quadrature, 3+ = table-lookup mode. In this mode the step_type parameter determines how long the step sequence is. Additionally the

stepgen_width parameter in the loadrt config string must be set to suit the number of pins per stepgen required. Any stepgen pins above this number will be available for GPIO. This mask defaults to 2. The maximum length is 16. Note that Table mode is not enabled in all firmwares but if you see GPIO pins between the stepgen instances in the dmesg/log hardware pin list then the option may be available.

In Quadrature mode (step_type=2), the stepgen outputs one complete Gray cycle (00 â 01 â 11 â 10 â 00) for each "step" it takes. In table mode up to 6 IO pins are individually controlled in an arbitrary sequence up to 16 phases long.

(u32 r/w) table−data−N

There are 4 table−data−N parameters, table−data−0 to table−data−3. These each contain 4 bytes corresponding to 4 stages in the step sequence. For example table−data−0 = 0x00000001 would set stepgen pin 0 (always called "Step" in the dmesg output) on the first phase of the step sequence, and table−data−4 = 0x20000000 would set stepgen pin 6 ("Table5Pin" in the dmesg output) on the 16th stage of the step sequence.

(s32 r/w) hm2_XiXX.N.stepgen.timer−number (default: −1)

Sets the hm2dpll timer instance to be used to latch stepgen counts. A setting of −1 does not latch encoder counts. A setting of 0 latches at the same time as the main hostmot2 write. A setting of 1..4 uses a time offset from the main hostmot2 write according to the dpll's timer−us setting.

Typically, timer−us should be a negative number with a magnitude larger than the largest latency (e.g., −100 for a system with mediocre latency, −50 for a system with good latency).

If no DPLL module is present in the FPGA firmware, or if the stepgen module does not support DPLL, then this pin is not created.

When available, this feature should typically be enabled. Doing so generally reduces following errors.

Smart Serial Interface

The Smart Serial Interface allows up to 32 different devices such as the Mesa 8i20 2.2kW 3-phase drive or 7i64 48-way IO cards to be connected to a single FPGA card. The driver auto-detects the connected hardware port, channel and device type. Devices can be connected in any order to any active channel of an active port. (see the config modparam definition above).

For full details of the smart-serial devices see **man sserial**.

BSPI

The BSPI (Buffered SPI) driver is unusual in that it does not create any HAL pins. Instead the driver exports a set of functions that can be used by a sub-driver for the attached hardware. Typically these would be written in the "comp"

pre-processing language: see http://linuxcnc.org/docs/html/hal/comp.html or man halcompile for further details. See man mesa_7i65 and the source of mesa_7i65.comp for details of a typical sub-driver. See man hm2_bspi_setup_chan, man hm2_bspi_write_chan, man hm2_tram_add_bspi_frame, man hm2_allocate_bspi_tram, man hm2_bspi_set_read_funtion and man hm2_bspi_set_write_function for the exported functions.

The names of the available channels are printed to standard output during the driver loading

process and take the form hm2_<board name>.<board index>.bspi.<index> For example hm2_5i23.0.bspi.0

UART

The UART driver also does not create any HAL pins, instead it declares two simple read/write functions and a setup function to be utilised by user-written code. Typically this would be written in the "comp" pre-processing language: see http://linuxcnc.org/docs/html/hal/comp.html or man halcompile for further details. See man mesa_uart and the source of mesa_uart.comp for details of a typical sub-driver. See man hm2_uart_setup_chan, man hm2_uart_send, man hm2_uart_read and man hm2_uart_setup.

The names of the available uart channels are printed to standard output during the driver loading process and take the form hm2_<board name>.<board index>uart.<index> For example hm2_5i23.0.uart.0

General Purpose I/O

I/O pins on the board which are not used by a module instance are exported to HAL as "full" GPIO pins. Full GPIO pins can be configured at run-time to be inputs, outputs, or open drains, and have a HAL interface that exposes this flexibility. IO pins that are owned by an active module instance are constrained by the requirements of the owning module, and have a restricted HAL interface.

GPIOs have names like "hm2_<*BoardType*>.<*BoardNum*>.gpio.<*IONum*>". IONum is a three-digit number. The mapping from IONum to connector and pin-on-that-connector is written to the syslog when the driver loads, and it's documented in Mesa's manual for the Anything I/O boards.

So, for example, the HAL pin that has the current inverted input value read from GPIO 012 of the second 7i43 board is: hm2_7i43.1.gpio.012.in−not (this assumes that the firmware in that board is configured so that this HAL object is available)

The HAL parameter that controls whether the last GPIO of the first 5i22 is an input or an output is: hm2_5i22.0.gpio.095.is_output (this assumes that the firmware in that board is configured so that this HAL object is available)

The hm2 GPIO representation is modeled after the Digital Inputs and Digital Outputs described in the Canonical Device Interface (part of the HAL General Reference document). Each GPIO can have the following HAL Pins:

(bit out) in & in_not
: State (normal and inverted) of the hardware input pin. Both full GPIO pins and IO pins used as inputs by active module instances have these pins.

(bit in) out
: Value to be written (possibly inverted) to the hardware output pin. Only full GPIO pins have this pin.

Each GPIO can have the following Parameters:

(bit r/w) is_output
: If set to 0, the GPIO is an input. The IO pin is put in a high-impedance state (weakly pulled high), to be driven by other devices. The logic value on the IO pin is available in the "in" and "in_not" HAL pins. Writes to the "out" HAL pin have no effect. If this parameter is set to 1, the GPIO is an output; its behavior then depends on the

"is_opendrain" parameter. Only full GPIO pins have this parameter.

(bit r/w) is_opendrain
: This parameter only has an effect if the "is_output" parameter is true. If this parameter is false, the GPIO behaves as a normal output pin: the IO pin on the connector is driven to the value specified by the "out" HAL pin (possibly inverted), and the value of the "in" and "in_not" HAL pins is undefined. If this parameter is true, the GPIO behaves as an open-drain pin. Writing 0 to the "out" HAL pin drives the IO pin low, writing 1 to the "out" HAL pin puts the IO pin in a high-impedance state. In this high-impedance state the IO pin floats (weakly pulled high), and other devices can drive the value; the resulting value on the IO pin is available on the "in" and "in_not" pins. Only full GPIO pins and IO pins used as outputs by active module instances have this parameter.

(bit r/w) invert_output
: This parameter only has an effect if the "is_output" parameter is true. If this parameter is true, the output value of the GPIO will be the inverse of the value on the "out" HAL pin. Only full GPIO pins and IO pins used as outputs by active module instances have this parameter.

When a physical I/O pin is used by a special function, the related **is_output**, and **is_opendrain** HAL parameters are aliased to the special function. For instance, if gpio 1 is taken over by pwmgen 0's first output, then aliases like **hm2_7i92.0.pwmgen.00.out0.invert_output** (referring to **hm2_7i92.0.gpio.001.invert_output**) will be automatically created. When more than one GPIO is connected to the same special function, an extra .#. is inserted so that the settings for each related GPIO can be set separately. For example, for the firmware SV12IM_2X7I48_72, the alias **hm2_5i20.0.pwmgen.00.0.enable.invert_output** (referring to **hm2_5i20.0.gpio.000.invert_output**) and **hm2_5i20.0.pwmgen.00.1.enable.invert_output** (referring to **hm2_5i20.0.gpio.023.invert_output**) are both created.

led

Creates HAL pins for the LEDs on the FPGA board.

Pins:

(bit in) CR<NN>
: The pins are numbered from CR01 upwards with the name corresponding to the PCB silkscreen. Setting the bit to "true" or 1 lights the led.

Solid State Relay

SSRs have names like "hm2_<*BoardType*>.<*BoardNum*>.ssr.<*Instance*>". "Instance" is a two-digit number that corresponds to the HostMot2 SSR instance number. There are 'num_ssrs' instances, starting with 00.

Each instance has a rate control pin and between 1 and 32 output pins.

Pins:

(u32 in) rate
: Set the internal frequency of the SSR instance, in Hz (approximate). The valid range is 25 kHz to 25 MHz. Values below the minimum will use the minimum, and values above the max will use the max. 1 MHz is a typical value, and appropriate for all Mesa cards, and is the default. Set to 0 to disable this SSR instance.

(bit in) out-NN
: The state of this SSR instance's NNth output. Set to 0 to make the output pins act like an open switch (no connection), set to 1 to make them act like a closed switch.

Watchdog

The HostMot2 firmware may include a watchdog Module; if it does, the hostmot2 driver will use it. The HAL representation of the watchdog is named "hm2_<**BoardType**>.<**Board-Num**>.watchdog".

The watchdog starts out asleep and inactive. Once you access the board the first time by running the hm2 write() HAL function (see below), the watchdog wakes up. From them on it must be petted periodically or it will bite. Pet the watchdog by running the hm2 write() HAL function.

When the watchdog bites, all the board's I/O pins are disconnected from their Module instances and become high-impedance inputs (pulled high), and all communication with the board stops. The state of the HostMot2 firwmare modules is not disturbed (except for the configuration of the IO Pins). Encoder instances keep counting quadrature pulses, and pwm- and step-generators keep generating signals (which are *not* relayed to the motors, because the IO Pins have become inputs).

Resetting the watchdog (by clearing the has_bit pin, see below) resumes communication and resets the I/O pins to the configuration chosen at load-time.

If the firmware includes a watchdog, the following HAL objects will be exported:

Pins:

(bit in/out) has_bit
: True if the watchdog has bit, False if the watchdog has not bit. If the watchdog has bit and the has_bit bit is True, the user can reset it to False to resume operation.

  Parameters:

(u32 read/write) timeout_ns
: Watchdog timeout, in nanoseconds. This is initialized to 5,000,000 (5 milliseconds) at module load time. If more than this amount of time passes between calls to the hm2 write() function, the watchdog will bite.

Raw Mode

If the "enable_raw" config keyword is specified, some extra debugging pins are made available in HAL. The raw mode HAL pin names begin with "hm2_<*BoardType*>.<*BoardNum*>.raw".

With Raw mode enabled, a user may peek and poke the firmware from HAL, and may dump the internal state of the hostmot2 driver to the syslog.

Pins:

(u32 in) read_address
: The bottom 16 bits of this is used as the address to read from.

(u32 out) read_data
: Each time the hm2_read() function is called, this pin is updated with the value at .read_address.

(u32 in) write_address
The bottom 16 bits of this is used as the address to write to.

(u32 in) write_data
This is the value to write to .write_address.

(bit in) write_strobe
Each time the hm2_write() function is called, this pin is examined. If it is True, then value in .write_data is written to the address in .write_address, and .write_strobe is set back to False.

(bit in/out) dump_state
This pin is normally False. If it gets set to True the hostmot2 driver will write its representation of the board's internal state to the syslog, and set the pin back to False.

Setting up Smart Serial devices

See man setsserial for the current way to set smart-serial eeprom parameters.

FUNCTIONS

hm2_<*BoardType*>**.**<*BoardNum*>**.read−request**
On boards with long turn around time for reads (at the time of writing, this applies only to ethernet boards), this function sends a read request. When multiple boards are used, this can reduce the servo thread execution time. In this case, the appropriate thread order would be

```
addf hm2_7i80.0.read−request
addf hm2_7i80.1.read−request
addf hm2_7i80.0.read
addf hm2_7i80.1.read
```

which causes the read request to be sent to board 1 before waiting for the response to the read request to arrive from board 0.

hm2_<*BoardType*>**.**<*BoardNum*>**.read**
This reads the encoder counters, stepgen feedbacks, and GPIO input pins from the FPGA.

hm2_<*BoardType*>**.**<*BoardNum*>**.write**
This updates the PWM duty cycles, stepgen rates, and GPIO outputs on the FPGA. Any changes to configuration pins such as stepgen timing, GPIO inversions, etc, are also effected by this function.

hm2_<*BoardType*>**.**<*BoardNum*>**.read_gpio**
Read the GPIO input pins. Note that the effect of this function is a subset of the effect of the .read() function described above. Normally only .read() is used. The only reason to call this function is if you want to do GPIO things in a faster-than-servo thread. (This function is not available on the 7i43 due to limitations of the EPP bus.)

hm2_<*BoardType*>**.**<*BoardNum*>**.write_gpio**
Write the GPIO control registers and output pins. Note that the effect of this function is a subset of the effect of the .write() function described above. Normally only .write() is used. The only reason to call this function is if you want to do GPIO things in a faster-than-servo thread. (This function is not available on the 7i43 due to limitations of the EPP bus.)

hm2_<*BoardType*>**.**<*BoardNum*>**.trigger−encoders**
This function will only appear if the firmware contains a BiSS, Fanuc or SSI encoder module and if the firmare does not contain a hm2dpll module (qv) or if the modparam

contains num_dplls=0. This function should be inserted first in the thread so that the encoder data is ready when the main **hm2_XiXX.NN.read** function runs. An error message will be printed if the encoder read is not finished in time. It may be possible to avoid this by increasing the data rate. If the problem persists and if "stale" data is acceptable then the function may be placed later in the thread, allowing a full servo cycle for the data to be transferred from the devices. If available it is better to use the synchronous hm2dpll triggering function.

SEE ALSO

hm2_7i43(9)
hm2_pci(9)
Mesa’s documentation for the Anything I/O boards, at <http://www.mesanet.com>

LICENSE

GPL

NAME

hypot − Three-input hypotenuse (Euclidean distance) calculator

SYNOPSIS

loadrt hypot [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

hypot.*N*

(requires a floating-point thread)

PINS

hypot.*N***.in0**

float in

hypot.*N***.in1**

float in

hypot.*N***.in2**

float in

hypot.*N***.out**

float out out = sqrt(in0^2 + in1^2 + in2^2)

LICENSE

GPL

NAME

ilowpass − Low-pass filter with integer inputs and outputs

SYNOPSIS

loadrt ilowpass [count=*N***|names=***name1***[,***name2...***]]**

DESCRIPTION

While it may find other applications, this component was written to create smoother motion while jogging with an MPG.

In a machine with high acceleration, a short jog can behave almost like a step function. By putting the **ilowpass** component between the MPG encoder **counts** output and the axis jog-counts input, this can be smoothed.

Choose **scale** conservatively so that during a single session there will never be more than about 2e9/**scale** pulses seen on the MPG. Choose **gain** according to the smoothing level desired. Divide the axis.*N*.jog-scale values by **scale**.

FUNCTIONS

ilowpass.*N*

(requires a floating-point thread) Update the output based on the input and parameters

PINS

ilowpass.*N***.in**

s32 in

ilowpass.*N***.out**

s32 out **out** tracks **in***__scale__ through a low-pass filter of **gain** per period.

PARAMETERS

ilowpass.*N***.scale**

float rw (default: *1024*) A scale factor applied to the output value of the low-pass filter.

ilowpass.*N***.gain**

float rw (default: *.5*) Together with the period, sets the rate at which the output changes. Useful range is between 0 and 1, with higher values causing the input value to be tracked more quickly. For instance, a setting of 0.9 causes the output value to go 90% of the way towards the input value in each period

AUTHOR

Jeff Epler <jepler@unpythonic.net>

LICENSE

GPL

NAME

integ − Integrator with gain pin and windup limits

SYNOPSIS

loadrt integ [count=*N***|names=***name1***[,***name2...***]]**

FUNCTIONS

integ.*N* (requires a floating-point thread)

PINS

integ.*N***.in**
float in

integ.*N***.gain**
float in (default: *1.0*)

integ.*N***.out**
float out The discrete integral of ’gain * in’ since ’reset’ was deasserted

integ.*N***.reset**
bit in When asserted, set out to 0

integ.*N***.max**
float in (default: *1e20*)

integ.*N***.min**
float in (default: *-1e20*)

LICENSE

GPL

NAME

invert − Compute the inverse of the input signal

SYNOPSIS

The output will be the mathematical inverse of the input, ie **out** = 1/**in**. The parameter **deadband** can be used to control how close to 0 the denominator can be before the output is clamped to 0. **deadband** must be at least 1e-8, and must be positive.

FUNCTIONS

invert.*N*

(requires a floating-point thread)

PINS

invert.*N***.in**

float in Analog input value

invert.*N***.out**

float out Analog output value

PARAMETERS

invert.*N***.deadband**

float rw The **out** will be zero if **in** is between -**deadband** and +**deadband**

LICENSE

GPL

NAME

joyhandle − sets nonlinear joypad movements, deadbands and scales

SYNOPSIS

loadrt joyhandle [count=*N***|names=***name1***[,***name2***...]]**

DESCRIPTION

The component **joyhandle** uses the following formula for a non linear joypad movements:

y = (scale * (a*x^power + b*x)) + offset

The parameters a and b are adjusted in such a way, that the function starts at (deadband,offset) and ends at (1,scale+offset).

Negative values will be treated point symetrically to origin. Values −deadband < x < +deadband will be set to zero.

Values x > 1 and x < −1 will be skipped to ±(scale+offset). Invert transforms the function to a progressive movement.

With power one can adjust the nonlinearity (default = 2). Default for deadband is 0.

Valid values are: power >= 1.0 (reasonable values are 1.x .. 4-5, take higher power-values for higher dead-bands (>0.5), if you want to start with a nearly horizontal slope), 0 <= deadband < 0.99 (reasonable 0.1).

An additional offset component can be set in special cases (default = 0).

All values can be adjusted for each instance separately.

FUNCTIONS

joyhandle.*N*
(requires a floating-point thread)

PINS

joyhandle.*N***.in**
float in
joyhandle.*N***.out**
float out

PARAMETERS

joyhandle.*N***.power**
float rw (default: *2.0*)
joyhandle.*N***.deadband**
float rw (default: *0.*)
joyhandle.*N***.scale**
float rw (default: *1.*)
joyhandle.*N***.offset**
float rw (default: *0.*)
joyhandle.*N***.inverse**
bit rw (default: *0*)

LICENSE

GPL

NAME

kins − kinematics definitions for LinuxCNC

SYNOPSIS

loadrt trivkins (use for most cartesian machines)

loadrt corexykins

loadrt genhexkins

loadrt genserkins

loadrt lineardeltakins (see separate manpage)

loadrt maxkins

loadrt pumakins

loadrt rosekins

loadrt rotarydeltakins

loadrt rotatekins

loadrt scarakins

loadrt tripodkins

loadrt xyzac−trt−kins

loadrt xyzbc−trt−kins

loadrt 5axiskins

DESCRIPTION

Rather than exporting HAL pins and functions, these components provide the forward and inverse kinematics definitions for LinuxCNC.

trivkins − generalized trivial kinematics

Joint numbers are assigned sequentialy according to the axis letters specified with the **coordinates=** parameter.

If the coordinates= parameter is omitted, joint numbers are assigned **sequentially** to every known axis letter ("xyzabcuvw").

Example: loadrt **trivkins**

Assigns all axis letters to joint numbers in sequence:

x==joint0, y==joint1, z==joint2
a==joint3, b==joint4, c==joint5
u==joint6, v==joint7, w==joint8

Example: loadrt **trivkins coordinates=xyz**
Assigns: x==joint0, y==joint1, z==joint2

Example: loadrt **trivkins coordinates=xz**
Assigns: x==joint0, z==joint1

Example: loadrt **trivkins coordinates=xyzy**
Assigns: x==joint0, y0==joint1, z==joint2, y1==joint3

The default kinematics type is **KINEMATICS_IDENTITY**. Guis may provide special features for

configurations using this default kinematics type. For instance, the axis gui automatically handles joint and world mode operations so that the distinctions between joints and axes are not visible to the operator. This is feasible since there is an exact correspondence between a joint number and its matching axis letter.

The kinematics type can be set with the **kinstype=** parameter:

kinstype=**1** for KINEMATICS_IDENTITY (default if kinstype= omitted)
kinstype=[**b**|**B**] for KINEMATICS_BOTH
kinstype=[**f**|**F**] for KINEMATICS_FORWARD_ONLY
kinstype=[**i**|**I**] for KINEMATICS_INVERSE_ONLY

Example: loadrt **trivkins coordinates=xyz kinstype=b**

Use kinstype=**B** (KINEMATICS_BOTH) for configurations that need to move joints independently (joint mode) or as coordinated (teleop) movements in world coordinates.

When using the axis gui with KINEMATICS_BOTH, the '**$**' key is used to toggle between joint and teleop (world) modes.

An axis letter may be used more than once (**duplicated**) to assign multiple joints to a single axis coordinate letter.

Example: coordinates=**xyyzw** kinstype=**B**
Assigns: x==joint0, y==joint1 **AND** joint2, z==joint3, w==joint4

The above example illustrates a gantry configuration that uses **duplicated** coordinate letters to indicate that two joints (joint1 and joint2) move a single axis (y). Using kinstype=**B** allows the configuration to be toggled between joint and world modes of operation. Homing configuration options are available to synchronize the final homing move for selected joints -- see the documentation for **Homing Configuration**.

NOTES for **duplicated** coordinates:

When **duplicated** coordinate letters are used, specifying KINEMATICS_BOTH (kinstype=**B**) allows a gui to support jogging of each individual joint in **joint mode**. **Caution** is required for machines where the movement of a single joint (in a set specified by a **duplicated** coordinate letter) can lead to gantry racking or other unwanted outcomes. When the kinstype= parameter is omitted, operation defaults to KINEMATICS_IDENTITY (kinstype=**1**) and a gui may allow jogging based upon a selected axis coordinate letter (or by a keyboard key) before homing is completed and the machine is still in **joint mode**. The joint selected will depend upon the gui implementation but typically only one of the multiple joints in the set will jog. Consequently, specifying KINEMATICS_BOTH is recommended as it enables support for unambiguous, independent jogging of each individual joint. Machines that implement homing for all joints (including the provisions for synchronizing the final homing move for multiple joints) may be homed at machine startup and automatically switch to **world** mode where per-coordinate jogging is available.

corexykins − CoreXY Kinematics

X = 0.5*(JOINT_0 + JOINT_1)
Y = 0.5*(JOINT_0 − JOINT_1)
Z = JOINT_2

[KINS]JOINTS= must specify 3 or more joints (maximum 9)

If enabled by the number of [KINS]JOINTS= specified, JOINT_3,4,5,6,7,8 correspond to coordinates A,B,C,U,V,W respectively.

genhexkins − Hexapod Kinematics

Gives six degrees of freedom in position and orientation (XYZABC). The location of base and platform joints is defined by hal parameters. The forward kinematics iteration is controlled by hal pins.

genhexkins.base.*N*.x
genhexkins.base.*N*.y
genhexkins.base.*N*.z
genhexkins.platform.*N*.x
genhexkins.platform.*N*.y
genhexkins.platform.*N*.z
: Parameters describing the *N*th joint's coordinates.

genhexkins.spindle−offset
: Added to all joints Z coordinates to change the machine origin. Facilitates adjusting spindle position.

genhexkins.base−n.*N*.x
genhexkins.base−n.*N*.y
genhexkins.base−n.*N*.z
genhexkins.platform−n.*N*.x
genhexkins.platform−n.*N*.y
genhexkins.platform−n.*N*.z
: Parameters describing unit vectors of *N*th joint's axis. Used to calculate strut length correction for cardanic joints and non-captive actuators.

genhexkins.screw−lead
: Lead of strut actuator screw, positive for the right-handed thread. Default is 0 (strut length correction disabled).

genhexkins.correction.*N*
: Current values of strut length correction for non-captive actuators with cardanic joints. **genhexkins.convergence−criterion** Minimum error value that ends iterations with converged solution.

genhexkins.limit−iterations
: Limit of iterations, if exceeded iterations stop with no convergence.

genhexkins.max−error
: Maximum error value, if exceeded iterations stop with no convergence.

genhexkins.last−iterations
: Number of iterations spent for the last forward kinematics solution.

genhexkins.max−iterations
: Maximum number of iterations spent for a converged solution during current session.

genhexkins.tool−offset
: TCP offset from platform origin along Z to implement RTCP function. To avoid joints jump change tool offset only when the platform is not tilted.

genserkins − generalized serial kinematics

Kinematics that can model a general serial-link manipulator with up to 6 angular joints.

The kinematics use Denavit-Hartenberg definition for the joint and links. The DH definitions are the ones used by John J Craig in "Introduction to Robotics: Mechanics and Control" The parameters for the manipulator are defined by hal pins. Note that this uses a convention sometimes known as "Modified DH Paremeters" and this must be borne in mind when setting up the system.
https://en.wikipedia.org/wiki/Denavit%E2%80%93Hartenberg_parameters#Modified_DH_parameters

genserkins.A−*N*
genserkins.ALPHA−*N*
genserkins.D−*N*
: Parameters describing the *N*th joint's geometry.

maxkins − 5-axis kinematics example

Kinematics for Chris Radek's tabletop 5 axis mill named 'max' with tilting head (B axis) and horizintal rotary mounted to the table (C axis). Provides UVW motion in the rotated coordinate system. The source file, maxkins.c, may be a useful starting point for other 5-axis systems.

pumakins − kinematics for puma typed robots

Kinematics for a puma-style robot with 6 joints

pumakins.A2
pumakins.A3
pumakins.D3
pumakins.D4

Describe the geometry of the robot

rosekins − kinematics for a rose engine using

a transverse, longitudinal, and rotary joint (3 joints)

rotarydeltakins − kinematics for a rotary delta machine

Rotary delta robot (3 Joints)

rotatekins − Rotated Kinematics

The X and Y axes are rotated 45 degrees compared to the joints 0 and 1.

scarakins − kinematics for SCARA-type robots

scarakins.D1

Vertical distance from the ground plane to the center of the inner arm.

scarakins.D2

Horizontal distance between joint[0] axis and joint[1] axis, ie. the length of the inner arm.

scarakins.D3

Vertical distance from the center of the inner arm to the center of the outer arm. May be positive or negative depending on the structure of the robot.

scarakins.D4

Horizontal distance between joint[1] axis and joint[2] axis, ie. the length of the outer arm.

scarakins.D5

Vertical distance from the end effector to the tooltip. Positive means the tooltip is lower than the end effector, and is the normal case.

scarakins.D6

Horizontal distance from the centerline of the end effector (and the joints 2 and 3 axis) and the tooltip. Zero means the tooltip is on the centerline. Non-zero values should be positive, if negative they introduce a 180 degree offset on the value of joint[3].

tripodkins − Tripod Kinematics

The joints represent the distance of the controlled point from three predefined locations (the motors), giving three degrees of freedom in position (XYZ)

tripodkins.Bx
tripodkins.Cx
tripodkins.Cy

The location of the three motors is (0,0), (Bx,0), and (Cx,Cy)

xyzac−trt−kins − 5 Axis mill (Table Rotary/Tilting)
Tilting table (A) and horizontal rotary mounted tothe table (C) (5 Joints)

xyzbc−trt−kins − 5 Axis mill (Table Rotary/Tilting)
Tilting table (B) and horizontal rotary mounted to table (C axis) (5 Joints)

5axiskins − 5 Axis bridge mill
XYZBC (5 Joints)

SEE ALSO

Kinematics section in the LinuxCNC documentation

NAME

knob2float − Convert counts (probably from an encoder) to a float value

SYNOPSIS

loadrt knob2float [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

knob2float.*N*

(requires a floating-point thread)

PINS

knob2float.*N***.counts**

s32 in Counts

knob2float.*N***.enable**

bit in When TRUE, output is controlled by count, when FALSE, output is fixed

knob2float.*N***.scale**

float in Amount of output change per count

knob2float.*N***.out**

float out Output value

PARAMETERS

knob2float.*N***.max-out**

float rw (default: *1.0*) Maximum output value, further increases in count will be ignored

knob2float.*N***.min-out**

float rw (default: *0.0*) Minimum output value, further decreases in count will be ignored

LICENSE

GPL

NAME

latencybins − comp utility for scripts/latency-histogram

SYNOPSIS

Usage:
Read availablebins pin for the number of bins available.
Set the maxbinnumber pin for the number of ± bins.
Ensure maxbinnumber <= availablebins
For maxbinnumber = N, the bins are numbered:
−N ... 0 ... + N bins
(the −0 bin is not populated)
(total effective bins = 2*maxbinnumber +1)
Set nsbinsize pin for the binsize (ns)
Iterate:
Set index pin to a bin number: 0 <= index <= maxbinnumber.
Read check pin and verify that check pin == index pin.
Read output pins:
pbinvalue is count for bin = +index
nbinvalue is count for bin = −index
pextra is count for all bins > maxbinnumber
nextra is count for all bins < maxbinnumber
latency-min is max negative latency
latency-max is max positive latency

If index is out of range (index < 0 or index > maxbinnumber)
then pbinvalue = nbinvalue = −1.
The reset pin may be used to restart.
The latency pin outputs the instantaneous latency.

Maintainers note: hardcoded for MAXBINNUMBER==1000

FUNCTIONS

latencybins.*N*

PINS

latencybins.*N***.maxbinnumber**
s32 in (default: *1000*)
latencybins.*N***.index**
s32 in
latencybins.*N***.reset**
bit in
latencybins.*N***.nsbinsize**
s32 in
latencybins.*N***.check**
s32 out
latencybins.*N***.latency**
s32 out
latencybins.*N***.latency-max**
s32 out
latencybins.*N***.latency-min**
s32 out

latencybins.*N*.pbinvalue
s32 out
latencybins.*N*.nbinvalue
s32 out
latencybins.*N*.pextra
s32 out
latencybins.*N*.nextra
s32 out
latencybins.*N*.variance
s32 out
latencybins.*N*.availablebins
s32 out (default: *1000*)

LICENSE

GPL

NAME

lcd − Stream HAL data to an LCD screen

SYNOPSIS

loadrt lcd fmt_strings=""Plain Text %4.4f\nAnd So on|Second Page, Next Inst""

FUNCTIONS

lcd (requires a floating-point thread). All LCD instances are updated by the same function.

PINS

lcd.*NN*.out (u32) out

The output byte stream is sent via this pin. One character is sent every thread invocation. There in no handshaking provided.

lcd.*NN*.page.*PP*.arg.*NN* (float/s32/u32/bit) in

The input pins have types matched to the format string specifiers.

lcd.*NN*.page_num (u32) in

Selects the page number. Multiple layouts may be defined, and this pin switches between them.

lcd.*NN*.contrast (float) in

Attempts to set the contrast of the LCD screen using the byte sequence ESC C and then a value from 0x20 to 0xBF. (matching the Mesa 7i73). The value should be between 0 and 1.

PARAMETERS

lcd.*NN*.decimal−separator (u32) rw

Sets the decimal separator used for floating point numbers. The default value is 46 (0x2E) which corresponds to ".". If a comma is required then set this parameter to 44 (0x2C).

DESCRIPTION

lcd takes format strings much like those used in C and many other languages in the printf and scanf functions and their variants.

The component was written specifically to support the Mesa 7i73 pendant controller, however it may be of use streaming data to other character devices and, as the output format mimics the ADM3 terminal format, it could be used to stream data to a serial device. Perhaps even a genuine ADM3. The strings contain a mixture of text values (which are displayed directly), "escaped" formatting codes and numerical format descriptors. For a detailed description of formatting codes see: http://en.wikipedia.org/wiki/Printf

The component can be configured to display an unlimited number of differently-formatted pages, which may be selected with a HAL pin.

Escaped codes

\n Inserts a clear-to-end, carriage return and line feed character. This will still linefeed and clear even if an automatic wrap has occurred (lcd has no knowledge of the width of the lcd display.) To print in the rightmost column it is necessary to allow the format to wrap and omit the \n code.

\t Inserts a tab (actually 4 spaces in the current version rather than a true tab.)

\NN inserts the character defined by the hexadecimal code NN.
As the ’,’ character is used in the format string to separate LCD instances it must be represented by \2C in the format string. (the decimal separator is handled differently)

\\ Inserts a literal \.

Numerical formats

lcd differs slightly from the standard printf conventions. One significant difference is that width limits are strictly enforced to prevent the LCD display wrapping and spoiling the layout. The field width includes the sign character so that negative numbers will often have a smaller valid range than positive. Numbers that do not fit in the specified width are displayed as a line of asterisks (**********).

Each format begins with a "%" symbol. (For a literal % use "%%"). Immediately after the % the following modifiers may be used:

" " (space) Pad the number to the specified width with spaces. This is the default and is not strictly necessary.

"0" Pad the number to the specified width with the numeral 0.

"+" Force display of a + symbol before positive numbers. This (like the − sign) will appear immediately to the left of the digits for a space-padded number and in the extreme left position for a 0-padded number.

"1234567890" A numerical entry (other than the leading 0 above) defines the total number of characters to display including the decimal separator and the sign. Whilst this number can be as many digits as required the maximum field width is 20 characters. The inherent precison of the "double" data type means that more than 14 digits will tend to show errors in the least significant digits. The integer data types will never fill more than 10 decimal digits.

Following the width specifier should be the decimal specifier. This can only be a full-stop character (.) as the comma (,) is used as the instance separator. Currently lcd does not access the locale information to determine the correct separator but the **decimal−separator** HAL parameter can be used to choose any desired separator.

Following the decimal separator should be a number that determines how many places of decimals to display. This entry is ignored in the case of integer formats.

All the above modifiers are optional, but to specify a decimal precision the decimal point must precede the precision. For example %.3f.
The default decimal precision is 4.

The numerical formats supported are:

%f %F (for example, %+09.3f) These create a floating-point type HAL pin. The example would be displayed in a 9-character field, with 3 places of decimals, . as a decimal separator, padded to the left with 0s and with a sign displayed for both positive and negative. Conversely a plain %f would be 6 digits of decimal, variable format width, with a sign only shown for negative numbers. both %f and %F create exactly the same format.

%i %d (For example %+ 4d) Creates a signed (s32) HAL pin. The example would display the value at a fixed 4 characters, space padded, width including the + giving a range of +999 to −999. %i and %d create identical output.

%u (for example %08u) Creates an unsigned (u32) HAL pin. The example would be a fixed 8 characters wide, padded with zeros.

%x, %X Creates an unsigned (u32) HAL pin and displays the value in Hexadecimal. Both %x

and %X display capital letters for digits ABCDEF. A width may be specified, though the u32 HAL type is only 8 hex digits wide.

%o Creates an unsigned (u32) pin and displays the value in Octal.

%c Creates a u32 HAL pin and displays the character corresponding to the value of the pin. Values less than 32 (space) are suppressed. A width specifier may be used, for example %20c might be used to create a complete line of one character.

%b This specifier has no equivalent in printf. It creates a bit (boolean) type HAL pin. The b should be followed by two characters and the display will show the first of these when the pin is true, and the second when false. Note that the characters follow, not precede the "b", unlike the case with other formats. The characters may be "escaped" Hex values. For example "%b\FF " will display a solid black block if true, and a space if false and "%b\7F\7E" would display right-arrow for false and left-arrow for true. An unexpected value of 'E' indicates a formatting error.

Pages The page separator is the "|" (pipe) character. (if the actual character is needed then \7C may be used). A "Page" in this context refers to a separate format which may be displayed on the same display.

Instances The instance separator is the comma. This creates a completely separate lcd instance, for example to drive a second lcd display on the second 7i73. The use of comma to separate instances is built in to the modparam reading code so not even escaped commas "\," can be used. A comma may be displayed by using the \2C sequence.

AUTHOR

Andy Pugh

LICENSE

GPL

NAME

limit1 − Limit the output signal to fall between min and max

SYNOPSIS

loadrt limit1 [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

limit1.*N*

(requires a floating-point thread)

PINS

limit1.*N***.in**

float in

limit1.*N***.out**

float out

limit1.*N***.min**

float in (default: *-1e20*)

limit1.*N***.max**

float in (default: *1e20*)

LICENSE

GPL

NAME

limit2 − Limit the output signal to fall between min and max and limit its slew rate to less than maxv per second. When the signal is a position, this means that position and velocity are limited.

SYNOPSIS

loadrt limit2 [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

limit2.*N*

(requires a floating-point thread)

PINS

limit2.*N***.in**
float in

limit2.*N***.out**
float out

limit2.*N***.load**
bit in When TRUE, immediately set **out to in**, ignoring maxv

limit2.*N***.min**
float in (default: *-1e20*)

limit2.*N***.max**
float in (default: *1e20*)

limit2.*N***.maxv**
float in (default: *1e20*)

LICENSE

GPL

NAME

limit3 − Follow input signal while obeying limits

SYNOPSIS

Limit the output signal to fall between min and max, limit its slew rate to less than maxv per second, and limit its second derivative to less than maxa per second squared. When the signal is a position, this means that the position, velocity, and acceleration are limited.

FUNCTIONS

limit3.*N*

(requires a floating-point thread)

PINS

limit3.*N***.in**
float in

limit3.*N***.enable**
bit in (default: *1*) 1: out follows in, 0: out returns to 0 (always per constraints)

limit3.*N***.out**
float out

limit3.*N***.load**
bit in (default: *0*) When TRUE, immediately set **out to in**, ignoring maxv and maxa

limit3.*N***.min**
float in (default: *-1e20*)

limit3.*N***.max**
float in (default: *1e20*)

limit3.*N***.maxv**
float in (default: *1e20*)

limit3.*N***.maxa**
float in (default: *1e20*)

limit3.*N***.smooth-steps**
u32 in (default: *2*) Smooth out acceleration this many periods before reaching input or max/min limit. Higher values avoid oscillation, but will accelerate slightly more slowly.

LICENSE

GPL

NAME

lincurve − one-dimensional lookup table

SYNOPSIS

loadrt lincurve [count=*N***|names=***name1***[,***name2***...]] [personality=***P,P,...***]**

DESCRIPTION

This component can be used to map any floating-point input to a floating-point output. Typical uses would include linearisation of thermocouples, defining PID gains that vary with external factors or to substitute for any mathematical function where absolute accuracy is not required.

The component can be thought of as a 2-dimensional graph of points in (x,y) space joined by straight lines. The input value is located on the x axis, followed up until it touches the line, and the output of the component is set to the corresponding y-value.

The (x,y) points are defined by the x-val-NN and y-val-NN parameters which need to be set in the HAL file using "setp" commands.

The maximum number if (x,y) points supported is 16.

For input values less than the x-val-00 breakpoint the y-val-00 is returned. For x greater than the largest x-val-NN the yval corresponding to x-max is returned (ie, no extrapolation is performed.)

Sample usage: loadrt lincurve count=3 personality=4,4,4 for a set of three 4-element graphs.

FUNCTIONS

lincurve.*N*

(requires a floating-point thread)

PINS

lincurve.*N***.in**

float in The input value

lincurve.*N***.out**

float out The output value

lincurve.*N***.out-io**

float io The output value, compatible with PID gains

PARAMETERS

lincurve.*N***.x-val-***MM*

float rw

(MM=00..personality) axis breakpoints

lincurve.*N***.y-val-***MM*

float rw

(MM=00..personality) output values to be interpolated

AUTHOR

Andy Pugh

LICENSE

GPL

NAME

lineardeltakins − Kinematics for a linear delta robot

SYNOPSIS

loadrt lineardeltakins

KINEMATICS

The kinematics model is appropriate for a rostock/kossel-style design with three joints arranged in an equilateral triangle. (0,0) is always the center of the working volume. Joint 0 is at (0,R) and subsequent joints are 120 degrees clockwise (note that joint 0 is not at zero radians). The length of the arm is L.

Joints 0-2 are the linear carriages. Axes ABC and UVW are passed through unchanged in joints 3-8, so that e.g., A can still be used to control an extruder.

PINS

lineardeltakins.R float in

Effective diameter of the platform.

R is different than the distance from the center of the table to the center of the belt/smooth rod/extrusion that the joints ride on. In RepRap delta parlance, R is DELTA_RADIUS which is computed as

DELTA_SMOOTH_ROD_OFFSET - DELTA_EFFECTOR_OFFSET - DELTA_CARRIAGE_OFFSET.

lineardeltakins.L float in

Length of the rod connecting the carriage to the effector. In RepRap delta parlance, L is DELTA_DIAGONAL_ROD

NOTES

The R and L values can be adjusted while LinuxCNC is running. However, doing so while in coordinated mode will lead to a step change in joint position, which generally will trigger a following error if in joint mode with machine on.

NAME

logic − LinuxCNC HAL component providing configurable logic functions

SYNOPSIS

loadrt logic [count=*N***|names=***name1***[,***name2...***]] [personality=***P,P,...***]**

DESCRIPTION

General ‘logic function’ component. Can perform ‘and’, ‘or’, ‘nand’, ‘nor’ and ‘xor’ of up to 16 inputs.

Determine the proper value for ‘personality’ by adding the inputs and outputs then convert to hex:

- The number of input pins, usually from 2 to 16
- 256 (0x100) if the ‘and’ output is desired
- 512 (0x200) if the ‘or’ output is desired
- 1024 (0x400) if the ‘xor’ (exclusive or) output is desired
- 2048 (0x800) if the ‘nand’ output is desired
- 4096 (0x1000) if the ‘nor’ output is desired

Outputs can be combined, for example 2 + 256 + 1024 = 1282 converted to hex would be 0x502 and would have two inputs and have both ‘xor’ and ‘and’ outputs.

FUNCTIONS

logic.*N*

PINS

logic.*N***.in-***MM*
bit in
(MM=00..personality & 0xff)

logic.*N***.and**
bit out
[if personality & 0x100]

logic.*N***.or**
bit out
[if personality & 0x200]

logic.*N***.xor**
bit out
[if personality & 0x400]

logic.*N***.nand**
bit out
[if personality & 0x800]

logic.*N***.nor**
bit out
[if personality & 0x1000]

LICENSE

GPL

NAME

lowpass − Low-pass filter

SYNOPSIS

loadrt lowpass [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

lowpass.*N*

(requires a floating-point thread)

PINS

lowpass.*N***.in**

float in

lowpass.*N***.out**

float out

out += (in - out) * gain

lowpass.*N***.load**

bit in When TRUE, copy **in** to **out** instead of applying the filter equation.

PARAMETERS

lowpass.*N***.gain**

float rw

NOTES

gain pin setting

The digital filter implemented is equivalent to a unity-gain continuous-time single-pole low-pass filter that is preceded by a zero-order-hold and sampled at a fixed period. For a pole at **-a** (radians/seconds) the corresponding continuous-time lowpass filter LaPlace transfer function is:

H(s) = a/(s + a)

For a sampling period **T** (seconds), the gain for this Hal lowpass component is:

gain = 1 - eˆ(-a * T)

e = 2.71828 https://en.wikipedia.org/wiki/E_(mathematical_constant)

Examples:

T = 0.001 seconds (typical servo thread period)
a = (2*pi*100) (**100Hz** bandwith single pole)
gain = **0.466**

T = 0.001 seconds (typical servo thread period)
a = (2*pi*10) (**10Hz** bandwith single pole)
gain = **0.0609**

T = 0.001 seconds (typical servo thread period)
a = (2*pi*1) (**1Hz** bandwith single pole)
gain = **0.0063**

LICENSE

GPL

NAME

lut5 − Arbitrary 5-input logic function based on a look-up table

SYNOPSIS

loadrt lut5 [count=*N***|names=***name1***[,***name2***...]]**

DESCRIPTION

lut5 constructs a logic function with up to 5 inputs using a **l**ook-**u**p **t**able. The value for **function** can be determined by writing the truth table, and computing the sum of **all** the **weights** for which the output value would be TRUE. The weights are hexadecimal not decimal so hexadecimal math must be used to sum the weights. A wiki page has a calculator to assist in computing the proper value for function.

http://wiki.linuxcnc.org/cgi-bin/wiki.pl?Lut5

Note that LUT5 will generate any of the 4,294,967,296 logical functions of 5 inputs so **AND**, **OR**, **NAND**, **NOR**, **XOR** and every other combinatorial function is possible.

Example Functions

A 5-input *and* function is TRUE only when all the inputs are true, so the correct value for **function** is **0x80000000**.

A 2-input *or* function would be the sum of **0x2** + **0x4** + **0x8**, so the correct value for **function** is **0xe**.

A 5-input *or* function is TRUE whenever any of the inputs are true, so the correct value for **function** is **0xfffffffe**. Because every weight except **0x1** is true the function is the sum of every line except the first one.

A 2-input *xor* function is TRUE whenever exactly one of the inputs is true, so the correct value for **function** is **0x6**. Only **in-0** and **in-1** should be connected to signals, because if any other bit is **TRUE** then the output will be **FALSE**.

Weights for each line of truth table					
Bit 4	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	**Weight**
0	0	0	0	0	0x1
0	0	0	0	1	0x2
0	0	0	1	0	0x4
0	0	0	1	1	0x8
0	0	1	0	0	0x10
0	0	1	0	1	0x20
0	0	1	1	0	0x40
0	0	1	1	1	0x80
0	1	0	0	0	0x100
0	1	0	0	1	0x200
0	1	0	1	0	0x400
0	1	0	1	1	0x800
0	1	1	0	0	0x1000
0	1	1	0	1	0x2000
0	1	1	1	0	0x4000
0	1	1	1	1	0x8000
1	0	0	0	0	0x10000
1	0	0	0	1	0x20000
1	0	0	1	0	0x40000
1	0	0	1	1	0x80000
1	0	1	0	0	0x100000
1	0	1	0	1	0x200000
1	0	1	1	0	0x400000
1	0	1	1	1	0x800000
1	1	0	0	0	0x1000000
1	1	0	0	1	0x2000000
1	1	0	1	0	0x4000000
1	1	0	1	1	0x8000000
1	1	1	0	0	0x10000000
1	1	1	0	1	0x20000000
1	1	1	1	0	0x40000000
1	1	1	1	1	0x80000000

FUNCTIONS

lut5.*N*

PINS

lut5.*N***.in-0**
bit in

lut5.*N***.in-1**
bit in

lut5.*N***.in-2**
bit in

lut5.*N***.in-3**
bit in

lut5.*N***.in-4**
bit in

lut5.*N*.out
bit out

PARAMETERS

lut5.*N*.function
u32 rw

LICENSE

GPL

NAME

maj3 − Compute the majority of 3 inputs

SYNOPSIS

loadrt maj3 [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

maj3.*N*

PINS

maj3.*N***.in1**
bit in
maj3.*N***.in2**
bit in
maj3.*N***.in3**
bit in
maj3.*N***.out**
bit out

PARAMETERS

maj3.*N***.invert**
bit rw

LICENSE

GPL

NAME

match8 − 8-bit binary match detector

SYNOPSIS

loadrt match8 [count=*N***|names=***name1***[,***name2...***]]**

FUNCTIONS

match8.*N*

PINS

match8.*N***.in**
bit in (default: *TRUE*) cascade input - if false, output is false regardless of other inputs

match8.*N***.a0**
bit in

match8.*N***.a1**
bit in

match8.*N***.a2**
bit in

match8.*N***.a3**
bit in

match8.*N***.a4**
bit in

match8.*N***.a5**
bit in

match8.*N***.a6**
bit in

match8.*N***.a7**
bit in

match8.*N***.b0**
bit in

match8.*N***.b1**
bit in

match8.*N***.b2**
bit in

match8.*N***.b3**
bit in

match8.*N***.b4**
bit in

match8.*N***.b5**
bit in

match8.*N***.b6**
bit in

match8.*N***.b7**
bit in

match8.*N***.out**
bit out true only if in is true and a[m] matches b[m] for m = 0 thru 7

LICENSE

GPL

NAME

matrix_kb − Convert integers to HAL pins. Optionally scan a matrix of IO ports to create those integers.

SYNOPSIS

loadrt matrix_kb config=*RxCs,RxCs***... names=***name1,name2***...**

Creates a component configured for R rows and N columns of matrix keyboard.

If the **s** option is specified then a set of output rows will be cyclically toggled, and a set of input columns will be scanned.

The **names** parameter is optional, but if used then the HAL pins and functions will use the specified names rather than the default ones. This can be useful for readbility and 2-pass HAL parsing.

There must be no spaces in the parameter lists.

DESCRIPTION

This component was written to convert matrix keyboard scancodes into HAL pins. However, it might also find uses in converting integers from 0 to N into N HAL pins.

The component can work in two ways, and the HAL pins created vary according to mode.

In the default mode the component expects to be given a scan code from a separate driver but could be any integer from any source. Most typically this will be the keypad scancode from a Mesa 7i73. The default codes for keyup and keydown are based on the Mesa 7i73 specification with 0x40 indicating a keydown and 0x80 a keyup event.
If using the 7i73 it is important to match the keypad size jumpers with the HAL component. Valid configs for the 7i73 are 4x8 and 8x8. Note that the component will only work properly with the version 12 (0xC) 7i73 firmware. The firmware version is visible on the component parameters in HAL.

In the optional scan-generation mode the **matrix_kb.***N***.keycode** pin changes to an output pin and a set of output row pins and input column pins are created. These need to be connected to physical inputs and outputs to scan the matrix and return values to HAL. Note the **negative−logic** parameter described below, this will need to be set on the most common forms of inputs which float high when unconnected.

In both modes a set of HAL output pins are created corresponding to each node of the matrix.

FUNCTIONS

matrix_kb.*N*

Perform all requested functions. Should be run in a slow thread for effective debouncing.

PINS

matrix_kb.*N***.col−***CC***−in** bit in

The input pin corresponding to column C.

matrix_kb.*N***.key.r***R***c***C** bit out

The pin corresponding to the key at row R column C of the matrix.

matrix_kb.*N***.keycode** unsigned in or out depending on mode.

This pin should be connected to the scancode generator if hardware such as a 7i73 is being used. In this mode it is an input pin. In the internally-generated scanning mode this pin is an output, but will not normally be connected. **matrix_kb.***N***.row−***RR***−out bit out** The row scan drive pins.Should be connected to external hardware pins connected to the keypad.

PARAMETERS

matrix_kb.*N*.key_rollover unsigned r/w (default 2)

With most matrix keyboards the scancodes are only unambiguous with 1 or 2 keys pressed. With more keys pressed phantom keystrokes can appear. Some keyboards are optimised to reduce this problem, and some have internal diodes so that any number of keys may be pressed simultaneously. Increase the value of this parameter if such a keyboard is connected, or if phantom keystrokes are more acceptable than only two keys being active at one time.

matrix_kb.*N*.negative−logic bit r/w (default 1) only in scan mode

When no keys are pressed a typical digital input will float high. The input will then be pulled low by the keypad when the corresponding poll line is low. Set this parameter to 0 if the IO in use requires one row at a time to be high, and a high input corresponds to a button press.

NAME

max31855 − Support for the MAX31855 Thermocouple-to-Digital converter using bitbanged spi

SYNOPSIS

loadrt max31855 [count=*N***|names=***name1***[,***name2***...]] [personality=***P,P,...***]**

DESCRIPTION

The component requires at least 3 pins to bitbang spi protocol, for example:

```
loadrt max31855 personality=1

setp hm2_6i25.0.gpio.023.is_output true
setp hm2_6i25.0.gpio.024.is_output true

net spi.clk.in    hm2_6i25.0.gpio.023.out     max31855.0.clk.out
net spi.cs.in     hm2_6i25.0.gpio.024.out     max31855.0.cs.out
net spi.data0.in  hm2_6i25.0.gpio.033.in_not  max31855.0.data.0.in

addf max31855.0.bitbang-spi servo-thread
```

The MAX31855 supports a range of -270C to 1800C, however linearization data is only available for the -200C to 1350C range, beyond which raw temperature is returned.

Temperature pins are provided for readings in Celsius, Fahrenheit and Kelvin, temperature values are not updated while a fault condition is present.

The personality parameter is used to indicate the number of sensors. Multiple sensors share the clk and cs pins, but connect to discrete data input pins. A maximum of 15 sensors are supported.

FUNCTIONS

max31855.*N*.bitbang-spi
(requires a floating-point thread)

PINS

max31855.*N*.data.*M*.in
bit in
(M=0..(personality & 0xf)) Pin(s) connected to data out.

max31855.*N*.cs.out
bit out Pin connected to cs, pulled low to shift data, pulled high for data refresh.

max31855.*N*.clk.out
bit out Pin connected to clk.

max31855.*N*.temp-celsius.*M*
float out
(M=0..(personality & 0xf)) Temperature output values in Celsius.

max31855.*N*.temp-fahrenheit.*M*
float out
(M=0..(personality & 0xf)) Temperature in Fahrenheit.

max31855.*N*.temp-kelvin.*M*
float out
(M=0..(personality & 0xf)) Temperature in Kelvin.

max31855.*N*.fault.*M*
bit out
(M=0..(personality & 0xf)) Fault condition detected.

max31855.*N*.fault-flags.*M*
u32 out
(M=0..(personality & 0xf)) Fault flags: 0x1 = open sensor, 0x2 short to gnd, 0x3 short to vcc.

AUTHOR

Joseph Calderon

LICENSE

GPL

NAME

mesa_7i65 − Support for the Mesa 7i65 Octuple Servo Card

SYNOPSIS

loadrt mesa_7i65

DESCRIPTION

The component takes parameters in the form of a comma-separated list of bspi (buffered SPI) instance names, for example:

loadrt mesa_7i65 bspi_chans=hm2_5i23.0.bspi.0, hm2_5i23.0.bspi.1

The BSPI instances are printed to the dmesg buffer during the Hostmot2 setup sequence, one for each bspi instance included in the bitfile loaded to each installed card during the Hostmot2 setup sequence. Type "dmesg" at the terminal prompt to view the output.

PINS

mesa-7i65.*N*.analogue.*M*.out
float in
(M=0..7) Analogue output values. The value will be limited to a -1.0 to +1.0 range

mesa-7i65.*N*.analogue.*M*.in
float out
(M=0..7) Analogue outputs read by the 7i65 (in Volts)

mesa-7i65.*N*.digital.*M*.in
bit out
(M=0..3) Miscellaneous Digital Inputs

mesa-7i65.*N*.enable.*M*.out
bit in
(M=0..7) Amplifier-enable control pins

mesa-7i65.*N*.watchdog.has-bit
bit out Indicates the status of the 7i65 Watchdog (which is separate from the FPGA card watchdog

PARAMETERS

mesa-7i65.*N*.scale-*M*
float rw
(M=0..7) (default: *10*) Analogue output scale factor. For example if the scale is 7 then an input of 1.0 will give 7V on the output terminals

mesa-7i65.*N*.is-bipolar-*M*
bit rw
(M=0..7) (default: *1*) Set this value to TRUE for a plus/minus "scale" output. Set to 0 for a 0-"scale" output

AUTHOR

Andy Pugh / Cliff Blackburn

LICENSE

GPL

NAME

mesa_pktgyro_test − PktUART simple test with Microstrain 3DM-GX3-15 gyro

SYNOPSIS

loadrt mesa_pktgyro_test [count=*N***|names=***name1***[,***name2***...]]**

DESCRIPTION

This component is written in order to test the PktUART driver for Mesa. It resembles partly Andy Pugh's mesa_uart.comp .

This module uses the names= mode of loadrt declaration to specifiy which PktUART instances to enable. A check is included to ensure that the count= option is not used instead. For simplicity we test only one PktUART instance, therefore load the component like this:

loadrt mesa_uart names=hm2_5i25.0.pktuart.0

The PktUART instance names are printed to the dmesg buffer during the Hostmot2 setup sequence, one for each PktUART instance included in the bitfile loaded to each installed card during the Hostmot2 setup sequence. Type "dmesg" at the terminal prompt to view the output. If you want to work with more than one PktUART instance, consult Andy Pugh's mesa_uart.comp

In order to compile and install do:
halcompile --install src/hal/drivers/mesa_pktgyro_test.comp

The component exports only one function, namely receive, which needs to be added to a realtime thread. To test this component set DEBUG=5 before and execute this HAL script:

```
loadrt hostmot2
loadrt hm2_pci
loadrt mesa_pktgyro_test names=hm2_5i25.0.pktuart.0
loadrt threads name1=test1 period1=10000000
addf hm2_5i25.0.pktuart.0.receive test1
start
```

Check linuxcnc.log for debug output.

FUNCTIONS

mesa-pktgyro-test.*N***.receive**
(requires a floating-point thread)

PINS

mesa-pktgyro-test.*N***.rxbytes**
s32 out Number of Bytes received or negative Error code

AUTHOR

Boris Skegin

LICENSE

GPL

NAME

message − Display a message

SYNOPSIS

loadrt message [count=*N***|names=***name1***[,***name2***...]]** [messages=*N*]

messages

The messages to display. These should be listed, comma-delimited, inside a single set of quotes. See the "Description" section for an example. If there are more messages than "count" or "names" then the excess will be ignored. If there are fewer messages than "count" or "names" then an error will be raised and the component will not load.

DESCRIPTION

Allows HAL pins to trigger a message. Example hal commands:

```
loadrt message names=oillow,oilpressure,inverterfail messages="Slideway oil low,No oil pressure,Spindle inverter fault"
addf oillow servo-thread
addf oilpressure servo-thread
addf inverterfail servo-thread

setp oillow.edge 0 #this pin should be active low
net no-oil classicladder.0.out-21 oillow.trigger
net no-pressure classicladder.0.out-22 oilpressure.trigger
net no-inverter classicladder.0.out-23 inverterfail.trigger
```

When any pin goes active, the corresponding message will be displayed.

FUNCTIONS

message.*N*

Display a message

PINS

message.*N***.trigger**
bit in (default: *FALSE*) signal that triggers the message

message.*N***.force**
bit in (default: *FALSE*) A FALSE->TRUE transition forces the message to be displayed again if the trigger is active

PARAMETERS

message.*N***.edge**
bit rw (default: *TRUE*) Selects the desired edge: TRUE means falling, FALSE means rising

LICENSE

GPL v2

NAME

minmax − Track the minimum and maximum values of the input to the outputs

SYNOPSIS

loadrt minmax [count=*N***|names=***name1***[,***name2...***]]**

FUNCTIONS

minmax.*N*

(requires a floating-point thread)

PINS

minmax.*N***.in**

float in

minmax.*N***.reset**

bit in When reset is asserted, ’in’ is copied to the outputs

minmax.*N***.max**

float out

minmax.*N***.min**

float out

LICENSE

GPL

NAME

motion − accepts NML motion commands, interacts with HAL in realtime

SYNOPSIS

loadrt motmod [base_period_nsec=*period***] [base_thread_fp=***0 or 1***] [servo_period_nsec=***period***] [traj_period_nsec=***period***] [num_joints=***[1-9]***] [num_dio=***[1-64]***] [num_aio=***[1-64]***] [num_spindles=***[1-8]***] [unlock_joints_mask=***jointmask***]**

The limits for the following items are compile-time settings:
Number of joints available (num_joints) is set by EMCMOT_MAX_JOINTS.
Maximum number of digital inputs (num_dio) is set by EMCMOT_MAX_DIO.
Maximum number of analog inputs (num_aio) is set by EMCMOT_MAX_AIO.
Maximum number of spindles (num_spindles) is set by EMCMOT_MAX_SPINDLES

DESCRIPTION

By default, the base thread does not support floating point. Software stepping, software encoder counting, and software pwm do not use floating point. **base_thread_fp** can be used to enable floating point in the base thread (for example for brushless DC motor control).

These pins and parameters are created by the realtime **motmod** module. This module provides a HAL interface for LinuxCNC's motion planner. Basically **motmod** takes in a list of waypoints and generates a nice blended and constraint-limited stream of joint positions to be fed to the motor drives.

Optionally the number of Digital I/O is set with num_dio. The number of Analog I/O is set with num_aio. The default is 4 each.

Pin names starting with "**joint**" or "**axis**" are are read and updated by the motion-controller function.

MOTION PINS

motion-command-handler.time OUT S32
Time (in CPU clocks) for the motion module motion-command-handler

motion-controller.time OUT S32
Time (in CPU clocks) for the motion module motion-controller

motion.adaptive−feed IN FLOAT
When adaptive feed is enabled with M52 P1, the commanded velocity is multiplied by this value. This effect is multiplicative with the NML-level feed override value and motion.feed−hold.

motion.analog−in−*NN* IN FLOAT
These pins are used by M66 Enn wait-for-input mode.

motion.analog−out−*NN* OUT FLOAT
These pins are used by M67-68.

motion.coord−error OUT BIT
TRUE when motion has encountered an error, such as exceeding a soft limit

motion.coord−mode OUT BIT
TRUE when motion is in "coordinated mode", as opposed to "teleop mode"

motion.current−vel OUT FLOAT
Current cartesian velocity

motion.digital−in−*NN* IN BIT
These pins are used by M66 Pnn wait-for-input mode.

motion.digital−out−*NN* OUT BIT
These pins are controlled by the M62 through M65 words.

motion.distance−to−go OUT FLOAT
Distance remaining in the current move

motion.enable IN BIT
If this bit is driven FALSE, motion stops, the machine is placed in the "machine off" state, and a message is displayed for the operator. For normal motion, drive this bit TRUE.

motion.eoffset-active OUT BIT
Indicates external offsets are active (non-zero)

motion.eoffset-limited OUT BIT
Indicates motion with external offsets was limited by a soft limit constraint ([AXIS_L]MIN_LIMIT,MAX_LIMIT).

motion.feed−hold IN BIT
When Feed Stop Control is enabled with M53 P1, and this bit is TRUE, the feed rate is set to 0.

motion.feed−inhibit IN BIT
When this pin is TRUE, machine motion is inhibited (this includes jogs, programmed feeds, and programmed rapids, aka traverse moves).

If the machine is performing a spindle synchronized move when this pin goes TRUE, the spindle synchronized motion will finish, and any following moves will be inhibited (this is to prevent damage to the machine, the tool, or the work piece).

If the machine is in the middle of a (non-spindle synchronized) move when this pin goes TRUE, the machine will decelerate to a stop at the maximum allowed acceleration rate.

Motion resumes when this pin goes FALSE.

motion.homing−inhibit IN BIT
If this bit is TRUE, initiation of any joint homing move (including "Home All") is disallowed and an error is reported. By default, homing is allowed in joint mode whenever motion is enabled.

motion.in−position OUT BIT
TRUE if the machine is in position (ie, not currently moving towards the commanded position).

motion.motion−enabled OUT BIT

motion.motion−type OUT S32
These values are from src/emc/nml_intf/motion_types.h

0: Idle (no motion)

1: Traverse

2: Linear feed

3: Arc feed

4: Tool change

5: Probing

6: Rotary unlock for traverse

motion.on−soft−limit OUT BIT

motion.probe−input IN BIT
G38.n uses the value on this pin to determine when the probe has made contact. TRUE for probe contact closed (touching), FALSE for probe contact open.

motion.program−line OUT S32
The current program line while executing. Zero if not running or between lines while single stepping.

motion.requested−vel OUT FLOAT
The current requested velocity in user units per second. This value is the F-word setting from the G-code file, possibly reduced to accomodate machine velocity and acceleration limits. The value on this pin does not reflect the feed override or any other adjustments.

motion.servo.last−period OUT U32
The number of CPU clocks between invocations of the servo thread. Typically, this number divided by the CPU speed gives the time in seconds, and can be used to determine whether the realtime motion controller is meeting its timing constraints

motion.teleop−mode OUT BIT
Motion mode is teleop (axis coordinate jogging available).

motion.tooloffset.L OUT FLOAT
Current tool offset for each axis where (**L** is the axis letter, one of: **x y z a b c u v w**)

AXIS PINS

(**L** is the axis letter, one of: **x y z a b c u v w**)

axis.*L*.eoffset OUT FLOAT
Current external offset.

axis.*L*.eoffset-clear IN BIT
Clear external offset request

axis.*L*.eoffset-counts IN S32
Counts input for external offset. The eoffset-counts are transferred to an internal register. The applied external offset is the product of the register counts and the eoffset-scale value. The

register is **reset to zero at each machine startup**. If the machine is turned off with an external offset active, the eoffset-counts pin should be set to zero before restarting.

axis.*L*.eoffset-enable IN BIT
Enable for external offset (also requires ini file setting for [AXIS_L]OFFSET_AV_RATIO)

axis.*L*.eoffset-request OUT FLOAT
Debug pin for requested external offset.

axis.*L*.eoffset-scale IN FLOAT
Scale for external offset.

axis.*L*.jog−accel−fraction IN FLOAT
Sets acceleration for wheel jogging to a fraction of the ini max_acceleration for the axis. Values greater than 1 or less than zero are ignored.

axis.*L*.jog−counts IN S32
Connect to the "counts" pin of an external encoder to use a physical jog wheel.

axis.*L*.jog−enable IN BIT
When TRUE (and in manual mode), any change to "jog−counts" will result in motion. When false, "jog−counts" is ignored.

axis.*L*.jog−scale IN FLOAT
Sets the distance moved for each count on "jog−counts", in machine units.

axis.*L*.jog−vel−mode IN BIT
When FALSE (the default), the jogwheel operates in position mode. The axis will move exactly jog−scale units for each count, regardless of how long that might take. When TRUE, the wheel operates in velocity mode - motion stops when the wheel stops, even if that means the commanded motion is not completed.

axis.*L*.kb−jog−active OUT BIT
(free planner axis jogging active (keyboard or halui))

axis.*L*.pos−cmd OUT FLOAT
The axis commanded position. There may be several offsets between the axis and motor coordinates: backlash compensation, screw error compensation, and home offsets. External offsets are reported separately (axis.**L**.eoffset).

axis.*L*.teleop−pos−cmd OUT FLOAT

axis.*L*.teleop−tp−enable OUT BIT
TRUE when the "teleop planner" is enabled for this axis

axis.*L*.teleop−vel−cmd OUT FLOAT
The axis's commanded velocity

axis.*L*.teleop−vel−lim OUT FLOAT
The velocity limit for the teleop planner

axis.*L*.wheel−jog−active OUT BIT

JOINT PINS

N is the joint number (**0** ... **num_joints−1**))

(**Note:** pins marked **(DEBUG)** serve as debugging aids
and are subject to change or removal at any time.)

joint.*N*.joint−acc−cmd OUT FLOAT **(DEBUG)**
The joint's commanded acceleration

joint.*N*.active OUT BIT **(DEBUG)**
TRUE when this joint is active

joint.*N*.amp−enable−out OUT BIT
TRUE if the amplifier for this joint should be enabled

joint.*N*.amp−fault−in IN BIT
Should be driven TRUE if an external fault is detected with the amplifier for this joint

joint.*N*.backlash−corr OUT FLOAT **(DEBUG)**
Backlash or screw compensation raw value

joint.*N*.backlash−filt OUT FLOAT **(DEBUG)**
Backlash or screw compensation filtered value (respecting motion limits)

joint.*N*.backlash−vel OUT FLOAT **(DEBUG)**
Backlash or screw compensation velocity

joint.*N*.coarse−pos−cmd OUT FLOAT **(DEBUG)**

joint.*N*.error OUT BIT **(DEBUG)**
TRUE when this joint has encountered an error, such as a limit switch closing

joint.*N*.f−error OUT FLOAT **(DEBUG)**
The actual following error

joint.*N*.f−error−lim OUT FLOAT **(DEBUG)**
The following error limit

joint.*N*.f−errored OUT BIT **(DEBUG)**
TRUE when this joint has exceeded the following error limit

joint.*N*.faulted OUT BIT **(DEBUG)**

joint.*N*.free−pos−cmd OUT FLOAT **(DEBUG)**
The "free planner" commanded position for this joint.

joint.*N*.free−tp−enable OUT BIT **(DEBUG)**
TRUE when the "free planner" is enabled for this joint

joint.*N*.free−vel−lim OUT FLOAT **(DEBUG)**
The velocity limit for the free planner

joint.*N*.home−state OUT S32 **(DEBUG)**
homing state machine state

joint.*N*.home−sw−in IN BIT
Should be driven TRUE if the home switch for this joint is closed

joint.*N*.homed OUT BIT **(DEBUG)**
TRUE if the joint has been homed

joint.*N*.homing OUT BIT
TRUE if the joint is currently homing

joint.*N*.in−position OUT BIT **(DEBUG)**
TRUE if the joint is using the "free planner" and has come to a stop

joint.*N*.index−enable IO BIT
Should be attached to the index−enable pin of the joint's encoder to enable homing to index pulse

joint.N.is−unlocked IN BIT
Indicates joint is unlocked (see JOINT UNLOCK PINS).

joint.*N*.jog−accel−fraction IN FLOAT
Sets acceleration for wheel jogging to a fraction of the ini max_acceleration for the joint. Values greater than 1 or less than zero are ignored.

joint.*N*.jog−counts IN S32
Connect to the "counts" pin of an external encoder to use a physical jog wheel.

joint.*N*.jog−enable IN BIT
When TRUE (and in manual mode), any change to "jog−counts" will result in motion. When false, "jog−counts" is ignored.

joint.*N*.jog−scale IN FLOAT
Sets the distance moved for each count on "jog−counts", in machine units.

joint.*N*.jog−vel−mode IN BIT
When FALSE (the default), the jogwheel operates in position mode. The joint will move exactly jog−scale units for each count, regardless of how long that might take. When TRUE, the wheel operates in velocity mode - motion stops when the wheel stops, even if that means the commanded motion is not completed.

joint.*N*.kb−jog−active OUT BIT **(DEBUG)**
(free planner joint jogging active (keyboard or halui))

joint.*N*.motor−offset OUT FLOAT **(DEBUG)**
joint motor offset established when joint is homed.

joint.*N*.motor−pos−cmd OUT FLOAT
The commanded position for this joint.

joint.*N*.motor−pos−fb IN FLOAT
The actual position for this joint.

joint.*N*.neg−hard−limit OUT BIT **(DEBUG)**
The negative hard limit for the joint

joint.*N*.neg−lim−sw−in IN BIT
Should be driven TRUE if the negative limit switch for this joint is tripped.

joint.*N*.pos−cmd OUT FLOAT
The joint (as opposed to motor) commanded position. There may be several offsets between the joint and motor coordinates: backlash compensation, screw error compensation, and home offsets.

joint.*N*.pos−fb OUT FLOAT
The joint feedback position. This value is computed from the actual motor position minus joint offsets. Useful for machine visualization.

joint.*N*.pos−hard−limit OUT BIT **(DEBUG)**
The positive hard limit for the joint

joint.*N*.pos−lim−sw−in IN BIT
Should be driven TRUE if the positive limit switch for this joint is tripped.

joint.*N*.unlock OUT BIT
TRUE if the axis is a locked joint (typically a rotary) and a move is commanded (see JOINT UNLOCK PINS).

joint.*N*.joint−vel−cmd OUT FLOAT **(DEBUG)**
The joint's commanded velocity

joint.*N*.wheel−jog−active OUT BIT **(DEBUG)**

JOINT UNLOCK PINS

The joint pins used for unlocking a joint (**joint.N.unlock**, **joint.N.is-unlocked**), are created according to the **unlock_joints_mask=**jointmask parameter for motmod. These pins may be required for locking indexers (typically a rotary joint)

The jointmask bits are: (lsb)0:joint0, 1:joint1, 2:joint2, ...

Example: loadrt motmod ... **unlock_joints_mask=**0x38 creates unlock pins for joints 3,4,5

SPINDLE PINS

(**M** is the spindle number (**0** ... **num_spindles−1**))

spindle.M.amp−fault−in IN BIT
Should be driven TRUE if an external fault is detected with the amplifier for this spindle

spindle.M.at−speed IN BIT
Motion will pause until this pin is TRUE, under the following conditions: before the first feed move after each spindle start or speed change; before the start of every chain of spindle−synchronized moves; and if in CSS mode, at every rapid−>feed transition.

spindle.M.brake OUT BIT
TRUE when the spindle brake should be applied

spindle.M.forward OUT BIT
TRUE when the spindle should rotate forward

spindle.M.index−enable I/O BIT
For correct operation of spindle synchronized moves, this signal must be hooked to the index−enable pin of the spindle encoder.

spindle.M.inhibit IN BIT
When TRUE, the spindle speed is set and held to 0.

spindle.M.is−oriented IN BIT
Acknowledge pin for spindle−orient. Completes orient cycle. If spindle−orient was true when spindle−is−oriented was asserted, the spindle−orient pin is cleared and the spindle−locked pin is asserted. Also, the spindle−brake pin is asserted.

spindle.M.locked OUT BIT
Spindle orient complete pin. Cleared by any of M3,M4,M5.

spindle.M.on OUT BIT
TRUE when spindle should rotate

spindle.M.orient OUT BIT
Indicates start of spindle orient cycle. Set by M19. Cleared by any of M3,M4,M5.

If spindle−orient−fault is not zero during spindle−orient true, the M19 command fails with an error message.

spindle.M.orient−angle OUT FLOAT
Desired spindle orientation for M19. Value of the M19 R word parameter plus the value of the [RS274NGC]ORIENT_OFFSET ini parameter.

spindle.M.orient−fault IN S32
Fault code input for orient cycle. Any value other than zero will cause the orient cycle to abort.

spindle.M.orient−mode OUT BIT
Desired spindle rotation mode. Reflects M19 P parameter word.

spindle.M.reverse OUT BIT
TRUE when the spindle should rotate backward

spindle.M.revs IN FLOAT
For correct operation of spindle synchronized moves, this signal must be hooked to the position pin of the spindle encoder.

spindle.M.speed−cmd−rps FLOAT OUT
Commanded spindle speed in units of revolutions per second

spindle.M.speed−in IN FLOAT
Actual spindle speed feedback in revolutions per second; used for G96 (constant surface speed) and G95 (feed per revolution) modes.

spindle.M.speed−out OUT FLOAT
Desired spindle speed in rotations per minute

spindle.M.speed−out−abs OUT FLOAT
Desired spindle speed in rotations per minute, always positive regardless of spindle direction.

spindle.M.speed−out−rps OUT FLOAT
Desired spindle speed in rotations per second

spindle.M.speed−out−rps−abs OUT FLOAT
Desired spindle speed in rotations per second, always positive regardless of spindle direction.

MOTION PARAMETERS

Many of the parameters serve as debugging aids, and are subject to change or removal at any time.

motion−command−handler.tmax RW S32
Show information about the execution time of these HAL functions in CPU clocks

motion−command−handler.tmax−increased RO S32

motion−controller.tmax RW S32
Show information about the execution time of these HAL functions in CPU clocks

motion−controller.tmax−increased RO BIT

motion.debug−*
These values are used for debugging purposes.

FUNCTIONS

Generally, these functions are both added to the servo-thread in the order shown.

motion−command−handler

Processes motion commands coming from user space. The pin named **motion-command-handler.time** and parameters **motion-command-handler.tmax,tmax-increased**are created for this function.

motion−controller

Runs the LinuxCNC motion controller The pin named **motion-controller.time** and parameters **motion-controller.tmax,tmax-increased** are created for this function.

BUGS

This manual page is incomplete.
Identification of pins categorized with **(DEBUG)** is dubious.

SEE ALSO

iocontrol(1), milltask(1)

NAME

moveoff − Component for Hal-only offsets

SYNOPSIS

loadrt moveoff [count=*N***|names=***name1***[,***name2...***]] [personality=***P,P,...***]**

DESCRIPTION

The moveoff component is used to offset joint positions using custom Hal connections. Implementing an offset-while-program-is-paused functionality is supported with appropriate connections for the input pins. Nine joints are supported.

The axis offset pin values (offset-in-M) are continuously applied (respecting limits on value, velocity, and acceleration) to the output pins (offset-current-M, pos-plusoffset-M, fb-minusoffset-M) when both enabling input pins (apply-offsets and move-enable) are TRUE. The two enabling inputs are anded internally. A **warning** pin is set and a message issued if the apply-offsets pin is deasserted while offsets are applied. The warning pin remains TRUE until the offsets are removed or the apply-offsets pin is set.

Typically, the move-enable pin is connected to external controls and the apply-offsets pin is connected to halui.program.is-paused (for offsets only while paused) or set to TRUE (for continuously applied offsets).

Applied offsets are **automatically returned** to zero (respecting limits) when either of the enabling inputs is deactivated. The zero value tolerance is specified by the epsilon input pin value.

Waypoints are recorded when the moveoff componenent is enabled. Waypoints are managed with the waypoint-sample-secs and waypoint-threshold pins. When the backtrack-enable pin is TRUE, the auto-return path follows the recorded waypoints. When the memory available for waypoints is exhausted, offsets are frozen and the waypoint-limit pin is asserted. This restriction applies regardless of the state of the backtrack-enable pin. An enabling pin must be deasserted to allow a return to the original (non-offset position).

Backtracking through waypoints results in **slower** movement rates as the moves are point-to-point respecting velocity and acceleration settings. The velocity and acceleration limit pins can be managed dynamically to control offsets at all times.

When backtrack-enable is FALSE, the auto-return move is **NOT** coordinated, each axis returns to zero at its own rate. If a controlled path is wanted in this condition, each axis should be manually returned to zero before deasserting an enabling pin.

The waypoint-sample-secs, waypoint-threshold, and epsilon pins are evaluated only when the component is idle.

The offsets-applied output pin is provided to indicate the current state to a GUI so that program resumption can be managed. If the offset(s) are non-zero when the apply-offsets pin is deasserted (for example when resuming a program when offsetting during a pause), offsets are returned to zero (respecting limits) and an **Error** message is issued.

Caution: If offsets are enabled and applied and the machine is turned off for any reason, any **external** Hal logic that manages the enabling pins and the offset-in-M inputs is responsible for their state when the machine is subsequently turned on again.

This Hal-only means of offsetting is typically not known to LinuxCNC nor available in GUI preview displays. **No protection is provided** for offset moves that exceed soft limits managed by LinuxCNC. Since soft limits are not honored, an offset move may encounter hard limits (or **CRASH** if there are no limit switches). Use of the offset-min-M and offset-max-M inputs to limit travel is recommended. Triggering a hard limit will turn off the machine -- see **Caution** above.

The offset-in-M values may be set with inifile settings, controlled by a GUI, or managed by other Hal components and connections. Fixed values may be appropriate in simple cases where the direction and amount of offset is well-defined but a control method is required to deactivate an enabling pin in order to return offsets to zero. GUIs may provide means for users to set, increment, decrement, and accumulate offset values for each axis and may set offset-in-M values to zero before deasserting an enabling pin.

The default values for accel, vel, min, max, epsilon, waypoint-sample-secs, and waypoint-threshold may not be suitable for any particular application. This Hal component is unaware of limits enforced elsewhere by LinuxCNC. Users should test usage in a simulator application and understand all hazards **before** use on hardware.

The module personality item sets the number of joints supported (default==3, maximum is 9).

Use of the names= option for naming is **required** for compatibility with the gui provided as scripts/moveoff_gui:
loadrt moveoff names=**mv** personality=number_of_joints

man moveoff_gui for more information

EXAMPLES

Example simulator configs that demonstrate the moveoff component and a simple gui (scripts/moveoff_gui) are located in configs/sim/axis/moveoff. The axis gui is used for the demonstrations and the configs can be adapted for other guis like touchy and gscreen. An example with the touchy gui is provided in configs/sim/touchy/ngcgui/.

FUNCTIONS

moveoff.*N*.read-inputs
(requires a floating-point thread) Read all inputs

moveoff.*N*.write-outputs
(requires a floating-point thread) Write computed offset outputs (offset-current-M, pos-plusoffset-M, fb-minusoffset-M). All other outputs are updated by read-inputs()

PINS

moveoff.*N*.power-on
bit in Connect to motion.motion-enabled

moveoff.*N*.move-enable
bit in Enable offsets (Enabling requires apply-offset TRUE also)

moveoff.*N*.apply-offsets
bit in Enable offsets (Enabling requires move-enable TRUE also)

moveoff.*N*.backtrack-enable
bit in (default: *1*) Enable backtrack on auto-return

moveoff.*N*.epsilon
float in (default: *0.0005*) When enabling pins are deactivated, return to un-offsetted position within epsilon units. Warning: values that are too small in value may cause overshoot, A minimum value of 0.0001 is **silently enforced**

moveoff.*N*.waypoint-threshold
float in (default: *0.02*) Minimum distance (in a single axis) for a new waypoint

moveoff.*N*.waypoint-sample-secs
float in (default: *0.02*) Minimum sample interval (in seconds) for a new waypoint

moveoff.*N*.warning
bit out Set TRUE if apply-offsets is deasserted while offset-applied is TRUE

moveoff.*N*.offset-applied
bit out TRUE if one or more offsets are applied

moveoff.*N*.waypoint-limit
bit out (default: *0*) Indicates waypoint limit reached (motion ceases), an enabling pin must be deasserted to initiate return to original position

moveoff.*N*.waypoint-ct
s32 out Waypoint count (for debugging)

moveoff.*N*.waypoint-percent-used
s32 out Percent of available waypoints used

moveoff.*N*.offset-in-*M*
float in
(M=0..personality) Joint offset input value

moveoff.*N*.pos-*M*
float in
(M=0..personality) Joint position (typ: axis.0.motor-pos-cmd)

moveoff.*N*.fb-*M*
float in
(M=0..personality) Joint feedback (typ from encoder and input to pid controller (pid.feedback))

moveoff.*N*.offset-current-*M*
float out
(M=0..personality) Joint offset current value

moveoff.*N*.pos-plusoffset-*M*
float out
(M=0..personality) Computed joint position plus offset (typically connect to pid command input)

moveoff.*N*.fb-minusoffset-*M*
float out
(M=0..personality) Computed Joint feedback minus offset (typically connected to axis.0.motor-pos-fb

moveoff.*N*.offset-vel-*M*
float in
(M=0..personality) (default: *10*) Joint offset velocity limit

moveoff.*N*.offset-accel-*M*
float in
(M=0..personality) (default: *100*) Joint offset acceleration limit

moveoff.*N*.offset-min-*M*
float in
(M=0..personality) (default: *-1e20*) Minimum limit for applied joint offset (typ negative)

moveoff.*N*.offset-max-*M*
float in
(M=0..personality) (default: *1e20*) Maximum limit for applied offset (typ positive)

moveoff.*N*.dbg-waypoint-limit-test
bit in Debug input to test with limited number of waypoints

moveoff.*N*.dbg-state
s32 out Debug output for current state of state machine

LICENSE

GPL

NAME

mult2 − Product of two inputs

SYNOPSIS

loadrt mult2 [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

mult2.*N*

(requires a floating-point thread)

PINS

mult2.*N***.in0**

float in

mult2.*N***.in1**

float in

mult2.*N***.out**

float out out = in0 * in1

LICENSE

GPL

NAME

multiclick − Single-, double-, triple-, and quadruple-click detector

SYNOPSIS

loadrt multiclick [count=*N***|names=***name1***[,***name2***...]]**

DESCRIPTION

A click is defined as a rising edge on the ’in’ pin, followed by the ’in’ pin being True for at most ’max-hold-ns’ nanoseconds, followed by a falling edge.

A double-click is defined as two clicks, separated by at most ’max-space-ns’ nanoseconds with the ’in’ pin in the False state.

I bet you can guess the definition of triple- and quadruple-click.

You probably want to run the input signal through a debounce component before feeding it to the multiclick detector, if the input is at all noisy.

The ’*-click’ pins go high as soon as the input detects the correct number of clicks.

The ’*-click-only’ pins go high a short while after the click, after the click separator space timeout has expired to show that no further click is coming. This is useful for triggering halui MDI commands.

FUNCTIONS

multiclick.*N*

Detect single-, double-, triple-, and quadruple-clicks

PINS

multiclick.*N***.in**
bit in The input line, this is where we look for clicks.

multiclick.*N***.single-click**
bit out Goes high briefly when a single-click is detected on the ’in’ pin.

multiclick.*N***.single-click-only**
bit out Goes high briefly when a single-click is detected on the ’in’ pin and no second click followed it.

multiclick.*N***.double-click**
bit out Goes high briefly when a double-click is detected on the ’in’ pin.

multiclick.*N***.double-click-only**
bit out Goes high briefly when a double-click is detected on the ’in’ pin and no third click followed it.

multiclick.*N***.triple-click**
bit out Goes high briefly when a triple-click is detected on the ’in’ pin.

multiclick.*N***.triple-click-only**
bit out Goes high briefly when a triple-click is detected on the ’in’ pin and no fourth click followed it.

multiclick.*N***.quadruple-click**
bit out Goes high briefly when a quadruple-click is detected on the ’in’ pin.

multiclick.*N***.quadruple-click-only**
bit out Goes high briefly when a quadruple-click is detected on the ’in’ pin and no fifth click followed it.

multiclick.*N*.state
s32 out

PARAMETERS

multiclick.*N*.invert-input
bit rw (default: *FALSE*) If FALSE (the default), clicks start with rising edges. If TRUE, clicks start with falling edges.

multiclick.*N*.max-hold-ns
u32 rw (default: *250000000*) If the input is held down longer than this, it's not part of a multi-click. (Default 250,000,000 ns, 250 ms.)

multiclick.*N*.max-space-ns
u32 rw (default: *250000000*) If the input is released longer than this, it's not part of a multi-click. (Default 250,000,000 ns, 250 ms.)

multiclick.*N*.output-hold-ns
u32 rw (default: *100000000*) Positive pulses on the output pins last this long. (Default 100,000,000 ns, 100 ms.)

LICENSE

GPL

NAME

multiswitch − This component toggles between a specified number of output bits

SYNOPSIS

loadrt multiswitch personality=*P* [cfg=*N***]**

cfg

cfg should be a comma-separated list of sizes for example cfg=2,4,6 would create 3 instances of 2, 4 and 6 bits respectively.
Ignore the "personality" parameter, that is auto-generated

FUNCTIONS

multiswitch.*N*
(requires a floating-point thread)

PINS

multiswitch.*N***.up**
bit in (default: *false*) Receives signal to toggle up

multiswitch.*N***.down**
bit in (default: *false*) Receives signal to toggle down

multiswitch.*N***.bit-***MM***
bit out
(MM=00..personality) (default: *false*) Output bits

PARAMETERS

multiswitch.*N***.top-position**
u32 rw Number of positions

multiswitch.*N***.position**
s32 rw Current state (may be set in the HAL)

AUTHOR

ArcEye schooner30@tiscali.co.uk / Andy Pugh andy@bodgesoc.org

LICENSE

GPL

NAME

mux16 − Select from one of sixteen input values

SYNOPSIS

loadrt mux16 [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

mux16.*N*

(requires a floating-point thread)

PINS

mux16.*N***.use-graycode**

bit in This signifies the input will use Gray code instead of binary. Gray code is a good choice when using physical switches because for each increment only one select input changes at a time.

mux16.*N***.suppress-no-input**

bit in This suppresses changing the output if all select lines are false. This stops unwanted jumps in output between transitions of input. but make in00 unavaliable.

mux16.*N***.debounce-time**

float in sets debouce time in seconds. eg. .10 = a tenth of a second input must be stable this long before outputs changes. This helps to ignore 'noisy' switches.

mux16.*N***.sel***M*

bit in

(M=0..3) Together, these determine which **in***N* value is copied to **out**.

mux16.*N***.out-f**

float out

mux16.*N***.out-s**

s32 out Follows the value of one of the **in***N* values according to the four **sel** values and whether use-graycode is active. The s32 value will be trunuated and limited to the max and min values of signed values.

sel3=FALSE, **sel2=FALSE**, **sel1=FALSE**, **sel0=FALSE**

out follows **in0**

sel3=FALSE, **sel2=FALSE**, **sel1=FALSE**, **sel0=TRUE**

out follows **in1**

etc.

mux16.*N***.in***MM*

float in

(MM=00..15) array of selectable outputs

PARAMETERS

mux16.*N***.elapsed**

float r Current value of the internal debounce timer for debugging.

mux16.*N***.selected**

s32 r Current value of the internal selection variable after conversion for debugging

LICENSE

GPL

NAME

mux2 − Select from one of two input values

SYNOPSIS

loadrt mux2 [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

mux2.*N*

(requires a floating-point thread)

PINS

mux2.*N***.sel**

bit in

mux2.*N***.out**

float out Follows the value of in0 if sel is FALSE, or in1 if sel is TRUE

mux2.*N***.in1**

float in

mux2.*N***.in0**

float in

LICENSE

GPL

NAME

mux4 − Select from one of four input values

SYNOPSIS

loadrt mux4 [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

mux4.*N*

(requires a floating-point thread)

PINS

mux4.*N***.sel0**

bit in

mux4.*N***.sel1**

bit in Together, these determine which **in***N* value is copied to **out**.

mux4.*N***.out**

float out Follows the value of one of the **in***N* values according to the two **sel** values

sel1=FALSE, **sel0=FALSE**

out follows **in0**

sel1=FALSE, **sel0=TRUE**

out follows **in1**

sel1=TRUE, **sel0=FALSE**

out follows **in2**

sel1=TRUE, **sel0=TRUE**

out follows **in3**

mux4.*N***.in0**

float in

mux4.*N***.in1**

float in

mux4.*N***.in2**

float in

mux4.*N***.in3**

float in

LICENSE

GPL

NAME

mux8 − Select from one of eight input values

SYNOPSIS

loadrt mux8 [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

mux8.*N*

(requires a floating-point thread)

PINS

mux8.*N***.sel0**
bit in
mux8.*N***.sel1**
bit in
mux8.*N***.sel2**
bit in Together, these determine which **in***N* value is copied to **out**.

mux8.*N***.out**
float out Follows the value of one of the **in***N* values according to the three **sel** values

sel2=FALSE, **sel1=FALSE**, **sel0=FALSE**
out follows **in0**

sel2=FALSE, **sel1=FALSE**, **sel0=TRUE**
out follows **in1**

sel2=FALSE, **sel1=TRUE**, **sel0=FALSE**
out follows **in2**

sel2=FALSE, **sel1=TRUE**, **sel0=TRUE**
out follows **in3**

sel2=TRUE, **sel1=FALSE**, **sel0=FALSE**
out follows **in4**

sel2=TRUE, **sel1=FALSE**, **sel0=TRUE**
out follows **in5**

sel2=TRUE, **sel1=TRUE**, **sel0=FALSE**
out follows **in6**

sel2=TRUE, **sel1=TRUE**, **sel0=TRUE**
out follows **in7**

mux8.*N***.in0**
float in
mux8.*N***.in1**
float in
mux8.*N***.in2**
float in
mux8.*N***.in3**
float in
mux8.*N***.in4**
float in
mux8.*N***.in5**
float in

mux8.*N*.in6
float in
mux8.*N*.in7
float in

LICENSE

GPL

NAME

mux_generic − choose one from several input values

SYNOPSIS

loadrt mux_generic config="bb8,fu12...."

FUNCTIONS

mux−gen.*NN* Depending on the data types can run in either a floating point or non-floating point thread.

PINS

mux−gen.*NN***.suppress−no−input** bit in

This suppresses changing the output if all select lines are false. This stops unwanted jumps in output between transitions of input. but makes in00 unavaliable.

mux−gen.*NN***.debounce−us** unsigned in

sets debouce time in microseconds. eg. 100000 = a tenth of a second. The selection inputs must be stable this long before the output changes. This helps to ignore 'noisy' switches.

mux−gen.*NN***.sel−bit***MM* bit in (M=0..N)

mux−gen.*NN***.sel−int** unsigned in

Together, these determine which **in***N* value is copied to **output**. The bit pins are interpreted as binary bits, and the result is simply added on to the integer pin input. It is expected that either one or the other would normally be used. Hower, the possibility exists to use a higher-order bit to "shift" the values set by the integer pin. The sel−bit pins are only created when the size of the mux_gen component is an integer power of two. This component (unlike mux16) does not offer the option of decoding gray-code, however the same effect can be achieved by arranging the order of the input values to suit.

mux−gen.*NN***.out−[bit/float/s32/u32]** variable-type out

Follows the value of one of the **in***N* values according to the selection bits and/or the selection number. Values will be converted/truncated according to standard C rules. This means, for example that a float input greater than 2147483647 will give an S32 output of −2147483648.

mux−gen.*NN***.in−[bit/float/s32/u32]−***MM* variable-type in

The possible output values that are selected by the selection pins.

PARAMETERS

mux−gen.*N***.elapsed** float r

Current value of the internal debounce timer for debugging.

mux−gen.*N***.selected** s32 r

Current value of the internal selection variable after conversion for debugging. Possibly useful for setting up gray-code switches.

DESCRIPTION

This component is a more general version of the other multiplexing components. It allows the creation of arbitrary-size multiplexers (up to 1024 entries) and also supports differing data types on the input and output pins. The configuration string is a comma-separated list of code-letters and numbers, such as "bb4,fu12" This would create a 4-element bit-to-bit mux and a 12-element float-to-unsigned mux. The code letters are b = bit, f = float, s = signed integer, u = unsigned integer. The first letter code is the input type, the second is the output type. The codes are not case-sensitive. The order of the letters is significant but the position in the string is not. Do not insert any spaces in the config string. Any non-zero float value will be

converted to a "true" output in bit form. Be wary that float datatypes can be very, very, close to zero and not actually be equal to zero.

Each mux has its own HAL function and must be added to a thread separately. If neither input nor output is of type float then the function is base-thread (non floating-point) safe. Any mux_generic with a floating point input or output can only be added to a floating-point thread.

LICENSE

GPL

AUTHOR

Andy Pugh

NAME

near − Determine whether two values are roughly equal.

SYNOPSIS

loadrt near [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

near.*N* (requires a floating-point thread)

PINS

near.*N***.in1**
float in

near.*N***.in2**
float in

near.*N***.out**
bit out

out is true if **in1** and **in2** are within a factor of **scale** (i.e., for in1 positive, in1/scale <= in2 <= in1*scale), OR if their absolute difference is no greater than **difference** (i.e., |in1-in2| <= difference). **out** is false otherwise.

PARAMETERS

near.*N***.scale**
float rw (default: *1*)

near.*N***.difference**
float rw (default: *0*)

LICENSE

GPL

NAME

not − Inverter

SYNOPSIS

loadrt not [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

not.*N*

PINS

not.*N***.in**
bit in

not.*N***.out**
bit out

LICENSE

GPL

NAME

offset − Adds an offset to an input, and subtracts it from the feedback value

SYNOPSIS

loadrt offset [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

offset.*N*.update-output
(requires a floating-point thread) Updated the output value by adding the offset to the input

offset.*N*.update-feedback
(requires a floating-point thread) Update the feedback value by subtracting the offset from the feedback

PINS

offset.*N*.offset
float in The offset value

offset.*N*.in
float in The input value

offset.*N*.out
float out The output value

offset.*N*.fb-in
float in The feedback input value

offset.*N*.fb-out
float out The feedback output value

LICENSE

GPL

NAME

oneshot − one-shot pulse generator

SYNOPSIS

loadrt oneshot [count=*N***|names=***name1***[,***name2***...]]**

DESCRIPTION

creates a variable-length output pulse when the input changes state. This function needs to run in a thread which supports floating point (typically the servo thread). This means that the pulse length has to be a multiple of that thread period, typically 1mS. For a similar function that can run in the base thread, and which offers higher resolution, see "edge".

FUNCTIONS

oneshot.*N*

(requires a floating-point thread) Produce output pulses from input edges

PINS

oneshot.*N***.in**
bit in Trigger input

oneshot.*N***.reset**
bit in Reset

oneshot.*N***.out**
bit out Active high pulse

oneshot.*N***.out-not**
bit out Active low pulse

oneshot.*N***.width**
float in (default: *0*) Pulse width in seconds

oneshot.*N***.time-left**
float out Time left in current output pulse

PARAMETERS

oneshot.*N***.retriggerable**
bit rw (default: *TRUE*) Allow additional edges to extend pulse

oneshot.*N***.rising**
bit rw (default: *TRUE*) Trigger on rising edge

oneshot.*N***.falling**
bit rw (default: *FALSE*) Trigger on falling edge

LICENSE

GPL

NAME

opto_ac5 − Realtime driver for opto22 PCI-AC5 cards

SYNOPSIS

loadrt opto_ac5 [portconfig0=0x*N***] [portconfig1=0x***N***]**

DESCRIPTION

These pins and parameters are created by the realtime **opto_ac5** module. The portconfig0 and portconfig1 variables are used to configure the two ports of each card. The first 24 bits of a 32 bit number represent the 24 i/o points of each port. The lowest (rightmost) bit would be HAL pin 0 which is header connector pin 47. Then next bit to the left would be HAL pin 1, header connector pin 45 and so on, untill bit 24 would be HAL pin 23 , header connector pin 1. "1" bits represent output points. So channel 0..11 as inputs and 12..23 as outputs would be represented by (in binary) 111111111111000000000000 which is 0xfff000 in hexadecimal. That is the number you would use Eg. loadrt opto_ac5 portconfig0=0xfff000

If no portconfig variable is specified the default configuration is 12 inputs then 12 outputs.

Up to 4 boards are supported. Boards are numbered starting at 0.

Portnumber can be 0 or 1. Port 0 is closes to the card bracket.

PINS

opto_ac5.[*BOARDNUMBER***].port[***PORTNUMBER***].in−[***PINNUMBER***]** OUT bit
opto_ac5.[*BOARDNUMBER***].port[***PORTNUMBER***].in−[***PINNUMBER***]**−not OUT bit
Connect a hal bit signal to this pin to read an i/o point from the card. The PINNUMBER represents the position in the relay rack. Eg. PINNUMBER 0 is position 0 in a opto22 relay rack and would be pin 47 on the 50 pin header connector. The **−not** pin is inverted so that LOW gives TRUE and HIGH gives FALSE.

opto_ac5.[*BOARDNUMBER***].port[***PORTNUMBER***].out−[***PINNUMBER***]** IN bit
Connect a hal bit signal to this pin to write to an i/o point of the card. The PINNUMBER represents the position in the relay rack.Eg. PINNUMBER 23 is position 23 in a opto22 relay rack and would be pin 1 on the 50 pin header connector.

opto_ac5.[*BOARDNUMBER***].led[***NUMBER***]** OUT bit
Turns one of the on board LEDS on/off. LEDS are numbered 0 to 3.

PARAMETERS

opto_ac5.[*BOARDNUMBER***].port[***PORTNUMBER***].out−[***PINNUMBER***]**−invert W bit
When TRUE, invert the meaning of the corresponding **−out** pin so that TRUE gives LOW and FALSE gives HIGH.

FUNCTIONS

opto_ac5.0.digital−read
Add this to a thread to read all the input points.

opto_ac5.0.digital−write
Add this to a thread to write all the output points and LEDS.

BUGS

All boards are loaded with the same port configurations as the first board.

SEE ALSO

http://wiki.linuxcnc.org/cgi−bin/wiki.pl?OptoPciAc5

NAME

or2 − Two-input OR gate

SYNOPSIS

loadrt or2 [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

or2.*N*

PINS

or2.*N***.in0**
bit in

or2.*N***.in1**
bit in

or2.*N***.out**
bit out

out is computed from the value of **in0** and **in1** according to the following rule:

in0=FALSE in1=FALSE
out=FALSE

Otherwise,
out=TRUE

LICENSE

GPL

NAME

orient − Provide a PID command input for orientation mode based on current spindle position, target angle and orient mode

SYNOPSIS

loadrt orient [count=*N***|names=***name1***[,***name2...***]]**

DESCRIPTION

This component is designed to support a spindle orientation PID loop by providing a command value, and fit with the motion spindle-orient support pins to support the M19 code.

The spindle is assumed to have stopped in an arbitrary position. The spindle encoder position is linked to the **position** pin. The current value of the position pin is sampled on a positive edge on the **enable** pin, and **command** is computed and set as follows: floor(number of full spindle revolutions in the **position** sampled on positive edge) plus **angle**/360 (the fractional revolution) +1/-1/0 depending on **mode**.

The **mode** pin is interpreted as follows:

0: the spindle rotates in the direction with the lesser angle, which may be clockwise or counterclockwise.

1: the spindle rotates always rotates clockwise to the new angle.

2: the spindle rotates always rotates counterclockwise to the new angle.

HAL USAGE

On **spindle.N.orient** disconnect the spindle control and connect to the orient-pid loop:

loadrt orient names=orient
loadrt pid names=orient-pid
net orient-angle spindle.N.orient-angle orient.angle
net orient-mode spindle.N.orient-mode orient.mode
net orient-enable spindle.N.orient orient.enable orient-pid.enable
net spindle-in-pos orient.is-oriented spindle.N.is-oriented
net spindle-pos encoder.position orient.position orient-pid.feedback
net orient-command orient.command orient-pid.command

FUNCTIONS

orient.*N*

(requires a floating-point thread) Update **command** based on **enable**, **position**, **mode** and **angle**.

PINS

orient.*N***.enable**
bit in enable angular output for orientation mode

orient.*N***.mode**
s32 in 0: rotate - shortest move; 1: always rotate clockwise; 2: always rotate counterclockwise

orient.*N***.position**
float in spindle position input, unit 1 rev

orient.*N***.angle**
float in orient target position in degrees, 0 <= angle < 360

orient.*N***.command**
float out target spindle position, input to PID command

orient.*N*.poserr
float out in degrees - aid for PID tuning

orient.*N*.is-oriented
bit out This pin goes high when poserr < tolerance. Use to drive spindle.N.is-oriented

orient.*N*.tolerance
float in (default: *0.5*) The tolerance in degrees for considering the align completed

AUTHOR

Michael Haberler

LICENSE

GPL

NAME

pid − proportional/integral/derivative controller

SYNOPSIS

loadrt pid [num_chan=*num* **| names=***name1***[,***name2...***]] [debug=***dbg*]

DESCRIPTION

pid is a classic Proportional/Integral/Derivative controller, used to control position or speed feedback loops for servo motors and other closed-loop applications.

pid supports a maximum of sixteen controllers. The number that are actually loaded is set by the **num_chan** argument when the module is loaded. Alternatively, specify names= and unique names separated by commas.

The **num_chan=** and **names=** specifiers are mutually exclusive. If neither **num_chan=** nor **names=** are specified, the default value is three. If **debug** is set to 1 (the default is 0), some additional HAL parameters will be exported, which might be useful for tuning, but are otherwise unnecessary.

NAMING

The names for pins, parameters, and functions are prefixed as:
pid.N. for N=0,1,...,num−1 when using **num_chan=num**
nameN. for nameN=name1,name2,... when using **names=name1,name2,...**

The **pid.N.** format is shown in the following descriptions.

FUNCTIONS

pid.*N***.do−pid−calcs** (uses floating-point) Does the PID calculations for control loop *N*.

PINS

pid.*N***.command** float in
The desired (commanded) value for the control loop.

pid.*N***.Pgain** float in
Proportional gain. Results in a contribution to the output that is the error multiplied by **Pgain**.

pid.*N***.Igain** float in
Integral gain. Results in a contribution to the output that is the integral of the error multiplied by **Igain**. For example an error of 0.02 that lasted 10 seconds would result in an integrated error (**errorI**) of 0.2, and if **Igain** is 20, the integral term would add 4.0 to the output.

pid.*N***.Dgain** float in
Derivative gain. Results in a contribution to the output that is the rate of change (derivative) of the error multiplied by **Dgain**. For example an error that changed from 0.02 to 0.03 over 0.2 seconds would result in an error derivative (**errorD**) of of 0.05, and if **Dgain** is 5, the derivative term would add 0.25 to the output.

pid.*N***.feedback** float in
The actual (feedback) value, from some sensor such as an encoder.

pid.*N***.output** float out
The output of the PID loop, which goes to some actuator such as a motor.

pid.*N***.command−deriv** float in
The derivative of the desired (commanded) value for the control loop. If no signal is connected then the derivative will be estimated numerically.

pid.*N***.feedback−deriv** float in
The derivative of the actual (feedback) value for the control loop. If no signal is connected then the derivative will be estimated numerically. When the feedback is from a quantized position

source (e.g., encoder feedback position), behavior of the D term can be improved by using a better velocity estimate here, such as the velocity output of encoder(9) or hostmot2(9).

pid.*N*.error−previous−target bit in
Use previous invocation's target vs. current position for error calculation, like the motion controller expects. This may make torque-mode position loops and loops requiring a large I gain easier to tune, by eliminating velocity−dependent following error.

pid.*N*.error float out
The difference between command and feedback.

pid.*N*.enable bit in
When true, enables the PID calculations. When false, **output** is zero, and all internal integrators, etc, are reset.

pid.*N*.index−enable bit in
On the falling edge of **index−enable**, pid does not update the internal command derivative estimate. On systems which use the encoder index pulse, this pin should be connected to the index−enable signal. When this is not done, and FF1 is nonzero, a step change in the input command causes a single-cycle spike in the PID output. On systems which use exactly one of the **−deriv** inputs, this affects the D term as well.

pid.*N*.bias float in
bias is a constant amount that is added to the output. In most cases it should be left at zero. However, it can sometimes be useful to compensate for offsets in servo amplifiers, or to balance the weight of an object that moves vertically. **bias** is turned off when the PID loop is disabled, just like all other components of the output. If a non-zero output is needed even when the PID loop is disabled, it should be added with an external HAL sum2 block.

pid.*N*.FF0 float in
Zero order feed-forward term. Produces a contribution to the output that is **FF0** multiplied by the commanded value. For position loops, it should usually be left at zero. For velocity loops, **FF0** can compensate for friction or motor counter-EMF and may permit better tuning if used properly.

pid.*N*.FF1 float in
First order feed-forward term. Produces a contribution to the output that **FF1** multiplied by the derivative of the commanded value. For position loops, the contribution is proportional to speed, and can be used to compensate for friction or motor CEMF. For velocity loops, it is proportional to acceleration and can compensate for inertia. In both cases, it can result in better tuning if used properly.

pid.*N*.FF2 float in
Second order feed-forward term. Produces a contribution to the output that is **FF2** multiplied by the second derivative of the commanded value. For position loops, the contribution is proportional to acceleration, and can be used to compensate for inertia. For velocity loops, it should usually be left at zero.

pid.*N*.deadband float in
Defines a range of "acceptable" error. If the absolute value of **error** is less than **deadband**, it will be treated as if the error is zero. When using feedback devices such as encoders that are inherently quantized, the deadband should be set slightly more than one-half count, to prevent the control loop from hunting back and forth if the command is between two adjacent encoder values. When the absolute value of the error is greater than the deadband, the deadband value is subtracted from the error before performing the loop calculations, to prevent a step in the transfer function at the edge of the deadband. (See **BUGS**.)

pid.*N*.maxoutput float in
Output limit. The absolute value of the output will not be permitted to exceed **maxoutput**, unless **maxoutput** is zero. When the output is limited, the error integrator will hold instead of integrating, to prevent windup and overshoot.

pid.*N*.maxerror float in
Limit on the internal error variable used for P, I, and D. Can be used to prevent high **Pgain** values from generating large outputs under conditions when the error is large (for example, when the command makes a step change). Not normally needed, but can be useful when tuning non-linear systems.

pid.*N*.maxerrorD float in
Limit on the error derivative. The rate of change of error used by the **Dgain** term will be limited to this value, unless the value is zero. Can be used to limit the effect of **Dgain** and prevent large output spikes due to steps on the command and/or feedback. Not normally needed.

pid.*N*.maxerrorI float in
Limit on error integrator. The error integrator used by the **Igain** term will be limited to this value, unless it is zero. Can be used to prevent integrator windup and the resulting overshoot during/after sustained errors. Not normally needed.

pid.*N*.maxcmdD float in
Limit on command derivative. The command derivative used by **FF1** will be limited to this value, unless the value is zero. Can be used to prevent **FF1** from producing large output spikes if there is a step change on the command. Not normally needed.

pid.*N*.maxcmdDD float in
Limit on command second derivative. The command second derivative used by **FF2** will be limited to this value, unless the value is zero. Can be used to prevent **FF2** from producing large output spikes if there is a step change on the command. Not normally needed.

pid.*N*.saturated bit out
When true, the current PID output is saturated. That is,
output = ± **maxoutput**.

pid.*N*.saturated−s float out
pid.*N*.saturated−count s32 out
When true, the output of PID was continually saturated for this many seconds (**saturated−s**) or periods (**saturated−count**).

PARAMETERS

pid.*N*.errorI float ro (only if debug=1)
Integral of error. This is the value that is multiplied by **Igain** to produce the Integral term of the output.

pid.*N*.errorD float ro (only if debug=1)
Derivative of error. This is the value that is multiplied by **Dgain** to produce the Derivative term of the output.

pid.*N*.commandD float ro (only if debug=1)
Derivative of command. This is the value that is multiplied by **FF1** to produce the first order feed-forward term of the output.

pid.*N*.commandDD float ro (only if debug=1)
Second derivative of command. This is the value that is multiplied by **FF2** to produce the second order feed-forward term of the output.

BUGS

Some people would argue that deadband should be implemented such that error is treated as zero if it is within the deadband, and be unmodified if it is outside the deadband. This was not done because it would cause a step in the transfer function equal to the size of the deadband. People who prefer that behavior are welcome to add a parameter that will change the behavior, or to write their own version of **pid**. However, the default behavior should not be changed.

Negative gains may lead to unwanted behavior. It is possible in some situations that negative FF gains

make sense, but in general all gains should be positive. If some output is in the wrong direction, negating gains to fix it is a mistake; set the scaling correctly elsewhere instead.

NAME

pwmgen − software PWM/PDM generation

SYNOPSIS

loadrt pwmgen output_type=*type0*[,*type1*...]

DESCRIPTION

pwmgen is used to generate PWM (pulse width modulation) or PDM (pulse density modulation) signals. The maximum PWM frequency and the resolution is quite limited compared to hardware-based approaches, but in many cases software PWM can be very useful. If better performance is needed, a hardware PWM generator is a better choice.

pwmgen supports a maximum of eight channels. The number of channels actually loaded depends on the number of *type* values given. The value of each *type* determines the outputs for that channel.

type 0: single output
: A single output pin, **pwm**, whose duty cycle is determined by the input value for positive inputs, and which is off (or at **min−dc**) for negative inputs. Suitable for single ended circuits.

type 1: pwm/direction
: Two output pins, **pwm** and **dir**. The duty cycle on **pwm** varies as a function of the input value. **dir** is low for positive inputs and high for negative inputs.

type 2: up/down
: Two output pins, **up** and **down**. For positive inputs, the PWM/PDM waveform appears on **up**, while **down** is low. For negative inputs, the waveform appears on **down**, while **up** is low. Suitable for driving the two sides of an H-bridge to generate a bipolar output.

FUNCTIONS

pwmgen.make−pulses (no floating-point)
: Generates the actual PWM waveforms, using information computed by **update**. Must be called as frequently as possible, to maximize the attainable PWM frequency and resolution, and minimize jitter. Operates on all channels at once.

pwmgen.update (uses floating point)
: Accepts an input value, performs scaling and limit checks, and converts it into a form usable by **make−pulses** for PWM/PDM generation. Can (and should) be called less frequently than **make−pulses**. Operates on all channels at once.

PINS

pwmgen.*N***.enable** bit in
: Enables PWM generator *N* - when false, all **pwmgen.***N* output pins are low.

pwmgen.*N***.value** float in
: Commanded value. When **value** = 0.0, duty cycle is 0%, and when **value** = ±**scale**, duty cycle is ± 100%. (Subject to **min−dc** and **max−dc** limitations.)

pwmgen.*N***.pwm** bit out (output types 0 and 1 only)
: PWM/PDM waveform.

pwmgen.*N***.dir** bit out (output type 1 only)
: Direction output: low for forward, high for reverse.

pwmgen.*N***.up** bit out (output type 2 only)
: PWM/PDM waveform for positive input values, low for negative inputs.

pwmgen.*N***.down** bit out (output type 2 only)
: PWM/PDM waveform for negative input values, low for positive inputs.

pwmgen.*N*.curr−dc float out
The current duty cycle, after all scaling and limits have been applied. Range is from −1.0 to +1.0.

pwmgen.*N*.max−dc float in/out
The maximum duty cycle. A value of 1.0 corresponds to 100%. This can be useful when using transistor drivers with bootstrapped power supplies, since the supply requires some low time to recharge.

pwmgen.*N*.min−dc float in/out
The minimum duty cycle. A value of 1.0 corresponds to 100%. Note that when the pwm generator is disabled, the outputs are constantly low, regardless of the setting of **min−dc**.

pwmgen.*N*.scale float in/out
pwmgen.*N*.offset float in/out
These parameters provide a scale and offset from the **value** pin to the actual duty cycle. The duty cycle is calculated according to *dc = (value/scale) + offset*, with 1.0 meaning 100%.

pwmgen.*N*.pwm−freq float in/out
PWM frequency in Hz. The upper limit is half of the frequency at which **make−pulses** is invoked, and values above that limit will be changed to the limit. If **dither−pwm** is false, the value will be changed to the nearest integer submultiple of the **make−pulses** frequency. A value of zero produces Pulse Density Modulation instead of Pulse Width Modulation.

pwmgen.*N*.dither−pwm bit in/out
Because software-generated PWM uses a fairly slow timebase (several to many microseconds), it has limited resolution. For example, if **make−pulses** is called at a 20KHz rate, and **pwm−freq** is 2KHz, there are only 10 possible duty cycles. If **dither−pwm** is false, the commanded duty cycle will be rounded to the nearest of those values. Assuming **value** remains constant, the same output will repeat every PWM cycle. If **dither−pwm** is true, the output duty cycle will be dithered between the two closest values, so that the long-term average is closer to the desired level. **dither−pwm** has no effect if **pwm−freq** is zero (PDM mode), since PDM is an inherently dithered process.

NAME

rosekins − Kinematics for a rose engine

SYNOPSIS

loadrt rosekins

KINEMATICS

joint_0 linear, transverse (perpendicular to spindle)
joint_1 linear, longitudinal (parallel to spindle identity to z)
joint_2 rotary, spindle (workholding, not tool holding, e.g. not a highspeed spindle)

PINS

rosekins.revolutions float out
Count of crossings of the negative X axis. Clockwise crossings increment revolutions by 1, Counterclockwise crossings decrement by 1

rosekins.theta_degrees float out
Principal value for arctan(Y/X)

rosekins.bigtheta_degrees float out
Accumulated angle (theta + revolutions * 360)

NOTES

Theta is the principal value of arctan(Y/X). Joint_2 angle values are not limited to principal values of arctan(Y/X) but accumulate continuously as the spindle is rotated. Hal pins are provided for the principal value and a count of the number of revolutions.

The transverse motion is exactly perpendicular to the spindle. In a traditional rose engine, the transverse motion is created by ´rocking´ the headstock about a pivot. A typical pivot length combined with the limited amount of X travel in a real machine make the perpendicular approximation a reasonable model.

NAME

sample_hold − Sample and Hold

SYNOPSIS

loadrt sample_hold [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

sample-hold.*N*

PINS

sample-hold.*N***.in**
s32 in
sample-hold.*N***.hold**
bit in
sample-hold.*N***.out**
s32 out

LICENSE

GPL

NAME

sampler − sample data from HAL in real time

SYNOPSIS

loadrt sampler depth=*depth1[,depth2...]* **cfg=***string1[,string2...]*

DESCRIPTION

sampler and **halsampler**(1) are used together to sample HAL data in real time and store it in a file. **sampler** is a realtime HAL component that exports HAL pins and creates a FIFO in shared memory. It then begins sampling data from the HAL and storing it to the FIFO. **halsampler** is a user space program that copies data from the FIFO to stdout, where it can be redirected to a file or piped to some other program.

OPTIONS

depth=*depth1[,depth2...]*

sets the depth of the realtime->user FIFO that **sampler** creates to buffer the realtime data. Multiple values of *depth* (separated by commas) can be specified if you need more than one FIFO (for example if you want to sample data from two different realtime threads).

cfg=*string1[,string2...]*

defines the set of HAL pins that **sampler** exports and later samples data from. One *string* must be supplied for each FIFO, separated by commas. **sampler** exports one pin for each character in *string.* Legal characters are:

F, f (float pin)

B, b (bit pin)

S, s (s32 pin)

U, u (u32 pin)

FUNCTIONS

sampler.*N*

One function is created per FIFO, numbered from zero.

PINS

sampler.*N***.pin.***M* input

Pin for the data that will wind up in column *M* of FIFO *N* (and in column *M* of the output file). The pin type depends on the config string.

sampler.*N***.curr−depth** s32 output

Current number of samples in the FIFO. When this reaches *depth* new data will begin overwriting old data, and some samples will be lost.

sampler.*N***.full** bit output

TRUE when the FIFO *N* is full, FALSE when there is room for another sample.

sampler.*N***.enable** bit input

When TRUE, samples are captured and placed in FIFO *N*, when FALSE, no samples are acquired. Defaults to TRUE.

PARAMETERS

sampler.*N***.overruns** s32 read/write

The number of times that **sampler** has tried to write data to the HAL pins but found no room in the FIFO. It increments whenever **full** is true, and can be reset by the **setp** command.

sampler.*N*.sample−num s32 read/write

A number that identifies the sample. It is automatically incremented for each sample, and can be reset using the **setp** command. The sample number can optionally be printed in the first column of the output from **halsampler**, using the *−t* option. (see **man 1 halsampler**)

SEE ALSO

halsampler(1) **streamer**(9) **halstreamer**(1)

HISTORY

BUGS

AUTHOR

Original version by John Kasunich, as part of the LinuxCNC project. Improvements by several other members of the LinuxCNC development team.

REPORTING BUGS

Report bugs to jmkasunich AT users DOT sourceforge DOT net

COPYRIGHT

NAME

scale − LinuxCNC HAL component that applies a scale and offset to its input

SYNOPSIS

loadrt scale [count=*N***|names=***name1***[,***name2...***]]**

FUNCTIONS

scale.*N* (requires a floating-point thread)

PINS

scale.*N***.in**
float in

scale.*N***.gain**
float in

scale.*N***.offset**
float in

scale.*N***.out**
float out out = in * gain + offset

LICENSE

GPL

NAME

select8 − 8-bit binary match detector

SYNOPSIS

loadrt select8 [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

select8.*N*

PINS

select8.*N***.enable**

bit in (default: *TRUE*) Set enable to FALSE to cause all outputs to be set FALSE

select8.*N***.sel**

s32 in The number of the output to set TRUE. All other outputs well be set FALSE

select8.*N***.out***M*

bit out

(M=0..7) Output bits. If enable is set and the sel input is between 0 and 7, then the corresponding output bit will be set true

LICENSE

GPL

NAME

serport − Hardware driver for the digital I/O bits of the 8250 and 16550 serial port.

SYNOPSIS

loadrt serport io=*addr[,addr...]*

The pin numbers refer to the 9-pin serial pinout. Keep in mind that these ports generally use rs232 voltages, not 0/5V signals.

Specify the I/O address of the serial ports using the module parameter **io=***addr[,addr...]*. These ports must not be in use by the kernel. To free up the I/O ports after bootup, install setserial and execute a command like:

sudo setserial /dev/ttyS0 uart none

but it is best to ensure that the serial port is never used or configured by the Linux kernel by setting a kernel commandline parameter or not loading the serial kernel module if it is a modularized driver.

FUNCTIONS

serport.*N*.read

serport.*N*.write

PINS

serport.*N*.pin-1-in
bit out Also called DCD (data carrier detect); pin 8 on the 25-pin serial pinout

serport.*N*.pin-6-in
bit out Also called DSR (data set ready); pin 6 on the 25-pin serial pinout

serport.*N*.pin-8-in
bit out Also called CTS (clear to send); pin 5 on the 25-pin serial pinout

serport.*N*.pin-9-in
bit out Also called RI (ring indicator); pin 22 on the 25-pin serial pinout

serport.*N*.pin-1-in-not
bit out Inverted version of pin-1-in

serport.*N*.pin-6-in-not
bit out Inverted version of pin-6-in

serport.*N*.pin-8-in-not
bit out Inverted version of pin-8-in

serport.*N*.pin-9-in-not
bit out Inverted version of pin-9-in

serport.*N*.pin-3-out
bit in Also called TX (transmit data); pin 2 on the 25-pin serial pinout

serport.*N*.pin-4-out
bit in Also called DTR (data terminal ready); pin 20 on the 25-pin serial pinout

serport.*N*.pin-7-out
bit in Also called RTS (request to send); pin 4 on the 25-pin serial pinout

PARAMETERS

serport.*N*.pin-3-out-invert
bit rw

serport.*N*.pin-4-out-invert
bit rw
serport.*N*.pin-7-out-invert
bit rw
serport.*N*.ioaddr
u32 r

LICENSE

GPL

NAME

setsserial - a utility for setting Smart Serial NVRAM parameters.

NOTE: This rather clunky utility is no longer needed except for flashing new smart-serial remote firmware. Smart-serial remote parameters can now be set in the HAL file in the normal way.

SYNOPSIS

loadrt setsserial cmd="set hm2_8i20.001f.nvmaxcurrent 750"

FUNCTIONS

None

PINS

None

USAGE

loadrt setsserial cmd="{command} {parameter/device} {value/filename}"

Commands available are **set** and **flash**.

This utility should be used under halcmd, without LinuxCNC running or any realtime threads running.

A typical command sequence would be:

```
halrun
loadrt hostmot2 use_serial_numbers=1
loadrt hm2_pci config="firmware=hm2/5i23/svss8_8.bit"
show param
loadrt setsserial cmd="set hm2_8i20.001f.nvmaxcurrent 750"
exit
```

This example uses the option to have the hal pins and parameters labelled by the serial number of the remote. This is not necessary but can reduce the scope for confusion. (The serial number is normally on a sticker on the device.)

The next line loads the hm2_pci driver in the normal way. The hm2_7i43 driver should work equally well, as should any future 7i80 driver. If the card has already been strted up and a firmware has been loaded, then the config string may be omitted.

"show param" is optional, but provides a handy list of all the devices and parameters. It also shows the current values of the parameters which can be useful for determining scaling. u32 pin values are always shown in hex, but new values can be entered in decimal or hex. Use the Ox123ABC format to enter a hex value.

The next line invokes setsserial. This is run in a slightly strange way in order to have kernel-level access to a live Hostmot2 config. It is basically a HAL module that always fails to load. This may lead to error messages being printed to the halcmd prompt. These can often be ignored. All the real feedback is via the dmesg command. It is suggested to have a second terminal window open to run dmesg after each command.

On exiting there will typically be a further error message related to the driver failing to unload setsserial. This can be ignored.

The parameter changes will not show up until the drivers are reloaded. //TODO// Add a "get" command to avoid this problem.

Flashing Firmware To flash new firmware to an FPGA card such as the 5i25 or 5i20 the "mesaflash" utility should be used. Setsserial is only useful for changing/updating the firmare on smart-serial remote such

as the 8i20. The firmware should be placed somewhere in the /lib/firmware/hm2 tree, where the Linux firmware loading macros can find it.

The flashing routine operates in a realtime thread, and can only send prompts to the user through the kernel log (dmesg). It is most convenient to open two terminal windows, one for command entry and one to monitor progress.

In the first terminal enter

tail −f /var/log/kern.log

This terminal will now display status information.

The second window will be used to enter the commands. It is important that LinuxCNC and/or HAL are not already loaded when the process is started. To flash new firmware it is necessary to move a jumper on the smart-serial remote drive and to switch smart-serial communication to a slower baudrate.

A typical command sequence is then
```
halrun
loadrt hostmot2 sserial_baudrate=115200
loadrt hm2_pci config="firmware=hm2/5i23/svss8_8.bit"
loadrt setsserial cmd="flash hm2_5i23.0.8i20.0.1 hm2/8i20/8i20T.BIN"
exit
```

It is not necessary (or useful) to specify a config string in a system using the 5i25 or 6i25 cards.

Note that it is necessary to exit halrun and unload the realtime environment before flashing the next card (exit)

The correct sserial channel name to use can be seen in the dmesg output in the feedback terminal after the loadrt hm2_pci step of the sequence.

LICENSE

GPL

NAME

siggen − signal generator

SYNOPSIS

loadrt siggen [num_chan=*num* **| names=***name1***[,***name2...***]]**

DESCRIPTION

siggen is a signal generator that can be used for testing and other applications that need simple waveforms. It produces sine, cosine, triangle, sawtooth, and square waves of variable frequency, amplitude, and offset, which can be used as inputs to other HAL components.

siggen supports a maximum of sixteen channels. The number of channels actually loaded is set by the **num_chan** argument when the module is loaded. Alternatively, specify **names=** and unique names separated by commas.

The **num_chan=** and **names=** specifiers are mutually exclusive. If neither **num_chan=** nor **names=** are specified, the default value is one.

NAMING

The names for pins, parameters, and functions are prefixed as:
siggen.N. for N=0,1,...,num−1 when using **num_chan=num**
nameN. for nameN=name1,name2,... when using **names=name1,name2,...**

The **siggen.N.** format is shown in the following descriptions.

FUNCTIONS

siggen.*N*.update (uses floating-point)

Updates output pins for signal generator *N*. Each time it is called it calculates a new sample. It should be called many times faster than the desired signal frequency, to avoid distortion and aliasing.

PINS

siggen.*N*.frequency float in

The output frequency for signal generator *N*, in Hertz. The default value is 1.0 Hertz.

siggen.*N*.amplitude float in

The output amplitude for signal generator *N*. If **offset** is zero, the outputs will swing from −**amplitude** to +**amplitude**. The default value is 1.00.

siggen.*N*.offset float in

The output offset for signal generator *N*. This value is added directly to the output signal. The default value is zero.

siggen.*N*.reset bit in

Resets output pins to pretermined states:
sine 0
sawtooth 0
square -1 * amplitude
cosine -1 * amplitude
triangle -1 * amplitude

siggen.*N*.clock bit out
The clock output. Bit type clock signal output at the commanded frequency.

siggen.*N*.square float out
The square wave output. Positive while **triangle** and **cosine** are ramping upwards, and while **sine** is negative.

siggen.*N*.sine float out
The sine output. Lags **cosine** by 90 degrees.

siggen.*N*.cosine float out
The cosine output. Leads **sine** by 90 degrees.

siggen.*N*.triangle float out
The triangle wave output. Ramps up while **square** is positive, and down while **square** is negative. Reaches its positive and negative peaks at the same time as **cosine**.

siggen.*N*.sawtooth float out
The sawtooth output. Ramps upwards to its positive peak, then instantly drops to its negative peak and starts ramping again. The drop occurs when **triangle** and **cosine** are at their positive peaks, and coincides with the falling edge of **square**.

PARAMETERS

None

NAME

sim_axis_hardware − A component to simulate home and limit switches

SYNOPSIS

loadrt sim_axis_hardware [count=*N***|names=***name1***[,***name2...***]]**

DESCRIPTION

This component creates simulated home and limit switches based on the current position.
It currently can supply simulation for X,Y,Z,U,V and A axes.

FUNCTIONS

sim-axis-hardware.*N*.update
(requires a floating-point thread)

PINS

sim-axis-hardware.*N*.Xcurrent-pos
float in The current position on the axis - eg connect to joint.0.motor-pos-fb

sim-axis-hardware.*N*.Ycurrent-pos
float in
sim-axis-hardware.*N*.Zcurrent-pos
float in
sim-axis-hardware.*N*.Acurrent-pos
float in
sim-axis-hardware.*N*.Ucurrent-pos
float in
sim-axis-hardware.*N*.Vcurrent-pos
float in
sim-axis-hardware.*N*.Xhomesw-pos
float in (default: *1*) The position of the home switch

sim-axis-hardware.*N*.Yhomesw-pos
float in (default: *1*)
sim-axis-hardware.*N*.Zhomesw-pos
float in (default: *1*)
sim-axis-hardware.*N*.Ahomesw-pos
float in (default: *1*)
sim-axis-hardware.*N*.Uhomesw-pos
float in (default: *1*)
sim-axis-hardware.*N*.Vhomesw-pos
float in (default: *1*)
sim-axis-hardware.*N*.Xmaxsw-upper
float in The upper range of the maximum limit switch, above this is false.

sim-axis-hardware.*N*.Ymaxsw-upper
float in
sim-axis-hardware.*N*.Zmaxsw-upper
float in
sim-axis-hardware.*N*.Amaxsw-upper
float in
sim-axis-hardware.*N*.Umaxsw-upper
float in
sim-axis-hardware.*N*.Vmaxsw-upper
float in

sim-axis-hardware.*N*.Xmaxsw-lower
float in The lower range of the maximum limit switch, below this is false.

sim-axis-hardware.*N*.Ymaxsw-lower
float in
sim-axis-hardware.*N*.Zmaxsw-lower
float in
sim-axis-hardware.*N*.Amaxsw-lower
float in
sim-axis-hardware.*N*.Umaxsw-lower
float in
sim-axis-hardware.*N*.Vmaxsw-lower
float in
sim-axis-hardware.*N*.Xminsw-upper
float in The upper range of the minimum limit switch, above this is false.

sim-axis-hardware.*N*.Yminsw-upper
float in
sim-axis-hardware.*N*.Zminsw-upper
float in
sim-axis-hardware.*N*.Aminsw-upper
float in
sim-axis-hardware.*N*.Uminsw-upper
float in
sim-axis-hardware.*N*.Vminsw-upper
float in
sim-axis-hardware.*N*.Xminsw-lower
float in The lower range of the minimum limit switch, below this is false.

sim-axis-hardware.*N*.Yminsw-lower
float in
sim-axis-hardware.*N*.Zminsw-lower
float in
sim-axis-hardware.*N*.Aminsw-lower
float in
sim-axis-hardware.*N*.Uminsw-lower
float in
sim-axis-hardware.*N*.Vminsw-lower
float in
sim-axis-hardware.*N*.Xhomesw-hyst
float in (default: *.02*) range that home switch will be true +- half this to the home position

sim-axis-hardware.*N*.Yhomesw-hyst
float in (default: *.02*)
sim-axis-hardware.*N*.Zhomesw-hyst
float in (default: *.02*)
sim-axis-hardware.*N*.Ahomesw-hyst
float in (default: *.02*)
sim-axis-hardware.*N*.Uhomesw-hyst
float in (default: *.02*)
sim-axis-hardware.*N*.Vhomesw-hyst
float in (default: *.02*)
sim-axis-hardware.*N*.Xhomesw-out
bit out
Home switch for the X axis

sim-axis-hardware.*N*.Yhomesw-out
bit out
sim-axis-hardware.*N*.Zhomesw-out
bit out
sim-axis-hardware.*N*.Ahomesw-out
bit out
sim-axis-hardware.*N*.Uhomesw-out
bit out
sim-axis-hardware.*N*.Vhomesw-out
bit out
sim-axis-hardware.*N*.homesw-all
bit out
sim-axis-hardware.*N*.Xmaxsw-out
bit out Max limit switch
sim-axis-hardware.*N*.Xminsw-out
bit out min limit switch
sim-axis-hardware.*N*.Xbothsw-out
bit out True for both max and min limit switch
sim-axis-hardware.*N*.Ymaxsw-out
bit out
sim-axis-hardware.*N*.Yminsw-out
bit out
sim-axis-hardware.*N*.Ybothsw-out
bit out
sim-axis-hardware.*N*.Zmaxsw-out
bit out
sim-axis-hardware.*N*.Zminsw-out
bit out
sim-axis-hardware.*N*.Zbothsw-out
bit out
sim-axis-hardware.*N*.Amaxsw-out
bit out
sim-axis-hardware.*N*.Aminsw-out
bit out
sim-axis-hardware.*N*.Abothsw-out
bit out
sim-axis-hardware.*N*.Umaxsw-out
bit out
sim-axis-hardware.*N*.Uminsw-out
bit out
sim-axis-hardware.*N*.Ubothsw-out
bit out
sim-axis-hardware.*N*.Vmaxsw-out
bit out
sim-axis-hardware.*N*.Vminsw-out
bit out
sim-axis-hardware.*N*.Vbothsw-out
bit out
sim-axis-hardware.*N*.limitsw-all
bit out
sim-axis-hardware.*N*.limitsw-homesw-all
bit out True for all limits and all home.

sim-axis-hardware.*N*.Xmaxsw-homesw-out
bit out
sim-axis-hardware.*N*.Xminsw-homesw-out
bit out
sim-axis-hardware.*N*.Xbothsw-homesw-out
bit out
sim-axis-hardware.*N*.Ymaxsw-homesw-out
bit out
sim-axis-hardware.*N*.Yminsw-homesw-out
bit out
sim-axis-hardware.*N*.Ybothsw-homesw-out
bit out
sim-axis-hardware.*N*.Zmaxsw-homesw-out
bit out
sim-axis-hardware.*N*.Zminsw-homesw-out
bit out
sim-axis-hardware.*N*.Zbothsw-homesw-out
bit out
sim-axis-hardware.*N*.Amaxsw-homesw-out
bit out
sim-axis-hardware.*N*.Aminsw-homesw-out
bit out
sim-axis-hardware.*N*.Abothsw-homesw-out
bit out
sim-axis-hardware.*N*.Umaxsw-homesw-out
bit out
sim-axis-hardware.*N*.Uminsw-homesw-out
bit out
sim-axis-hardware.*N*.Ubothsw-homesw-out
bit out
sim-axis-hardware.*N*.Vmaxsw-homesw-out
bit out
sim-axis-hardware.*N*.Vminsw-homesw-out
bit out
sim-axis-hardware.*N*.Vbothsw-homesw-out
bit out
sim-axis-hardware.*N*.limit-offset
float in (default: *.01*) how much the limit switches are offset from inputed position. added to max, subracted from min

AUTHOR

Chris Morley

LICENSE

GPL

NAME

sim_encoder − simulated quadrature encoder

SYNOPSIS

loadrt sim_encoder [num_chan=*num* **| names=***name1***[,***name2***...]]**

DESCRIPTION

sim_encoder can generate quadrature signals as if from an encoder. It also generates an index pulse once per revolution. It is mostly used for testing and simulation, to replace hardware that may not be available. It has a limited maximum frequency, as do all software based pulse generators.

sim_encoder supports a maximum of eight channels. The number of channels actually loaded is set by the **num_chan=** argument when the module is loaded. Alternatively, specify **names=** and unique names separated by commas.

The **num_chan=** and **names=** specifiers are mutually exclusive. If neither **num_chan=** nor **names=** are specified, the default value is one.

FUNCTIONS

sim−encoder.make−pulses (no floating-point)
: Generates the actual quadrature and index pulses. Must be called as frequently as possible, to maximize the count rate and minimize jitter. Operates on all channels at once.

sim−encoder.update−speed (uses floating-point)
: Reads the **speed** command and other parameters and converts the data into a form that can be used by **make−pulses**. Changes take effect only when **update−speed** runs. Can (and should) be called less frequently than **make−pulses**. Operates on all channels at once.

NAMING

The names for pins and parameters are prefixed as:
sim−encoder.N. for N=0,1,...,num−1 when using **num_chan=num**
nameN. for nameN=name1,name2,... when using **names=name1,name2,...**

The **sim−encoder.N.** format is shown in the following descriptions.

PINS

sim−encoder.*N*.phase−A bit out
: One of the quadrature outputs.

sim−encoder.*N*.phase−B bit out
: The other quadrature output.

sim−encoder.*N*.phase−Z bit out
: The index pulse.

sim−encoder.*N*.speed float in
: The desired speed of the encoder, in user units per per second. This is divided by **scale**, and the result is used as the encoder speed in revolutions per second.

PARAMETERS

sim−encoder.*N*.ppr u32 rw

The pulses per revolution of the simulated encoder. Note that this is pulses, not counts, per revolution. Each pulse or cycle from the encoder results in four counts, because every edge is counted. Default value is 100 ppr, or 400 counts per revolution.

sim−encoder.*N*.scale float rw

Scale factor for the **speed** input. The **speed** value is divided by **scale** to get the actual encoder speed in revolutions per second. For example, if **scale** is set to 60, then **speed** is in revolutions per minute (RPM) instead of revolutions per second. The default value is 1.00.

NAME

sim_home_switch − Simple home switch simulator

SYNOPSIS

loadrt sim_home_switch [count=*N***|names=***name1***[,***name2***...]]**

DESCRIPTION

After tripping home switch, travel in opposite direction is required (amount set by the hysteresis pin)

FUNCTIONS

sim-home-switch.*N*

(requires a floating-point thread)

PINS

sim-home-switch.*N***.cur-pos**

float in Current position (typically: joint.n.motor-pos-fb)

sim-home-switch.*N***.home-pos**

float in (default: *1*) Home switch position

sim-home-switch.*N***.hysteresis**

float in (default: *0.1*) Travel required to backoff (hysteresis)

sim-home-switch.*N***.home-sw**

bit out Home switch activated

LICENSE

GPL

NAME

sim_matrix_kb − convert HAL pin inputs to keycodes

SYNOPSIS

loadrt sim_matrix_kb [count=*N***|names=***name1***[,***name2...***]]**

FUNCTIONS

sim-matrix-kb.*N*

(requires a floating-point thread)

PINS

sim-matrix-kb.*N***.out**

u32 out pin that outputs the Keycode

sim-matrix-kb.*N***.button.c00.r***MM*

bit in

(MM=00..07) array of inputs

sim-matrix-kb.*N***.button.c01.r***MM*

bit in

(MM=00..07) array of inputs

sim-matrix-kb.*N***.button.c02.r***MM*

bit in

(MM=00..07) array of inputs

sim-matrix-kb.*N***.button.c03.r***MM*

bit in

(MM=00..07) array of inputs

sim-matrix-kb.*N***.button.c04.r***MM*

bit in

(MM=00..07) array of inputs

sim-matrix-kb.*N***.button.c05.r***MM*

bit in

(MM=00..07) array of inputs

sim-matrix-kb.*N***.button.c06.r***MM*

bit in

(MM=00..07) array of inputs

sim-matrix-kb.*N***.button.c07.r***MM*

bit in

(MM=00..07) array of inputs

LICENSE

GPL

NAME

sim_parport − A component to simulate the pins of the hal_parport component

SYNOPSIS

loadrt sim_parport [count=*N***|names=***name1***[,***name2***...]]**

DESCRIPTION

Sim_parport is used to replace the pins of a real parport without changing any of the pins names in the rest of the config.
It has pass-through pins (ending in −fake) that allows connecting to other components.

eg pin−02−in will follow pin−02−in−fake 's logic.
pin_01_out−fake will follow pin_01_out (possibly modified by pin_01_out−invert)

It creates all possible pins of both 'in' and 'out' options of the hal_parport component.
This allows using other hardware I/O in place of the parport (without having to change the rest of the config)
or simulating hardware such as limit switches.
it's primary use is in Stepconf for building simulated configs.
You must use the names= option to have the right pin names.
eg. names=parport.0,parport.1
The read and write functions pass the logic from pins to fake pins or vice vera
The reset function is a no operation.

FUNCTIONS

sim-parport.*N*.read

sim-parport.*N*.write

sim-parport.*N*.reset

PINS

sim-parport.*N*.pin-01-out
bit in
sim-parport.*N*.pin-02-out
bit in
sim-parport.*N*.pin-03-out
bit in
sim-parport.*N*.pin-04-out
bit in
sim-parport.*N*.pin-05-out
bit in
sim-parport.*N*.pin-06-out
bit in
sim-parport.*N*.pin-07-out
bit in
sim-parport.*N*.pin-08-out
bit in

sim-parport.*N*.pin-09-out
bit in
sim-parport.*N*.pin-14-out
bit in
sim-parport.*N*.pin-16-out
bit in
sim-parport.*N*.pin-17-out
bit in
sim-parport.*N*.pin-01-out-fake
bit out
sim-parport.*N*.pin-02-out-fake
bit out
sim-parport.*N*.pin-03-out-fake
bit out
sim-parport.*N*.pin-04-out-fake
bit out
sim-parport.*N*.pin-05-out-fake
bit out
sim-parport.*N*.pin-06-out-fake
bit out
sim-parport.*N*.pin-07-out-fake
bit out
sim-parport.*N*.pin-08-out-fake
bit out
sim-parport.*N*.pin-09-out-fake
bit out
sim-parport.*N*.pin-14-out-fake
bit out
sim-parport.*N*.pin-16-out-fake
bit out
sim-parport.*N*.pin-17-out-fake
bit out
sim-parport.*N*.pin-02-in
bit out
sim-parport.*N*.pin-03-in
bit out
sim-parport.*N*.pin-04-in
bit out
sim-parport.*N*.pin-05-in
bit out
sim-parport.*N*.pin-06-in
bit out
sim-parport.*N*.pin-07-in
bit out
sim-parport.*N*.pin-08-in
bit out
sim-parport.*N*.pin-09-in
bit out
sim-parport.*N*.pin-10-in
bit out
sim-parport.*N*.pin-11-in
bit out

sim-parport.*N*.pin-12-in
bit out
sim-parport.*N*.pin-13-in
bit out
sim-parport.*N*.pin-15-in
bit out
sim-parport.*N*.pin-02-in-fake
bit in
sim-parport.*N*.pin-03-in-fake
bit in
sim-parport.*N*.pin-04-in-fake
bit in
sim-parport.*N*.pin-05-in-fake
bit in
sim-parport.*N*.pin-06-in-fake
bit in
sim-parport.*N*.pin-07-in-fake
bit in
sim-parport.*N*.pin-08-in-fake
bit in
sim-parport.*N*.pin-09-in-fake
bit in
sim-parport.*N*.pin-10-in-fake
bit in
sim-parport.*N*.pin-11-in-fake
bit in
sim-parport.*N*.pin-12-in-fake
bit in
sim-parport.*N*.pin-13-in-fake
bit in
sim-parport.*N*.pin-15-in-fake
bit in
sim-parport.*N*.pin-02-in-not
bit out
sim-parport.*N*.pin-03-in-not
bit out
sim-parport.*N*.pin-04-in-not
bit out
sim-parport.*N*.pin-05-in-not
bit out
sim-parport.*N*.pin-06-in-not
bit out
sim-parport.*N*.pin-07-in-not
bit out
sim-parport.*N*.pin-08-in-not
bit out
sim-parport.*N*.pin-09-in-not
bit out
sim-parport.*N*.pin-10-in-not
bit out
sim-parport.*N*.pin-11-in-not
bit out

sim-parport.*N*.pin-12-in-not
bit out
sim-parport.*N*.pin-13-in-not
bit out
sim-parport.*N*.pin-15-in-not
bit out
sim-parport.*N*.reset-time
float in

PARAMETERS

sim-parport.*N*.pin-01-out-invert
bit rw
sim-parport.*N*.pin-02-out-invert
bit rw
sim-parport.*N*.pin-03-out-invert
bit rw
sim-parport.*N*.pin-04-out-invert
bit rw
sim-parport.*N*.pin-05-out-invert
bit rw
sim-parport.*N*.pin-06-out-invert
bit rw
sim-parport.*N*.pin-07-out-invert
bit rw
sim-parport.*N*.pin-08-out-invert
bit rw
sim-parport.*N*.pin-09-out-invert
bit rw
sim-parport.*N*.pin-14-out-invert
bit rw
sim-parport.*N*.pin-16-out-invert
bit rw
sim-parport.*N*.pin-17-out-invert
bit rw
sim-parport.*N*.pin-01-out-reset
bit rw
sim-parport.*N*.pin-02-out-reset
bit rw
sim-parport.*N*.pin-03-out-reset
bit rw
sim-parport.*N*.pin-04-out-reset
bit rw
sim-parport.*N*.pin-05-out-reset
bit rw
sim-parport.*N*.pin-06-out-reset
bit rw
sim-parport.*N*.pin-07-out-reset
bit rw
sim-parport.*N*.pin-08-out-reset
bit rw
sim-parport.*N*.pin-09-out-reset
bit rw
sim-parport.*N*.pin-14-out-reset
bit rw

sim-parport.*N*.pin-16-out-reset
bit rw
sim-parport.*N*.pin-17-out-reset
bit rw

AUTHOR

Chris Morley

LICENSE

GPL

NAME

sim_spindle − Simulated spindle with index pulse

SYNOPSIS

loadrt sim_spindle [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

sim-spindle.*N*

(requires a floating-point thread)

PINS

sim-spindle.*N***.velocity-cmd**

float in Commanded speed

sim-spindle.*N***.position-fb**

float out Feedback position, in revolutions

sim-spindle.*N***.index-enable**

bit io Reset **position-fb** to 0 at the next full rotation

PARAMETERS

sim-spindle.*N***.scale**

float rw (default: *1.0*) factor applied to **velocity-cmd**.

The result of '**velocity-cmd** * **scale**' be in revolutions per second. For example, if **velocity-cmd** is in revolutions/minute, **scale** should be set to 1/60 or 0.016666667.

LICENSE

GPL

NAME

simple_tp − This component is a single axis simple trajectory planner, same as used for jogging in linuxcnc.

SYNOPSIS

Used by PNCconf to allow testing of acceleration and velocity values for an axis.

FUNCTIONS

simple-tp.*N*.update
(requires a floating-point thread)

PINS

simple-tp.*N*.target-pos
float in target position to plan for.

simple-tp.*N*.maxvel
float in Maximum velocity

simple-tp.*N*.maxaccel
float in Acceleration rate

simple-tp.*N*.enable
bit in If disabled, planner sets velocity to zero immedately.

simple-tp.*N*.current-pos
float out position commanded at this point in time.

simple-tp.*N*.current-vel
float out velocity commanded at this moment in time.

simple-tp.*N*.active
bit out if active is true, the planner is requesting movement.

LICENSE

GPL

NAME

sphereprobe − Probe a pretend hemisphere

SYNOPSIS

loadrt sphereprobe [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

sphereprobe.*N*

update probe-out based on inputs

PINS

sphereprobe.*N***.px**
s32 in
sphereprobe.*N***.py**
s32 in
sphereprobe.*N***.pz**
s32 in **rawcounts** position from software encoder

sphereprobe.*N***.cx**
s32 in
sphereprobe.*N***.cy**
s32 in
sphereprobe.*N***.cz**
s32 in Center of sphere in counts

sphereprobe.*N***.r**
s32 in Radius of hemisphere in counts

sphereprobe.*N***.probe-out**
bit out

AUTHOR

Jeff Epler

LICENSE

GPL

NAME

spindle_monitor − spindle at-speed and underspeed detection

SYNOPSIS

loadrt spindle_monitor [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

spindle-monitor.*N*
(requires a floating-point thread)

PINS

spindle-monitor.*N***.spindle-is-on**
bit in
spindle-monitor.*N***.spindle-command**
float in
spindle-monitor.*N***.spindle-feedback**
float in
spindle-monitor.*N***.spindle-at-speed**
bit out
spindle-monitor.*N***.spindle-underspeed**
bit out

PARAMETERS

spindle-monitor.*N***.level**
u32 rw state machine state

spindle-monitor.*N***.threshold**
float rw

LICENSE

gpl v2 or higher

NAME

hostmot2 - Smart Serial LinuxCNC HAL driver for the Mesa Electronics HostMot2 Smart-Serial remote cards

SYNOPSIS

The Mesa Smart-Serial interface is a 2.5Mbs proprietary interface between the Mesa Anything-IO cards and a range of subsidiary devices termed "smart-serial remotes". The remote cards perform a variety of functions, but typically they combine various classes of IO. The remot cards are self-configuring, in that they tell the main LinuxCNC Hostmot2 driver what their pin functions are and what they should be named.

Many sserial remotes offer different pinouts depending on the mode they are started up in. This is set using the sserial_port_N= option in the hm2_pci modparam. See the hostmot2 manpage for further details.

It is likely that this documentation will be permanently out of date.

Each Anything-IO board can attach up to 8 sserial remotes to each header (either the 5-pin headers on the 5i20/5i22/5i23/7i43 or the 25-pin connectors on the 5i25, 6i25 and 7i80). The remotes are grouped into "ports" of up to 8 "channels". Typically each header will be a single 8 channel port, but this is not necessarily always the case.

PORTS

In addition to the per-channel/device pins detailed below there are three per-port pins and three parameters.

Pins:

(bit, in) .sserial.port−N.run: Enables the specific Smart Serial module. Setting this pin low will disable all boards on the port and puts the port in a pass-through mode where device parameter setting is possible. It is necessary to toggle the state of this pin if there is a requirement to alter a remote parameter on a live system. This pin defaults to TRUE and can be left unconnected. However, toggling the pin low-to-high will re-enable a faulted drive so the pin could usefully be connected to the iocontrol.0.user−enable−out pin.

(u32, ro) .run_state: Shows the state of the sserial communications state-machine. This pin will generally show a value of 0x03 in normal operation, 0x07 in setup mode and 0x00 when the "run" pin is false.

(u32, ro) .error−count: Indicates the state of the Smart Serial error handler, see the parameters sections for more details.

Parameters:

(u32 r/w) .fault−inc: Any over-run or handshaking error in the SmartSerial communications will increment the .fault−count pin by the amount specified by this parameter. Default = 10.

(u32 r/w) .fault−dec: Every successful read/write cycle decrements the fault counter by this amount. Default = 1.

(u32 r/w) .fault−lim: When the fault counter reaches this threshold the Smart Serial interface on the corresponding port will be stopped and an error printed in dmesg. Together these three pins allow for control over the degree of fault- tolerance allowed in the interface. The default values mean that if more than one transaction in ten fails, more than 20 times, then a hard error will be raised. If the increment were to be set to zero then no error would ever be raised, and the system would carry on regardless. Conversely setting decrement to zero, threshold to 1 and limit to 1 means that absolutely no errors will be tolerated. (This structure is copied directly from vehicle ECU practice)

Any other parameters than the ones above are created by the card istelf from data in the remote firmware. They may be set in the HAL file using "setp" in the usual way.

NOTE: Because a Smart-Serial remote can only communicate non-process data to the host card in setup mode it is necessary to stop and re-start the smart-serial port associated with the card to alter the value of a parameter.

HALSO NOTE: in the case of parameters beginning with "nv" (which are stored in non-volatile memory) the effect will not be seen until after the next power cycle of the drive.

Unchanged values will not be re-written so it is safe to leave the "setp" commands in the HAL file or delete them as you see fit.

DEVICES

The other pins and parameters created in HAL depend on the devices detected. The following list of Smart Serial devices is by no means exhaustive.

8i20 The 8i20 is a 2.2kW three-phase drive for brushless DC motors and AC servo motors. 8i20 pins and parameters have names like "hm2_<*BoardType*>.<*BoardNum*>.8i20.<*PortNum*>.<*ChanNum*>.<*Pin*>", for example "hm2_5i23.0.8i20.1.3.current" would set the phase current for the drive connected to the fourth channel of the second sserial port of the first 5i23 board. Note that the sserial ports do not necessarily correlate in layout or number to the physical ports on the card.

Pins:

(float in) angle
The rotor angle of the motor in fractions of a full **phase** revolution. An angle of 0.5 indicates that the motor is half a turn / 180 degrees / π radians from the zero position. The zero position is taken to be the position that the motor adopts under no load with a poitive voltage applied to the A (or U) phase and both B and C (or V and W) connected to −V or 0V. A 6 pole motor will have 3 zero positions per physical rotation. Note that the 8i20 drive automatically adds the phase lead/lag angle, and that this pin should see the raw rotor angle. There is a HAL module (bldc) which handles the complexity of differing motor and drive types.

(float, in) current
The phase current command to the drive. This is scaled from −1 to +1 for forwards and reverse maximum currents. The absolute value of the current is set by the max_current parameter.

(float, ro) bus-voltage
The drive bus voltage in V. This will tend to show 25.6V when the drive is unpowered and the drive will not operate below about 50V.

(float, ro) temp
The temperature of the driver in degrees C.

(u32, ro) comms
The communication status of the drive. See the manual for more details.

(bit, ro) status and fault.
The following fault/status bits are exported. For further details see the 8i20 manual. fault.U−current / fault.U−current−not fault.V−current / fault.V−current−not fault.W−current / fault.W−current−not fault.bus−high / fault.bus−high−not fault.bus−overv / fault.bus−overv−not fault.bus−underv / fault.bus−underv−not fault.framingr / fault.framingr−not fault.module / fault.module−not fault.no−enable / fault.no−enable−not fault.overcurrent / fault.overcurrent−not

fault.overrun / fault.overrun−not fault.overtemp / fault.overtemp−not fault.watchdog / fault.watchdog−not

status.brake−old / status.brake−old−not status.brake−on / status.brake−on−not status.bus−underv / status.bus−underv−not status.current−lim / status.current−lim−no status.ext−reset / status.ext−reset−not status.no−enable / status.no−enable−not status.pid−on / status.pid−on−not status.sw−reset / status.sw−reset−not status.wd−reset / status.wd−reset−not

Parameters:

The following parameters are exported. See the pdf documentation downloadable from Mesa for further details

hm2_5i25.0.8i20.0.1.angle−maxlim
hm2_5i25.0.8i20.0.1.angle−minlim
hm2_5i25.0.8i20.0.1.angle−scalemax
hm2_5i25.0.8i20.0.1.current−maxlim
hm2_5i25.0.8i20.0.1.current−minlim
hm2_5i25.0.8i20.0.1.current−scalemax
hm2_5i25.0.8i20.0.1.nvbrakeoffv
hm2_5i25.0.8i20.0.1.nvbrakeonv
hm2_5i25.0.8i20.0.1.nvbusoverv
hm2_5i25.0.8i20.0.1.nvbusundervmax
hm2_5i25.0.8i20.0.1.nvbusundervmin
hm2_5i25.0.8i20.0.1.nvkdihi
hm2_5i25.0.8i20.0.1.nvkdil
hm2_5i25.0.8i20.0.1.nvkdilo
hm2_5i25.0.8i20.0.1.nvkdp
hm2_5i25.0.8i20.0.1.nvkqihi
hm2_5i25.0.8i20.0.1.nvkqil
hm2_5i25.0.8i20.0.1.nvkqilo
hm2_5i25.0.8i20.0.1.nvkqp
hm2_5i25.0.8i20.0.1.nvmaxcurrent
hm2_5i25.0.8i20.0.1.nvrembaudrate
hm2_5i25.0.8i20.0.1.swrevision
hm2_5i25.0.8i20.0.1.unitnumber

(float, rw) max_current

Sets the maximum drive current in Amps. The default value is the maximum current programmed into the drive EEPROM. The value must be positive, and an error will be raised if a current in excess of the drive maximum is requested.

(u32, ro) serial_number

The serial number of the connected drive. This is also shown on the label on the drive.

7i64 The 7i64 is a 24-input 24-output IO card. 7i64 pins and parameters have names like "hm2_<*BoardType*>.<*BoardNum*>.7i64. <PortNum>.<ChanNum>.<Pin>", for example hm2_5i23.0.7i64.1.3.output−01

Pins: (bit, in) 7i64.0.0.output−NN: Writing a 1 or TRUE to this pin will enable output driver NN. Note that the outputs are drivers (switches) rather than voltage outputs. The LED adjacent to the connector on the board shows the status. The output can be inverted by setting a parameter.

(bit, out) 7i64.0.0.input−NN: The value of input NN. Note that the inputs are isolated and both

pins of each input must be connected (typically to signal and the ground of the signal. This need not be the ground of the board.)

(bit, out) 7i64.0.0.input−NN−not: An inverted copy of the corresponding input.

(float, out) 7i64.0.0.analog0 & 7i64.0.0.analog1: The two analogue inputs (0 to 3.3V) on the board.

Parameters: (bit, rw) 7i64.0.0.output−NN−invert: Setting this parameter to 1 / TRUE will invert the output value, such that writing 0 to .gpio.NN.out will enable the output and vice-versa.

7i76 The 7i76 is not only a smart-serial device. It also serves as a breakout for a number of other Hostmot2 functions. There are connections for 5 step generators (for which see the main hostmot2 manpage). The stepgen pins are associated with the 5i25 (hm2_5i25.0.stepgen.00....) whereas the smart-serial pins are associated with the 7i76 (hm2_5i25.0.7i76.0.0.output−00).

Pins:

(float out) .7i76.0.0.analogN (modes 1 and 2 only) Analogue input values.

(float out) .7i76.0.0.fieldvoltage (mode 2 only) Field voltage monitoring pin.

(bit in) .7i76.0.0.spindir: This pin provides a means to drive the spindle VFD direction terminals on the 7i76 board.

(bit in) .7i76.0.0.spinena: This pin drives the spindle-enable terminals on the 7i76 board.

(float in) .7i76.0.0.spinout: This controls the analogue output of the 7i76. This is intended as a speed control signal for a VFD.

(bit out) .7i76.0.0.output−NN: (NN = 0 to 15). 16 digital outputs. The sense of the signal can be set via a parameter

(bit out) .7i76.0.0.input−NN: (NN = 0 to 31) 32 digital inputs.

(bit in) .7i76.0.0.input−NN−not: (NN = 0 to 31) An inverted copy of the inputs provided for convenience. The two complementary pins may be connected to different signal nets.

Parameters:

(u32 ro) .7i76.0.0.nvbaudrate: Indicates the vbaud rate. This probably should not be altered.

(u32 ro) .7i76.0.0.nvunitnumber: Indicates the serial number of the device and should match a sticker on the card. This can be useful for working out which card is which.

(u32 ro) .7i76.0.0.nvwatchdogtimeout: The sserial remote watchdog timeout. This is separate from the Anything-IO card timeout. This is unlikley to need to be changed.

(bit rw) .7i76.0.0.output−NN−invert: Invert the sense of the corresponding output pin.

(bit rw) .7i76.0.0.spindir−invert: Invert the senseof the spindle direction pin.

(bit rw) .7i76.0.0.spinena−invert: Invert the sense of the spindle−enable pin.

(float rw) .7i76.0.0.spinout−maxlim: The maximum speed request allowable

(float rw) .7i76.0.0.spinout−minlim: The minimum speed request.

(float rw) .7i76.0.0.spinout−scalemax: The spindle speed scaling. This is the speed request which would correspond to full-scale output from the spindle control pin. For example with a 10V drive voltage and a 10000rpm scalemax a value of 10,000 rpm on the spinout pin would produce 10V output. However, if spinout−maxlim were set to 5,000 rpm then no voltage above 5V would be output.

(u32 ro) .7i76.0.0.swrevision: The onboard firmware revision number. Utilities (man setsserial for details) exist to update and change this firmware.

7i77 The 7i77 is an 6-axis servo control card. The analogue outputs are smart-serial devices but the encoders are conventional hostmot2 encoders and further details of them may be found in the hostmot2 manpage.

Pins: (bit out) .7i77.0.0.input−NN: (NN = 0 to 31) 32 digital inputs.

(bit in) .7i77.0.0.input−NN−not: (NN = 0 to 31) An inverted copy of the inputs provided for convenience. The two complementary pins may be connected to different signal nets.

(bit out) .7i77.0.0.output−NN: (NN = 0 to 15). 16 digital outputs. The sense of the signal can be set via a parameter

(bit in) .7i77.0.0.spindir: This pin provides a means to drive the spindle VFD direction terminals on the 7i76 board.

(bit in) .7i77.0.0.spinena: This pin drives the spindle-enable terminals on the 7i76 board.

(float in) .7i77.0.0.spinout: This controls the analog output of the 7i77. This is intended as a speed control signal for a VFD.

(bit in) .7i77.0.1.analogena: This pin drives the analog enable terminals on the 7i77 board.

(float in) .7i77.0.1.analogoutN: (N = 0 to 5) This controls the analog output of the 7i77.

Parameters: (bit rw) .7i77.0.0.output−NN−invert: Invert the sense of the corresponding output pin.

(bit rw) .7i77.0.0.spindir−invert: Invert the sense of the spindle direction pin.

(bit rw) .7i77.0.0.spinena−invert: Invert the sense of the spindle−enable pin.

(float rw) .7i77.0.0.spinout−maxlim: The maximum speed request allowable

(float rw) .7i77.0.0.spinout−minlim: The minimum speed request.

(float rw) .7i77.0.0.spinout−scalemax: The spindle speed scaling. This is the speed request which would correspond to full-scale output from the spindle control pin. For example with a 10V drive voltage and a 10000rpm scalemax a value of 10,000 rpm on the spinout pin would produce 10V output. However, if spinout−maxlim were set to 5,000 rpm then no voltage above 5V would be output.

(float rw) .7i77.0.0.analogoutN−maxlim: (N = 0 to 5) The maximum speed request allowable

(float rw) .7i77.0.0.analogoutN−minlim: (N = 0 to 5) The minimum speed request.

(float rw) .7i77.0.0.analogoutN−scalemax: (N = 0 to 5) The analog speed scaling. This is the speed request which would correspond to full-scale output from the spindle control pin. For example with a 10V drive voltage and a 10000rpm scalemax a value of 10,000 rpm on the spinout pin would produce 10V output. However, if spinout−maxlim were set to 5,000 rpm then no voltage above 5V would be output.

7i69 The 7i69 is a 48 channel digital IO card. It can be configured in four different modes: Mode 0 B 48 pins bidirectional (all outputs can be set high then driven low to work as inputs)
Mode 1 48 pins, input only
Mode 2 48 pins, all outputs
Mode 3 24 inputs and 24 outputs.

Pins: (bit in) .7i69.0.0.output−NN: Digital output. Sense can be inverted with the corresponding Parameter

(bit out) .7i69.0.0.input−NN: Digital input

(bit out) .7i69.0.0.input−NN−not: Digital input, inverted.

Parameters:

(u32 ro) .7i69.0.0.nvbaudrate: Indicates the vbaud rate. This probably should not be altered.

(u32 ro) .7i69.0.0.nvunitnumber: Indicates the serial number of the device and should match a sticker on the card. This can be useful for working out which card is which.

(u32 ro) .7i69.0.0.nvwatchdogtimeout: The sserial remote watchdog timeout. This is separate from the Anything-IO card timeout. This is unlikley to need to be changed.

(bit rw) .7i69.0.0.output−NN−invert: Invert the sense of the corresponding output pin.

(u32 ro) .7i69.0.0.swrevision: The onboard firmware revision number. Utilities exist to update and change this firmware.

7i70

The 7I70 is a remote isolated 48 input card. The 7I70 inputs sense positive inputs relative to a common field ground. Input impedance is 10K Ohms and input voltage can range from 5VDC to 32VDC. All inputs have LED status indicators. The input common field ground is galvanically isolated from the communications link.

The 7I70 has three software selectable modes. These different modes select different sets of 7I70 data to be transferred between the host and the 7I70 during real time process data exchanges. For high speed applications, choosing the correct mode can reduced the data transfer sizes, resulting in higher maximum update rates.

MODE 0 Input mode (48 bits input data only
MODE 1 Input plus analog mode (48 bits input data plus 6 channels of analog data)
MODE 2 Input plus field voltage

Pins:

(float out) .7i70.0.0.analogN (modes 1 and 2 only) Analogue input values.

(float out) .7i70.0.0.fieldvoltage (mode 2 only) Field voltage monitoring pin.

(bit out) .7i70.0.0.input−NN: (NN = 0 to 47) 48 digital inputs.

(bit in) .7i70.0.0.input−NN−not: (NN = 0 to 47) An inverted copy of the inputs provided for convenience. The two complementary pins may be connected to different signal nets.

Parameters:

(u32 ro) .7i70.0.0.nvbaudrate: Indicates the vbaud rate. This probably should not be altered.

(u32 ro) .7i70.0.0.nvunitnumber: Indicates the serial number of the device and should match a sticker on the card. This can be useful for working out which card is which.

(u32 ro) .7i70.0.0.nvwatchdogtimeout: The sserial remote watchdog timeout. This is separate from the Anything-IO card timeout. This is unlikley to need to be changed.

(u32 ro) .7i69.0.0.swrevision: The onboard firmware revision number. Utilities exist to update and change this firmware.

7i71

The 7I71 is a remote isolated 48 output card. The 48 outputs are 8VDC to 28VDC sourcing drivers (common + field power) with 300 mA maximum current capability. All outputs have LED status indicators.

The 7I71 has two software selectable modes. For high speed applications, choosing the correct mode can reduced the data transfer sizes, resulting in higher maximum update rates

MODE 0 Output only mode (48 bits output data only)
MODE 1 Outputs plus read back field voltage

Pins:

(float out) .7i71.0.0.fieldvoltage (mode 2 only) Field voltage monitoring pin.

(bit out) .7i71.0.0.output−NN: (NN = 0 to 47) 48 digital outputs. The sense may be inverted by the invert parameter.

Parameters:

(bit rw) .7i71.0.0.output−NN−invert: Invert the sense of the corresponding output pin.

(u32 ro) .7i71.0.0.nvbaudrate: Indicates the vbaud rate. This probably should not be altered.

(u32 ro) .7i71.0.0.nvunitnumber: Indicates the serial number of the device and should match a sticker on the card. This can be useful for determining which card is which.

(u32 ro) .7i71.0.0.nvwatchdogtimeout: The sserial remote watchdog timeout. This is separate from

the Anything-IO card timeout. This is unlikley to need to be changed.

(u32 ro) .7i69.0.0.swrevision: The onboard firmware revision number. Utilities exist to update and change this firmware.

7i73 The 7I73 is a remote real time pendant or control panel interface.

The 7I73 supports up to four 50KHz encoder inputs for MPGs, 8 digital inputs and 6 digital outputs and up to a 64 Key keypad. If a smaller keypad is used, more digital inputs and outputs become available. Up to eight 0.0V to 3.3V analog inputs are also provided. The 7I73 can drive a 4 line 20 character LCD for local DRO applications.

The 7I73 has 3 software selectable process data modes. These different modes select different sets of 7I73 data to be transferred between the host and the 7 I73 during real time process data exchanges. For high speed applications, choosing the correct mode can reduced the data transfer sizes, resulting in higher maximum update rates
MODE 0 I/O + ENCODER
MODE 1 I/O + ENCODER +ANALOG IN
MODE 2 I/O + ENCODER +ANALOG IN FAST DISPLAY

Pins:

(float out) .7i73.0.0.analoginN: Analogue inputs. Up to 8 channels may be available dependant on software and hardware configuration modes. (see the pdf manual downlaodable from www.mesanet.com)

(u32 in) .7i73.0.1.display (modes 1 and 2). Data for LCD display. This pin may be conveniently driven by the HAL "lcd" component which allows the formatted display of the values any number of HAL pins and textual content.

(u32 in) .7i73.0.1.display32 (mode 2 only). 4 bytes of data for LCD display. This mode is not supported by the HAL "lcd" component.

(s32 out) .7i73.0.1.encN: The position of the MPG encoder counters.

(bit out) .7i73.0.1.input−NN: Up to 24 digital inputs (dependent on config)

(bit out) .7i73.0.1.input−NN−not: Inverted copy of the digital inputs

(bit in) .7i73.0.1.output−NN: Up to 22 digital outputs (dependent on config)

Parameters:

(u32 ro) .7i73.0.1.nvanalogfilter:
(u32 ro) .7i73.0.1.nvbaudrate
(u32 ro) .7i73.0.1.nvcontrast
(u32 ro) .7i73.0.1.nvdispmode
(u32 ro) .7i73.0.1.nvencmode0
(u32 ro) .7i73.0.1.nvencmode1
(u32 ro) .7i73.0.1.nvencmode2
(u32 ro) .7i73.0.1.nvencmode3
(u32 ro) .7i73.0.1.nvkeytimer
(u32 ro) .7i73.0.1.nvunitnumber

(u32 ro) .7i73.0.1.nvwatchdogtimeout
(u32 ro) .7i73.0.1.output−00−invert

For further details of the use of the above see the Mesa manual.

(bit rw) .7i73.0.1.output−01−invert: Invert the corresponding output bit.

(s32 ro) .7i73.0.1.swrevision: The version of firmware installed.

TODO: Add 7i77, 7i66, 7i72, 7i83, 7i84, 7i87.

NAME

stepgen − software step pulse generation

SYNOPSIS

loadrt stepgen step_type=*type0*[,*type1*...] [**ctrl_type=***type0*[,*type1*...]] [**user_step_type=#,#**...]

DESCRIPTION

stepgen is used to control stepper motors. The maximum step rate depends on the CPU and other factors, and is usually in the range of 5KHz to 25KHz. If higher rates are needed, a hardware step generator is a better choice.

stepgen has two control modes, which can be selected on a channel by channel basis using **ctrl_type**. Possible values are "**p**" for position control, and "**v**" for velocity control. The default is position control, which drives the motor to a commanded position, subject to acceleration and velocity limits. Velocity control drives the motor at a commanded speed, again subject to accel and velocity limits. Usually, position mode is used for machine axes. Velocity mode is reserved for unusual applications where continuous movement at some speed is desired, instead of movement to a specific position. (Note that velocity mode replaces the former component **freqgen**.)

stepgen can control a maximum of 16 motors. The number of motors/channels actually loaded depends on the number of *type* values given. The value of each *type* determines the outputs for that channel. Position or velocity mode can be individually selected for each channel. Both control modes support the same 16 possible step types.

By far the most common step type is ’0’, standard step and direction. Others include up/down, quadrature, and a wide variety of three, four, and five phase patterns that can be used to directly control some types of motor windings. (When used with appropriate buffers of course.)

Some of the stepping types are described below, but for more details (including timing diagrams) see the **stepgen** section of the HAL reference manual.

type 0: step/dir
: Two pins, one for step and one for direction. **make−pulses** must run at least twice for each step (once to set the step pin true, once to clear it). This limits the maximum step rate to half (or less) of the rate that can be reached by types 2-14. The parameters **steplen** and **stepspace** can further lower the maximum step rate. Parameters **dirsetup** and **dirhold** also apply to this step type.

type 1: up/down
: Two pins, one for ’step up’ and one for ’step down’. Like type 0, **make−pulses** must run twice per step, which limits the maximum speed.

type 2: quadrature
: Two pins, phase−A and phase−B. For forward motion, A leads B. Can advance by one step every time **make−pulses** runs.

type 3: three phase, full step
: Three pins, phase−A, phase−B, and phase−C. Three steps per full cycle, then repeats. Only one phase is high at a time - for forward motion the pattern is A, then B, then C, then A again.

type 4: three phase, half step
: Three pins, phases A through C. Six steps per full cycle. First A is high alone, then A and B together, then B alone, then B and C together, etc.

types 5 through 8: four phase, full step
: Four pins, phases A through D. Four steps per full cycle. Types 5 and 6 are suitable for use with unipolar steppers, where power is applied to the center tap of each winding, and four open-collector transistors drive the ends. Types 7 and 8 are suitable for bipolar steppers, driven by two H-bridges.

types 9 and 10: four phase, half step
: Four pins, phases A through D. Eight steps per full cycle. Type 9 is suitable for unipolar drive, and type 10 for bipolar drive.

types 11 and 12: five phase, full step
: Five pins, phases A through E. Five steps per full cycle. See HAL reference manual for the patterns.

types 13 and 14: five phase, half step
: Five pins, phases A through E. Ten steps per full cycle. See HAL reference manual for the patterns.

type 15: user-specified
: This uses the waveform specified by the **user_step_type** module parameter, which may have up to 10 steps and 5 phases.

FUNCTIONS

stepgen.make−pulses (no floating-point)
: Generates the step pulses, using information computed by **update−freq**. Must be called as frequently as possible, to maximize the attainable step rate and minimize jitter. Operates on all channels at once.

stepgen.capture−position (uses floating point)
: Captures position feedback value from the high speed code and makes it available on a pin for use elsewhere in the system. Operates on all channels at once.

stepgen.update−freq (uses floating point)
: Accepts a velocity or position command and converts it into a form usable by **make−pulses** for step generation. Operates on all channels at once.

PINS

stepgen.*N*.counts s32 out
: The current position, in counts, for channel *N*. Updated by **capture−position**.

stepgen.*N*.position−fb float out
: The current position, in length units (see parameter **position−scale**). Updated by **capture−position**. The resolution of **position−fb** is much finer than a single step. If you need to see individual steps, use **counts**.

stepgen.*N*.enable bit in
: Enables output steps - when false, no steps are generated.

stepgen.*N*.velocity−cmd float in (velocity mode only)
: Commanded velocity, in length units per second (see parameter **position−scale**).

stepgen.*N*.position−cmd float in (position mode only)
: Commanded position, in length units (see parameter **position−scale).**

stepgen.*N*.step bit out (step type 0 only)
: Step pulse output.

stepgen.*N*.dir bit out (step type 0 only)
: Direction output: low for forward, high for reverse.

stepgen.*N*.up bit out (step type 1 only)
: Count up output, pulses for forward steps.

stepgen.*N*.down bit out (step type 1 only)
: Count down output, pulses for reverse steps.

stepgen.*N*.phase−A thru **phase−E** bit out (step types 2-14 only)
: Output bits. **phase−A** and **phase−B** are present for step types 2-14, **phase−C** for types 3-14, **phase−D** for types 5-14, and **phase−E** for types 11-14. Behavior depends on selected stepping

type.

PARAMETERS

stepgen.*N*.frequency float ro
The current step rate, in steps per second, for channel *N*.

stepgen.*N*.maxaccel float rw
The acceleration/deceleration limit, in length units per second squared.

stepgen.*N*.maxvel float rw
The maximum allowable velocity, in length units per second. If the requested maximum velocity cannot be reached with the current combination of scaling and **make−pulses** thread period, it will be reset to the highest attainable value.

stepgen.*N*.position−scale float rw
The scaling for position feedback, position command, and velocity command, in steps per length unit.

stepgen.*N*.rawcounts s32 ro
The position in counts, as updated by **make−pulses**. (Note: this is updated more frequently than the **counts** pin.)

stepgen.*N*.steplen u32 rw
The length of the step pulses, in nanoseconds. Measured from rising edge to falling edge.

stepgen.*N*.stepspace u32 rw (step types 0 and 1 only) The minimum
space between step pulses, in nanoseconds. Measured from falling edge to rising edge. The actual time depends on the step rate and can be much longer. If **stepspace** is 0, then **step** can be asserted every period. This can be used in conjunction with **hal_parport**'s auto-resetting pins to output one step pulse per period. In this mode, **steplen** must be set for one period or less.

stepgen.*N*.dirsetup u32 rw (step type 0 only)
The minimum setup time from direction to step, in nanoseconds periods. Measured from change of direction to rising edge of step.

stepgen.*N*.dirhold u32 rw (step type 0 only)
The minimum hold time of direction after step, in nanoseconds. Measured from falling edge of step to change of direction.

stepgen.*N*.dirdelay u32 rw (step types 1 and higher only)
The minimum time between a forward step and a reverse step, in nanoseconds.

TIMING

There are five timing parameters which control the output waveform. No step type uses all five, and only those which will be used are exported to HAL. The values of these parameters are in nano-seconds, so no recalculation is needed when changing thread periods. In the timing diagrams that follow, they are identfied by the following numbers:

(1) **stepgen.n.steplen**

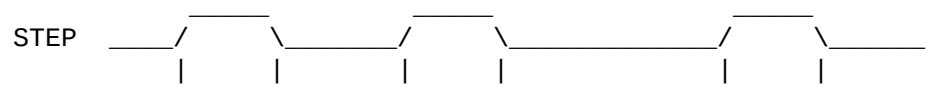
(2) **stepgen.n.stepspace**

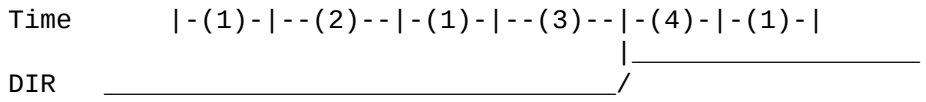
(3) **stepgen.n.dirhold**

(4) **stepgen.n.dirsetup**

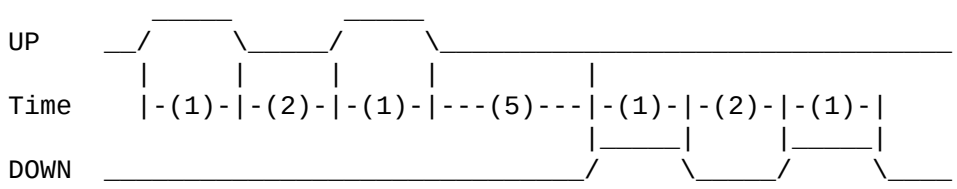
(5) **stepgen.n.dirdelay**

For step type 0, timing parameters 1 thru 4 are used. The following timing diagram shows the output waveforms, and what each parameter adjusts.





For step type 1, timing parameters 1, 2, and 5 are used. The following timing diagram shows the output waveforms, and what each parameter adjusts.



For step types 2 and higher, the exact pattern of the outputs depends on the step type (see the HAL manual for a full listing). The outputs change from one state to another at a minimum interval of **steplen**. When a direction change occurs, the minimum time between the last step in one direction and the first in the other direction is the sum of **steplen** and **dirdelay**.

SEE ALSO

The HAL User Manual.

NAME

steptest − Used by Stepconf to allow testing of acceleration and velocity values for an axis.

SYNOPSIS

loadrt steptest [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

steptest.*N*

(requires a floating-point thread)

PINS

steptest.*N***.jog-minus**
bit in Drive TRUE to jog the axis in its minus direction

steptest.*N***.jog-plus**
bit in Drive TRUE to jog the axis in its positive direction

steptest.*N***.run**
bit in Drive TRUE to run the axis near its current position_fb with a trapezoidal velocity profile

steptest.*N***.maxvel**
float in Maximum velocity

steptest.*N***.maxaccel**
float in Permitted Acceleration

steptest.*N***.amplitude**
float in Approximate amplitude of positions to command during 'run'

steptest.*N***.dir**
s32 in Direction from central point to test: 0 = both, 1 = positive, 2 = negative

steptest.*N***.position-cmd**
float out

steptest.*N***.position-fb**
float in

steptest.*N***.running**
bit out

steptest.*N***.run-target**
float out

steptest.*N***.run-start**
float out

steptest.*N***.run-low**
float out

steptest.*N***.run-high**
float out

steptest.*N***.pause**
s32 in (default: *0*) pause time for each end of run in seconds

PARAMETERS

steptest.*N***.epsilon**
float rw (default: *.001*)

steptest.*N***.elapsed**
float r Current value of the internal timer

LICENSE

GPL

NAME

streamer − stream file data into HAL in real time

SYNOPSIS

loadrt streamer depth=*depth1[,depth2...]* **cfg**=*string1[,string2...]*

DESCRIPTION

streamer and **halstreamer(1)** are used together to stream data from a file into the HAL in real time. **streamer** is a realtime HAL component that exports HAL pins and creates a FIFO in shared memory. **hal_streamer** is a user space program that copies data from stdin into the FIFO, so that **streamer** can write it to the HAL pins.

OPTIONS

depth=*depth1[,depth2...]*

Sets the depth of the userârealtime FIFO that **streamer** creates to receive data from **hal-streamer**. Multiple values of *depth* (separated by commas) can be specified if you need more than one FIFO (for example if you want to stream data from two different realtime threads).

cfg=*string1[,string2...]*

Defines the set of HAL pins that **streamer** exports and later writes data to. One *string* must be supplied for each FIFO, separated by commas. **streamer** exports one pin for each character in *string*. Legal characters are:

- **F**, **f** (float pin)
- **B**, **b** (bit pin)
- **S**, **s** (s32 pin)
- **U**, **u** (u32 pin)

FUNCTIONS

streamer.*N*

One function is created per FIFO, numbered from zero.

PINS

streamer.*N*.**pin**.*M* output

Data from column *M* of the data in FIFO *N* appears on this pin. The pin type depends on the config string.

streamer.*N*.**curr−depth** s32 output

Current number of samples in the FIFO. When this reaches zero, new data will no longer be written to the pins.

streamer.*N*.**empty** bit output

TRUE when the FIFO *N* is empty, FALSE when valid data is available.

streamer.*N*.**enable** bit input

When TRUE, data from FIFO *N* is written to the HAL pins. When false, no data is transferred. Defaults to TRUE.

streamer.*N*.**underruns** s32 read/write

The number of times that **sampler** has tried to write data to the HAL pins but found no fresh data in the FIFO. It increments whenever **empty** is true, and can be reset by the **setp** command.

streamer.*N*.*clock bit input
Clock for data as specified by the clock−mode pin

streamer.*N*.*clock−mode s32 input
Defines behavior of clock pin:

- 0 (**default**) free run at every iteration
- 1 clock on falling edge of clock pin
- 2 clock on rising edge of clock pin
- 3 clock on any edge of clock pin

SEE ALSO

halstreamer(1) **sampler**(9) **halsampler**(1)

BUGS

Should an enable HAL pin be added, to allow streaming to be turned on and off?

AUTHOR

Original version by John Kasunich, as part of the LinuxCNC project. Improvements by several other members of the LinuxCNC development team.

REPORTING BUGS

Report bugs to jmkasunich AT users DOT sourceforge DOT net

COPYRIGHT

NAME

sum2 − Sum of two inputs (each with a gain) and an offset

SYNOPSIS

loadrt sum2 [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

sum2.*N*

(requires a floating-point thread)

PINS

sum2.*N***.in0**

float in

sum2.*N***.in1**

float in

sum2.*N***.out**

float out out = in0 * gain0 + in1 * gain1 + offset

PARAMETERS

sum2.*N***.gain0**

float rw (default: *1.0*)

sum2.*N***.gain1**

float rw (default: *1.0*)

sum2.*N***.offset**

float rw

LICENSE

GPL

NAME

supply − set output pins with values from parameters (obsolete)

SYNOPSIS

loadrt supply num_chan=*num*

DESCRIPTION

supply was used to allow the inputs of other HAL components to be manipulated for testing purposes. When it was written, the only way to set the value of an input pin was to connect it to a signal and connect that signal to an output pin of some other component, and then let that component write the pin value. **supply** was written to be that "other component". It reads values from parameters (set with the HAL command **setp**) and writes them to output pins.

Since **supply** was written, the **setp** command has been modified to allow it to set unconnected pins as well as parameters. In addition, the **sets** command was added, which can directly set HAL signals, as long as there are no output pins connected to them. Therefore, **supply** is obsolete.

supply supports a maximum of eight channels. The number of channels actually loaded is set by the **num_chan** argument when the module is loaded. If **numchan** is not specified, the default value is one.

FUNCTIONS

supply.*N*.update (uses floating-point)
Updates output pins for channel *N*.

PINS

supply.*N*.q bit out
Output bit, copied from parameter **supply.*N*.d**.

supply.*N*._q bit out
Output bit, inverted copy of parameter **supply.*N*.d**.

supply.*N*.variable float out
Analog output, copied from parameter **supply.*N*.value**.

supply.*N*._variable float out
Analog output, equal to −1.0 times parameter **supply.*N*.value**.

supply.*N*.d bit rw
Data source for **q** and **_q** output pins.

supply.*N*.value bit rw
Data source for **variable** and **_variable** output pins.

NAME

thc − Torch Height Control

SYNOPSIS

loadrt thc

DESCRIPTION

Torch Height Control Mesa THC > Encoder > LinuxCNC THC component

The Mesa THC sends a frequency based on the voltage detected to the encoder. The velocity from the encoder is converted to volts with the velocity scale parameter inside the THC component.

The THCAD card sends a frequency at 0 volts so the scale offset parameter is used to zero the calculated voltage.

Component Functions If enabled and torch is on and X + Y velocity is within tolerance of set speed allow the THC to offset the Z axis as needed to maintain voltage.

If enabled and torch is off and the Z axis is moving up remove any correction at a rate not to exceed the rate of movement of the Z axis.

If enabled and torch is off and there is no correction pass the Z position and feed back untouched.

If not enabled pass the Z position and feed back untouched.

Physical Connections
Plasma Torch Arc Voltage Signal => 6 x 487k 1% resistors => THC Arc Voltage In
THC Frequency Signal => Encoder #0, pin A (Input)
Plasma Torch Arc OK Signal => input pin
output pin => Plasma Torch Start Arc Contacts

HAL Plasma Connections
encoder.nn.velocity => thc.encoder-vel (tip voltage)
spindle.0.on => output pin (start the arc)
thc.arc-ok <= motion.digital-in-00 <= input pin (arc ok signal)

HAL Motion Connections
thc.requested-vel <= motion.requested-vel
thc.current-vel <= motion.current-vel

FUNCTIONS

thc (requires a floating-point thread)

PINS

thc.encoder-vel
float in Connect to hm2_5i20.0.encoder.00.velocity

thc.current-vel
float in Connect to motion.current-vel

thc.requested-vel
float in Connect to motion.requested-vel

thc.volts-requested
float in Tip Volts current_vel >= min_velocity requested

thc.vel-tol
float in Velocity Tolerance (Corner Lock)

thc.torch-on
bit in Connect to spindle.N.on

thc.arc-ok
bit in Arc OK from Plasma Torch

thc.enable
bit in Enable the THC, if not enabled Z position is passed through

thc.z-pos-in
float in Z Motor Position Command in from axis.n.motor-pos-cmd

thc.z-pos-out
float out Z Motor Position Command Out

thc.z-fb-out
float out Z Position Feedback to Axis

thc.volts
float out The Calculated Volts

thc.vel-status
bit out When the THC thinks we are at requested speed

thc.offset-value
float out The Current Offset

PARAMETERS

thc.vel-scale
float rw The scale to convert the Velocity signal to Volts

thc.scale-offset
float rw The offset of the velocity input at 0 volts

thc.velocity-tol
float rw The deviation percent from planned velocity

thc.voltage-tol
float rw The deviation of Tip Voltage before correction takes place

thc.correction-vel
float rw The amount of change in user units per period to move Z to correct

AUTHOR

John Thornton

LICENSE

GPLv2 or greater

NAME

thcud − Torch Height Control Up/Down Input

SYNOPSIS

loadrt thcud

DESCRIPTION

Torch Height Control This THC takes either an up or a down input from a THC

If enabled and torch is on and X + Y velocity is within tolerance of set speed allow the THC to offset the Z axis as needed to maintain voltage.

If enabled and torch is off and the Z axis is moving up remove any correction at a rate not to exceed the rate of movement of the Z axis.

If enabled and torch is off and there is no correction pass the Z position and feed back untouched.

If not enabled pass the Z position and feed back untouched.

Typical Physical Connections using a Parallel Port
Parallel Pin 12 <= THC controller Plasma Up
Parallel Pin 13 <= THC controller Plasma Down
Parallel Pin 15 <= Plasma Torch Arc Ok Signal
Parallel Pin 16 => Plasma Torch Start Arc Contacts

HAL Plasma Connections
net torch-up thcud.torch-up <= parport.0.pin-12-in
net torch-down thcud.torch-down <= parport.0.pin-13-in
net torch-on spindle.0.on => parport.0.pin-16-out (start the arc)
net arc-ok thcud.arc-ok <= motion.digital-in-00 <= parport.0.pin-15-in (arc ok signal)

HAL Motion Connections
net requested-vel thcud.requested-vel <= motion.requested-vel
net current-vel thcud.current-vel <= motion.current-vel

Pyvcp Connections In the xml file you need something like:

```
<pyvcp>
<checkbutton>
  <text>"THC Enable"</text>
  <halpin>"thc-enable"</halpin>
</checkbutton>
</pyvcp>
```

Connect the Pyvcp pins in the postgui.hal file like this:

net thc-enable thcud.enable <= pyvcp.thc-enable

FUNCTIONS

thcud (requires a floating-point thread)

PINS

thcud.torch-up
bit in Connect to an input pin

thcud.torch-down
bit in Connect to input pin

thcud.current-vel
float in Connect to motion.current-vel

thcud.requested-vel
float in Connect to motion.requested-vel

thcud.torch-on
bit in Connect to spindle.N.on

thcud.arc-ok
bit in Arc Ok from Plasma Torch

thcud.enable
bit in Enable the THC, if not enabled Z position is passed through

thcud.z-pos-in
float in Z Motor Position Command in from axis.n.motor-pos-cmd

thcud.z-pos-out
float out Z Motor Position Command Out

thcud.z-fb-out
float out Z Position Feedback to Axis

thcud.cur-offset
float out The Current Offset

thcud.vel-status
bit out When the THC thinks we are at requested speed

thcud.removing-offset
bit out Pin for testing

PARAMETERS

thcud.velocity-tol
float rw The deviation percent from planned velocity

thcud.correction-vel
float rw The Velocity to move Z to correct

AUTHOR

John Thornton

LICENSE

GPLv2 or greater

NAME

threads − creates hard realtime HAL threads

SYNOPSIS

loadrt threads name1=*name* **period1=***period* [**fp1=**<**0**|**1**>] [<thread-2-info>] [<thread-3-info>]

DESCRIPTION

threads is used to create hard realtime threads which can execute HAL functions at specific intervals. It is not a true HAL component, in that it does not export any functions, pins, or parameters of its own. Once it has created one or more threads, the threads stand alone, and the **threads** component can be unloaded without affecting them. In fact, it can be unloaded and then reloaded to create additional threads, as many times as needed.

threads can create up to three realtime threads. Threads must be created in order, from fastest to slowest. Each thread is specified by three arguments. **name1** is used to specify the name of the first thread (thread 1). **period1** is used to specify the period of thread 1 in nanoseconds. Both *name* and *period* are required. The third argument, **fp1** is optional, and is used to specify if thread 1 will be used to execute floating point code. If not specified, it defaults to **1**, which means that the thread will support floating point. Specify **0** to disable floating point support, which saves a small amount of execution time by not saving the FPU context. For additional threads, **name2**, **period2**, **fp2**, **name3**, **period3**, and **fp3** work exactly the same. If more than three threads are needed, unload threads, then reload it to create more threads.

FUNCTIONS

None

PINS

None

PARAMETERS

None

BUGS

The existence of **threads** might be considered a bug. Ideally, creation and deletion of threads would be done directly with **halcmd** commands, such as "**newthread** *name period*", "**delthread** *name*", or similar. However, limitations in the current HAL implementation require thread creation to take place in kernel space, and loading a component is the most straightforward way to do that.

NAME

threadtest − LinuxCNC HAL component for testing thread behavior

SYNOPSIS

loadrt threadtest [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

threadtest.*N*.increment

threadtest.*N*.reset

PINS

threadtest.*N*.count
u32 out

LICENSE

GPL

NAME

time − Time on in Hours, Minutes, Seconds

SYNOPSIS

loadrt time [count=*N***|names=***name1***[,***name2***...]]**

DESCRIPTION

Time

When the time.N.start bit goes true the cycle timer resets and starts to time until time.N.start goes false. If you connect time.N.start to halui.is-running as a cycle timer it will reset during a pause. See the example connections below to keep the timer timing during a pause.

Time returns the hours, minutes, and seconds that time.N.start is true.

Sample pyVCP code to display the hours:minutes:seconds.

```
<pyvcp>
 <hbox>
 <label>
   <text>"Cycle Time"</text>
   <font>("Helvetica",14)</font>
 </label>
 <u32>
    <halpin>"time-hours"</halpin>
    <font>("Helvetica",14)</font>
    <format>"2d"</format>
 </u32>
 <label>
   <text>":"</text>
   <font>("Helvetica",14)</font>
 </label>
 <u32>
    <halpin>"time-minutes"</halpin>
    <font>("Helvetica",14)</font>
    <format>"2d"</format>
 </u32>
 <label>
   <text>":"</text>
   <font>("Helvetica",14)</font>
 </label>
 <u32>
    <halpin>"time-seconds"</halpin>
    <font>("Helvetica",14)</font>
    <format>"2d"</format>
 </u32>
 </hbox> </pyvcp>
```

In your post-gui.hal file you might use the following to connect it up

```
loadrt time
loadrt not
addf time.0 servo-thread
addf not.0 servo-thread
net prog-running not.0.in <= halui.program.is-idle
```

```
net cycle-timer time.0.start <= not.0.out
net cycle-seconds pyvcp.time-seconds <= time.0.seconds
net cycle-minutes pyvcp.time-minutes <= time.0.minutes
net cycle-hours pyvcp.time-hours <= time.0.hours
```

FUNCTIONS

time.*N* (requires a floating-point thread)

PINS

time.*N*.start
bit in Timer On

time.*N*.seconds
u32 out Seconds

time.*N*.minutes
u32 out Minutes

time.*N*.hours
u32 out Hours

AUTHOR

John Thornton

LICENSE

GPL

NAME

timedelay − The equivalent of a time-delay relay

SYNOPSIS

loadrt timedelay [count=*N***|names=***name1***[,***name2...***]]**

FUNCTIONS

timedelay.*N*

(requires a floating-point thread)

PINS

timedelay.*N***.in**

bit in

timedelay.*N***.out**

bit out Follows the value of **in** after applying the delays **on-delay** and **off-delay**.

timedelay.*N***.on-delay**

float in (default: *0.5*) The time, in seconds, for which **in** must be **true** before **out** becomes **true**

timedelay.*N***.off-delay**

float in (default: *0.5*) The time, in seconds, for which **in** must be **false** before **out** becomes **false**

timedelay.*N***.elapsed**

float out Current value of the internal timer

AUTHOR

Jeff Epler, based on works by Stephen Wille Padnos and John Kasunich

LICENSE

GPL

NAME

timedelta − LinuxCNC HAL component that measures thread scheduling timing behavior

SYNOPSIS

loadrt timedelta [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

timedelta.*N*

PINS

timedelta.*N***.out**
s32 out
timedelta.*N***.err**
s32 out (default: *0*)
timedelta.*N***.min**
s32 out (default: *0*)
timedelta.*N***.max**
s32 out (default: *0*)
timedelta.*N***.jitter**
s32 out (default: *0*)
timedelta.*N***.avg-err**
float out (default: *0*)
timedelta.*N***.reset**
bit in

LICENSE

GPL

NAME

toggle − ’push-on, push-off’ from momentary pushbuttons

SYNOPSIS

loadrt toggle [count=*N***|names=***name1***[,***name2...***]]**

FUNCTIONS

toggle.*N*

PINS

toggle.*N***.in**
bit in button input

toggle.*N***.out**
bit io on/off output

PARAMETERS

toggle.*N***.debounce**
u32 rw (default: *2*) debounce delay in periods

LICENSE

GPL

NAME

toggle2nist − toggle button to nist logic

SYNOPSIS

loadrt toggle2nist [count=*N***|names=***name1***[,***name2...***]]**

DESCRIPTION

toggle2nist can be used with a momentary push button connected to a toggle component to control a device that has separate on and off inputs and has an is-on output. If in changes states via the toggle output
If is-on is true then on is false and off is true.
If is-on is false the on true and off is false.

FUNCTIONS

toggle2nist.*N*

PINS

toggle2nist.*N***.in**
bit in
toggle2nist.*N***.is-on**
bit in
toggle2nist.*N***.on**
bit out
toggle2nist.*N***.off**
bit out

LICENSE

GPL

NAME

tristate_bit − Place a signal on an I/O pin only when enabled, similar to a tristate buffer in electronics

SYNOPSIS

loadrt tristate_bit [count=*N*|**names=***name1*[**,***name2...*]]

FUNCTIONS

tristate-bit.*N*

If **enable** is TRUE, copy **in** to **out**.

PINS

tristate-bit.*N***.in**
bit in Input value

tristate-bit.*N***.out**
bit io Output value

tristate-bit.*N***.enable**
bit in When TRUE, copy in to out

LICENSE

GPL

NAME

tristate_float − Place a signal on an I/O pin only when enabled, similar to a tristate buffer in electronics

SYNOPSIS

loadrt tristate_float [count=*N***|names=***name1***[,***name2...***]]**

FUNCTIONS

tristate-float.*N*

(requires a floating-point thread) If **enable** is TRUE, copy **in** to **out**.

PINS

tristate-float.*N***.in**

float in Input value

tristate-float.*N***.out**

float io Output value

tristate-float.*N***.enable**

bit in When TRUE, copy in to out

LICENSE

GPL

NAME

updown − Counts up or down, with optional limits and wraparound behavior

SYNOPSIS

loadrt updown [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

updown.*N*

Process inputs and update count if necessary

PINS

updown.*N***.countup**
bit in Increment count when this pin goes from 0 to 1

updown.*N***.countdown**
bit in Decrement count when this pin goes from 0 to 1

updown.*N***.reset**
bit in Reset count when this pin goes from 0 to 1

updown.*N***.count**
s32 out The current count

PARAMETERS

updown.*N***.clamp**
bit rw If TRUE, then clamp the output to the min and max parameters.

updown.*N***.wrap**
bit rw If TRUE, then wrap around when the count goes above or below the min and max parameters. Note that wrap implies (and overrides) clamp.

updown.*N***.max**
s32 rw (default: *0x7FFFFFFF*) If clamp or wrap is set, count will never exceed this number

updown.*N***.min**
s32 rw If clamp or wrap is set, count will never be less than this number

LICENSE

GPL

NAME

watchdog − monitor multiple inputs for a "heartbeat"

SYNOPSIS

loadrt watchdog num_inputs=*N*

You must specify the number of inputs, from 1 to 32. Each input has a separate timeout value.

FUNCTIONS

process

Check all input pins for transitions, clear the **ok−out** pin if any input has no transition within its timeout period. This function does not use floating point, and should be added to a fast thread.

set−timeouts

Check for timeout changes, and convert the float timeout inputs to int values that can be used in **process**. This function also monitors **enable−in** for false to true transitions, and re-enables monitoring when such a transition is detected. This function does use floating point, and it is appropriate to add it to the servo thread.

PINS

watchdog.input−n bit in

Input number n. The inputs are numbered from 0 to **num_inputs**−1.

watchdog.enable−in bit in (default: *FALSE*)

If TRUE, forces out−ok to be false. Additionally, if a timeout occurs on any input, this pin must be set FALSE and TRUE again to re-start the monitoring of input pins.

watchdog.ok−out bit out (default: *FALSE*)

OK output. This pin is true only if enable−in is TRUE and no timeout has been detected. This output can be connected to the enable input of a **charge_pump** or **stepgen** (in v mode), to provide a heartbeat signal to external monitoring hardware.

PARAMETERS

watchdog.timeout−n float in

Timeout value for input number n. The inputs are numbered from 0 to **num_inputs**−1. The timeout is in seconds, and may not be below zero. Note that a timeout of 0.0 will likely prevent **ok−out** from ever becoming true. Also note that excessively long timeouts are relatively useless for monitoring purposes.

LICENSE

GPL

NAME

wcomp − Window comparator

SYNOPSIS

loadrt wcomp [count=*N***|names=***name1***[,***name2...***]]**

FUNCTIONS

wcomp.*N*

(requires a floating-point thread)

PINS

wcomp.*N***.in**

float in Value being compared

wcomp.*N***.min**

float in Low boundary for comparison

wcomp.*N***.max**

float in High boundary for comparison

wcomp.*N***.out**

bit out True if **in** is strictly between **min** and **max**

wcomp.*N***.under**

bit out True if **in** is less than or equal to **min**

wcomp.*N***.over**

bit out True if **in** is greater than or equal to **max**

NOTES

If **max** <= **min** then the behavior is undefined.

LICENSE

GPL

NAME

weighted_sum − convert a group of bits to an integer

SYNOPSIS

loadrt weighted_sum wsum_sizes=*size[,size,...]*

Creates weighted sum groups each with the given number of input bits (*size*).

DESCRIPTION

This component is a "weighted summer": Its output is the offset plus the sum of the weight of each TRUE input bit. The default value for each weight is 2ˆn where n is the bit number. This results in a binary to unsigned conversion.

There is a limit of 8 weighted summers and each may have up to 16 input bits.

FUNCTIONS

process_wsums (requires a floating point thread)

Read all input values and update all output values.

PINS

wsum.*N***.bit.***M***.in** bit in

The *m*'th input of weighted summer *n*.

wsum.*N***.hold** bit in

When TRUE, the *sum* output does not change. When FALSE, the *sum* output tracks the *bit* inputs according to the weights and offset.

wsum.*N***.sum** signed out

The output of the weighted summer

wsum.*N***.bit.***M***.weight** signed rw

The weight of the *m*'th input of weighted summer *n*. The default value is 2ˆ*m*.

wsum.*N***.offset** signed rw

The offset is added to the weights corresponding to all TRUE inputs to give the final sum.

NAME

wj200_vfd − Hitachi wj200 modbus driver

SYNOPSIS

wj200_vfd

PINS

wj200-vfd.*N*.commanded-frequency
float in Frequency of vfd

wj200-vfd.*N*.reverse
bit in 1 when reverse 0 when forward

wj200-vfd.*N*.run
bit in run the vfd

wj200-vfd.*N*.enable
bit in 1 to enable the vfd. 0 will remote trip the vfd, thereby disabling it.

wj200-vfd.*N*.is-running
bit out 1 when running

wj200-vfd.*N*.is-at-speed
bit out 1 when running at assigned frequency

wj200-vfd.*N*.is-ready
bit out 1 when vfd is ready to run

wj200-vfd.*N*.is-alarm
bit out 1 when vfd alarm is set

wj200-vfd.*N*.motor-current
float out Output current in amps

wj200-vfd.*N*.heatsink-temp
float out Temperature of drive heatsink

wj200-vfd.*N*.watchdog-out
bit out Alternates between 1 and 0 after every update cycle. Feed into a watchdog component to ensure vfd driver is communicating with the vfd properly.

PARAMETERS

wj200-vfd.*N*.mbslaveaddr
u32 rw Modbus slave address

LICENSE

GPLv2 or greater

NAME

xhc_hb04_util − xhc-hb04 convenience utility

SYNOPSIS

loadrt xhc_hb04_util [count=*N***|names=***name1***[,***name2***...]]**

DESCRIPTION

Provides logic for a start/pause button and an interface to **halui.program.is_paused**, **is_idle**, **is_running** to generate outputs for **halui.program.pause**, **resume**, **run**.

Includes 4 simple lowpass filters with **coef** and **scale** pins. The coef value should be 0 <= coef <=1, smaller coef values slow response. See the lowpass manpage for calculating the filter time constant ($ man lowpass).

FUNCTIONS

xhc-hb04-util.*N*

(requires a floating-point thread)

PINS

xhc-hb04-util.*N***.start-or-pause**
bit in

xhc-hb04-util.*N***.is-paused**
bit in

xhc-hb04-util.*N***.is-idle**
bit in

xhc-hb04-util.*N***.is-running**
bit in

xhc-hb04-util.*N***.pause**
bit out

xhc-hb04-util.*N***.resume**
bit out

xhc-hb04-util.*N***.run**
bit out

xhc-hb04-util.*N***.in0**
s32 in

xhc-hb04-util.*N***.in1**
s32 in

xhc-hb04-util.*N***.in2**
s32 in

xhc-hb04-util.*N***.in3**
s32 in

xhc-hb04-util.*N***.out0**
s32 out

xhc-hb04-util.*N***.out1**
s32 out

xhc-hb04-util.*N***.out2**
s32 out

xhc-hb04-util.*N***.out3**
s32 out

xhc-hb04-util.*N***.scale0**
float in (default: *1.0*)

xhc-hb04-util.*N*.scale1
float in (default: *1.0*)
xhc-hb04-util.*N*.scale2
float in (default: *1.0*)
xhc-hb04-util.*N*.scale3
float in (default: *1.0*)
xhc-hb04-util.*N*.coef0
float in (default: *1.0*)
xhc-hb04-util.*N*.coef1
float in (default: *1.0*)
xhc-hb04-util.*N*.coef2
float in (default: *1.0*)
xhc-hb04-util.*N*.coef3
float in (default: *1.0*)
xhc-hb04-util.*N*.divide-by-k-in
float in
xhc-hb04-util.*N*.divide-by-k-out
float out
xhc-hb04-util.*N*.k
float in (default: *1.0*)

LICENSE

GPL

NAME

xor2 − Two-input XOR (exclusive OR) gate

SYNOPSIS

loadrt xor2 [count=*N***|names=***name1***[,***name2***...]]**

FUNCTIONS

xor2.*N*

PINS

xor2.*N***.in0**
bit in

xor2.*N***.in1**
bit in

xor2.*N***.out**
bit out **out** is computed from the value of **in0** and **in1** according to the following rule:

in0=TRUE in1=FALSE
in0=FALSE in1=TRUE
out=TRUE

Otherwise,
out=FALSE

LICENSE

GPL