Quarch Technology Ltd

GEN3 PCIe x16 Lite Card Module

+ Power Measurement

Technical Manual

For use with:

QTL1848 – GEN3 PCIe x16 Lite Card Module

Using Quarch firmware version 4.000 and above

Wednesday, 16 November 2016

Change History

1.0	4th October 2014	Initial (Draft) Version
1.1	10th December 2014	First full release
1.2	16th November 2016	Updated measurement accuracy data

Contents

Introduction

The **Torridon GEN 3 PCIe x16 Lite Card module** allows remote switching of PCIe power and supporting control pins in a PCIe x16 Gen 3 slot for test automation or fault injection purposes.

The module supports PCIe Gen 2 and Gen 3 devices at data rates up to 8 GT/s.

Pin can be switched switched, allowing control over the mating of the card connector. Individual pin(s) can be disconnected to simulate failures or configuration changes. If the devices support hot-swap, a sequenced hot-swap event can be run, connecting pins in a pre-defined sequence.

Unlike the QTL1630/QTL1688 (HS) versions, the LITE module does NOT switch and of the high speed data signals. These are always connected.

WARNING: Some systems DO NOT support hot-swap of a PCIe card while the system is powered up. You should verify that your hardware supports this feature before using it.

QTL1848 also provides basic power measurement facilities. Voltage/Current/Power measurements can be requested from the 12v, 3v3 and 3v3_aux power rails.

Technical Specifications

Switching Characteristics

PCIe Connector Pin	Description	Switching Action
A4, A12, A15, A18, A20, A23, A24, A27, A28, A31, A34, A37, A38, A41, A42, A45, A46, A49, A51, A54, A55, A58, A59, A62, A63, A66, A67, A70, A71, A74, A75, A78, A79, A82, B4, B7, B13, B16, B18, B21, B22, B25, B26, B29, B32, B35, B36, B39, B40, B43, B44, B47, B49, B52, B53, B56, B57, B60, B61, B64, B65, B68, B69, B72, B73, B76, B77, B80	PCIe Data and Power Ground Pins	All connected to ground on the Module
A16, A17, A21, A22, A25, A26, A29, A30, A35, A36, A39, A40, A43, A44, A47, A48, A52, A53, A56, A57, A60, A61, A64, A65, A68, A69, A72, A73, A76, A77, A80, A81, B14, B15, B19, B20, B23, B24, B27, B28, B33, B34, B37, B38, B41, B42, B45, B46, B50, B51, B54, B55, B58, B59, B62, B63, B66, B67, B70, B71, B74, B75, B78, B79	PCIe Data Signal pins	Each signal is permanently connected from host to device
A13, A14	PCIe Reference Clock pins	Individually switched by a bilateral analog switch
A2, A3, B1, B2, B3	12V Power Pins	Connected together and switched by 16A power FET
A9, A10, B8	3.3V Power Pins	Connected together and switched by

		16A power FET
B10	3.3Vaux Pin	Switched by 16A power FET
A1, B17, B31, B48, B81	Presence Pins	Switched as a group by analog switch
A5, A6, A7, A8, A11, B5, B6, B9, B11	Sideband Signal Pins	Switched by analog switch. JTAG signals are switched as a group
A19, A32, A33, A50, B12, B30, B82	Reserved Pins	Each signal is permanently connected from host to device

Power Injection

QTL1848 does NOT support power injection. Use a QTL1630 or QTL1688 if you require this feature.

SMBUS Monitoring

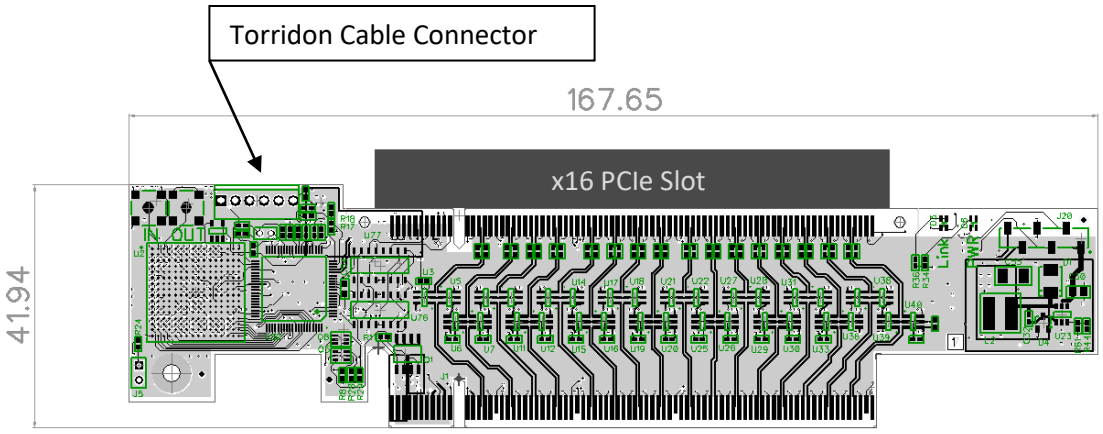
The QTL1848 module allows monitoring of the PCIe host SMBUS. This is done through the J9 header, a 2.5mm 3-way header (Molex 22-04-1031)

Pin 1(Closest to the PCIe edge connector)	SMDAT
Pin 2	GND
Pin 3	SMCLK

Mechanical Characteristics

Dimensions and Connector Locations

The module is half length and will displace a PCIe add in card upwards by 40.4mm. The horizontal and vertical dimensions of the card are shown below.



LEDs

The module has 2 LEDs:

PWR: This LED is green when the module is supplied with external power through its ribbon cable.

LINK: This LED is shows the connection state of the attached PCIe card. This LED has 3 states:

OFF:	ALL switched pins are disconnected
GREEN:	ALL switched pins are connected
ORANGE:	Some, but not all, switched pins are connected

Control Interfaces

All Torridon Control Modules are designed to be used with a Torridon Array Controller (QTL1079/QTL1461) or a single Torridon Interface Card (QTL1260).

The control cable is an ultra-thin Flex cable.

Control Interface	**Form Factor**	**Torridon Module Ports**	**Control Methods Available**	**Interfaces**
Torridon Array Controller	1U 19" Rack Mounted unit	24 at the front, 4 at the rear	Serial Scripting Script Generation through **TestMonkey GUI**	Serial via DB9 or RJ45 Ethernet
4 Port Array Controller	170mm x 165mm x 1U high	4 ports on front	Terminal Scripting Script Generation through **TestMonkey GUI**	Serial via RJ45 Ethernet
Torridon Interface Kit	60mm x 45mm x 30mm Box	1 port	Terminal Scripting TestMonkey 2 GUI	Serial via RJ-45 Serial via USB/Serial convertor

Basic Concepts

Each switch on the Torridon control cards is called a 'Signal' and can be programmed to follow one of 6 programmable delay profiles (called 'Sources'). This allows the user to sequence power and signal connections to the drive in up to six programmable steps.

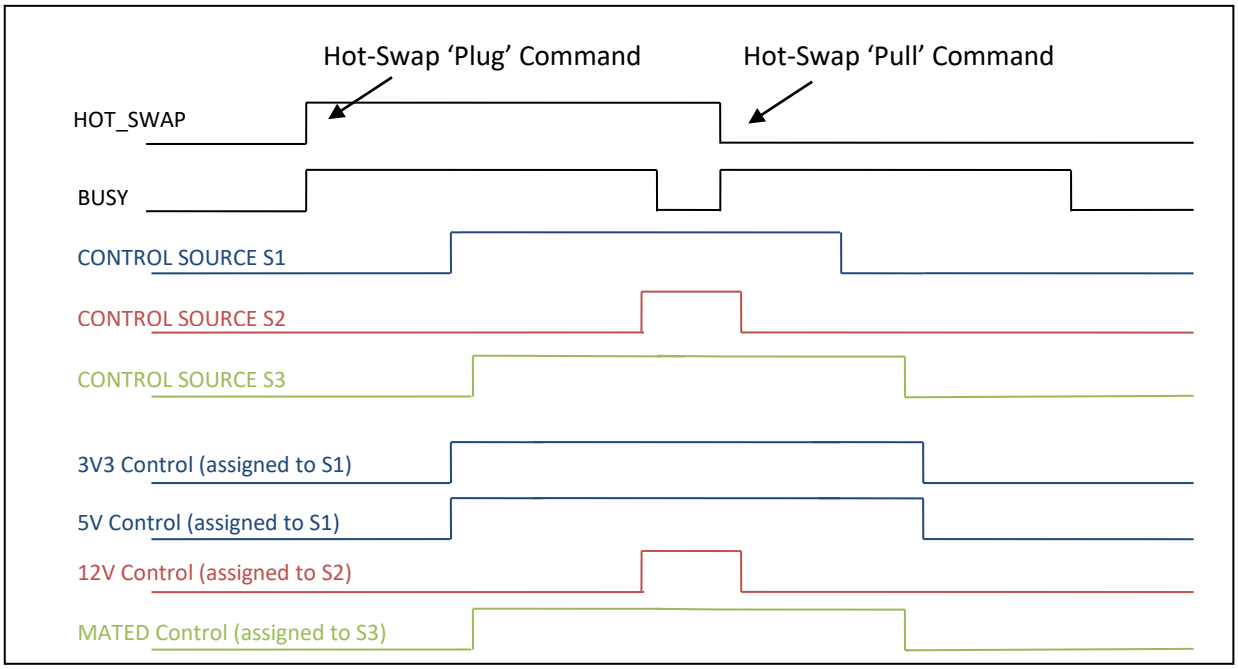
Each of the programmable delay profiles is called a control source, S1 to S6. For each control source the user can set up a delay parameter. Three special sources (S0, S7 and S8) are also provided as described in the table below.

Control Source Parameters for a power up event:

Once each delay period is set up, the user assigns each signal to follow the relevant control source, then uses the "run:power up" and "run:power down" commands to initiate the hot-swap.

The BUSY bit 1 in the control register is set during a power up and power down operation. This may be used to monitor for the completion of timed events.

Power up and Power down example:

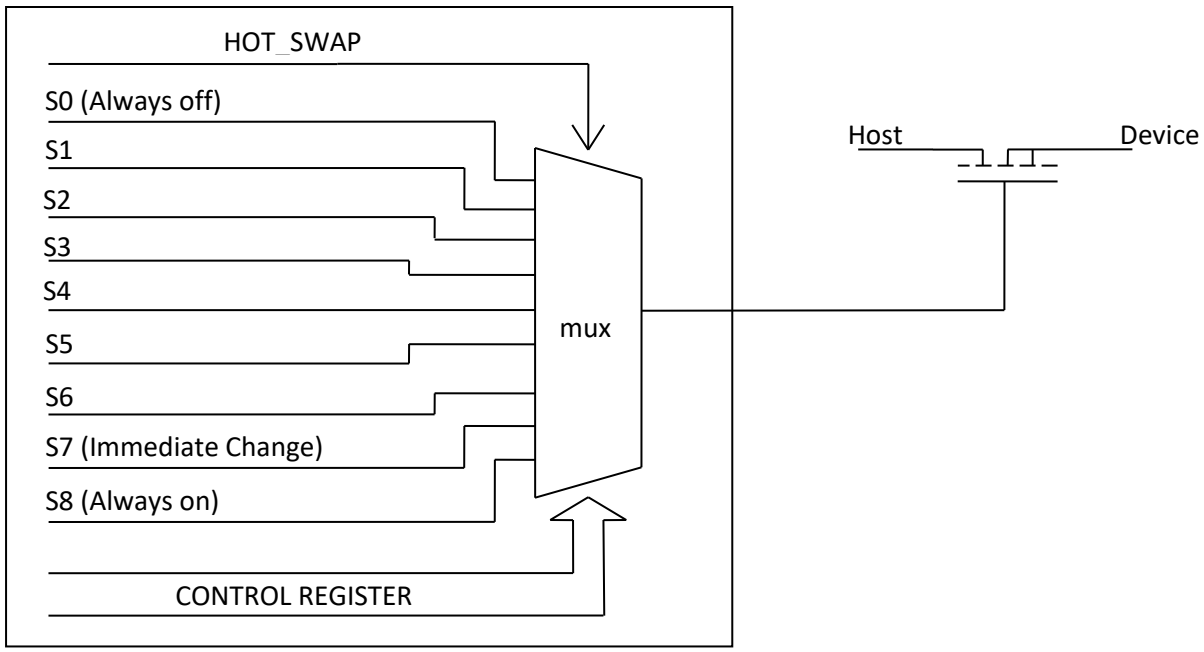


Signal Configuration

Each signal that is switched by the module is usually assigned to one of the 6 timed sources, S1 – S6. Each signal can also be assigned directly to 'always off' (source 0), 'immediate change' (source 7) or 'Always on' (source 8).

To assign a signal to a control source, write to its CONTROL_REGISTER:

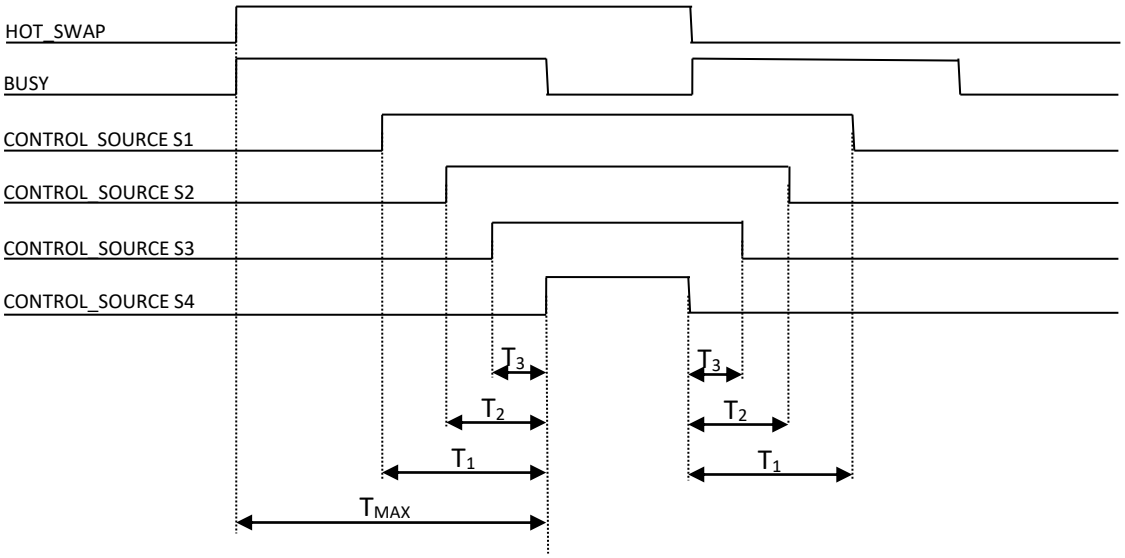
CONTROL_REGISTER Value	Description
0	Signal is always OFF
1	Signal assigned to control source 1
2	Signal assigned to control source 2
3	Signal assigned to control source 3
4	Signal assigned to control source 4
5	Signal assigned to control source 5
6	Signal assigned to control source 6
7	Signal changes with HOT_SWAP
8	Signal is always ON



This diagram shows the 9 possible source settings entering the control MUX for a switched signal. The value of the control register will determine which of the sources are used to control the signal. When enabled, the hot-swap line will cause the MUX to pass the control signal from that source through to the switch.

Power Up vs. Power Down Timing

Each control source is always configured with power-up parameters; the power-down profile is automatically generated by the module, and is the mirror image of the power up:



Power Down Times are automatically generated by the module but can be calculated as follows:

T_{MAX} = Largest Time Period
= the largest value from: (S1_DELAY),
(S2_ DELAY),

up to

(S6_ DELAY)

Power Down Delay T_X = T_{MAX} – (S_X_DELAY)

If you require a different power down sequence then you can alter any of the source timing values, pin bounce or signal assignments while the drive is in the plugged state. When you initiate the 'pull' action, the new settings will be used.

Measurements

The modules are capable of measuring various voltages both for self-test and system monitoring.

ADC measurements use additional circuitry, and are more accurate than the 'standard' measurements (which match what would be found on QTL1630/QTL1688 modules)

ADC Measurement Details

ADC Max current limits:
8.1A for 12V and 3V3
0.81A for 3V3_AUX

ADC Minimum measurable current:
-8.1A for 12V and 3V3
-0.81A for 3V3_AUX

ADC Resolution:
250uA for 12V and 3V3
2.5uA for 3V3_AUX

ADC accuracy is by design, and individual units are not calibrated. This is intended for indication only. Accuracy is specified at 20C.

ADC Current and voltages are sampled one after the other continuously every 8.244ms. Each result returned to the user is an average of four samples.
Measurement Bandwidth: 1kHz

Measurement Accuracy

Measurement Command	Description	Resolution / Accuracy
Self Test Voltages		
MEASure:VOLTage:SELF 3v3?	Returns the voltage of the modules internal 3.3v power rail – This powers the modules internal circuitry, and the active circuitry on the IN connector	64mV / 5%
MEASure:VOLTage:SELF 12v?	Returns the voltage of the modules internal 12v power rail	64mV/ 5%

ADC Power Measurements		
MEASure:12V_VOLTAGE?	Returns the voltage being supplied to the device on the 12v rail	+/- (7.5mV + 0.5%)
MEASure:3V3_VOLTAGE?	Returns the voltage being supplied to the device on the 3v3 rail	+/- (7.5mV + 0.5%)
MEASure:3V3aux_VOLTAGE?	Returns the voltage being supplied to the device on the 3v3 AUX rail	+/- (7.5mV + 0.5%)
MEASure:12V_CURRENT?	Returns the current being supplied to the device on the 12v rail	+/- (1mA + 1.5%) for 12V
MEASure:3V3_CURRENT?	Returns the current being supplied to the device on the 3v3 rail	+/- (1mA + 1.5%) for 12V
MEASure:3V3aux_CURRENT?	Returns the current being supplied to the device on the 3v3 AUX rail	+/- (0.1mA + 1.5%) for
MEASure:12V_POWER?	Returns the power being supplied to the device on the 12v rail	As Voltage x Current
MEASure:3V3_POWER?	Returns the power being supplied to the device on the 3v3 rail	As Voltage x Current
MEASure:3V3aux_ POWER?	Returns the power being supplied to the device on the 3v3 AUX rail	As Voltage x Current
Standard voltage rail monitoring		
MEASure:VOLTage 3v3_host?	Returns the host PC voltage on the 3v3 rail	64mV/ 5%
MEASure:VOLTage 3v3_device?	Returns the voltage being supplied to the device on the 3v3 rail	64mV/ 5%
MEASure:VOLTage 12v_host?	Returns the host PC voltage on the 12v rail	64mV/ 5%

MEASure:VOLTage 12v_device?	Returns the voltage being supplied to the device on the 12v rail	64mV/ 5%

Default Startup State

On power up or reset, the control modules enter a default state. On this module, all signals are connected at startup. The “run:power down” command will immediately disconnect the card without needing any initial setup.

The default hot-swap scenario will disconnect all pins based on the pin length, without any pin-bounce. All data and control pins are assigned to source 1 and will change immediately. Presence pins are assigned to source 2 and will change 25ms after the other pins.

Source Number	Initial Delay	Pin Bounce Mode	Bounce Length	Bounce Period	Bounce Duty Cycle
1	0mS	Standard	0mS	0uS	50%
2	25mS	Standard	0mS	0uS	50%
3	0mS	Standard	0mS	0uS	50%
4	0mS	Standard	0mS	0uS	50%
5	0mS	Standard	0mS	0uS	50%
6	0mS	Standard	0mS	0uS	50%

Signal	Assigned Source
PRSNT	Source 2
All other signals	Source 1

Hot-Swap State:
The module is in the ‘plugged’ state, waiting for a **RUN:POWer DOWN** command to disconnect it.

Controlling the Module

The module can be controlled either by:

- Serial ASCII terminal (such as HyperTerminal)
  This is normally used with scripted commands to automate a series of tests. The commands are normally generated by a script or user code (PERL, TCL, C, C# or similar).
- Telnet Terminal (Only when connected to an Array Controller). This mode uses exactly the same commands as the serial ASCII terminal

Serial Command Set

When connected via a serial terminal, the module has a simple command line interface

SCPI Style Commands

These commands are based on the SCPI style control system that is used by many manufacturers of test instruments. The entire SCPI specification has NOT been implemented but the command structure will be very familiar to anyone who has used it before.

- SCPI commands are NOT case sensitive
- SCPI commands are in a hierarchy separated by ':' (LEVel1:LEVel2:LEVel3)
- Most words have a short form (e.g. 'register' shortens to 'reg'). This will be documented as REGister, where the short form is shown in capitals.
- Some commands take parameters. These are separated by spaces after the main part of the command (e.g. "meas:volt:self 3v3?" Obtains the 3v3 self test measurement)
- Query commands that return a value all have a '?' on the end
- Commands with a preceding '*' are basic control commands, found on all devices
- Commands that do not return a particular value will return "OK" or "FAIL". Unless disabled, the fail response will also append a text description for the failure if it can be determined.

 # [comments]

Any line beginning with a # character is ignored as a comment. This allows commenting of scripts for use with the module.

***RST**

Triggers a reset, the module will behave as if it had just been powered on

***CLR**

Clear the terminal window and displays the normal start screen. Also runs the internal self test. The same action can be performed by pressing return on a blank line.

***IDN?**

Displays a standard set of information, identifying the device. An example return is shown below

Family:	Torridon System	[The parent family of the device]
Name:	Ethernet Cable Pull Module	[The name of the device]
Part#:	QTL1271-01	[The part number of the hardware]
Processor:	QTL1159-01,3.50	[Part# and version of firmware]
Bootloader:	QTL1170-01,1.00	[Part# and version of bootloader]
FPGA 1:	1.0	[Version of FPGA core]

***TST?**

Runs a set of standard tests to confirm the device is operating correctly, these tests are also performed at start up. Returns 'OK' or 'FAIL' followed by a list of errors that occurred, each on a new line.

CONFig:MODE BOOT

Configures the card for boot loader mode (to update the firmware), requires an update utility on the PC.

CONFig:MESSages [SHORt|USER]
CONFig:MESSages?

Gets or sets the mode for messages that are returned to the user's terminal

Short: Only a "FAIL" or "OK" will be returned
User: Full error messages are returned to the user on failure

CONFig:TERMinal USER

Sets the terminal response mode to the default 'User' setting. This is intended for use with HyperTerminal or similar and manually typed commands

CONFig:TERMinal SCRIPT

Sets the terminal response mode for easier parsing. Especially useful from a UNIX/LINUX based system. Characters sent from the PC are not echoed by the device and a <CR><LF> is sent after the cursor to force a flush of the USART buffer.

CONFig:TERMinal ?

Returns the current terminal mode

CONFig:DEFault:STATE

Resets the state of the module. This will set all source/signal/glitch etc logic to its default power-on values. Terminal setting will not be affected. This command allows the module to be brought back to a known state without resetting it.

SOURce:[1-6|ALL]:SETup [#1]

Sets up the source in a single command. All parameters are positive decimal numbers:

#1 = Initial delay (mS)
[Limits: 0 to 9999ms in steps of 1ms]

SOURce:[1-6|ALL]:DELAY [#ms]
SOURce:[1-6]:DELAY?

Sets the initial delay of a source in mS. The delay is entered as a decimal number with no units. E.g. “Source:1:delay 300”.

#1 = Initial delay (mS)
[Limits: 0 to 9999ms in steps of 1ms]

SOURce:[1-6|ALL]:STATE [ON|OFF]
SOURce:[1-6]:STATE?

Sets or returns the enable state of the source. Any signals assigned to a disabled (off) source will immediately be disconnected and vice versa. If a source state is changed, all signals assigned to it will change at exactly the same time (if a change is required). NOTE: If the ‘ALL’ selector is used, all 6 sources will be affected BUT there will be a very small delay between the change of each source. If timing is critical, assign all signals you want to change to the SAME source.

SIGnal:[SIG_NAME|ALL]:SETup [#num]
SIGnal:[SIG_NAME|ALL]:SOURce [#num]

Assigns a given signal to a numbered timing source (0-8). SIGNAL_NAME is one of the signals/groups as found in the ‘Signal Names’ appendix at the end of this manual

RUN:POWer [UP|DOWN]

Initiates a plug or pull operation (legacy name used to preserve compatibility between Torridon modules). This is done by changing the HOT_SWAP bit, register 0x00 bit 0. This is the master control for all switches on the card. The same action can be performed by writing this bit directly.

The command will fail if you order a power up when the module is already in the connected state and vice-versa as the action cannot be performed.

The “OK” response will be returned as soon as the hot-swap event has begun. If your timing sequence is very long you may have to poll the BUSY bit in register 0 to check when it has completed.

RUN:POWer?

Returns the current plugged/pulled state of the module.

Appendix 1 - Signal Names

The following signal names are used to specify a single signal or a group of signals. These may be used in commands that take a parameter “SIGNAL_NAME”. Note that some commands, such as those returning a value, only accept a parameter that resolves to a single signal. In this case you cannot use the group names

Signals

REFCLK

12V_POWER
3V3_POWER
3V3_AUX

PERST
WAKE
CLKREQ

SMCLK
SMDAT

PRSNT

JTAG

Signal Groups

ALL	(Allows change of all signals at the same time)
POWER	(All power supply pins)