Quarch Technology Ltd

Torridon GEN5 SFF Lite Module

Technical Manual

For use with:

QTL2757 – Gen5 SFF Lite Module

Wednesday, 02 March 2022

Change History

1.0	28th February 2022	Initial Release

Contents

Introduction

The **Torridon GEN5 SFF Lite Module** allows remote switching of power, drive presence, and sideband signals to a PCIe SFF Disk Drive whilst plugged into a host system.

Any standard NVMe drive compatible with the SFF-8639 can be controlled. Each set of pins can be individually switched, allowing complete control over the power up sequence of a drive. The switches can be sequenced at precise timings to simulate a hot-swap event, including pin bounce.

Unlike the HS versions, this LITE module does NOT switch the high speed data signals. These are always connected.

The Control module switches the high speed PCIe data lines at speeds up to Gen 5 (32GT/s). This greatly increases the number of faults that can be injected into the system and produces a more comprehensive hot-swap.

Technical Specifications

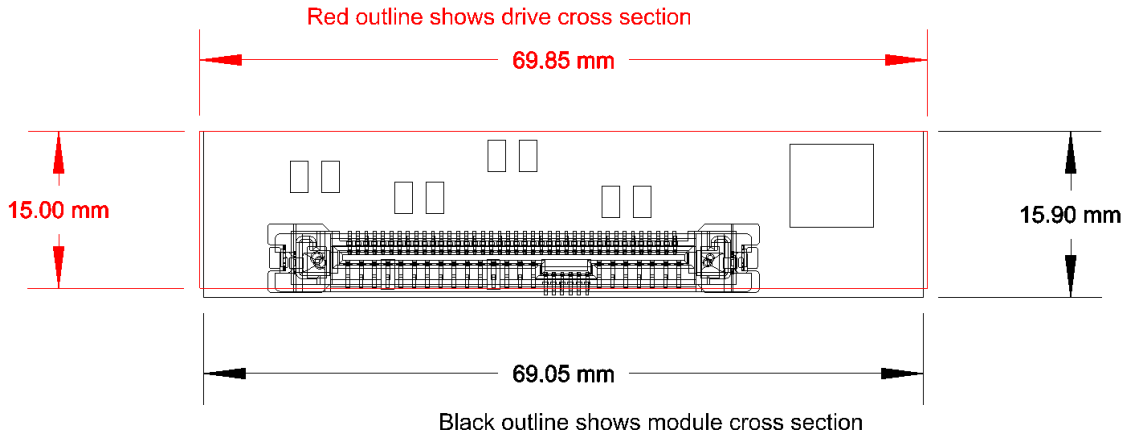
Switching Characteristics:

SFF8639 Connector Pin	Description	Switching Action
S1, S4, S7, S8, S11, S14, S16, S19, S22, S25, S28, P5, P6, P12, E9, E12, E15, E19, E22	Ground Pins	All connected to digital ground on the Module
S2, S3, S5, S6, S9, S10, S12, S13, S17, S18, S20, S21, S23, S24, S26, S27, E10, E11, E13, E14, E16, E17, E20, E21	PCIe Data Signals	Each signal passed through the board
E1, E2, E7, E8,	Reference Clocks	Each differential clock is switched by a dual SPST switch
P14, P15	12V Power	Connected together and switched by 6.9A power FET
P13	12V Precharge	Switched by 6.9A power FET
P8, P9	5V Power	Connected together and switched by 6.9A power FET
P7	5V Precharge	Switched by 6.9A power FET
E3	3V3 Aux Power	Switched by 0.7A FET
E5	PERSTA	Individually switched by an analog switch
E4	PERSTB/CLKREQ	Individually switched by an analog switch
E16, S15, P10	HPT1, HPT0, PRSNT	Switched by an analog switch (via SIDEBAND signal)
P1	WAKE	Switched by an analog switch (via SIDEBAND signal)
P4, E6, E25	IFDet,IFDet2, DualPortEn	Switched by an analog switch (via SIDEBAND signal)
P11	Activity LED	Switched by an analog switch (via SIDEBAND signal)
E23, E24	SM Bus Clock and Data	Switched by an analog switch (via SIDEBAND signal)

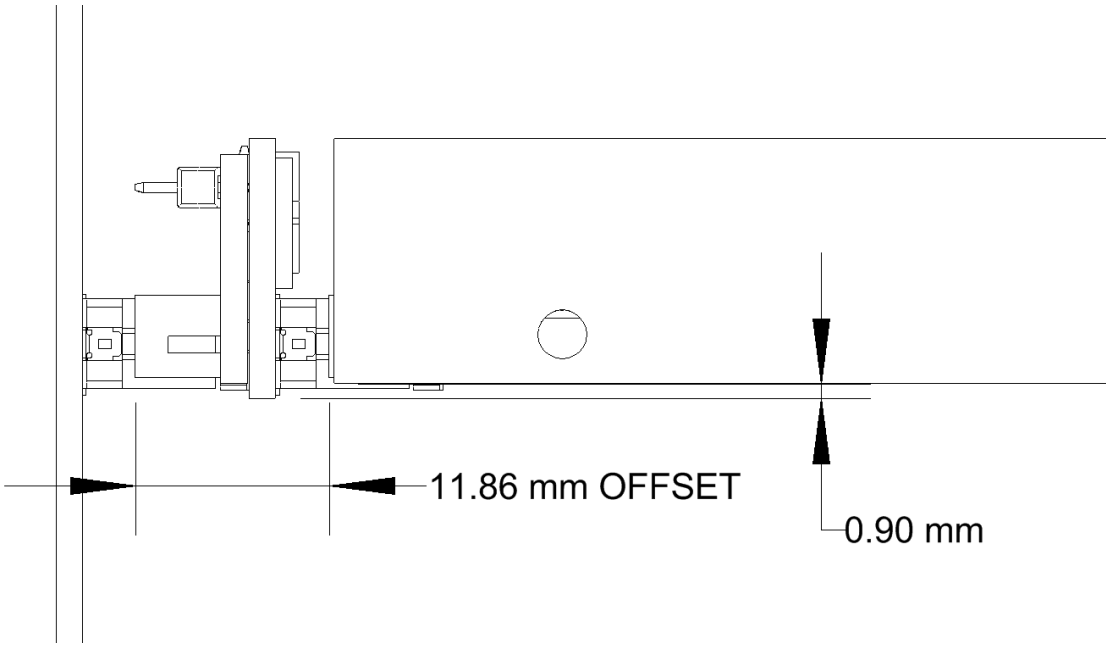
P2	Reserved	Switched by an analog switch (via SIDEBAND signal)

Mechanical Characteristics:

The module is designed to fit into a 2.5” SFF drive bay. The card does stick out 0.9mm below the allowed cross section of the drive, with the addition of the thickness of a drive carrier and general clearances within a chassis design this should not be a problem



- The module will offset the drive by 11.86mm when installed.



Control Interfaces

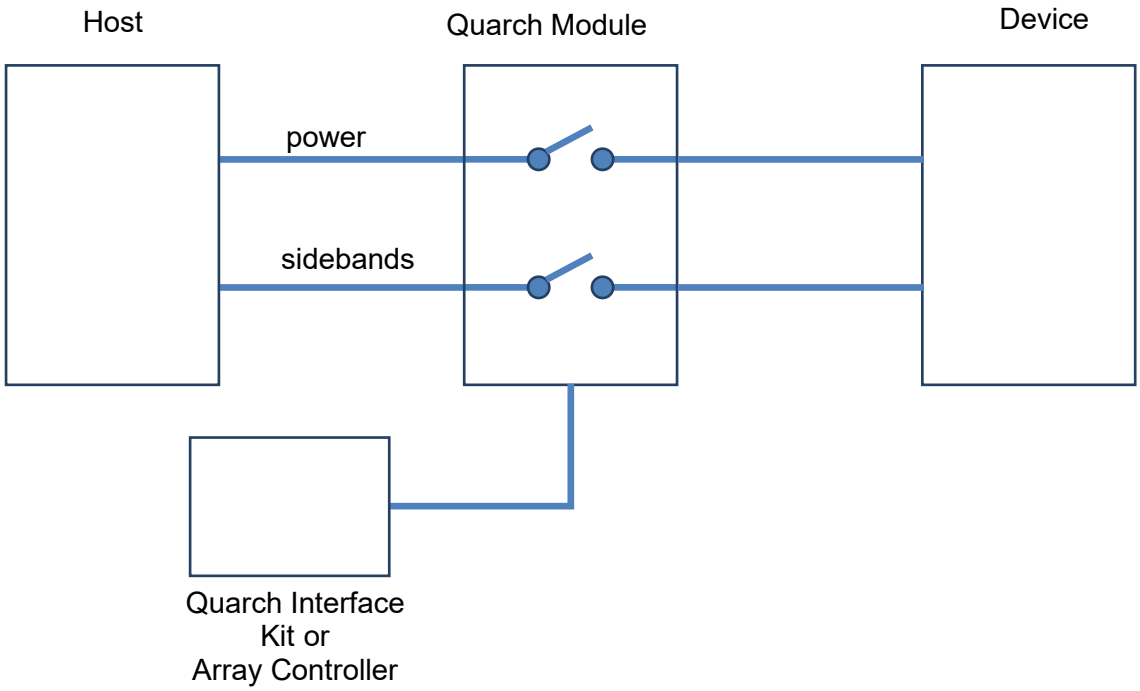
All Torridon modules are designed to be used with a Torridon Array Controller (QTL1461, QTL1079) or a single Torridon Interface Kit (QTL1260).

The control cable is an ultra-thin flex cable.

Control Interface	Form Factor	Torridon Ports	Control Methods Available	Interfaces
QTL1079 28 Port Torridon Array Controller	1U 19” Rack Mounted unit	24 at the front 4 at the rear	Terminal Scripting TestMonkey 2 GUI	Serial via DB9 or RJ45 Ethernet USB
QTL1461 4 Port Array Controller	160x165x53mm Enclosure 1U Enclosure also available	4 ports on front	Terminal Scripting TestMonkey 2 GUI	Serial via RJ45 Ethernet USB
QTL1461 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 USB

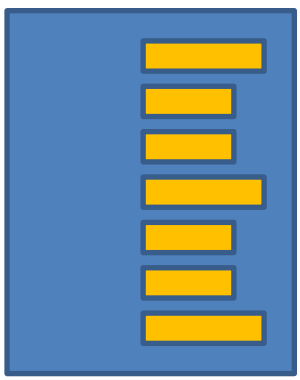
Basic Concepts

Each controlled pin is connected to a separate switch on the module, so it can be connected or isolated on command.

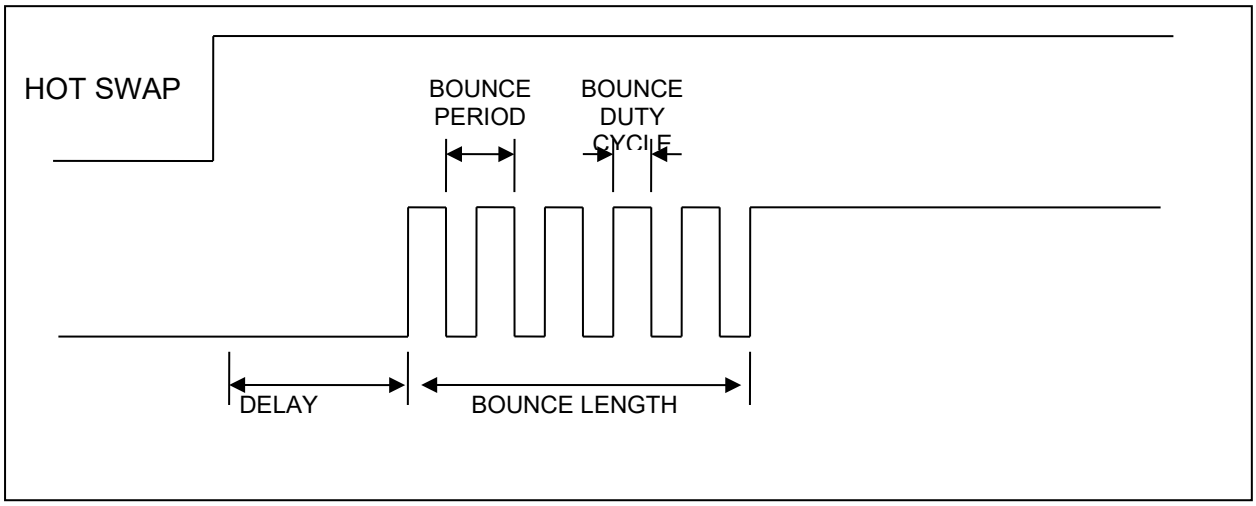


Each switch on the module is called a 'Signal' and can be programmed to follow one of six programmable delay and bounce profiles (called 'Sources'). This allows the user to sequence the signal connections in the cable in up to six programmable steps.

This allows us to create virtually any hot-swap scenario. The default scenario on the module is based on the pin lengths on the connector, so that the long pins mate first, followed by shorter pins.



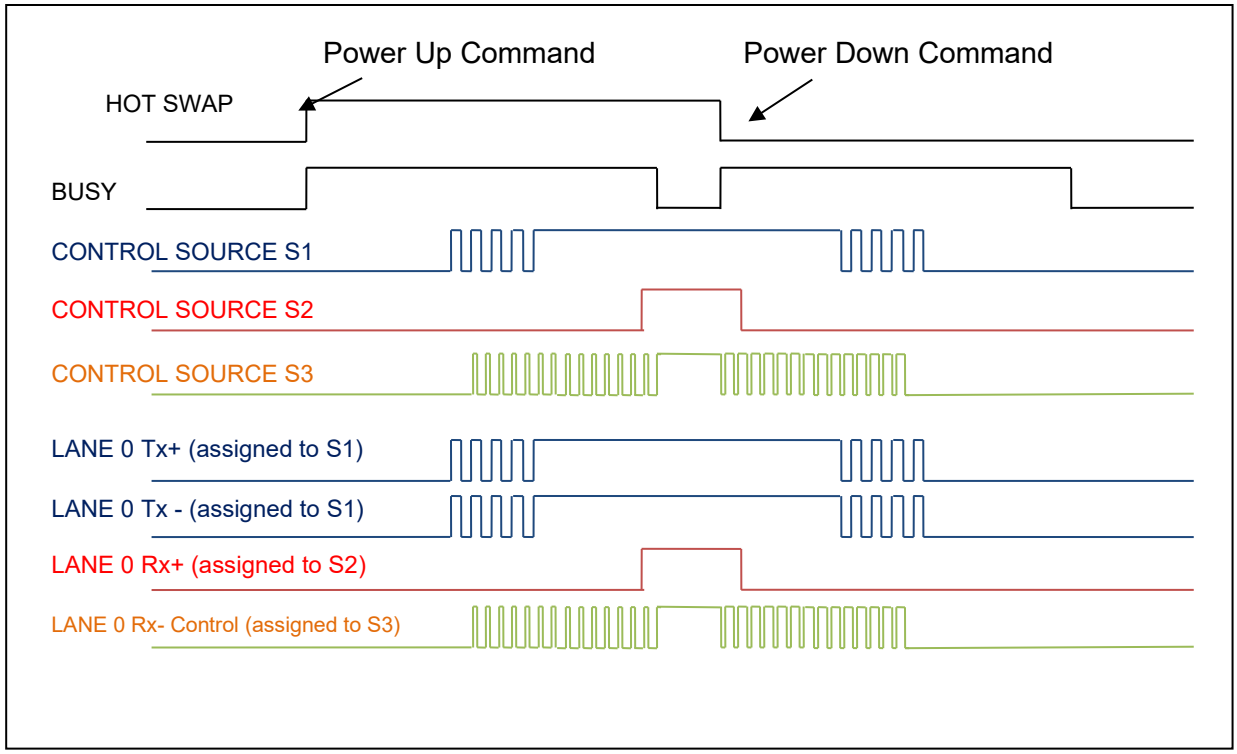
Each of the programmable delay and bounce profiles is called a control source, S1 to S6. For each control source the user sets up a delay, and bounce parameters. Three special sources (S0, S7 and S8) are also provided as described in the table below.



Control Source Parameters for a power up event (Basic Pin Bounce)

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, power down and short operation. This may be used to monitor for the completion of timed events.



Power up and Power down example

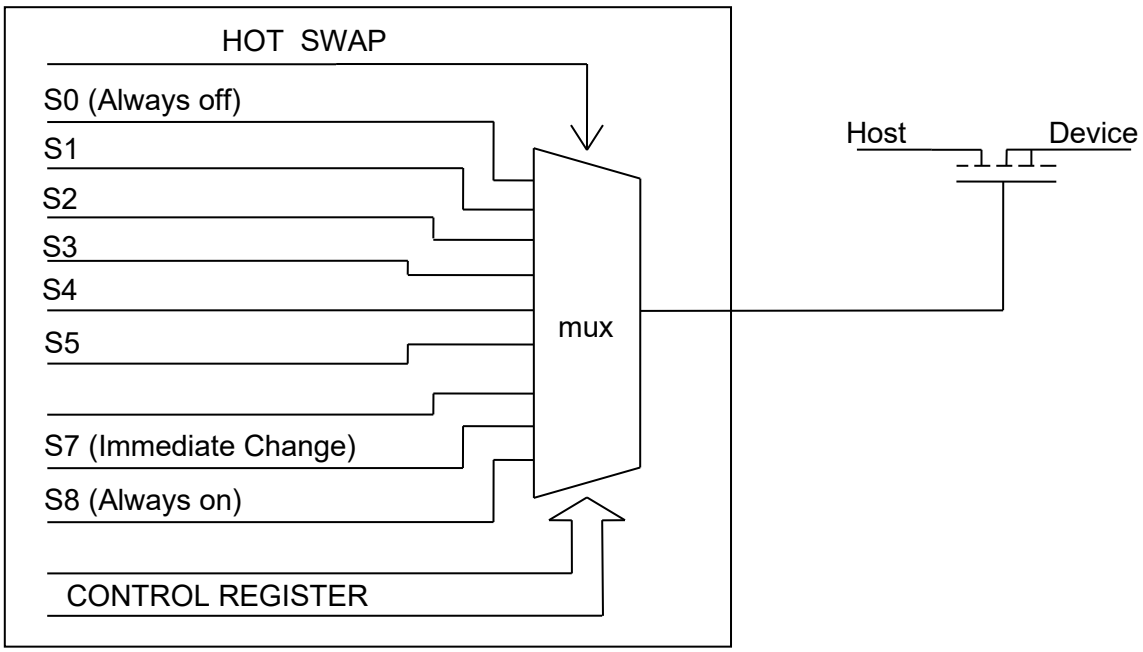
Signal Configuration

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).

Signals assignment is done through the command:

`SIGnal:[name]:SOURce [Source#]`

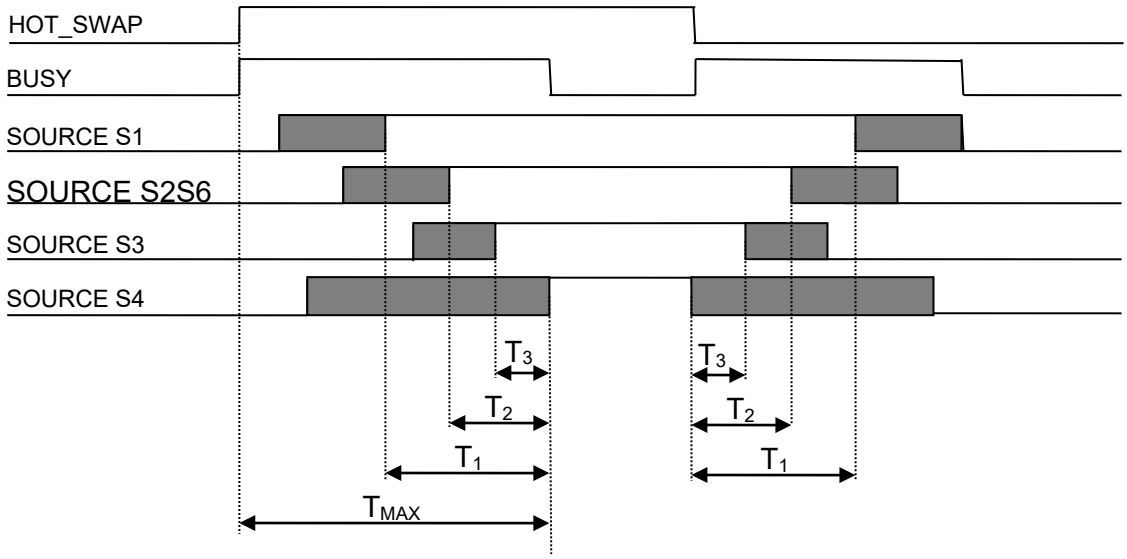
Source Number	Description
0	Signal is always OFF
1	Signal assigned to control source 1
2	Signal assigned to control source 2
3	Signal assigned to control source 3
4	Signal assigned to control source 4
5	Signal assigned to control source 5
6	Signal assigned to control source 6
7	Signal changes with HOT_SWAP state
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 + S1_BOUNCE_LENGTH),

(S2_DELAY + S2_BOUNCE_LENGTH),

up to

(S6_DELAY + S6_BOUNCE_LENGTH)

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

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 module is in the plugged state. When you initiate the 'pull' action, the new settings will be used.

Voltage Measurements

The modules are capable of measuring various voltages both for self test and to assist in the testing of a customer's system. The following measurement points are available:

Measurement Command	Description	Resolution / Accuracy
MEASure:VOLTage:SELF 3v3?	Returns the voltage of the modules internal 3.3v rail	12mV / 3%
MEASure:VOLTage:SELF 5v?	Returns the voltage of the modules internal 5v power rail	15mV / 3%
MEASure:VOLTage 12vin?	Returns the voltage of the 12V power pins on the backplane (unswitched) side of the Module	46mV / 3%
MEASure:VOLTage 12vout?	Returns the voltage of the 12v power pins on the drive (switched) side of the module	46mV / 3%
MEASure:VOLTage 12vin_chg?	Returns the voltage of the 12V charge pin on the backplane (unswitched) side of the Module	46mV / 3%
MEASure:VOLTage 12vout_chg?	Returns the voltage of the 12v charge pin on the drive (switched) side of the module	46mV / 3%
MEASure:VOLTage 5vin?	Returns the voltage of the 5V power pins on the backplane (unswitched) side of the Module	46mV / 3%
MEASure:VOLTage 5vout?	Returns the voltage of the 5v power pins on the drive (switched) side of the module	46mV / 3%
MEASure:VOLTage 5vin_chg?	Returns the voltage of the 5V charge pin on the backplane	46mV / 3%

	(unswitched) side of the Module	
MEASure:VOLTage 5vout_chg?	Returns the voltage of the 5v charge pin on the drive (switched) side of the module	46mV / 3%
MEASure:VOLTage 3v3in_aux?	Returns the voltage of the 3v3 aux pin on the host (unswitched) side of the module	46mV / 3%
MEASure:VOLTage 3v3out_aux?	Returns the voltage of the 3v3 aux pin on the host (switched) side of the module	46mV / 3%

Default Startup State

On power up or reset, the control modules enter a default state. To make the module as easy to use as possible, the default state is a 'standard' hot-swap scenario with preset source and signal settings such that the "run:power up" command will immediately power up the drive without needing any initial setup.

The default hot-swap scenario will connect pre-charge then power then pins, each step with a 25mS delay. All sources are enabled.

Source Number	Source Enabled	Initial Delay
1	YES	0mS
2	YES	25mS
3	YES	0ms
4	YES	0mS
5	YES	0mS
6	YES	0mS

Signal	Assigned Source
12V_CHARGE, 5V_CHARGE, SIDEBAND	Source 1
All other signals	Source 2

Hot-Swap State:
Drive is in the 'plugged' state, waiting for a "**RUN:POWer DOWN**" command to remove 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, but run over a standard Telnet connection.

- REST API (Only when connected to an Array Controller).

  Controllers provide a basic REST API, allowing multi-user control over Torridon products.

- USB

  Quarch's TestMonkey application can control a single module via USB, this allows simple graphical control of the module. The Quarch C# API and Python examples allow automation via USB.

Terminal Command Set

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.

MEASure:VOLTage [12vin?|12vout?|12vin_chg?|12vout_chg?|5vin?|5vout?|5vin_chg?|5vout_chg?|3v3in_aux?|3v3out_aux?]

Returns the voltage on the specified rail in mV. Vin refers to the upstream or host side of the card, and Vout refers to the switched, drive side. Values are returned in the form "3300mV".

M**EAS:VOLTage:SELF [3v3?,5v?]**

Returns the self test voltages. These are measurements of voltage rails required for correct operation of the module. The values are returned in the form "5000mV"

SOURce:[1-6|ALL]:SETup [#1] [#2] [#3] [#4]

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

#1 = Initial delay (mS)

[Limits: 0 to 127ms in steps of 1ms, 0 to 1270ms in steps of 10ms]

#2 = Bounce length (mS)

[Limits: 0 to 127ms in steps of 1ms, 0 to 1270ms in steps of 10ms]

#3 = Bounce Period (uS)

[Limits: 10 to 1270us in steps of 10us, 1000 to 127000us in steps of 1000us]

#4 = Duty Cycle (%)

[Limits: 0 to 100% in steps of 1%]

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

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

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

#1 = Initial delay (mS)

[Limits: 0 to 127ms in steps of 1ms, 0 to 1270ms in steps of 10ms]

#2 = Optional unit specifier (High resolution firmware only) [uS, mS, S]. High resolution firmware allows initial delay of 0 to 16,775mS in 1uS resolution. This parameter is optional, to be back-compatible with older firmware

#2 = Optional unit specifier (High resolution firmware only) [uS, mS, S]. High resolution firmware allows initial delay of 0 to 16,775mS in 1uS resolution. This parameter is optional, to be back-compatible with older firmware

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

SOURce:[1-6|ALL]: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).

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

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

Sets a given signal to a numbered timing source (0-8). SIGNAL_NAME is one of the items in the 'Signal Names' Appendix at the end of this manual.

SIGnal:[SIG_NAME]:SOURce?

Returns the source number that the signal is assigned to.

RUN:POWer [UP|DOWN]

Initiates a plug or pull operation (legacy name used to preserve compatibility between Torridon modules). This is the master control for all switches on the card.

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

12V_CHARGE	
12V_POWER	
5V_CHARGE	
5V_POWER	
3V3_AUX	
PERST_A	
PERST_B	
SIDEBAND	This signal is used to switch all the remaining sideband signals

Signal Groups

ALL	(Allows change of all signals at the same time)
PERST	(PERST_A and PERST_B)
MANAGEMENT	(SIDEBAND)
POWER	(All power and pre-charge signals)