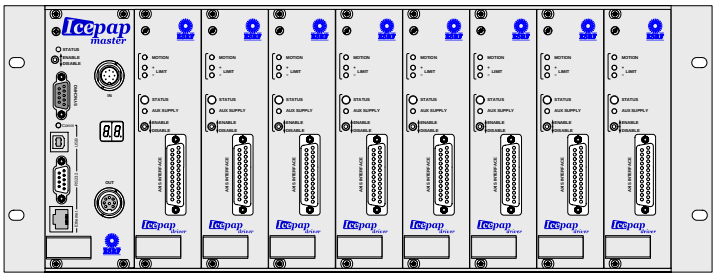
ESRF ISG

ESRF - Instrument Support Group

Icepap

Intelligent Controller for Positioning Applications

User Manual



DRAFT IN CONSTRUCTION

version 0.0a

Date	Version	Comments
19/02/2008	0.0a	Draft in construction

CONTENTS

MANUAL ORGANIZATION

This manual presents ….

Section 1 gives a brief overview of … The description is made in general terms and specific technical details are minimised.

Section 2 describes …. The connectors and signals functions of both front and rear panels are detailed.

Section 3 is dedicated to … in a *real world* setup.

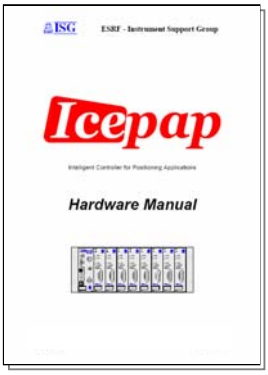
Section 4 covers the available commands to communicate with IcePAP systems.

Section 5 is intended to describe the programming aspects of ….

Related Documentation

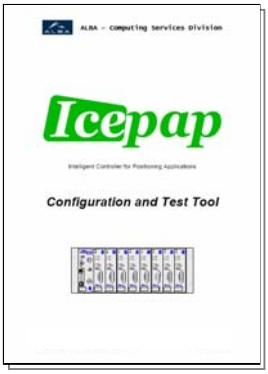
- *IcePAP Hardware Manual*

Presents in detail the components and functionality of the IcePAP system and provides a complete connector description.



- *IcePAP Configuration and Test Tool*

Describes the GUI tool used for driver configuration and testing.



1. INSTALLATION

1.1. System overview

IcePAP is a motor control system developed at the ESRF and optimised for high resolution position applications. An IcePAP system may drive up to 128 axes and integrates both control features, like trajectory generation, and the motor power management. Although motor control in IcePAP is axis-oriented, it includes system resources that allow the execution of synchronous multi-axis movements. In addition, all the position information signals are driven through internal multiplexers and can be sent to external devices to properly synchronise data acquisition during motion.

Besides high performance, IcePAP is fully software configurable and provides exhaustive diagnostic capabilities. Most of the functionality relies on programmable components what opens the possibility of adding new features by means of firmware upgrade.

Components

The IcePAP system is organised in racks. The mechanical support of each rack is provided by a 19” 3U crate that includes the power supply and an interconnection backplane with 9 slots.
The leftmost slot is wider than the other slots and must be always equipped with a controller board. The other slots may be equipped with 1 to 8 driver boards. Each driver board can operate a motorised axis.
The unused slots must be covered with blank front panel plates to avoid accidental access to energised parts.

Figure 1 depicts an IcePAP crate populated with 5 driver boards.

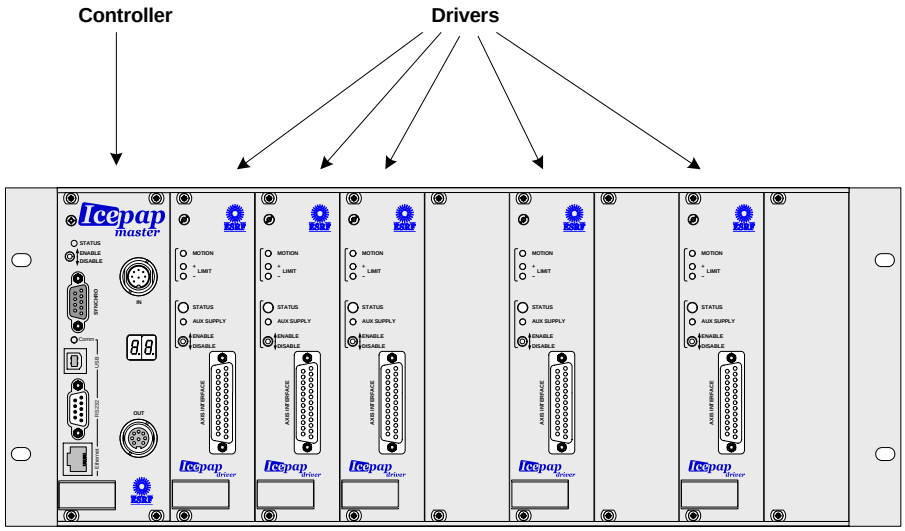


Figure 1: Example of a partially equipped IcePAP rack

Several racks can be connected to form a single multirack IcePAP system.
Each rack must be identified with a different number (0 to 15) that is visualised in a two-digit display at the controller front panel.
In a multirack system one of the controllers is the system master and takes care of communications and system management. The others are slaves.
Two types of controller boards: Master and slaves

If an multirack system includes more than one master board, the board in the rack with the lowest number operates as system master, the other master boards operate as slaves. Slave boards can never be configured or operate as system masters.

A more complete description of the IcePAP system and its hardware resources can be found in the *IcePAP Hardware Manual*.

1.2. Hardware connections and configuration

1.2.1. Rack number

Rotary switch (hexadecimal).
Controller must be extracted and rack power switched off (switch at the back).
Once the rack number is properly set, the controller board can be plugged in the leftmost slot.

1.2.2. Board installation (controllers and drivers)

No hardware configuration required. Driver configuration is implemented by software commands.

1.2.3. Rack links and termination

Multi-axis system needs rack links
lengths, wiring.
Bus terminator.

1.2.4. Rack disable

Each rack includes a disable connector at the rear panel that allows to disable remotely the motor power of all the driver boards in the rack.
If not used ([what happens?])

1.2.5. Communication links

Ethernet, serial (baudrate, wiring) (USB not implemented yet)

1.2.6. Motor and encoder connection

As described in the Hardware Manual.
Connecting the axis disable line is mandatory
Proper grounding and shielding.

1.2.7. Ventilation

IcePAP racks do not include internal fans of other method for forced ventilation. External ventilation may be necessary .

It is recommended that …
[At least the case of installation in closed 19” cabinets.]

1.3. Installation tips

- It is always useful to check ….
- Use ...

2. DRIVER CONFIGURATION

By software commands
Stored in non-volatile memory.
Use the configuration Tool

Commands: CONFIG, ?CONFIG, CFG, ?CFG, ?CFGINFO

2.1. Basic concepts

2.1.1. Motor types

Supported types

2.1.2. Axis resolution

Axis resolution.

2.2. Configuration parameters

ACTIVE { NO | YES } **Axis enable/disable flag**

This parameter marks a driver board as active or not. A non active driver is disabled, cannot be used to drive motors and rejects most of the power and motion related commands. The ACTIVE parameter does not reflects necessarily the actual state of a driver board can become not active (functionally disabled) if is moved to a icepap system. See xxx for more information.

PROTLEVEL <integer> **Protection level**

This value is not actually used by the icePAP drivers. It is provided as a way to store locally information about the level of protection that must be applied to the corresponding axis. This value is available to be used by the application software.

NAMELOCK { NO | YES } **Axis name lock**

If this flag is set to NO, the use of the NAME command to change the name of the driver board is not allowed.

POWERON { NO | YES } **Auto power on**

This flag instructs the driver board to switch the motor power on immediately after board initialisation. The flag has effect only if the driver is active.

MOTPHASES { 1 | 2 | 3 } **Number of electrical phases**
MOTPOLES <integer> **Number of pole pairs**

Configure the number of electrical phases and pole pairs of the motor. In case of rotary motors, the number of pole pairs corresponds to the number of electrical periods per motor turn.
In case of linear motors, the number of pole pairs corresponds to the number of electrical periods for a certain displacement distance. Such a distance will be adopted as the effective "*motor revolution*" for all internal calculations. All the configuration parameters that refer to motor turns will actually apply to such reference linear displacement.

MOTSENSE { NORMAL | INVERTED } **Sense of motor movement**

This value allows to invert the definition of positive direction for motor movements. Note that the limit switch signal Lim+ always blocks motion in the positive direction while Lim- blocks negative movements.

MREGMODE { EXT | CURR | TORQUE} **Motor regulation mode**

This value selects the type of power regulation in the motor. In the current firmware version only current regulation (CURR) is implemented. If this parameter is set to EXT, the board disables its internal power driver and assumes that the motor power is applied an external driver module.

NVOLT <float> **Nominal operation voltage (volts)**
IVOLT <float> **Idle operation voltage (volts)**
NCURR <float> **Nominal current (amps)**
ICURR <integer> **Idle current (%)**
BCURR <integer> **Boost current increment (%)**

This parameters set the motor voltage and current values. During movements, the driving voltage and phase current are set to NVOLT (in volts) and NCURR (in amps) respectively. When the motor is stopped the voltage and current are set IVOLT (in volts) and ICURR. Note that ICURR is not specified in amps, but in a given percentage of the nominal current NCURR.

It is possible to increase the phase current during acceleration phases by specifying a boost current increment BCURR greater than zero. BCURR is also specified in percentage of NCURR and adds to the nominal current.

CURRGAIN { CUSTOM | LOW | MEDIUM | HIGH } **Current regulation gain**
MREGP <float> **Proportional coefficient**
MREGI <float> **Integral coefficient**
MREGD <float> **Derivative coefficient**

MREGP, MREGI and MREGD are the PID coefficients used for motor current regulation. If CURRGAIN is set to CUSTOM, the PID values can be freely set. If CURRGAIN is set to LOW, MEDIUM or HIGH, the PID values are forced to predefined values.

INDEXER { INTERNAL | InPos | EncIn } **Default indexer source**

Selects if the axis must be operated by using the internal built-in indexer for trajectory generation or an external signal applied to InPos or EncIn inputs. This parameter refers to the default value, the actual indexer source can be changed during operation.

SHFTENC { NONE | InPos | EncIn | AbsEnc} **Shaft encoder**
TGTENC { NONE | InPos | EncIn | AbsEnc} **Target encoder**
CTRLENC { NONE | InPos | EncIn | AbsEnc} **Control encoder**

Select which input position signals will be used as shaft encoder, target encoder and control encoder. If any of these parameters is set to NONE the corresponding function is left unassigned.

POSSRC { INDEXER | SHFTENC | TGTENC } **Nominal axis position source**

Selects which functional signal, indexer, shaft encoder or target encoder, will be used to determine the nominal position of the axis.

ANTURN <integer> **Axis reference number of turns**
ANSTEP <integer> **Axis reference number of units/steps**

Defines the resolution of the axis by specifying the number of units/steps (ANSTEP) for a given number of motor turns (ANTURN). This resolution can be selected independently of the actual resolution of the signal selected as position source by the POSSRC parameter.

DEFVEL <float> **Default velocity**
DEFIVEL <float> **Default initial velocity**
DEFACCT <float> **Default acceleration time (sec)**

Configures the default values for velocity, initial velocity and acceleration time. The velocity values are specified in frequency referred to the indexer units/steps. The acceleration time is specified in seconds.

CTRLERROR <integer> **Maximum control encoder error**

Configures the ...

CLOOPENC { NONE | SHFTENC | TGTENC } **Default closed loop signal**
CLOOPTAU <float> **Position closed loop (sec)**
Selects the functional signal, shaft encoder or target encoder, that will be used to drive the axis in closed loop mode as well as the regulation time constant for position regulation.

LPPOL { NORMAL | INVERTED } **Polarity of the Lim+ signal**
LMPOL { NORMAL | INVERTED } **Polarity of the Lim- signal**
These parameters allow to invert the electrical polarity (logic value) of the limit switch signals. Note that these values do not change the functional assignment of the limit switches, Lim+ always blocks motion in the positive direction while Lim- blocks negative movements.

EINTURN <integer> **EncIn reference number of turns**
EINSTEP <integer> **EncIn reference number of units/steps**
INPNTURN <integer> **InPos reference number of turns**
INPNSTEP <integer> **InPos reference number of units/steps**
ABSNTURN <integer> **AbsEnc reference number of turns**
ABSNSTEP <integer> **AbsEnc reference number of units/steps**
Allow to define the resolution of the encoders connected to the physical encoder inputs: EncIn, InPos and AbsEnc. The resolution is defined by specifying the number of encoder units/steps (*encoder*NSTEP) for a given number of motor turns (*encoder*NTURN). This resolution must match the resolution of the encoders in the actual mechanics.

EINMODE { QUAD | PULSE+ | PULSE- } **EncIn input counting mode**
INPMODE { QUAD | PULSE+ | PULSE- } **InPos input counting mode**
Selects the input counting mode (quadrature counting or pulse/direction) for the incremental encoder signals connected to the position inputs EncIn and InPos. In the case of pulse/direction counting mode, it is possible to select if the incremental counting takes place at the rise edge (PULSE+) or the falling edge (PULSE+) of the pulse signal.

EINSENSE { NORMAL | INVERTED } **EncIn sense**
INPSENSE { NORMAL | INVERTED } **InPos sense**
Allows to change the sign of the incremental encoder signals EncIn and InPos. Inverting the sign of the incremental signal is equivalent to invert the sense of motion of the encoder.

ABSSENSE { NORMAL | INVERTED } **AbsEnc sense**
ABSOFSSET <integer> **AbsEnc position offset**
Allows to apply a sign inversion and an offset to the absolute encoder value read through the SSI encoder interface.

SSIDBITS <integer> **SSI data bits**
SSICODE { BINARY | GRAY } **SSI data coding**
SSISTATUS { S | .S | ES OS } **SSI status/control bits**
SSICLOCK { 125KHz | 250KHz | 500KHz | 1.25MHz | 2.5MHz | 5MHz | 12.5MHz | 25MHz | OFF} **SSI clock frequency**
SSIDELAY { 0 | 5us | 10us | 20us | 30us | 50us | 100us | 500us} **SSI polling delay**
Configuration parameter for the SSI interface.

OUTPSRC { AXIS | INDEXER | SHFTENC | TGTENC | InPos | EncIn | Sync} **OutPos source signal**
OUTPMODE { QUAD | PULSE+ | PULSE- } **OutPos output counting mode**
OUTPPULSE { 50ns | 200ns | 2us | 20us} **OutPos pulse width**
OUTPSENSE { NORMAL | INVERTED } **OutPos sense**
Configuration of the OutPos position output signal.

INFASRC { LOW | HIGH | Lim+ | Lim- | Home | EncAux | InpAux | SyncAux | ENABLE | ALARM | READY | MOVING | BOOST | STEADY}	**InfoA source signal**
INFBSRC { LOW | HIGH | Lim+ | Lim- | Home | EncAux | InpAux | SyncAux | ENABLE | ALARM | READY | MOVING | BOOST | STEADY}	**InfoB source signal**
INFCSRC { LOW | HIGH | Lim+ | Lim- | Home | EncAux | InpAux | SyncAux | ENABLE | ALARM | READY | MOVING | BOOST | STEADY}	**InfoC source signal**
INFAPOL { NORMAL | INVERTED }	**InfoA polarity**
INFBPOL { NORMAL | INVERTED }	**InfoB polarity**
INFCPOL { NORMAL | INVERTED }	**InfoC polarity**

Configuration of InfoA, InfoB and InfoC output signals.

3. OPERATION INSTRUCTIONS

This section deals with ...

3.1. Command basics

ASCII commands.

3.1.1. System Commands

…

3.1.2. Board Commands

...

3.2. Moving motors

3.3. Usage tips

Refer to Section 5.1 for all the commands mentioned below.

- It is quite common to have a situation where one wants to change an incremental encoder direction sign. This can be done easily by using the *INV* keyword in the correspondent channel configuration. Moreover, the *INV* keyword can be also used to change the polarity of the input signals (see the *CHCFG* command).

- It is always useful to check the …. The command allows .

4. COMMUNICATION PROTOCOL

4.1. Communication basics

This section covers the IcePAP communication protocol. The communication interface is implemented at the system master board.

Communication is achieved by bi-directional byte streams. Normal command and response messages are transferred as lines of printable ASCII characters. The only exception is the transfer of binary data blocks, a special feature described in 4.5.
Commands messages sent to IcePAP must be formatted as sequences of printable characters terminated by a "*carriage return*" (ASCII 0x0D). Any additional control character, like "*line feed*", is ignored.
Response messages produced by the device consist on lines terminated by a "*carriage return*" + "*line feed*" character sequence (ASCII 0x0D 0x0A).

4.1.1. System commands

Commands that ... These commands are prcessed by the system master.

4.1.2. Board commands

Commands addressed to specific boards. Both controller and drivers

4.1.3. Local driver interface

Each driver board has an individual communication port for diagnostic purposes. It can also be used for stand alone operation (no further discussed).

4.2. Interfaces

The master boards integrate three communication ports: an Ethernet interface, a serial line and an USB port. The characteristics of the different interfaces are the following:

Interface	*Type*	*Parameters*
Serial Line	**RS232**	9600bauds, No parity, 1 stop bit
Ethernet	**100baseT**	TCP sockets, port 5000
Universal Serial Bus	**USB 1.0**	Not implemented in the current version

4.3. Syntax conventions

In the most usual case remote control is implemented by an application program running in a host computer that sends commands and requests to the *isgdevice* as sequences of ASCII characters. The syntax rules are described below. See X for practical examples.

4.3.1. Commands and requests

- Command lines consist of a command keyword optionally followed by parameters.
  - The number and type of parameters depend on the particular command.
- Command keywords are not case sensitive.
  - The device converts internally all the characters to uppercase before any syntax checking. (TO BE DISCUSSED)

- Parameters are also converted to uppercase unless they are enclosed between double quotes (″ ″, ASCII 0x22). (TO BE DISCUSSED)

- Commands may be optionally preceded by the acknowledge character.
  - The acknowledge character is a hash symbol (#, ASCII 0x23) that must appear in the command line immediately before the first character of the command keyword.

- Normal (non query) commands never produce response messages unless the acknowledge character is used.
  - Non query command keywords always start by an alphabetical character (A to Z). Exceptions are binary transfer commands (see XX) that start by an asterisk character (*, ASCII 0x2A).
  - If the acknowledge character is used, the device produces the response string 0K if the command execution was successful.
  - If the acknowledge character is used and the command does not executes successfully, the device produces either the string ERROR or a string containing a human readable error message. The behaviour depends on the current setting of the *echo* mode (see 4.4).

- Requests are query commands that produce response messages from the device.
  - Requests keywords always start by a question mark character (?, ASCII 0x3F).
  - If the request is successful the content of the response message depends on the particular request.
  - If request fails the device produces either the string ERROR or a string containing a human readable error message. The behaviour depends on the current setting of the *echo* mode (see 4.4).
  - The acknowledge character has no effect when used with requests.

- Response messages consist of one or more ASCII character lines.
  - The way every line in a response message is terminated depends on the type of communication port (see **Error! Reference source not found.**).
  - A response message may contain either the output of a request, an acknowledgement keyword (0K or ERROR) or a human readable error message.
  - When a response message consists of more than one line, the first and last lines contain a single dollar character ($, ASCII 0x3F).

4.3.2. Addressing

- Board commands must be sent to the specific controller or drivers boards by using an addressing prefix. An addressing prefix consists of the board address in decimal format followed by a colon character (:, ASCII 0x3A). No spaces are allowed between the last address digit and the colon character.

- An addressing prefix consisting of only the colon character (:) with no address string is interpreted as a broadcast command. In that case the command is forwarded to all the boards in the system. Controller boards ignore broadcasts of driver-only commands as well as driver boards ignore controller-only broadcasts. No queries or acknowledge characters are allowed in broadcasts.

4.4. Terminal mode

When an IcePAP system is accessed through a serial port, two possible communication modes are available that can be selected with the commands `ECHO` and `NOECHO`. The differences between these two modes are described below. This commands can be issued through other interfaces (i.e. Ethernet) but they only have effect on the serial port.

Echo mode (terminal mode)

This mode should be used when the IcePAP master board is connected to a dumb terminal. In this case the user types commands on the keyboard and reads the answers and error messages on the terminal screen without computer intervention. This mode is usually not active by default and the user has to send the `ECHO` command every time the device is powered on.

In echo mode all the characters sent to the device are echoed back to the terminal. The device also sends human-readable messages to be printed on the terminal screen whenever an error is detected in commands or requests.
Case conversion takes place before the characters are sent back to the terminal, therefore characters are echoed back as uppercase even if they are typed and sent to the device as lowercase. (TO BE DISCUSSED)
In echo mode the backspace character (ASCII 0x08) has the effect of deleting the last character received by the device. In this way a minimum editing functionality is provided.

Noecho mode (host computer)

This is the default mode. In this case no characters are echoed and no error messages are returned by non-query commands unless they are explicitly requested by the acknowledge character. This mode is intended to be used when a program running in a host computer communicates with the controller, sending commands and analysing the answers.

4.5. Binary transfer

Binary transfer is a special mode that extends the standard protocol allowing faster data transfer. Binary blocks have a maximum size of 65535 data bytes (0xFFFF).

Binary transfer commands or requests are initiated by ASCII command lines that follow the same rules than ordinary commands or requests (see 4.3.1). The only difference is that binary transfer command lines must include an asterisk character (*, ASCII 0x2A) in the command or request keyword. Non-query commands keywords must start by an asterisk character. Request keywords must include the asterisk as the first character after the question mark.

Once the *isgdevice* has received the ASCII command line, the data is transferred as a binary block. In the case of non-query commands, the binary data block is sent from the host computer to the device. In case of binary requests, the device sends the binary block to the host (serial line) or puts it in its output buffer ready to be read by the host (GPIB).

If the device finds an error in a command line containing a binary request, instead of the binary block, it produces the string ERR0R.
The acknowledge character (`#`, ASCII 0x23) can be used in the same way that with non-binary commands. If it is included in a non-query command line, the device produces an acknowledgement keyword (`ERROR` or 0K) to signal if the command line contained errors or not. The acknowledge character has no effect in the case of binary requests.

Although binary transfer is initiated in the same way for both serial line and GPIB communication, the format of the binary data blocks and the management of the end of transfer condition are different in both cases.

4.5.1. Serial port binary blocks

In the case of transfer through a serial port, the binary block contains the binary data and 4 extra bytes. The structure of the block is the following:

byte Number	content
0	0xFF (signature)
1	DataSize (MSB)
2	DataSize (LSB)
3	data byte (first)
…	…
DataSize + 2	data byte (last)
DataSize + 3	Checksum

The first byte contains always the value 0xFF (255) and can be used the signature of the block. The next two bytes contain the number of data bytes to transfer. The last byte contains the check sum value that is used to verify data integrity.

The checksum value is calculated as the lower 8-bits of the sum of all the bytes in the binary block with exception of the signature byte (and the checksum byte itself).

4.5.2. TCP binary blocks

In the case of transfer by Ethernet, the binary block does not contain any additional control or protocol byte. Only the actual data bytes are transferred. The EOI line is asserted during the transfer of the last data byte to signal the end of the transmission.

5. COMMAND SET

BOARD COMMANDS

Command		Description	Controller	Driver	Page
	?ACTIVE	Query activation status		❒	21
	?MODE	Query board mode	❒	❒	46
	?STATUS	Query board status	❒	❒	61
CONFIG	?CONFIG	Manage configuration mode		❒	30
CFG	?CFG	Set/query configuration parameters		❒	26
	?CFGINFO	Query configuration parameter info		❒	28
	?VER	Query board version information	❒	❒	66
NAME	?NAME	Set/query board name		❒	48
	?ID	Query board identification	❒	❒	40
	?POST	Query power-on selftest results	❒	❒	52
POWER	?POWER	Set/query motor power state		❒	53
AUXPS	?AUXPS	Set/query auxiliary power supply state		❒	24
	?MEAS	Query measured value	❒	❒	44
POS	?POS	Set/query axis position in axis units	❒	❒	50
ENC	?ENC	Set/query axis position in encoder steps	❒	❒	33
VELOCITY	?VELOCITY	Set/query programmed axis velocity	❒	❒	65
ACCTIME	?ACCTIME	Set/query acceleration time	❒	❒	22
MOVE		Start absolute movement	❒	❒	47
RMOVE		Start relative movement	❒	❒	59
CMOVE		Start relative movement in configuration mode		❒	29
STOP		Stop movement	❒	❒	62
ABORT		Abort movement	❒	❒	20
INDEXER	?INDEXER	Set/query indexer signal source		❒	41
INFOA	?INFOA	Set/query InfoA signal source and polarity		❒	42
INFOB	?INFOB	Set/query InfoB signal source and polarity		❒	42
INFOC	?INFOC	Set/query InfoC signal source and polarity		❒	42
	?HELP	Query list of available commands	❒	❒	39
	?ERRMSG	Query last command error message	❒	❒	35
	?FERRMSG	Query first error message	❒	❒	36
BLINK	?BLINK	Set/query remaining blinking time	❒	❒	25
	?TIME	Query running time	❒	❒	64
DEBUG	?DEBUG	Set/query debug level	❒	❒	31
ECHO		Select echo mode		❒	32
NOECHO		Cancel echo mode		❒	49
	?MEMORY	Query available memory	❒	❒	45
	?ADDR	Query board address	❒	❒	23

SYSTEM COMMANDS

Command		Description	Page
MODE	?MODE	Set/query system mode	46
	?SYSSTAT	Query system configuration	63
	?STATUS	Query multiple board status	61
	?FSTATUS	Query multiple board fast status	38
REPORT	?REPORT	Set/query asynchronous report settings	55
	?VER	Query system firmware version information	66
	?RID	Query rack identification string	57
	?RTEMP	Query rack temperatures	60
*PROG PROG	?PROG	Firmware programming	54
RFPROG		Factory firmware programming	58
RESET		System or rack reset	56
POS	?POS	Set/query multiple axis position in axis units	50
ENC	?ENC	Set/query multiple axis position in encoder steps	33
	?FPOS	Query multiple board fast position	37
VELOCITY	?VELOCITY	Set/query programmed multiple axis velocity	65
ACCTIME	?ACCTIME	Set/query acceleration time	22
MOVE		Start multiple axis absolute movement	47
RMOVE		Start multiple axis relative movement	59
STOP		Stop multiple axis movement	62
ABORT		Abort movement	20
	?HELP	Query list of available commands	39
	?ERRMSG	Query last command error message	35
ECHO		Select serial line echo	32
NOECHO		Cancel serial line echo	49

5.1. Command reference

ABORT

Abort movement

Syntax:

<board_addr>:ABORT (board command)

or

ABORT [<axis1> <axis2> … <axisN>] (system command)

Description:

The ABORT command aborts all movement in the specified axis.

Examples:

Command: `16:ABORT`

Command: `ABORT` // abort all axes

Command: `ABORT 30 33 42`

?ACTIVE

Query activation status

Syntax:

<driver_addr>:?ACTIVE

Answer:

<driver_addr>:?ACTIVE { YES | NO }

Description:

Returns the current activation status of a driver board. A driver is active if ....

Examples:

Command: `16:?ACTIVE`

Answer: `16:?ACTIVE YES`

ACCTIME / ?ACCTIME

Set/query acceleration time

Syntax:

<board_addr>:ACCTIME [<accTime>] (board command)

or

ACCTIME <axis1> <accTime1> … <axisN> <accTimeN> (system command)

Description:

Sets the acceleration time for the corresponding axis to the <accTime> values in seconds. The actual acceleration for each axis is calculated internally based on the current value of the axis velocity (see VELOCITY command).

If no value is specified, the acceleration time is set to the default value.

The acceleration time is internally recalculated every time that the axis velocity changes.

Syntax:

<board_addr>:?ACCTIME (board command)

or

?ACCTIME <axis1> <axis2> … <axisN> (system command)

Answer:

<board_addr>:?ACCTIME <accTime> (board answer)

or

?ACCTIME <accTime1> <accTime2> … <accTimeN> (system answer)

Description:

Returns the current acceleration time of the specified axes in seconds.

Examples:

Command:	`16:?ACCTIME`
Answer:	`16:?ACCTIME 0.25`
Command:	`24:ACCTIME 0.1`
Command:	`?ACCTIME 16 24`
Answer:	`?ACCTIME 0.25 0.1`
Command:	`ACCTIME 16 0.1 17 0.2`

?ADDR

Query board address

Syntax:

<board_addr>:?ADDR

Answer:

<board_addr>:?ADDR <boardAddr>

Description:

The ?ADDR command returns the current board address. This command is only useful when the board is accessed through the local serial line interface.

Examples:

Command: `16:?ADDR`

Answer: `?ADDR 16` // useless information

Access through the local serial line interface:

Command: `? ADDR`

Answer: `?ADDR 16`

AUXPS / ?AUXPS

Set/query axis auxiliary power supply state

Syntax:

<driver_addr>:AUXPS [{ON | OFF}]

Description:

Switches on or off the auxiliary power supply in a driver board. When the auxiliary power supply is switched off, the motor power is also switched off.

Syntax:

<driver_addr>:?AUXPS

Answer:

<driver_addr>:?AUXPS [{ON | OFF}]

Description:

Returns the state of the auxiliary power supply of the driver board.

Examples:

Command: `83:?AUXPS`

Answer: `83:?AUXPS ON`

Command: `83:AUXPS OFF`

Command: `83:?AUXPS`

Answer: `83:?AUXPS OFF`

BLINK / ?BLINK

Set/query remaining blinking time

Syntax:

<board_addr>:BLINK <blinkTime>

Description:

If <blinkTime> is greater than zero, sets the board in blinking mode for a period given by <blinkTime> in seconds. If <blinkTime> is zero, this command stops blinking mode.

Syntax:

<board_addr>:?BLINK

Answer:

<board_addr>:?BLINK <remBlinkTime>

Description:

Returns the remaining blinking time.

Examples:

Command:	`83:BLINK 10`
Command:	`83:?BLINK`
Answer:	`83:?BLINK 8`
Command:	`83:?BLINK`
Answer:	`83:?BLINK 6`

CFG / ?CFG

Set/query configuration parameters

Syntax:

<driver_addr>:CFG <configPar> <configVal>

or

<driver_addr>:CFG {DEFAULT | EXPERT}

Description:

The CFG command allows to change the current values of the configuration parameters of a driver board. The driver has to be previously switched into configuration mode (see CONFIG command).

The configuration of driver boards as well as the list of available parameters is detailed in chapter 2.

If the CFG command is issued with the arguments DEFAULT or EXPERT. The command CFG DEFAULT instructs the driver board to revert all its configuration parameters to the default values.

The command CFG EXPERT sets an internal flag that can be read back with the ?CFG query. This flag has not any specific function in the IcePAP system but it is provided as an facility to external configuration tools to confirm the current driver configuration when the driver boards are moved among systems. As the expert flag is cleared by any other CFG command, it must be set immediately before the configuration is validated by the CONFIG command.

Syntax:

<driver_addr>:?CFG [<configPar> | EXPERT]

Answer:

<driver_addr>:?CFG <configPar> <configVal>

or

```
<driver_addr>:?CFG $
                  <configPar1> <configVal1>
                  <configPar2> <configVal2>
                      ...
                  <configParN> <configValN>
                  $
```

Description:

The ?CFG query returns the value <configVal> assigned to a particular configuration parameter <configPar>. If no parameter is specified, the query returns a multiline answer with the complete list of configuration parameters and their current values.

If the EXPERT keyword is used as a parameter name, the ?CFG query returns the value of the internal expert flag set by the CFG EXPERT command and cleared by any other CFG command. The value is returned as a YES/NO boolean value. Note however that EXPERT is not a configuration parameter.

Examples:

Command: `15:CFG DEFAULT`

Command: `15:?CFG NCURR`

Answer: `15:?CFG NCURR 0.1`

Command: `15:CFG NCURR 2.4`

Command: `15:?CFG`

Answer:
```
15:?CFG $
ACTIVE NO
PROTLEVEL 0
NAMELOCK NO
POWERON NO
MOTPHASES 2
MOTORSENSE NORMAL
MOTPOLES 50
MREGMODE CURR
...
NCURR 2.4
...
INFCSOURCE Home
INFCPOL NORMAL
$
```

Command: `23:?CFG EXPERT`

Answer: `23:?CFG EXPERT NO`

?CFGINFO

Query configuration parameter info

Syntax:

<driver_addr>:?CFGINFO [<configPar>]

Answer:

<driver_addr>:?CFGINFO <configPar> {INTEGER | FLOAT | *labelList* }

or

<driver_addr>:?CFGINFO $
<configPar1> {INTEGER | FLOAT | *labelList1* }
<configPar2> {INTEGER | FLOAT | *labelList2* }
...
<configParN> {INTEGER | FLOAT | *labelListN* }
$

Where *labelList* is a list of character strings separated by whitespaces and enclosed in curly braces ({}).

Description:

The ?CFGINFO query returns the type of the configuration parameter <configPar>. Possible types are numeric (*INTEGER* or *FLOAT*) or string. In the case of strings the query returns the list of acceptable values.

If no parameter is specified, the query returns a multiline answer with the complete list of type information for all the driver configuration parameters.

Examples:

Command: `7:?CFGINFO NCURR`

Answer: `7:?CFGINFO FLOAT`

Command: `103:?CFGINFO`

Answer:
```
103:?CFGINFO $
ACTIVE {NO YES}
PROTLEVEL INTEGER
NAMELOCK {NO YES}
POWERON {NO YES}
MOTPHASES {1 2 3}
MOTORSENSE {NORMAL INVERTED}
...
INFCPOL {NORMAL INVERTED}
$
```

CMOVE

Start relative movement in configuration mode

Syntax:

<driver_addr>:CMOVE <absolutePos>

Description:

Performs a relative movement on the specified driver board. This command can be executed when the driver is in configuration mode. In that case other move commands are not authorised.

Examples:

Command: `115:CMOVE -7000`

CONFIG / ?CONFIG

Manage configuration mode

Syntax:

<driver_addr>:CONFIG [<confID>]

Description:

The CONFIG command allows to switch a driver board into configuration mode. A driver board cannot be switched into configuration mode when the IcePAP system is in *PROG* or *TEST* modes (see MODE command).

When a driver is in configuration mode, the driver configuration parameters can be modified with the CFG command. Once the configuration has been modified, the CONFIG command, issued with a non empty <confID> string as parameter, validates the current configuration and stores it in the internal non volatile memory of the driver board. The <confID> string is also stored in the driver and can be used to identify the particular set of configuration parameters. The board also switches back to *OPER* mode.

If the driver is in configuration mode and the CONFIG command is issued with no parameters, the driver goes back to OPER mode and the last valid configuration before entering CONFIG mode is reloaded. In that case the most recent changes done during configuration mode are lost.

Syntax:

<driver_addr>:?CONFIG

Answer:

<driver_addr>:?CONFIG <confID>

Description:

The ?CONFIG query returns the identifier of the last valid configuration parameter set.

Examples:

```
Command:  32:?CFG ACTIVE
Answer:   32:?CFG ACTIVE NO
Command:  ?MODE
Answer:   ?MODE OPER                 // System mode is OPER
Command:  32:CONFIG                  // Switch axis 32 into CONFIG mode
Command:  32:?MODE

Answer:   32:?MODE CONFIG
Command:  32:CFG ACTIVE YES          // Change configuration parameter
Command:  32:CONFIG CONF001          // Validate driver configuration
Command:  32:?CFG ACTIVE
Answer:   32:?CFG YES
```

DEBUG / ?DEBUG

Set/query debug level

Syntax:

<board_addr>:DEBUG <debugLevel>

Description:

Sets the level of the debug facility to <debugLevel>. If the level is set to 0, the debug facility is switched off.

The debug level is stored in the board non-volatile memory and it is maintained after board reset.

Syntax:

<board_addr>:?DEBUG

Answer:

<board_addr>:?DEBUG <debugLevel>

Description:

Returns the current level of the debug facility.

Examples:

Command:	`15:?DEBUG`
Answer:	`15:?DEBUG 0`
Command:	`15:DEBUG 2`
Command:	`15:?DEBUG`
Answer:	`15:?DEBUG 2`

ECHO

Set echo mode

Syntax:

ECHO (system command)

or

<board_addr>:ECHO (board command)

Description:

Switches the echo mode on. Useful when accessing cards through serial line.

Example:

Command: `ECHO`

Command: `92:ECHO`

ENC / ?ENC

Set/query axis position in encoder steps

Syntax:

<board_addr>:ENC [*pos_sel*] <posVal> (board command)

or

ENC [*pos_sel*] <axis1> <posVal1> … <axisN> <posValN> (system command)

Description:

Loads the position registers in the specified boards with the <posVal> values. The specific register is selected by the optional parameter *pos_sel*, that must be one of the following values:

pos_sel	*Position register*
AXIS	
INDEXER	
EXTERR	
SHFTENC *	
TGTENC *	
ENCIN *	
INPOS *	
ABSENC *	

* Only valid for driver boards

If position is not specified, the value is loaded as axis position

---

Syntax:

<board_addr>:?ENC [*pos_sel*] (board query)

or

?ENC [*pos_sel*] <axis1> <axis2> … <axisN> (system query)

Answer:

<board_addr>:?ENC <posVal> (board answer)

or

?ENC <posVal1> <posVal2> … <posValN> (system answer)

Description:

Returns the current signal source used as axis indexer.

Examples:

Command: `115:ENC AXIS 500`

Command: `115:ENC INDEXER -3000`

Command: `115:?ENC`

Answer: `115:?ENC 500`

Command: `?ENC INDEXER 5 115`

Answer: `?ENC 13467895 -3000`

?ERRMSG

Query last command error message

Syntax:

?ERRMSG (system or local board query)

Answer:

?ERRMSG [<errorMessage>] (system or local board answer)

Description:

If the previous command produced an error, the ?ERRMSG query returns the error message as an ASCII string. If the previous command was successful, the ?ERRMSG query returns and empty string.

This command will retrieve the last error, regardless whether the previous command was a system command or a board command.

The system does not accept it as board command if it is not issued through the serial line.

Example:

Command:	`?VER`
Answer:	`?VER 1.00`
Command:	`?ERRMSG`
Answer:	`?ERRMSG`
Command:	`15:VELOCITY 0`
Command:	`15:?ERRMSG`
Answer:	`15:?ERRMSG Out of range value`

?FERRMSG

Query first error message

Syntax:

<board_addr>:?FERRMSG

Answer:

<board_addr>:?FERRMSG [command <errorMessage>]

Description:

Returns the message for the first command error that was produced since the last time the ?FERRMSG query was issued. The query returns the command that produced the error and the error message an as ASCII string.

[TODO: Explain difference: system errors, board errors].

Example:

Command:	`?VER`
Answer:	`?VER 1.00`
Command:	`?FERRMSG`
Answer:	`?FERRMSG`
Command:	`15:VELOCITY 0`
Command:	`15:?FERRMSG`
Answer:	`15:?FERRMSG Out of range value`

?FPOS

Set/query multiple board fast position

Syntax:

?FPOS [*pos_sel*] <axis1> <axis2> … <axisN>

Answer:

?FPOS <posVal1> <posVal2> … <posValN>

Description:

Returns the positions for the specified axes. The specific position is selected by the optional parameter *pos_sel*, that must be one of the following values:

pos_sel	***Position register***
AXIS	
INDEXER	

If *pos_sel* is not specified, the values returned are the axis positions

---

Examples:

Command: `?FPOS INDEXER 17 18 19`

Answer: `?FPOS 13467895 0 -3000`

Command: `?FPOS 25`

Answer: `?FPOS 5366703`

?FSTATUS

Set/query multiple board fast status

Syntax:

?FSTATUS <axis1> <axis2> … <axisN>

Answer:

?FSTATUS <statusReg1> <statusReg2> … <statusRegN>

Description:

Returns the value of the status of the selected boards as 32-bit hexadecimal values.
The difference with ?STATUS is ...

Example:

Command: `?FSTATUS 80 83 85`

Answer: `?FSTATUS 0x00000003 0x00000003 0x00000003`

?HELP

Query list of available commands

Syntax:

<board_addr>:?HELP (board command)

or

?HELP (system command)

Description:

Returns the list of available commands and queries. The list differs between system, controller and driver commands.

Examples:

Command: `16:?HELP`

Answer:

```
$
    RESET
          ?HDWVER
          ?STATE
          ?RETCODE
    CLEAR
          ?LIST
      RUN
$
```

?ID

Query board identification

Syntax:

<board_addr>:?ID [{ HW | SN }]

Answer:

<board_addr>:?ID { <hwIDstring> | <serialNumber> }

Description:

The ?ID query returns either the hardware identification string or the serial number as default the HW is return.

Examples:

Command:	`16:?ID`
Answer:	`?ID xxxx.xxxx.xxxx`
Command:	`31:?ID SN`
Answer:	`?ID 0034-44587`

INDEXER / ?INDEXER

Select/query indexer signal source

Syntax:

<driver_addr>:INDEXER [{ INTERNAL | SYNC | INPOS | ENCIN }]

Description:

Selects the signal source used for the axis indexer.

If no value is specified, the indexer source is set to the default value defined by the configuration parameters (see CFG INDEXER).

Available signal sources:

Source	***Indexer signal***
INTERNAL	Internally generated indexer is used
SYNC	*Sync* signal distributed through the rack backplane
INPOS	*InPos* signal at the front panel connector (Axis Interface)
ENCIN	*EncIn* signal at the rear panel

Syntax:

<driver_addr>:?INDEXER

Answer:

<driver_addr>:INDEXER { INTERNAL | SYNC | INPOS | ENCIN }

Description:

Returns the current signal source used as axis indexer.

Examples:

```
Command:  34:?CFG INDEXER
Answer:   34:?CFG INDEXER INTERNAL      // the default is INTERNAL
Command:  34:INDEXER SYNC               // change the indexer source
Command:  34:?INDEXER
Answer:   34:?INDEXER SYNC
Command:  34:INDEXER                    // set the default value back
Command:  34:?INDEXER
Answer:   34:?INDEXER INTERNAL
```

INFOA / ?INFOA
INFOB / ?INFOB
INFOC / ?INFOC

Set/query info signal source and polarity

Syntax:

<driver_addr>:INFOx [*signal_source* [{NORMAL | INVERTED}]]

where INFOx is one of INFOA, INFOB or INFOC.

Description:

Configures the Info outputs. If the polarity is not specified it is set to NORMAL.
If *signal_source* is not specified, the signal is configured to the default value.
Possible values of *signal_source* are:

Source	***...***
LOW	low logic level
HIGH	high logic level
LIM+	limit- signal
LIM-	limit+ signal
HOME	home signal
ENCAUX	EncAux signal
INPAUX	InPosAux signal
SYNCAUX	SyncAux signal
ENABLE	power enable
ALARM	alarm condition
READY	axis ready
MOVING	axis moving
BOOST	axis in acceleration phase
STEADY	axis moving at constant velocity
.MAIN	internal signals (only for diagnostic)
.ISR	

Syntax:

<driver_addr>:?INFOx

where ?INFOx is one of ?INFOA, ?INFOB or ?INFOC

Answer:

<driver_addr>:INFOx *signal_source* {NORMAL | INVERTED}

where *signal_source* is one of the possible values presented above.

Description:

Returns the configuration of the corresponding Info output signal.

Examples:

Command: `12:INFOB READY`

Command: `?12:INFOB`

Answer: `?12:INFOB READY NORMAL`

?MEAS

Query measured value

Syntax:

<board_addr>:?MEAS { VCC | VM | I | IA | IB | IC | T | RT}

Answer:

<board_addr>:?MEAS <measuredValue>

Description:

Returns a measured value for the specified axes. The of the possible measured values and their meaning is compiled in the following table:

magnitude	***description***	***units***	***applies to:***
VCC	Main power suppy voltage	volts	only drivers
VM	Motor voltage	volts	only drivers
I	Motor current	amps	only drivers
IA	Phase A current	amps	only drivers
IB	Phase B current	amps	only drivers
IC	Phase C current	amps	only drivers
T	Board temperature	° C	controllers and drivers
RT	Power supply temperature	° C	only controllers

Examples:

Command: `15:?MEAS VCC`

Answer: `15:?MEAS 80.1`

Command: `15:?MEAS T`

Answer: `15:?MEAS 24`

?MEMORY

Query available memory

Syntax:

<board_addr>:?MEMORY

Answer:

<board_addr>:?MEMORY <totalMemory> <freeMemory> <maxFreeBlock>

Description:

Returns the amount of total user memory <totalMemory>, unused memory <freeMemory> and the size of biggest available memory block <maxFreeBlock>. All the three quantities are returned in bytes.

Examples:

Command: `15:?MEMORY`

Answer: `15:?MEMORY ??? ??? ???`

MODE / ?MODE

Set/query board or system mode

Syntax:

MODE { OPER | PROG | TEST } (system command)

Description:

Changes the mode of the IcePAP system to operation (*OPER*), firmware reprogramming (*PROG*) or factory test (*TEST*) modes.

In normal operation, the system must be always set in mode *OPER*.

Syntax:

Answer:

?MODE { OPER | PROG | TEST | FAIL } (system answer)

or

<board_addr>:?MODE { CONFIG | OPER | PROG | TEST | FAIL } (board answer)

Description:

Returns the current mode of the system or the specific mode of one of the boards (controllers or drivers). In normal conditions, all the boards should return the same mode than the system.

If a particular driver is switched into configuration mode (see CONFIG command), the returned mode is CONFIG for that driver (note that CONFIG is not a system mode selectable by the MODE command).

If a non recoverable internal hardware error happens in a particular board, that board switches FAIL mode.

Examples:

```
Command:  ?MODE
Answer:   ?MODE OPER
Command:  25:?MODE
Answer:   25:?MODE OPER
Command:  25:CONFIG
Command:  25:?MODE
Answer:   25:?MODE CONFIG
Command:  ?MODE
Answer:   ?MODE OPER
```

MOVE

Start absolute movement

Syntax:

<board_addr>:MOVE <absolutePos> (board command)

or

MOVE <axis1> <absolutePos1> … <axisN> <absolutePosN> (system command)

Description:

Performs an absolute movement on the specified axis or axes.

Examples:

Command: `115:MOVE 4000`

Command: `MOVE 115 4000`

Command: `MOVE 31 250000 32 -29888 33 250000`

NAME / ?NAME

Set/query board name

Syntax:

<board_addr>:NAME <boardName>

Description:

Sets the internal board name to the ASCII string <boardName>. This name is only used for identification purposes and user convenience.

The maximum length is 20 [TODO: CHECK] characters .

If the name is locked cannot be changed.

Syntax:

<board_addr>:?NAME

Answer:

<board_addr>:?NAME <boardName>

Description:

Returns the application name field.

Examples:

Command:	`#11:NAME phi`
Answer:	`11:NAME OK`
Command:	`12:?NAME`
Answer:	`12:?NAME th`
Command:	`#12:NAME tth`
Answer:	`12:NAME ERROR The name of this board is locked`

NOECHO

Cancel echo mode

Syntax:

NOECHO (system command)

or

<board_addr>:NOECHO (board command)

Description:

Switches the echo mode off. See the ECHO command for more details. Only applies for serial line communication.

Example:

Command: `NOECHO`

Command: `2:NOECHO`

POS / ?POS

Set/query axis position in axis units

Syntax:

<board_addr>:POS [*pos_sel*] <posVal> (board command)

or

POS [*pos_sel*] <axis1> <posVal1> … <axisN> <posValN> (system command)

Description:

Loads the position registers in the specified boards with the <posVal> values. The specific register is selected by the optional parameter *pos_sel*, that must be one of the following values:

pos_sel	*Position register*
AXIS	
INDEXER	
POSERR	
SHFTENC *	
TGTENC *	
ENCIN *	
INPOS *	
ABSENC *	

* Only valid for driver boards

If position is not specified, the value is loaded as axis position

---

Syntax:

<board_addr>:?POS [*pos_sel*] (board query)

or

?POS [*pos_sel*] <axis1> <axis2> … <axisN> (system query)

Answer:

<board_addr>:?POS <posVal> (board answer)

or

<board_addr>:?POS <posVal1> <posVal2> … <posValN> (system answer)

Description:

Returns the current signal source used as axis indexer.

Examples:

Command: `115:POS AXIS 500`

Command: `115:POS INDEXER -3000`

Command: `115:?POS`

Answer: `115:?POS 500`

Command: `?POS INDEXER 5 115`

Answer: `?POS 13467895 -3000`

?POST

Query power-on selftest results

Syntax:

<board_addr>:?POST

Answer:

<board_addr>:?POST <testresultMask>

Description:

Returns the result of the power-on self tests as an binary mask <testresultMask>. A bit set to one in the mask indicates that a particular test has failed. If no tests failed during the power-on sequence, this query returns zero.

The meaning of the individual bits in <testresultMask> is summarised in the following table:

bit	*subsystem under test*	*applies to:*
0x01	external RAM	controllers and drivers
0x02	non volatile FRAM	controllers and drivers
0x04	internal 1-wire bus	controllers and drivers
0x08	ADC	only drivers
0x10	FPGA	controllers and drivers
0x20	external 1-wire bus	only controllers
0x40	CANbus	only controllers

Examples:

Command: `115:?POST`

Answer: `115:?POST 0`

POWER / ?POWER

Set/query motor power state

Syntax:

<driver_addr>:POWER [{ON | OFF}]

Description:

Switches on or off the motor power in a driver board.

Syntax:

<driver_addr>:?POWER

Answer:

<driver_addr>:?POWER [{ON | OFF}]

Description:

Returns the power state of the driver board.

Examples:

Command: `115:POWER OFF`

Answer: `115:POWER OFF`

*PROG / PROG / ?PROG

Firmware programming

Syntax:

***PROG {NONE | <bAddr> | DRIVERS | CONTROLLERS | ALL} [FORCE] [SAVE]**

PROG { <bAddr> | DRIVERS | CONTROLLERS | ALL} [FORCE]

Description:

The *PROG command reprograms the components of the IcePAP system by using firmware code that is transferred as a binary data block (see xxx). If the SAVE flag is used, the firmware code is stored in the non volatile FLASH memory of the system master board.

A mandatory parameter specifies the components to program, that can be either the components in the board with address <bAddr>, in all the driver boards (DRIVERS), in all controller boards (CONTROLLERS) or in both (ALL). If the parameter is set to NONE, no components are programmed, but the *PROG command can be use to store the firmware code in the system if the SAVE flag is used.

If one of the components in the system is already programmed with the same version of firmware, the programming operation for that specific component is skipped. This behaviour changes if the FORCE flag is used. In that case the components in the selected boards are always reprogrammed regardless of their current firmware version.

The *PROG command initiates the internal programming procedure and completes successfully if it started succesfully. The actual progress and the final success of the programming operation can be monitored by means of the ?PROG query.

The PROG command works in the same way than *PROG but uses the firmware code that was previously stored in the non volatile FLASH memory of the system master board by a previous *PROG SAVE commad.

Syntax:

?PROG

Answer:

?PROG [{OFF | ACTIVE <progress> | DONE | ERROR}]

Description:

Returns the state of firmware programming operations.

Examples:

REPORT / ?REPORT

Set/query asynchronous report settings

Syntax:

REPORT { ON | OFF } [<firstRack> <lastRack> [ ]]

Description:

The REPORT command allows to activate (ON) or deactivate (OFF) the asynchronous reporting feature on the current communication port. When asynchronous reporting is active in a particular port (RS232 serial line or TCP socket), the IcePAP master controller sends binary data blocks containing status and position information through that port to the listening device, usually the host computer. The binary blocks contain status and position information as the values returned by the ?FSTATUS and ?FPOS queries.

The data blocks contain the status as well as the axis and indexer positions for all the boards in the selected racks. The data block is sent whenever the data in the system master board changes or after a time interval of <maxPeriod> seconds.

The block includes data from all the boards in the racks from <firstRack> to <lastRack> that must be numbers from 0 to 15.

The format of the binary blocks is the following:

[TODO: explain block format and structure]

Syntax:

?REPORT

Answer:

?REPORT { ON | OFF } <firstRack> <lastRack> <maxPeriod>

Description:

Returns the status and range of the asynchronous status reporting feature.

Examples:

RESET

System or rack reset

Syntax:

RESET [<rackNumber>]

Description:

Resets the given rack or the whole system if no parameter is added.

Examples:

Command: RESET

Command: RESET 8

?RID

Query rack hardware identification string

Syntax:

?RID [<rackNumber1> <rackNumber2> ... <rackNumberN>]

Answer:

?RID <hwIDstring1> <hwIDstring2> ... <hwIDstringN>

Description:

The ?RID query returns the hardware identification strings of the racks specified by the list of rack numbers. If the query is issued with no parameters, it returns the identification strings of the rack with lowest number (the one hosting the system master controller).

Examples:

Command:	`?RID`
Answer:	`?RID xxxx.xxxx.xxxx yyyy.yyyy.yyyy`
Command:	`?RID 5`
Answer:	`?RID ZZZZ.ZZZZ.ZZZZ`

RFPROG

Factory firmware programming

Syntax:

RFPROG [<rackNumber1> <rackNumber2> ... <rackNumberN>]

Description:

The RFPROG command is intended to reload the firmware in IcePAP driver boards that are not responsive or that have never been programmed (i.e after manufacturing). It cannot be used to reload firmware in controller boards and should not be used in normal operation instead of the PROG command.

RFPROG initiates the programming procedure of all the driver boards in the racks specified in the command line. If the command is issued with no parameters, it initiates the programming of the drivers boards in all the racks present in the system.

The system uses the firmware code that was stored in the non volatile FLASH memory of the system master board by a previous *PROG SAVE command.

The progress of the programming procedure can be followed by means of the ?PROG query.

Examples:

```
Command:  MODE PROG
Command:  *PROG NONE SAVE
          [firmware as binary data block]
Command:  RFPROG
                    (wait some time)
Command:  ?PROG
Answer:   ?PROG ACTIVE 37%
                    (wait for full reprogramming)
Command:  ?PROG
Answer:   ?PROG DONE
```

RMOVE

Start relative movement

Syntax:

<board_addr>:RMOVE <absolutePos> (board command)

or

RMOVE <axis1> <absolutePos1> … <axisN> <absolutePosN> (system command)

Description:

Performs a relative movement on the specified axis or axes.

Examples:

Command: `115:RMOVE -7000`

Command: `RMOVE 115 -7000`

Command: `RMOVE 31 250000 32 -29888 33 250000`

?RTEMP

Query rack temperatures

Syntax:

?RTEMP [<rackNumber1> <rackNumber2> ... <rackNumberN>]

Answer:

?RTEMP <rackTemp1> <rackTemp2> ... <rackTempN>

Description:

The ?RTEMP query returns the temperature of the main power supply of the racks specified by the list of rack numbers. If the query is issued with no parameters, it returns the temperatures of the rack with lowest number (the one hosting the system master controller).

Examples:

Command:	`?RID`
Answer:	`?RID xxxx.xxxx.xxxx`
Command:	`?RID 5`
Answer:	`?RID ZZZZ.ZZZZ.ZZZZ`

?STATUS

Query board status

Syntax:

<board_addr>:?STATUS (board query)

or

?STATUS <axis1> <axis2> … <axisN> (system query)

Answer:

<board_addr>:?STATUS <statusReg> (board answer)

or

?STATUS <statusReg1> <statusReg2> … <statusRegN> (system answer)

Description:

Returns the current state of the boards as 32-bit hexadecimal values

---

Example:

Command: `53:?STATUS`

Answer: `53:?STATUS 0x00000003`

Command: `?STATUS 80 83 85`

Answer: `?STATUS 0x002c0403 0x00200403 0x00000403`

STOP

Stop movement

Syntax:

STOP [<axis1> <axis2> … <axisN>] (system command)

or

<board_addr>:STOP (board command)

Description:

The STOP command finalises the movement in the given axes with a normal deceleration ramp.

Examples:

Command:	`10:STOP`	
Command:	`STOP`	// stop all movements
Command:	`STOP 51 52 54`	// stop selected axes

?SYSSTAT

Query system configuration

Syntax:

?SYSSTAT [<rackNumber>]

Answer:

?SYSSTAT <rackPresenceMask>

or

?SYSSTAT <driverPresenceMask> <driverAliveMask>

Description:

By default, with no parameter, the SYSSTAT query returns a 16 bit mask that represents the list of racks present in the system. Every bit in the <rackPresenceMask> mask indicates if the corresponding rack (0 to 15) has been found in the system.

If the SYSSTAT command is issued with a valid rack number (0 to 15) as parameter, it returns two 8 bit values that indicates the drivers found in the rack and which of them are responsive. Every bit of each mask correspond to one of the drivers (1 to 8) within the rack. The bits in <driverPresenceMask> that are set to 1, indicate which driver boards are plugged in the rack. The bits in <driverAliveMask> indicates which drivers are responsive and communicate with the system master board.

In normal conditions <driverPresenceMask> and <driverAliveMask> are identical.

Example:

Command:	`?SYSSTAT`
Answer:	`0x004F`
Command:	`?SYSSTAT 8`
Answer:	`0x13 0x13`

?TIME

Query the board running time

Syntax:

<board_addr>:?TIME

Answer:

<board_addr>:?TIME *time_string*

Description:

Returns the time elapsed since the board processor start execution or was reset. The time is return as an ASCII string.

Examples:

Command: `115:?TIME`

Answer: `115:?TIME 1623hrs 31min 14sec`

VELOCITY / ?VELOCITY

Set/query programmed axis velocity

Syntax:

<board_addr>:VELOCITY [<velocity>] (board command)

or

VELOCITY <axis1> <velocity1> … <axisN> <velocityN> (system command)

Description:

Sets the velocity for the corresponding axis to the <velocity> values in steps per second. The actual acceleration for each axis is maintained to the previous value, and the acceleration time is internally recalculated (see ?ACCTIME query).

If no value is specified, the velocity is set to the default value.

Syntax:

<board_addr>:?VELOCITY (board command)

or

?VELOCITY <axis1> <axis2> … <axisN> (system command)

Answer:

<board_addr>:?VELOCITY <velocity> (board answer)

or

?VELOCITY <velocity1> <velocity2> … <velocity1> (system answer)

Description:

Returns the current velocity in steps per second.

Examples:

?VER

Query firmware version information

Syntax:

?VER [<verModule>] (system command)

or

<board_addr>:?VER [<verModule>] (board command)

Answer:

?VER <verModule> <verNumber> (system answer)

or

<board_addr>:?VER <verModule> <verNumber> (board answer)

Description:

Returns the version number XX.YY of the firmware.

module	***...***	***...***
SYSTEM		all cases
CONTROLLER		all cases
DRIVER		all cases
DSP		controllers and drivers
FPGA		controllers and drivers
PCB		controllers and drivers
IO		drivers
INFO		all cases

The ?VER INFO query returns a multiline answer with the version numbers of all the modules.

Example:

Command: ?VER

Answer: `...`

5.2. Board status registers

		DRIVER Status	CONTROLLER Status
Bit #	**name**	**value = Description**	**value = Description**
0	PRESENT	1 = driver present	1 = controller present
1	ALIVE	1 = board responsive	1 = board responsive
2-3	MODE	0 = OPER 1 = PROG 2 = TEST 3 = FAIL	0 = OPER 1 = PROG 2 = TEST 3 = FAIL
4-6	DISABLE	0 = enable 1 = axis not active 2 = hardware alarm 3 = remote rack disable input signal 4 = local rack disable switch 5 = remote axis disable input signal 6 = local axis disable switch 7 = software disable	0 = enable 1 = n/a 2 = hardware alarm 3 = remote rack disable input signal 4 = local rack disable switch 5 = n/a 6 = n/a 7 = software disable
7-8	INDEXER	0 = internal indexer 1 = in-system indexer 2 = external indexer 3 = n/a	0 = internal indexer 1 = n/a 2 = n/a (status of multiplexer?) 3 = n/a
9	READY	1 = ready to move	1 = ready to move
10	MOVING	1 = axis moving	1 = virtual axis moving
11	SETTLING	1 = closed loop in settling phase	n/a
12	FOLLOWERR	1 = follow error	n/a
13	HDWERR	1 = hardware error condition	n/a
14	SFTERR	1 = software error condition	1 = software error condition
15-17	STOPCODE	0 = end of movement 1 = STOP 2 = ABORT 3 = LIMIT+ reached 4 = LIMIT- reached 5 = FOLLOWERR 6 = DISABLE 7 = HDWERROR	0 = end of movement 1 = STOP 2 = ABORT 3 = n/a 4 = n/a 5 = n/a 6 = n/a 7 = n/a
18	LIMIT+	current value of the limit+ signal	n/a
19	LIMIT-	current value of the limit- signal	n/a
20	HOMEDONE	1 = Home switch reached (only in homing modes)	n/a
21	5VPOWER	1 = Aux power supply on	n/a
22	VERSERR	1 = inconsistency in firmware versions	1 = inconsistency in firmware versions
23		n/a	n/a
24-31	INFO	In PROG mode: programming phase In OPER mode: master indexer	In PROG mode: programming phase

5.3. IcePAP command quick reference

BOARD COMMANDS

BOARD CONFIGURATION and IDENTIFICATION

<board_addr>:?ACTIVE Query activation status
<board_addr>:?MODE Query board mode
<board_addr>:?STATUS Query board status
<driver_addr>:CONFIG [<confID>] **<driver_addr>:?CONFIG** Manage configuration mode
<driver_addr>:CFG <configPar> <configVal> **<driver_addr>:CFG {DEFAULT | EXPERT}** **<driver_addr>:?CFG {[<configPar>] | EXPERT}** Set/query configuration parameters
<driver_addr>:?CFGINFO [<configPar>] Query configuration parameter info
<board_addr>:?VER [<verModule>] Query board version information
<board_addr>:NAME <boardName> **<board_addr>:?NAME** Set/query board name
<board_addr>:?ID [{HW | SN}] Query board identification
<board_addr>:?POST Query power-on selftest results

POWER AND MOTION CONTROL

<driver_addr>:POWER [{ON | OFF}] **<driver_addr>:?POWER** Set/query motor power state
<driver_addr>:AUXPS [{ON | OFF}] **<driver_addr>:?AUXPS** Set/query auxiliary power supply state
<board_addr>:?MEAS {VCC | VM | IM | IA | IB | IC | T | RT} Query measured value
<board_addr>:POS [*pos_sel*] <posVal> **<board_addr>:?POS [*pos_sel*]** Set/query axis position in axis units
<board_addr>:ENC [*pos_sel*] <posVal> **<board_addr>:?ENC [*pos_sel*]** Set/query axis position in encoder steps
<board_addr>:VELOCITY [<velocity>] **<board_addr>:?VELOCITY** Set/query programmed axis velocity
<board_addr>:ACCTIME [<accTime>] **<board_addr>:?ACCTIME** Set/query acceleration time
<board_addr>:MOVE <absolutePos> Start absolute movement
<board_addr>:RMOVE <absolutePos> Start relative movement
<driver_addr>:CMOVE <absolutePos> Start relative movement in configuration mode
<board_addr>:STOP Stop movement
<board_addr>:ABORT Abort movement

INPUT/OUTPUT

<driver_addr>:INDEXER [{INTERNAL | SYNC | INPOS | ENCIN}] **<driver_addr>:?INDEXER** Set/query indexer signal source

<driver_addr>:INFOA [*signal_source* [{NORMAL | INVERTED}]]
<driver_addr>:INFOB [*signal_source* [{NORMAL | INVERTED}]]
<driver_addr>:INFOC [*signal_source* [{NORMAL | INVERTED}]]
<driver_addr>:?INFOA
<driver_addr>:?INFOB
<driver_addr>:?INFOC
Set/query Info signal source and polarity

COMMUNICATION and ERROR MANAGEMENT

<board_addr>:?HELP
Query list of available board commands

<board_addr>:?ERRMSG
Query last command error message

<board_addr>:?FERRMSG
Query first error message

<board_addr>:BLINK <blinkTime>
<board_addr>:?BLINK
Set/query remaining blinking time

<board_addr>:?TIME
Query running time

<board_addr>:DEBUG <debugLevel>
<board_addr>:?DEBUG
Set/query debug level

<board_addr>:ECHO
Select echo mode

<board_addr>:NOECHO
Cancel echo mode

<board_addr>:?MEMORY
Query available memory

<board_addr>:?ADDR
Query board address

SYSTEM COMMANDS

SYSTEM CONFIGURATION and IDENTIFICATION

MODE {OPER | PROG | TEST} **?MODE** Set/query system mode
?SYSSTAT [<rackNumber>] Query system configuration
?STATUS <axis1> <axis2> … <axisN> Query multiple board status
?FSTATUS [<axis1> <axis2> … <axisN>] Query multiple board fast status
REPORT {ON | OFF} [<firstRack> <lastRack> [<maxPeriod>]] **?REPORT** Set/query asynchronous report settings
?VER [<verModule>] Query system firmware version information
?RID [<rackNumber1> <rackNumber2> … <rackNumberN>] Query rack identification string
?RTEMP [<rackNumber1> <rackNumber2> … <rackNumberN>] Query rack temperatures
***PROG {NONE | <bAddr> | DRIVERS | CONTROLLERS | ALL} [FORCE] [SAVE]** **PROG {<bAddr> | DRIVERS | CONTROLLERS | ALL} [FORCE]** **?PROG** Firmware programming
RFPROG [<rackNumber1> <rackNumber2> … <rackNumberN>] Factory firmware programming
RESET [<rackNumber>] System or rack reset

MOTION CONTROL

POS [*pos_sel*] <axis1> <posVal1> … <axisN> <posValN> **?POS [*pos_sel*] <axis1> <axis2> … <axisN>** Set/query multiple axis position in axis units
ENC [*pos_sel*] <axis1> <posVal1> … <axisN> <posValN> **?ENC [*pos_sel*] <axis1> <axis2> … <axisN>** Set/query multiple axis position in encoder steps
?FPOS [*pos_sel*] <axis1> <axis2> … <axisN> Query multiple board fast position
?VELOCITY <axis1> <velocityN> … <axisN> <velocityN> **?VELOCITY <axis1> <axis2> … <axisN>** Set/query programmed multiple axis velocity
ACCTIME <axis1> <accTime1> … <axisN> <accTimeN> **?ACCTIME <axis1> <axis2> … <axisN>** Set/query acceleration time
MOVE <axis1> <absolutePos1> … <axisN> <absolutePosN> Start multiple axis absolute movement
RMOVE <axis1> <absolutePos1> … <axisN> <absolutePosN> Start multiple axis relative movement
STOP [<axis1> <axis2> … <axisN>] Stop multiple axis movement
ABORT [<axis1> <axis2> … <axisN>] Abort movement

COMMUNICATION and ERROR MANAGEMENT

?HELP	Query list of available commands
?ERRMSG	Query last command error message
ECHO	Select serial line echo
NOECHO	Cancel serial line echo