M88 Module Data Sheet

This document describes the M88[1], a member of the Network Synchronization Module for packet network timing applications based on the Silicon Labs AccuTime™ Servo Loop. This document describes how to design with the M88 sub-system module and how to use it in an embedded application. Its intended audience is system architects, who want to understand the functions of the M88 and how it can be used in various applications, hardware designers who want to integrate the M88 into their design, and software designers who need to write code that should communicate with the M88 module.

The integration section includes the pinout of the module and other physical aspects like the options of power supply. It also describes how to connect the necessary key components which are a prerequisite for proper operation.

Silicon Labs recommends anyone who wants to integrate the M88 in their design and to fully understand its characteristics to purchase the M88EVB evaluation board which contains the M88 and provides full access to all interfaces and functionality of the module.

This document applies to software Release 2.0 of the M88. M88 modules can be updated to Release 2.0 by following the directions in 27. Appendix 8: Firmware Upgrade.

Note:

1. There are three M88 variants: M88-32, M88-128, and M88-256. The number refers to the allowed number of slaves. Otherwise, the variants are identical and described merely as M88 in this document.

KEY FEATURES

- Synchronizes to GPS/GNSS, Synchronous Ethernet (SyncE), BITS, PTP (IEEE 1588-2008).
- Industry-leading IEEE 1588 time & frequency recovery algorithms with phase accuracy better than ±1 µs per G.8261
- Class C Constant time error generation (cTE) performance per ITU G.8272.2
- Fractional Frequency Offset better than 1ppb under ITU-T G.8261 test conditions
- Comprehensive IEEE 1588-2008 stack implements ordinary, gateway and boundary clock
- Supports one-step and two-step clock
- Fully compliant to telecom, power and default profiles
- This document applies to software release 2.0.0 and later. For details of any features added since release 2.0.0, see the Release Notes for the relevant version.

Table of Contents

1. General Description

The AccuTime M88 module combines a high precision IEEE 1588 2008 PTP packet gateway clock with the Si5348 ultra-low jitter network synchronizer. The M88 is a turnkey (hardware and software) solution that provides IEEE 1588 2008 and SyncE standards-compliant phase and frequency synchronization, jitter attenuation and clock generation in a unified, small form factor design.

The M88 can synchronize to a wide variety of references, including GPS/GNSS (1 PPS + ToD), IEEE 1588 (PTP), SyncE and BITS, while providing simplified clock input monitoring and management. The M88 incorporates an industry-leading IEEE 1588 servo algorithm to generate the high precision synchronized clock outputs required to distribute precise and accurate timing signals for LTE, LTE-Advanced and evolving 5G transport and access networks. Typical applications include phase and frequency synchronization for wireless infrastructure and wireline broadband networks such as PON, DOCSIS, G.fast DSL and data center switches.

The M88 offers unmatched frequency synthesis, flexibility and ultra-low jitter performance.

1.1 Technical Performance and Functions

The M88 is a fully managed clock module for systems implementing network-based timing. The M88 provides a PTP engine capable of operating as a IEEE 1588-2008 Grandmaster (with external PRTC), slave, boundary or gateway clock for packet-timing and a low-bandwidth, programmable network PLL for physical-layer synchronization.

Industry-leading algorithms deliver high precision PTP performance in either PTP-only or frequency-assist modes. The M88 achieves leading performance against ITU-T G.8261 and G.8273.2-compliant test suites.

The M88 combines clock generation, digital oscillator control, input monitoring, management and packet timing (PTP / IEEE 1588) with advanced servo algorithms. This enables the host system to provide multiple low-jitter (low phase noise) clock outputs.

Additionally, the M88 has cutting edge technology that enables it to manage multiple inputs. The ability to use multiple synchronization sources is particularly powerful in today’s applications, where a host system may need to be versatile and deployable in multiple environments, for example by supporting local-GPS/GNSS, BITS/SSU and SyncE in conjunction with PTP.

1.2 Key Features

Key features of the M88 include:

- Synchronizes to GPS/GNSS, SyncE, BITS/SSU (with external framer/LIU), PTP (IEEE 1588-2008).
- Industry-leading IEEE 1588 time & frequency recovery algorithms with phase accuracy better than ±1 μs
- Fractional Frequency Offset better than 5ppb under ITU-T G.8261 test conditions
- Comprehensive IEEE 1588-2008 stack implements ordinary, gateway and boundary clock
- Supports one-step and two-step clock
- Fully compliant to telecom, power and default profiles
- Meets the applicable requirements of:
  - ITU-T G.8261, G.8265, G.8275
  - ITU-T G.8273 T-GM
  - ITU-T G.8273.2 T-BC and T-TSC
  - ITU-T G.8273.4 T-BC-P and T-TSC-P
  - ITU-T G.8262 (SyncE) EEC Options 1 and 2 and ITU-T G.8262.1 Enhanced synchronous Ethernet Equipment Clock (eEEEC)
  - ITU-T G.812 Type III, IV
  - ITU-T G.813 Option 1
  - Telcordia GR1244, GR253 (Stratum 3/3E)
- Timing interface including PPS, TOD and up to five ultra-low jitter programmable frequency outputs
- Status monitoring: LOS, OOF, LOL
- Scalable to 256 unicast PTP clients
- Integrated TCP/IP stack
- IPv4 and auto-generated address IPv6 (PTP only)
- Low power microprocessor technology with hardware timestamping
- 8 Mbytes SDRAM memory, 2 Mbytes flash memory
- 2x RGMII interfaces to Network and/or Host
- Wirespeed pass-through eliminating the need for a switch in many applications
- Communication servers for serial ports, Telnet and SSH
- Built-in SNTP server
- 29.2x29.2mm Land Grid Array (LGA) module
- RoHS and WEEE compliant

1.3 Timing References

In addition to synchronizing to PTP over either of the two Ethernet interfaces, M88 can take the following timing and frequency references:

- 1 PPS and ToD, where ToD can be in plain ASCII, NMEA or China Mobile binary format. There is also the possibility for an alternate 1 PPS.
- Two high-speed clocks for SyncE or SDH
- Two low-speed clocks (up to 2.048 MHz)
- External oscillator

1.4 Time and Frequency Outputs

In addition to act as a PTP master on either or both Ethernet ports, the M88 can output a number of time and frequency signals, locked to any of the reference inputs.

- 5x ultra-low jitter outputs from three DSPLLs:
  - Programmable frequency up to 350 MHz
  - Can be locked to any reference input or derived from PTP
  - Programmable loop B/W per DSPLL: 1 MHz–4 kHz
- Additional 5/10/20/25 MHz syntonized output
- PPS and ToD, where ToD can be in plain ASCII, NMEA or China Mobile binary format. The PPS is configurable with respect to frequency (up to 2 kHz) and pulse width.

1.5 RGMII Interfaces

The M88 has two RGMII Interfaces intended to be connected directly to a generic RGMII interface offered by the host, or a RGMII PHY. The designer can choose voltage levels for adaptation to his RGMII port of the host system. Performance has only been verified at 1.8V.

The current FW supports the Marvell Alaska series PHYs. The M88 EVB reference design uses the 88E1512. Contact Silicon Labs Applications if you intend some use another PHY.

For applications with host processors or a switch offering only an SGMII interface, a PHY IC such as the 88E1512 from Marvell that converts between SGMII and RGMII needs to be added.

1.6 Communication Interfaces

The M88 offers three asynchronous serial ports besides the two Ethernet ports. Advanced users with the Development Kit will also have access to other serial and parallel interfaces including an analog section to connect to other peripherals outside the module.

1.7 JSON Machine-to-Machine Communications

New with Firmware release 2.0 is the addition of JavaScript Object Notation (JSON) structured configuration information. This greatly simplifies the development of software on host systems to interface with the M88.

1.8 Block Diagram

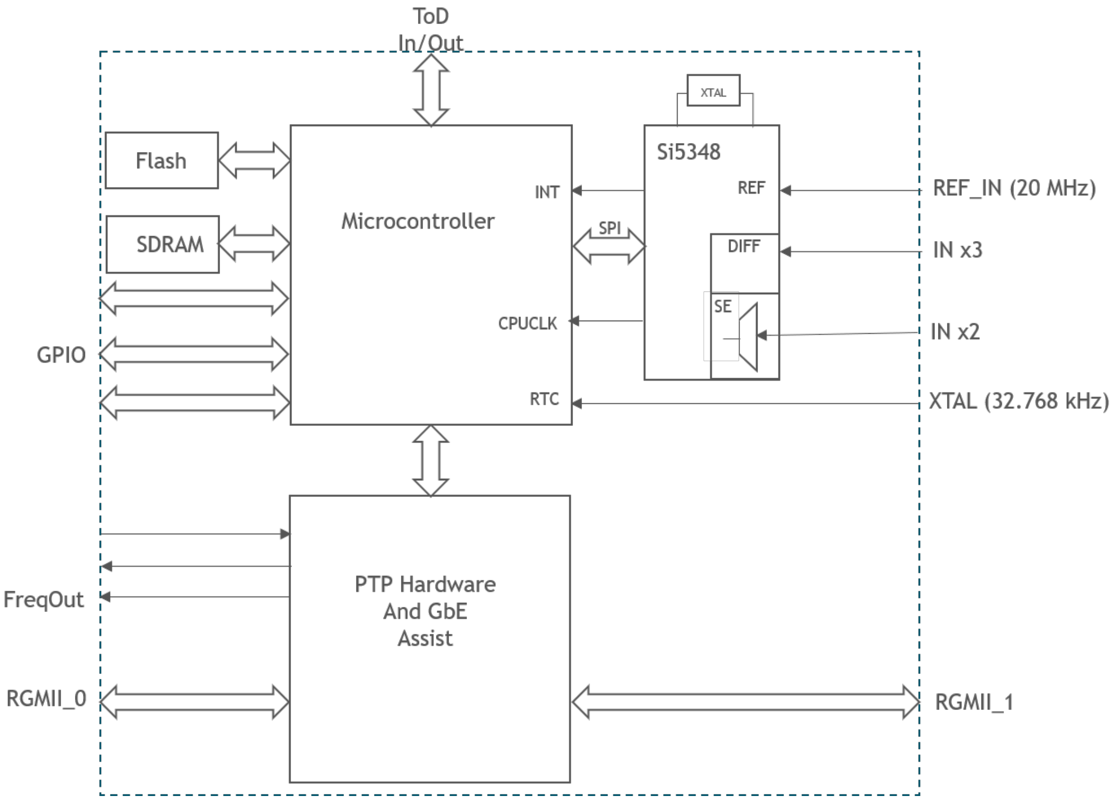


Figure 1.1. M88 Block Diagram

2. Applications

The M88 can be used in a wide range of applications, and the diagrams below are just some examples of how the M88 may be used in various types of equipment.

2.1 Mobile Backhaul Carrier Ethernet

With the M88 configured as a boundary clock, the M88 can either synchronize to a local GPS/GNSS receiver or to an upstream PTP GM. Frequency assist can be provided by SyncE.

2.2 Macro/Micro eNodeB and Small Cell

With the M88 configured as an ordinary clock, the M88 can synchronize to an upstream PTP GM. Frequency can be provided by SyncE.

2.3 C-RAN BBU to RRH Sync

Using Ethernet between BBU and RRH requires synchronization with high precision. M88 can be used both in the BBU as a master or in the RRH as a slave, combining PTP and SyncE for physical layer frequency assist.

3. Packaging

3.1 Dimensions

The module dimensions are 29.2 x 29.2 mm. The height varies over the module surface with a maximum of 3.3 mm and minimum value of 1.0 mm. The weight of the module is 3.0 grams.

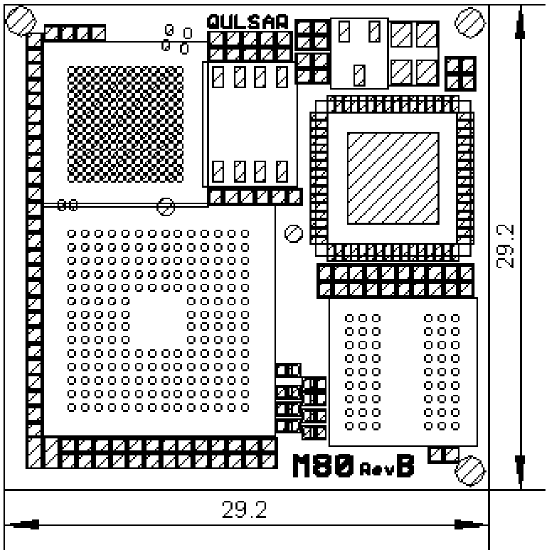


Figure 3.1. Module Size (mm)

3.2 Recommended Land Pattern

This is the recommended PCB land pattern for direct soldering of the M88 module (LGA143) to a host board. Spacing of the pads are 1.8 mm in both directions. First location (empty) is located 2 mm from the edge of the board in both directions. The pads shall be 1.1 mm square and have rounded corners. Copper defined (NSMD) pads shall be used. Gap to solder mask shall be 0.05–0.1 mm. Pads (NSMD) on the backside of M88 module are 1.0 mm square.

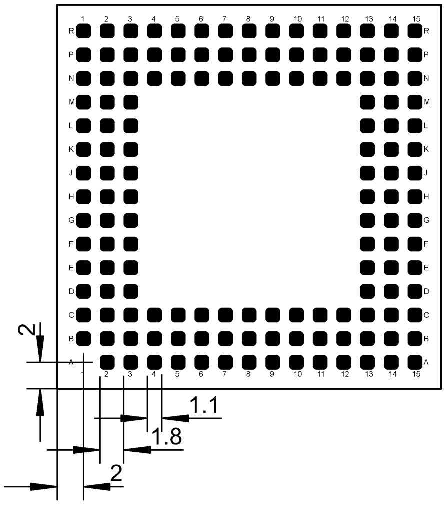


Figure 3.2. Land Pattern (mm)

3.3 Soldering and Handling

Since the M88 is a RoHS-compliant device, it is designed to tolerate lead-free soldering processes. The diagram below shows the recommended soldering profile for the device.

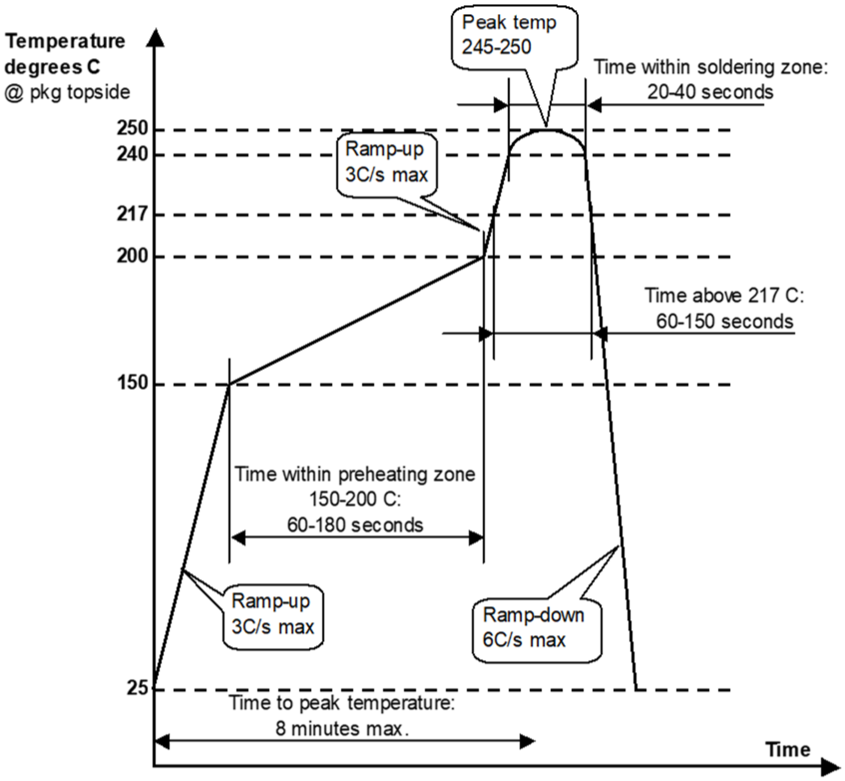


Figure 3.3. Reflow Soldering Profile

The M88 is classified as MSL 3.

3.4 Tape and Reel

The M88 is delivered on tape and reel and this section describes the orientation of the LGA components and the tape used for its packaging.

3.4.1 Pad A1 Orientation

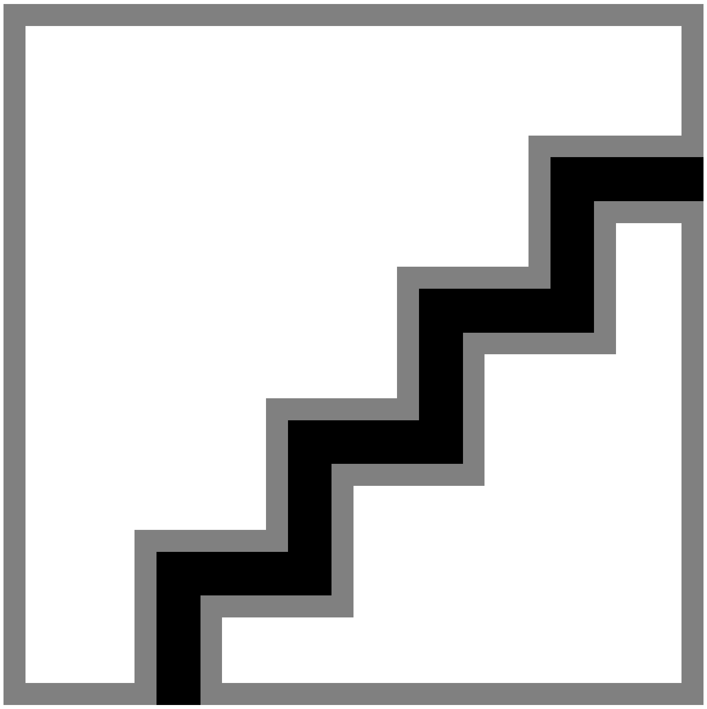


Figure 3.4. Pad A1 Orientation

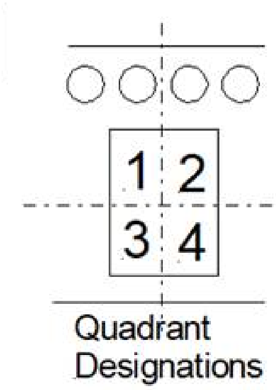


Figure 3.5. Tape and Reel Quadrant

3.4.2 Tape and Reel Specification

Table 3.1. Tape and Reel Specification

Package	Tape Width (mm)	Pitch (mm)	Reel Size (mm)	Devices per Reel	Typical Device
LGA143	44	36	330	250	M88-XX

4. LED Description

The M88 has two on-board LEDs. See Section 23. Appendix 4: Troubleshooting LED Error Codes for more information. One LED is green which shows the status of the boot sequence. The other LED is red and will light up briefly at the startup of the system. If the red LED keeps being lit, the system is not operating properly.

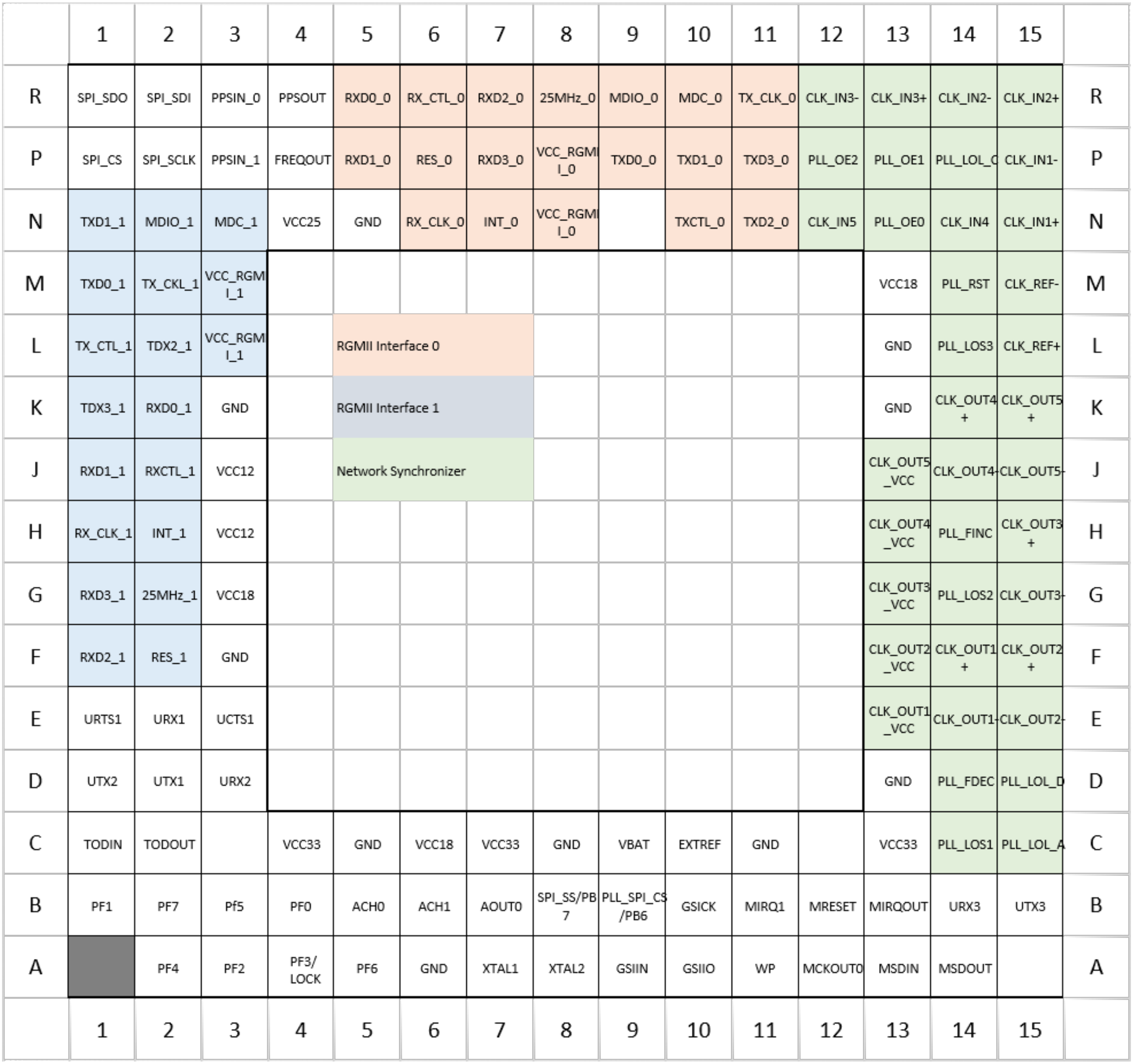
5. Pin List

The term “pin” used in the following table and throughout this document refers to one of the pads placed on the bottom side of the module.

Pin A1 is located in the lower left corner of the module seen from component side. Rest of the pins are enumerated horizontally using numbers and vertically using letters. Please note that this numbering is different from many other LGA devices.

The codes in the Type column below are: I for Input, O for Output, B for Bidirectional, P for Power, (PU) for Pull Up, and (PD) for Pull Down.

Most pins have 3.3 V signaling levels. In the Description column pins not belonging to the 3.3 V region, e.g., those pins powered by the External RGMII interfaces, are noted.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
R	SPI_SDO	SPI_SDI	PPSIN_0	PPSOUT	RXD0_0	RX_CTL_0	RXD2_0	25MHz_0	MDIO_0	MDC_0	TX_CLK_0	CLK_IN3-	CLK_IN3+	CLK_IN2-	CLK_IN2+	R
P	SPI_CS	SPI_SCLK	PPSIN_1	FREQOUT	RXD1_0	RES_0	RXD3_0	VCC_RGMII_0	TXD0_0	TXD1_0	TXD3_0	PLL_OE2	PLL_OE1	PLL_LOL_C	CLK_IN1-	P
N	TXD1_1	MDIO_1	MDC_1	VCC25	GND	RX_CLK_0	INT_0	VCC_RGMII_0		TXCTL_0	TXD2_0	CLK_IN5	PLL_OE0	CLK_IN4	CLK_IN1+	N
M	TXD0_1	TX_CKL_1	VCC_RGMII_1										VCC18	PLL_RST	CLK_REF-	M
L	TX_CTL_1	TDX2_1	VCC_RGMII_1		RGMII Interface 0								GND	PLL_LOS3	CLK_REF+	L
K	TDX3_1	RXD0_1	GND		RGMII Interface 1								GND	CLK_OUT4+	CLK_OUT5+	K
J	RXD1_1	RXCTL_1	VCC12		Network Synchronizer								CLK_OUT5_VCC	CLK_OUT4-	CLK_OUT5-	J
H	RX_CLK_1	INT_1	VCC12										CLK_OUT4_VCC	PLL_FINC	CLK_OUT3+	H
G	RXD3_1	25MHz_1	VCC18										CLK_OUT3_VCC	PLL_LOS2	CLK_OUT3-	G
F	RXD2_1	RES_1	GND										CLK_OUT2_VCC	CLK_OUT1+	CLK_OUT2+	F
E	URTS1	URX1	UCTS1										CLK_OUT1_VCC	CLK_OUT1-	CLK_OUT2-	E
D	UTX2	UTX1	URX2										GND	PLL_FDEC	PLL_LOL_D	D
C	TODIN	TODOUT		VCC33	GND	VCC18	VCC33	GND	VBAT	EXTREF	GND		VCC33	PLL_LOS1	PLL_LOL_A	C
B	PF1	PF7	Pf5	PF0	ACH0	ACH1	AOUT0	SPI_SS/PB7	PLL_SPI_CS/PB6	GSICK	MIRQ1	MRESET	MIRQOUT	URX3	UTX3	B
A		PF4	PF2	PF3/LOCK	PF6	GND	XTAL1	XTAL2	GSIIN	GSIIO	WP	MCKOUT0	MSDIN	MSDOUT		A
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	

Figure 5.1. Pin Placement (Seen from Top/Component Side)

Pin Group	Pin #	Pin Name	Type	Description
Network Synchronizer See Operating Conditions.	M15	CLK_REF-	I	External Reference Clock input. This input can also be used single ended. If so the CLK_REF- input must be connected to GND via 100 nF. Current FW requires this to be 20 MHz.
	L15	CLK_REF+	I	
	P15	CLK_IN1-	I	Differential Clock input. If used as single ended input the negative input must be connected to GND via 100 nF.
	N15	CLK_IN1+	I	
	R14	CLK_IN2-	I	Differential Clock input. If used as single ended input the negative input must be connected to GND via 100 nF.
	R15	CLK_IN2+	I	
	R12	CLK_IN3-	I	Differential Clock input. If used as single ended input the negative input must be connected to GND via 100 nF.
	R13	CLK_IN3+	I	
	N14	CLK_IN4	I	Single ended Clock input. 8 kHz only.
	N12	CLK_IN5	I	Single ended Clock input. 8 kHz only.
	E13	CLK_OUT1_VCC	P	Power for CLK_OUT1.
	E14	CLK_OUT1-	O	Network Synchronizer differential output
	F14	CLK_OUT1+	O	
	F13	CLK_OUT2_VCC	P	Power for CLK_OUT2.
	E15	CLK_OUT2-	O	Network Synchronizer differential output
	F15	CLK_OUT2+	O	
	G13	CLK_OUT3_VCC	P	Power for CLK_OUT3.
	G15	CLK_OUT3-	O	Network Synchronizer differential output
	H15	CLK_OUT3+	O	
	H13	CLK_OUT4_VCC	P	Power for CLK_OUT4.
	J14	CLK_OUT4-	O	Network Synchronizer differential output
	K14	CLK_OUT4+	O	
	J13	CLK_OUT5_VCC	P	Power for CLK_OUT5.
	J15	CLK_OUT5-	O	Network Synchronizer differential output.
	K15	CLK_OUT5+	O	
	M14	PLL_RST	I	Active low Network Synchronizer reset
	C14	PLL_LOS1	O	Loss of signal IN1
	G14	PLL_LOS2	O	Loss of signal IN2
	L14	PLL_LOS3	O	Loss of signal IN3
	C15	PLL_LOL_A	O	Loss of Lock DSPLL_A
	P14	PLL_LOL_C	O	Loss of Lock DSPLL_C
	D15	PLL_LOL_D	O	Loss of Lock DSPLL_D
SPI (only for configuration)	B9	PLL_SPI_CS/PB6	I	SPI Chip Select signal for Network Synchronizer

Pin Group	Pin #	Pin Name	Type	Description
Optional Network Synchronizer inputs. Contact Silicon Labs Apps for details about usage.	D14	PLL_FDEC	I	Use 10 k Pull-down
	H14	PLL_FINC	I	Use 10k Pull-down
	N13	PLL_OE0	I	Can be left open
	P13	PLL_OE1	I	Can be left open
	P12	PLL_OE2	I	Can be left open
Time and Frequency	C1	TODIN	I	Time of day in
	C2	TODOUT	O	Time of day out
	P4	FREQOUT	O	Frequency out
	R3	PPSIN_0	I	Pulse per second in
	P3	PPSIN_1	I	Pulse per second in
	R4	PPSOUT	O	Pulse per second out
RTC	A7	XTAL1	I	RTC crystal connections
	A8	XTAL2	O	
GPIO	B2	PF7	B	Port F
	A5	PF6	B	
	B3	PF5	B	
	A2	PF4	B	
	A4	PF3/LOCK	B	
	A3	PF2	B	
	B1	PF1	B	
	B4	PF0	B	
Analog	C10	EXTREF	I	Reference input for the ADC
	B5	ACH0	I	ADC input
	B6	ACH1	I	ADC input
	B7	AOUT0	O	DAC output
GPIO Serial	D2	UTX1	O	COM1, includes HW flow control
	E2	URX1	I	
	E1	URTS1	O	
	E3	UCTS1	I	
	D1	UTX2	O	COM2
	D3	URX2	I	
	B15	UTX3	O	COM3, Used by Debug interface
	B14	URX3	I	

Pin Group	Pin #	Pin Name	Type	Description
Debug I/F	A13	MSDIN	I (PU)	Serial debug data in
	A14	MSDOUT	O	Serial debug data out
	B12	MRESET	I (PU)	Active low reset input
	B13	MIRQOUT	O	Active low debug interrupt
	B11	MIRQ1	I	Shared Interrupt
	A12	MCKOUT0	O	Debug clock
	A11	WP	I (PD)	Active low flash write protect
RGMII_1 All pins in this group are powered by VCC_RGMII_1	N2	MDIO_1	B	MDIO for PHY_1
	N3	MDC_1	O	
	L3	VCC_RGMII_1	P	RGMII power supply.
	M3	VCC_RGMII_1	P	
	K1	TXD3_1	O	TX Data
	L2	TXD2_1	O	
	N1	TXD1_1	O	
	M1	TXD0_1	O	
	L1	TX_CTL_1	O	TX Control
	M2	TX_CLK_1	O	TX Clock
	G1	RXD3_1	I	RX Data
	F1	RXD2_1	I	
	J1	RXD1_1	I	
	K2	RXD0_1	I	
	G2	25MHz_1	O	Clock to PHY_1
	H1	RX_CLK_1	I	RX Clock
	H2	INT_1	I	PHY_1 Interrupt
	J2	RX_CTL_1	I	RX Control
	F2	RES_1	O	Reset to PHY_1

Pin Group	Pin #	Pin Name	Type	Description
RGMII_0 All pins in this group are powered by VCC_RGMII_0	R9	MDIO_0	B	MDIO for PHY_0
	R10	MDC_0	O	
	N8	VCC_RGMII_0	P	RGMII power supply.
	P8	VCC_RGMII_0	P	
	P11	TXD3_0	O	TX Data
	N11	TXD2_0	O	
	P10	TXD1_0	O	
	P9	TXD0_0	O	
	N10	TX_CTL_0	O	TX Control
	R11	TX_CLK_0	O	TX Clock
	P7	RXD3_0	I	RX Data
	R7	RXD2_0	I	
	P5	RXD1_0	I	
	R5	RXD0_0	I	
	R6	RX_CTL_0	I	RX Control
	N6	RX_CLK_0	I	RX Clock
	N7	INT_0	I	PHY_0 Interrupt
	R8	25MHz_0	O	Clock to PHY_0
	P6	RES_0	O	Reset to PHY_0

Pin Group	Pin #	Pin Name	Type	Description
Power Supply	C9	VBAT	P	3 V battery backup of RTC
	C4	VCC33	P	3.3 V power supply
	C7	VCC33	P	
	C13	VCC33	P	
	N4	VCC25	P	2.5 V power supply. Can be connected to a 3.3 V power supply at the cost of slightly higher power consumption.
	C6	VCC18	P	1.8 V power supply
	G3	VCC18	P	
	M13	VCC18	P	
	H3	VCC12	P	1.2 V power supply
	J3	VCC12	P	
	A6	GND	P	Ground
	C5	GND	P	
	C8	GND	P	
	C11	GND	P	
	D13	GND	P	
	F3	GND	P	
	K3	GND	P	
	K13	GND	P	
	L13	GND	P	
	N5	GND	P	
Not Used	A9	No Connect		These pins are reserved for future use and should be left open.
	A10	No Connect		
	A15	No Connect		
	B8	No Connect		
	B10	No Connect		
	C3	No Connect		
	C12	No Connect		
	N9	No Connect		
	P1	No Connect		
	P2	No Connect		
	R1	No Connect		
	R2	No Connect		

5.1 Pin Descriptions

5.1.1 Network Synchronizer

Many of the pins of the Network Synchronizer has connections to the module pins.
Three of the four inputs are differential, if used as single ended an external capacitor must be connected between the negative input and GND.

Five outputs are brought to the module pins as differential pairs but can also be used as single ended. Each output can be set to either LVCMOS, LVDS or LVPECL by software. Each output has a separate power pin that can be connected to either a 1.8, 2.5 or 3.3 Volts source.

Note that the numbering of inputs and outputs on the Si5348 and the M88 are different.

Table 5.1. M88 and Si5348 Inputs and Outputs

M88	Si5348		M88
IN	IN	OUT	OUT
1	0	0	Internal
2	1	1	Internal
3	2	2	1
4	3	3	2
5	4	4	3
		5	4
		6	5

5.1.1.1 PLL_RST

The PLL_RST signal should be tied together with the MRESET signal to avoid situations where a misconfigured Si5348 puts the M88 in a non-operable condition, where only a power cycle would restore operation.

5.1.1.2 PLL_SPI_CS/PB6

The PLL_SPI_CS/PB6 pin can be left unconnected. (*This interface is only required if the ClockBuilder Pro tool and Field Programmer are to be used. The Network Synchronizer is configured during manufacturing of the module.*)

5.1.2 Time and Frequency

5.1.2.1 Reference Time Input

It consists of signals PPSIN_0, PPSIN_1 and TODIN, and is intended for connection to an external time source like a GPS/GNSS receiver or similar. Current SW allows only either PPSIN_0 or PPSIN_1 to be used. If a signal is not used, it can be left unconnected.

PPSIN expects a pulse-per-second signal. Rising edge should be on second boundary, the pulse width is not critical.

TODIN should receive time-of-day information, for example in NMEA 0183 format. Polarity will be automatically detected. The current FW supports 4800 or 9600 baud 8N1 on the TODIN pin.

5.1.2.2 Precision Time Output

The interface consists of signals PPSOUT, TODOUT and FREQOUT.

PPSOUT outputs a pulse-per-second. Pulse width, frequency, phase and polarity of this signal can be controlled by software.

TODOUT outputs time-of-day, for example in NMEA 0183 format. Baudrate can be set to 4800 or 9600 baud 8N1.

FREQOUT outputs a syntonized frequency in the MHz range and at LVTTL levels. The frequency is software selectable 5/10/20/25 MHz. If an ultra- low-jitter signal is needed, it’s better to use one of the CLK_OUT signals coming from the network synchronizer instead.

5.1.2.3 PF3/LOCK Pin

The PF3/LOCK pin can be configured to indicate that the PTP loop is locked. See the ptp2 lock command.

5.1.3 RTC

For RTC support, connect a 32.768 kHz crystal between XTAL1 and XTAL2. Otherwise, keep pins unconnected.

5.1.4 Analog

EXTREF is used as an external voltage reference for the ADC. Connect it to a temperature stable voltage reference of e.g. 2.5 V for best performance. Optionally connect it to 2.5 V power supply. For voltage-controlled oscillators AOUT0 is used for the control voltage. The output voltage range is 0.8–2 V. This might need to be adopted to the VCO range of the oscillator by external circuitry. ACH0 can be used for voltage feedback of the control voltage to the VCO. In case this is not used, remain unconnected and turn off voltage feedback in the servo. See 15.1.4 ptp2 config.

5.1.5 GPIO Serial

The serial ports support several communication options with different combinations of parity, stop bits and character length, and are capable of baud rates from 300 bit/s up to 921,600 bits/s.

- COM1: Serial interface with flow control
- COM2: Serial interface without flow control.
- COM3: Serial interface without flow control

5.1.6 RGMII

Please note that the VCC_RGMII_1/0 pins must be connected to a power source, even if the interface is unused.

6. Specifications

6.1 Metrics

Metric	Value
Dimensions	29.2 x 29.2 x 3.3 mm
Weight	3.0 g
Operating temperature	Ambient –40°C to +85°C
Storage temperature	–40 to +150 °C

6.2 Absolute Maximum Ratings

Parameter	Symbol	Min	Max
Supply voltage 3.3 V	V_{CC33}	–0.3 V	3.6 V
Supply voltage 2.5 V	V_{CC25}	–0.3 V	3.6 V
Supply voltage VCC_RGMII_1 and VCC_RGMII_0 Performance has only been verified at 1.8 V.	V_{CC_RGMII}	–0.3 V	3.6 V
Supply voltage 1.8 V	V_{CC18}	–0.3 V	2.5 V
Supply voltage 1.2 V	V_{CC12}	–0.3 V	1.32 V
RTC battery backup supply	V_{BAT}	–0.3 V	4.0 V
I/O voltage (all other pins)	V_{IO33}	–0.3 V	4.0 V
ESD tolerance (human body model)	V_{ESD}		2 kV

Permanent device damage may occur if the absolute maximum ratings are exceeded. These are stress ratings only, and functional operation should be restricted to within the conditions detailed in the next section.

Exposure to absolute maximum rating conditions for extended periods may affect the device’s reliability.

6.3 Recommended Operating Conditions (Preliminary)

Table 6.1. Recommended Operating Conditions (Preliminary)

Parameter	Symbol	Min	Typ	Max
Supply voltage 3.3 V	V_{CC33}	3.15 V	3.3 V	3.45 V
Supply voltage 2.5 V	V_{CC25}	2.38 V	2.5 V	2.62 V
Supply voltage VCC_RGMII Performance has only been verified at 1.8 V.	V_{CC_RGMII}	3.15 V	3.3 V	3.45 V
		2.38 V	2.5 V	2.62 V
		1.71 V	1.8 V	1.89 V
		1.43 V	1.5 V	1.57 V
		1.14 V	1.2 V	1.26 V
Supply voltage 1.8 V	V_{CC18}	1.71 V	1.8 V	1.89 V
Supply voltage 1.2 V	V_{CC12}	1.14 V	1.2 V	1.26 V
RTC battery backup supply	V_{BAT}	2.7 V		3.63 V

Parameter	Symbol	Min	Typ	Max
I/O voltage (RGMII pins)	V_{IO_RGMII}	-0.3 V	V_{CC_RGMII}	V_{CC_RGMII} + 0.5 V
I/O voltage (REFCLK pins)	V_{REF}	-0.3 V		1.8 Vpp_se
I/O voltage (all other pins)	V_{IO33}	0 V		3.63 V

6.4 DC Electrical Characteristics (Preliminary)

Table 6.2. DC Electrical Characteristics (Preliminary)

Parameter	Symbol	Min	Typ	Max
Power consumption				1.7 W
Supply current	I_{CCxx}	(see table below)		
RTC backup current (V_{BAT} = 3.0 V, V_{CC} = 0 V)	I_{BAT}		5.5 µA	
Input low voltage	V_{IL}			0.8 V
Input high voltage	V_{IH}	2.0 V		
Input/tristate leakage current	$\lvert I_I \rvert$		1 µA	10 µA
GPIO Output low voltage ($\lvert I_{OL} \rvert$ = 8 mA)	V_{OL}			0.4 V
GPIO Output high voltage ($\lvert I_{OH} \rvert$ = 8 mA)	V_{OH}	2.4 V		
PPSOUT Output low voltage ($\lvert I_{OL} \rvert$ = 12 mA)	V_{OL}			0.4 V
PPSOUT Output high voltage ($\lvert I_{OH} \rvert$ = 12 mA)	V_{OH}	2.4 V		

The following table lists the preliminary values for a gigabit-speed connected module.

Table 6.3. Preliminary Values for a Gigabit Speed Connected Module

Preliminary and Typical Consumption by the Network Synchronizer	
V	mA
1.8	230
2.5	15
3.3	230

Power dissipation of the Network Synchronizer is dependent how many outputs are used, what frequency and what I/O standards used. Typically, the power consumption of this device is in the 400 to 1000 mW range.

6.5 AC Electrical Characteristics

Parameter	Symbol	Min	Typ	Max
External reference oscillator frequency	f_{OSC}		20 MHz	

6.6 MTBF

The reliability prediction of the M88 has been in accordance with the Telecordia Technologies Special Report SR-332, issue 4 with method Part stress analysis:

- Lambda (FIT): 98
- MTBF (hours): 10,2 M

Environmental conditions: Ground, Benign and ambient temperature 25 □C.

7. PCB Design Considerations

This chapter should be read before starting a design comprising a M88 module.

7.1 Land Pattern

The module has 143 pads placed on the back-side of the board. See section 3.2 Recommended Land Pattern for further information.

7.2 Power

The module has connections for four different voltages. Three of those voltages are mandatory. An optional backup battery, for the RTC, can be connected to the module.

7.2.1 Required Voltage

For Maximum and Operating Voltage Levels see sections 6.2 Absolute Maximum Ratings and 6.3 Recommended Operating Conditions (Preliminary).

Maximum Supply Currents during operation are listed in 6.4 DC Electrical Characteristics (Preliminary). During start-up, the current consumption can momentarily be higher.

Pin Name	Voltage	Description
VCC33	3.3 V	This voltage is used for driving signals on the module and for some of the modules I/O’s.
VCC25	2.5 V or 3.3 V	If connected to 3.3 V there will be slightly higher power dissipation.
VCC18	1.8 V	Used for the devices on the module.
VCC12	1.2 V	Used for the devices on the module.
VCC_RGMII_1 VCC_RGMII_0	1.2 V to 3.3 V	Those power pins are used to drive the RGMII interfaces and must be connected to the same voltage source as the PHY’s RGMII interface. Those pins must not be left unconnected. If no external PHY used this pin should be connected to VCC18.
VBAT	3 V	If backup is required, this pin shall be connected to a 3V lithium coin cell battery. No current is drawn from the battery when power is available on pin VCC33.

7.2.2 Decoupling Capacitors

It is important that the decoupling capacitors has the right specifications, are placed close to the module and, to minimize inductance, are connected using as wide tracks as possible. The use of power planes is of course the ideal solution.

Decoupling capacitors on the module itself are placed very close to the on-module circuits. Those capacitors will provide for the immediate current requirement. Bulk capacitance must be placed external to the module. All 4.7 µF capacitors mentioned below shall be placed as close as possible to the corresponding module connection. The larger capacitors, 100 µF, can be placed further away from the module.

Pin Name	Decoupling Capacitors
VCC33	Connect one 4.7 µF and one 100 µF capacitor to this pin.
VCC25	Connect one 4.7 µF and one 100 µF capacitor to this pin.
VCC18	Connect one 4.7 µF and one 100 µF capacitor to this pin.
VCC12	Connect two 4.7 µF capacitors to this pin.
VCC_RGMII	Connect one 4.7 µF and one 100 µF capacitor to this pin.

The decoupling capacitors must have the following specifications:

- Ceramic X7R or X5R, 6.3 V.
- 100 µF: max size 1210, ESLmax 5 nH, 10 mΩ < ESR < 60 mΩ.
- 4.7 µF: max size 0805, ESLmax 2 nH, 10 mΩ < ESR < 60 mΩ.

7.3 RGMII Interfaces

This interface is clocked at 125 MHz when running GbE. Needless to say, care must be taken during design.

RGMII clocking is source synchronous, what is the RX clock is generated by the PHY and the TX clock by the module. All traces within a channel must have equal length. Delay of the clock, sampling in the middle of the data-eye, is taken care of by the external PHY and the RGMII interface on the module.

7.4 Reference Clock Inputs and Outputs

The input clocks and the output clocks should have vias that immediately go to a buried layer with a ground plane above them and a ground flooded bottom layer. There is a ground flooding between the clock pairs to avoid crosstalk. There should be a line of vias through the ground flood on either side of the clocks to ensure that the ground flood immediately next to the differential pairs has a low inductance path to the ground plane.

8. Application Software

8.1 System Access

See the Quick Start Guide for setting up communication to the module when located in a system board like the M88 EVB. To log on to the system, the username is “root”, and password “root” is the initial credential.

You can change them later with the passwd command and add or delete users in the database, see the passwd.ini section.

On entering the system, you will see a prompt and an identifier for the system. The interface is very similar to UNIX.

8.2 System Files

The system directory, **A:/system**, contains firmware files and a number of system initialization and configuration files. These are listed in the Appendix 1 for reference. The files most applications should check and modify are the **system.ini** and **startup.ini** to setup the module in its environment and give the PTP engine the parameters for the synchronization scheme.

8.3 Module Shell Environment

The shell, called ISH, is responsible for the high-level system initialization, for execution of various servers and for providing a UNIX-like command interface.

8.3.1 High-Level Initialization

The shell startup code completes initialization and configuration of the system and performs the following tasks:

- Initializes the serial port interfaces
- Registers stdout and stderr functions
- Reads the Hardware Identification String from the flash memory
- Reads and processes a shell configuration file ish.ini.
- Reads and processes a system configuration file system.ini
- Initializes and starts a Serial server
- Configures a hostname
- Initializes and configures TCP/IP stack software
- Starts FTP and Telnet servers
- Sets the Time Zone and Daylight Saving
- Reads and executes startup file startup.ini

8.3.2 Communication Servers

The shell includes Serial server, Telnet server and FTP server. The shell starts them automatically during startup, if specified in the system configuration file. Otherwise they can be started and stopped manually using startserver and stopserver commands.

8.3.2.1 Serial Server CLI

The Serial server provides the command-line user interface over a serial channel. The serial port number and port parameters can be specified though environment variables.

8.3.2.2 Telnet Server CLI

The Telnet server provides the command-line user interface over a TCP/IP communication channel. The TCP port number and the server priority can be specified though the environment variable.

8.3.2.3 SSH Server

The SSH server is not started by default but has to be started manually using the command:

```
startserver –d
```

Note: For the current implementation, initialization takes about 30 seconds, and establishing the connection takes about another 60 seconds.

8.3.2.4 FTP Server

The FTP server provides remote access to the local file system. It supports both get and put operations. The number of simultaneous connections and the server priority can be specified through environmental variables.

8.3.2.5 JSON

The command interface (default is COM3) can be used in either CLI/HMI command mode or JSON mode. The JSON mode is turned on or off with the following commands.

```
ptp2 engine json on
ptp2 engine json off
```

See Section 16 JSON for more details.

8.4 Passthrough

The passthrough mode allows M88-based system with two Ethernet interfaces to act as a "synchronization gateway" for non-PTP hosts.

On its primary Ethernet port, such "gateway" is connected to a network which transports data and PTP synchronization. To its secondary Ethernet port, the non-PTP system is connected. The "gateway" participates in PTP activity acting as a PTP slave and synchronizing its local clock. The PTP traffic is filtered out while non-PTP data is passed through to the host along with PPS/TOD/FREQ-out synchronization signals.

The command to turn on and off pass-through is:

```
ifconfig frwd [on|off]
```

8.5 VLAN

The M88 supports VLAN tagging. If VLAN is used in combination with PTP, the VLAN needs to be set before the PTP engine is started.

To enable VLAN on the interface, use the following command:

```
ifconfig [iface] vlan [parameters]
```

where `[iface]` is the interface name. If not given, `enet0` will be used.

`[parameters]` can be:

- `off`—Sends and receives untagged frames only.
- `none`—Send untagged frames; receives untagged and priority tagged frames.
- `0 [prio_code]`—Sends priority-tagged frames; receives untagged and priority-tagged frames.
- `<vlan_id> [prio_code]`—Sends and receives VLAN-tagged frames only.

For example:

```
ifconfig enet0 vlan 1588 0
```

To disable VLAN on enet1, use the `ifconfig enet1 vlan off` command.

8.6 MDIO

The M88 supports the possibility to control and monitor equipment such as a PHY connected over MDIO. To enable MDIO mode, use the following command:

```
ifconfig [iface] mdio
```

This will disable all other access to the MDIO registers to avoid conflicting writes to the page register. To then read from MDIO registers use the following command:

```
<reg>
```

And, to write to an MDIO register in the exclusive MDIO mode, use:

```
<reg> <value>
```

To exit from the exclusive MDIO mode, type “q”.

For example, to enter MDIO mode on interface 0 and write hex 4885 to register 18 on page 3 (reg 22 is page register):

```
A:/root> ifconfig enet0 mdio
Enter exclusive MDIO mode on enet0
22 3
22: 0x0003
18
18: 0x4b85
18 0x4885
18: 0x4885
q
Quit exclusive MDIO mode on enet0
A:/root>
```

It is also possible to read or write directly to a MDIO register without entering the exclusive mode:

```
ifconfig [iface] mdio <reg> <value>
```

But, be aware of any page register settings.

To simplify things for the user, some common operations on the PHY has been defined as specific commands: to manage link speed and duplex, to reset the PHY, and to manage SyncE master/slave behavior.

8.7 Link Speed

The PHY link speed and duplex can be controlled by the command:

```
ifconfig [iface] link [parameters]
```

where `[iface]` is the interface name. If not given, `enet0` will be used.

`[parameters]` can be one of the following modes: 1000F, 1000H, 100F, 100H, 10F, 10H which disables autonegotiation and force the interface into the desired speed and duplex (F – full, H – half) or auto [mode_mask] which will enable autonegotiation and optionally set advertised modes. If mode_mask is not given all supported modes will be advertised, i.e., 1000F|1000H|100F|100H|10F|10H

For example, to set interface 0 to 100Mb/s Full duplex:

```
ifconfig enet0 link 100F
```

or set interface 0 to autonegotiation with only 1000Mb/s and 100Mb/s full duplex supported.

```
Ifconfig enet0 link auto 1000F|100F
```

8.8 PHY Reset

It is possible to reset the PHY with the following command:

```
ifconfig [iface] reset [options]
```

Where `[iface]` is interface name. If not given, `enet0` will be used. `[options]` can be either `sw`, `noinit`, or not given at all.

If no option is given, a HW reset is performed, i.e., the reset pin of the PHY is pulled, after which initialization is done.

If the option, `noinit`, is also given; a HW reset is performed, but no initialization of the PHY is performed. This can be used when PHY needs to be configured manually using MDIO.

The option `sw` sets the reset bit in the MDIO registers, performing a SW reset. This is of course only relevant if the PHY's MDIO interface lines are connected.

For example, to perform a HW reset of the PHY on interface 1:

```
ifconfig enet1 reset
```

8.9 SyncE

For PHY devices supporting SyncE it is possible to define the direction of frequency on a link. This is only valid for 1000Base-T interfaces.

```
ifconfig [iface] synce [parameters]
```

Where `[iface]` is the interface name. If not given, `enet0` will be used.

`[parameters]` can be:

`master|slave` which will *disable* autonegotiation and force the interface into either master or slave mode or

auto `master|slave` which will *enable* autonegotiation with either master or slave preference

If no parameter is given, the current resolved state will be reported.

For example, setting interface 1 to be the preferred `SyncE` master:

```
ifconfig enet1 synce auto master
```

8.10 SFP

There is support for managing an SFP connected to the specified network interface.

```
ifconfig [iface] sfp [parameters]
```

Where `[iface]` is the interface name. If not given, `enet0` will be used.

`[parameters]` can be:

`raw` prints SFP information in raw hex format

`state` shows state of LOS, enable, presence and fault

`enable` enables the SFP transmitter

`disable` disables the SFP transmitter

`mdio <reg>` performs single read from MDIO register in SFP PHY

`mdio <reg> <value>` performs single write to MDIO register in SFP PHY

If no parameter is given, prints formatted SFP information.

9. IEEE 1588/PTP Engine

9.1 General Features

The IEEE 1588/PTP Engine (PTP Engine) has the following features:

- Implements an ordinary clock and boundary clock in accordance to IEEE Std 1588™-2008
- Fully flexible to comply with Default, Telecom and Power Profiles
- Supports both GPS/GNSS and PTP as the primary and backup time source
- Built-in SNTP server
- Supports five different operational modes
- Provides the command-line interface (can be configured and monitored either locally via Terminal or over the network via Telnet or SSL)
- Supports PTP Management interface (can be configured and monitored over the network from a PTP Management station)
- Provides a rich set of APIs
- Uses high-precision hardware timestamp engine
- Can be partially customized by the customer

9.2 PTP Software Implementation

PTP is divided into three layers; Protocol Layer, OS Abstraction Layer and the OS Layer.

9.2.1 Protocol Layer

The protocol layer contains the PTP engine which is implemented according to the IEEE 1588-2008 standard. The protocol engine encapsulates a number of functions necessary to run the PTP clock. Among those functions are best master clock algorithm, PTP message handling and maintaining of PTP clock data sets.

9.2.2 OS Abstraction Layer

The OS abstraction layer implements a number of interfaces between the protocol engine and the underlying operating system.

9.2.2.1 GPS/GNSS Interface

The GPS/GNSS interface contains functionality for GPS/GNSS synchronization. This interface is used when running the grandmaster clock.

9.2.2.2 PTP Interface

The interface PTP encapsulates the functions of the PTP environment and therefore only provides the functions that must be callable from the outside of the protocol engine. PTP is a wrapper of PTP environment – it represents the API of the PTP protocol.

9.2.2.3 Port Interface

The port interface is used to send and receive PTP messages. It makes use of the functions the OS provides (e.g., sockets) in order to communicate over the network.

9.2.2.4 Timestamp Interface

The time stamp interface is used to pass time stamps for Sync and Delay_Req messages to the PTP protocol engine. It also implements the connection which is used to read the timestamps from the timestamp unit.

9.2.2.5 Clock Interface

The clock interface provides functions to read, write and configure the local clock. The clock interface uses the clock driver functions (set time, get time, drift compensation etc.) in order to access the clock.

9.2.2.6 Log Interface

Through the log interface the protocol engine can output log information. The log provides human readable information that shows current settings and current state of the protocol engine. This log information can be monitored either via a serial port or TCP/IP.

Log output is initiated and controlled though the Human Machine Interface.

9.3 GPS/GNSS Driver

The GPS/GNSS driver consists of a PPS Receiver unit and a GPS/GNSS Time Receiver.

When a PPS signal from the attached GPS/GNSS unit is received by the GPS/GNSS Receiver, the signal is timestamped by the PTP timestamp unit. The timestamp is then delivered to the GPS/GNSS Interface where it is put in an event queue for processing by the protocol stack.

The GPS/GNSS Time Receiver receives time of day information from the GPS/GNSS unit. This time information specifies the date and time of the PPS signals.

9.4 Managed Timing Engine – MTE

The Managed Timing Engine, MTE, consists of configurable timers and MAC hardware with timestamp capabilities.

The MAC hardware reports timestamps for all incoming or outgoing Ethernet frames.

The PTP engine receives and sends PTP messages through the TCP/IP stack using a socket interface. It accesses the timestamp list to get timestamps for these messages.

The MAC hardware is augmented with input timestampers and output coincidence triggers to allow it to set timestamps at input events and cause output events at certain times.

9.5 Starting/Stopping the PTP Engine

The PTP engine runs as a separate thread and there can only be one instance of the PTP engine running at one time. An application can start the PTP engine by a call to the function `PTP2_Start()`.

As the parameter to that function, a pointer to the configuration structure is passed. In this structure one can specify whether a pulse-train needs to be enabled and a mode for the PTP engine operations (see detail below).

The PTP engine can also be automatically started at boot time by the Shell, ISH. For more information about ISH see the ISH documentation in the Profile Help.

To stop the PTP engine, use the `PTP2_Stop()` function or the corresponding shell command.

9.6 Pulse Train

A pulse-train can be generated by the PTP engine. The pulse-train can be continuous or a specified number of pulses can be generated. The user can also specify the width and period of the pulse-train as well as the starting time for the pulse-train.

9.7 Human Machine Interface

The PTP engine has a command interface that the user can use to manually change settings and issue different printouts from the engine's current state. The Human Machine Interface (HMI) commands can be entered either manually (from a Terminal or Telnet console).

To find exact syntax of each command simply type "h" – stands for Help.

When using the HMI commands, you can type either the command word or use the letter(s) in the parentheses before the command. For example, to disable unicast negotiation, type `unicast n off` or type `u n off`. To see a list of the command set, first make sure you are in HMI mode by typing `ptp2 hmi` at the prompt. Next, type `help` and the commands display.

The following table shows the structure of the commands

Command	Example	Results
command	`unicast` or `u`	Prints a list of subcommands.
Command subcommand	`unicast n` or `u n`	Prints current value of associated parameter.
Command subcommand value	`unicast n off` or `u n off`	Sets associated parameter to a different value.

The next series of tables describe each command and its associated subcommands and values. The last table shows command examples.

Clock Command	Subcommand & Parameters	Description
(c)clock	(i)info	Print clock description.
	(u)user <string>	Change user description.
	(f)profile <default|g8265|g8275.1|g8275.2|power [v2]>	Change clock profile.
	(m)mode <oc|bc>	Change clock type mode.
	(t)twostep <on|off>	Change two-step mode.
	(q)quality <class> <accuracy> <variance>	Change clock quality.
	(p)priority 1|2 <value>	Change priority 1 or 2.
	(d)domain <number>	Change domain number.
	(s)slaveonly <on|off>	Change slave-only mode.

Port Command	Subcommand & Parameters	Description
(p)port <port_number>	(s)state	Print port state.
	(m)mechanism <e2e|p2p|disable>	Change or disable delay mechanism.
	(p)protocol <udp|eth|udp6>	Change network protocol.
	(c)compatibility <on|off|auto [timeout]>	Change V1 HW compatibility mode.
	(a)asymmetry <value>	Change delay asymmetry. Value is expressed in seconds.
	(si)sync <value>	Change log sync interval.
	(di)delay <value>	Change min log delay request interval.
	(pi)pdelay <value>	Change min log pdelay request interval.
	(ai)announce <value>	Change log announce interval.
	(rt)receipt <value>	Change the announce receipt timeout.
	(u)unicast <master|slave|both|disable>	Enable/disable unicast operation.
	(f)profile <default|g8265|g8275.1|g8275.2|power [v2]>	Change PTP profile.
	(d)dscp <value>	Set DSCP in PTP messages.

Unicast Command	Subcommand & Parameters	Description
(u)unicast <port_number>	(s)status	Print port unicast information.
	(n)negotiation <on|off>	Enable/disable unicast negotiation.
	node (m)master [add|del] <address> [clock_id] <priority> <si|x> <di|x> [domain]	Change unicast master discovery table.
	node (s)slave [add|del] <address> <ai|x> <si|x> <di|x>	Change static unicast slave table.
	(q)query <interval>	Change unicast discovery query interval.
	(d)duration <value>	Change unicast transmission duration.
	(t)timeout <value>	Change cancel acknowledge receipt timeout.
	(l)limit <value>	Change total unicast messages rate limit.
	(f)filter (m)master [add|del] <address|*> [clock_id] [x | [priority] [si] [di|x]]	Change acceptable unicast master table.
	(f)filter (s)slave [add|del] <address|*> [clock_id] [x | [ai] [si] [di|x]]	Change acceptable unicast slave table.

Power Profile Command	Subcommand & Parameters	Description
(pw)power	(g)gmid <0..65535>	Change grandmaster ID.
	(i)inacc <grandmaster> <network>	Change grandmaster and network time inaccuracy.

G.8275 Command	Subcommand & Parameters	Description
(g2)g8275	(p)priority <1..255>	Change clock local priority.
	(s)steps <1..255>	Change max steps removed.
	<port_number> (p)priority <1..255>	Change port local priority.
	<port_number> (m)masteronly <on|off>	Change port master-only attribute

Dataset Command	Subcommand & Parameters	Description
(d)dataset	(d)default	Print default dataset.
	(c)current	Print current dataset.
	(m)parent|master	Print parent dataset.
	(t)time	Print time properties dataset.
	(p)port	Print port dataset.
	(f)foreign	Print foreign master dataset.
	(u)unicast	Print unicast master or slave node dataset.
	(pw)power	Print power profile dataset.
	(g1)g8265	Print G.8265 profile dataset.
	(g2)g8275	Print G.8275 profile default dataset.
	(g2)g8275 <port_number>	Print G.8275 profile port dataset.

Time Command	Subcommand & Parameters	Description
(t)time	(i)info	Print time and synchronization information.
	(s)sync	Print synchronization status.
	arb <time>	Print or set time in +/-SSSSSSSSS.NNNNNNNNN format.
	ptp <time>	Print or set time in YYYY-MM-DD HH:MM:SS.NNNNNNNNN format.
	utc <time>	Print or set time in UTC YYYY-MM-DD HH:MM:SS.NNNNNNNNN format.
	ntp <server>	Print or set time from NTP server specified by name or IP address.
	(t)timescale <ptp|arb>	Change timescale.
	(o)offset <value>	Change UTC offset.
	(l)leap <save|load>	Print UTC leap table or save/load it into/from file.
	(l)leap 59|61 <0|1>	Change leap seconds flags.
	(u)update <on|off>	Turn on/off automatic update of RTC time from PTP time.
	(h)holdover <value>	Change period of holdover state.

Time Command	Subcommand & Parameters	Description
(f)freq	(s)status	Print frequency status.
	(o)option <opt1|opt2>	Change frequency option.
	(r)ref <ql>	Change reference oscillator QL[1].
	(i)input <1..3> synce <port_number>	Input is from SyncE port. Always subject of autoselection by QL[1], [2].
	(i)input <1..3> ext <ql> [auto]	Input is from external source of specified QL . Optional [auto] includes input into autoselection by QL[1], [2].
	(p)prefer <input|ref>	Change preference for autoselection in case of equal QLs.

Note:

1. QLs supported in OPT1: prc, ssu-a, ssu-b, sec, dnu.
2. QLs supported in OPT2: prs, stu, st2, tnc, st3e, st3, smc, dus.

Time Command	Subcommand & Parameters	Description
(se)synce	(s)status	Print SyncE port status.
<port_number>	(e)esmc <enable|disable>	Enable/disable ESMC.
	(q)quality in|out auto|<ql>	Change input/output quality level[1], [2].

Note:

1. QLs supported in OPT1: prc, ssu-a, ssu-b, sec, dnu.
2. QLs supported in OPT2: prs, stu, st2, tnc, st3e, st3, smc, dus.

GPS Command	Subcommand & Parameters	Description
(g)gps	(s)status	Print GPS/GNSS interface information.
	(n)nmea	Print NMEA position/satellites information.
	(p)ppsin <enable|disable> <0|1>	Enable/disable PPS input reception on each PPSIN.
	(t)todin <enable|disable>	Enable/disable TOD input reception.
	(c)class <active> <holdover> <free>	Change clock state to clock class mapping.
	(t)todin <required|optional>	Change non-present or invalid TOD-in handling.
	(d)delay <value>	Change PPS-in cable delay compensation.
	(f)format <nmea|ascii|cm>	Change TOD-in message format.
	(v)void <ignore|syntonize|holdover>	Changes NMEA RMC void flag handling.
	(i)interface <default|com[n]> <baudrate>	Change TOD-in interface.
	(m)message <string>	Send message to GPS/GNSS receiver via TOD interface.
	cm <status> <class> <accuracy> <variance> <source> <tt> <ft>	Change CM status to clock properties mapping.

Pulsetime Command	Subcommand & Parameters	Description
(pt)pulsetime	(s)status	Print PPS-TOD status and configuration.
	(p)pulse <period> <width>	Change PPS-out pulse parameters.
	(d)delay <value>	Change TOD-out delay after PPS-out rising edge.
	(f)format <nmea [rmc|zda|both]|ascii [utc|local]|cm|custom>	Change TOD-out message format.
	(v)void <never|free|holdover>	Change NMEA RMC Active/Void flag behavior.
	(z)zone <none|tz|dst>	Change NMEA ZDA timezone/daylight field.
	cm <class> <status>	Change clock class to CM status mapping.
	(i)interface <default|com[n]> <baudrate>	Change TOD-out interface.
	(t)todout <enable|disable>	Enable/disable TOD output.
	(m)mode <1|2|3>	Change PPS-TOD output mode (sync, holdover, always) 1= sync 2= holdover 3= always
	(e)error <value>	Change error tolerance.
	(a)autorestart <on|off>	Turn on/off automatic restart.
	start <time> <count>	Start/schedule PPS-TOD output.
	stop	Stop/cancel PPS-TOD output.

Nettime Command	Subcommand & Parameters	Description
(nt)nettime	(s)status	Print SNTP server status and configuration.
	(m)mode <1..4>	Change server mode (unicast, manycast, broadcast, and mixed). 1= unicast 2= manycast 3= broadcast 4= mixed
	(pi)poll <0..64>	Change poll/broadcast interval.
	start	Start SNTP server.
	stop	Stop SNTP server.

Engine Command	Subcommand & Parameters	Description
(e)engine	(i)init default|nvm	Reinitialize clock. Currently not supported.
	(p)port <enable|disable>	Change port operational status.
	(e)esmc <auto|0..15|off>	Enable ESMC message transmission.
	(e)esmc map <class> <ssm>	Change clock class to SSM code mapping.
	(n)nvm save|reset	Change configuration in non-volatile storage. Currently not supported.
	(d)debug <on|off>	Turn on/off debug output.
	(v)verbose <level>	Change verbose level for debug output.
	(m)monitor <on com[n]|off>	Enable output for PTP monitor program.
	(f)freqout <5|10|20|25>	Change frequency output (5, 10, 20, 25 MHz).
	(a)asymmetry <value>	Change PHY asymmetry compensation. Value is expressed in nanoseconds.

Table 9.1. Examples

Function	Command
Set the sync rate to -6	`p si -6`
Set the delay rate to -6	`p di -6`
Start PPS	`pt start`
Print list of clock subcommands	`c`
Print value of priority1	`c p 1`
Set value of priority1 to 130.	`c p 1 130`
Print value of log sync interval.	`p si`
Set value of log sync interval to -2 (4 sync per sec).	`p si -2`
Print content of parent dataset.	`d m`
Print content of port dataset.	`d p`
Print list of debug output levels.	`e v`
Enable clock monitor program on COM3.	`e m 3`

10. PLL

The M88 contains a feature rich Si5348 PLL that allows the user to use multiple input frequencies for synchronization and generate multiple output frequencies either locked to an input frequency or controlled by the PTP engine.

10.1 PLL Overview

The PLL section of the M88 has 5 inputs, 3 DSPLL and 5 outputs. Any input can be connected to any DSPLL which will then lock to its input frequency. Any DSPLL can then be connected to any output through a divider to produce the desired output frequency. In addition, the frequency of each DSPLL can be adjusted by a DCO.

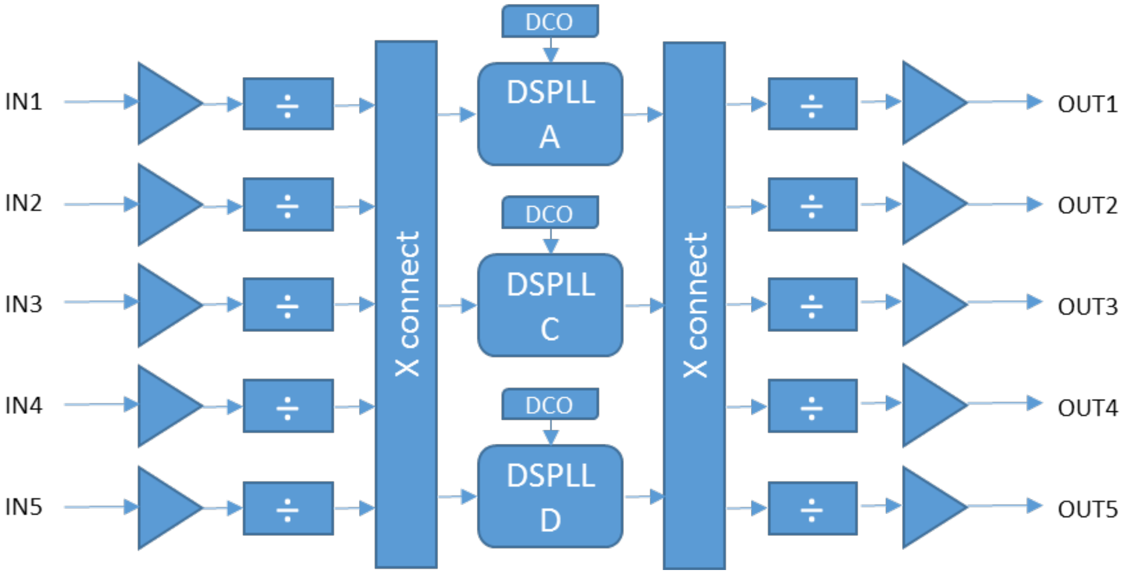


Figure 10.1. PLL Block Diagram

10.1.1 Input frequencies

M88 will accept the following input frequencies: 8kHz, 1.544 MHz, 2.048 MHz, 10 MHz, 19.44 MHz, 20 MHz, 25 MHz, 125 MHz, 155.52 MHz and 156.25 MHz. IN4 and IN5 will accept 8kHz only.

10.1.2 DSPLLs:

The DSPLLs can be configured to run on different “frequency plans”. The point of this is to allow a bigger range of possible output frequencies. The “frequency plan” sets the DSPLL output frequency, which can then be divided to produce the required output frequency. DSPLL A can only run on frequency plan 1G, while DSPLL C and D can be set to any of the following four frequency plans:

Frequency Plan Name	DSPLL Frequency
1G SyncE / GPS	1 GHz
10G SyncE	1.25 GHz
SDH	933.12 MHz
PDH	790.528 MHz

Each DSPLL will also have the option of different bandwidths: opt-1, opt-2, t4, eEEC. These are telecom requirements, and will be configured similar to the frequency plan above.

Opt-1 bandwidth: 10 Hz, 100 Hz fastlock

Opt-2 bandwidth: 100 MHz, 10 Hz fastlock

T4 bandwidth: 80 Hz, 100 Hz fastlock

EEEC - 3 Hz, 100 Hz Fastlock

10.1.3 DCO

Each DSPLL can be controlled by a DCO adjusting its frequency. This is a generic feature, but with the current SW, DCOs are controlled by the PTP engine making the output frequency syntonized to PTP. To have a DSPLL controlled by the PTP engine by means of the DCO, this needs to be configured with the ptp2 config command. See chapter 15.1.4 ptp2 config.

Normally, either all DSPLL should be controlled by DCO or none according to the following table:

DSPLL Input Clock	DCO Mode	Function	Usage	Typical PTP Time Constant	Minimum Local Oscillator	DSPLL Outputs Syntonized to
No	Off	(Not useful)				
No	On	PTP-only mode	Use when no physical clock is available	Mid (TCXO) High (OCXO)	TCXO or OCXO	PTP
Yes	Off	PTP+Physical layer (congruent SyncE)	Use for G.8275.1-type networks where common PRTC drives both PTP and SyncE	Low	TCXO	SyncE
Yes	On	PTP with frequency assist (non-congruent SyncE)	Use when a physical clock (SyncE or, for example, BITS) is available but may not be traceable to the PTP master	Mid - High	TCXO	PTP

10.1.4 Outputs

All outputs can be driven from any of the DSPLLs. The choice of output frequencies will differ depending on the output frequency of the DSPLL, which is decided by the chosen frequency plan.

There is an integer divider associated with each output, and it shall be used to divide down to the required output frequency from the base DSPLL output frequency.

The CLI allows the configuration of the following output frequencies based the choice of DSPLL that will drive that output:

Frequency Plan Name	Available output frequencies by using the CLI:
1G SyncE / GPS	8 kHz, 10 MHz, 20 MHz, 25 MHz, 125 MHz
10G SyncE	8 kHz, 25 MHz, 125 MHz, 156.25 MHz
SDH	8 kHz, 19.44 MHz, 155.52 MHz
PDH	8 kHz, 1.544 MHz, 2.048 MHz

These output frequencies are chosen to support telecom customers. Other “frequency plans” and choice of outputs might be added in future revisions.

Outputs can also be configured to what type they should be. The following types are supported:

Type	Voltages		
LVDS	3.3 V	2.5 V	1.8 V
LVCMOS	3.3 V	2.5 V	1.8 V
LVPECL	3.3 V	2.5 V	

Note that the corresponding output voltage supply pin (CLK_OUTn_VCC) needs to be connected to the matching voltage.

10.2 PLL Configuration and Control CLI

There are two classes of CLI commands to control the Si5348.

- Commands that take the form pll config and will behave such that all modifications to the configuration are stored in memory and will only take effect after a subsequent command (pll load current).
- Commands can be issued at runtime and takes the form pll control.

An example of a runtime command can be disabling or enabling an output signal. An example of a configuration time command would be changing the frequency of an output signal. The below table provides details on all the commands related to the PLL.

CLI structure Overview:

Usage: `pll <command> [params]`

command:

`config` - setup configuration for PLL device.

`load` - apply configuration to PLL device.

`control` - control operations of PLL device.

`read` - read from register on PLL device.

`write` - write to register on PLL device.

`help` - print detailed description of available commands.

The following parameters are used throughout PLL command interface:

`dspll_num` - DSPLL number: A, C, D

`inpin_num` - Input pin number: 1..5 or 1..3

`outpin_num` - Output pin number: 1..5

10.3 PLL Register Commands

Command	Description
`pll read <reg>`	Read a Si5348 register value. Reg is a hex number in the format 0xR
`pll write <reg> <data>`	Write value to a Si5348 register. Reg and data is a hex number in the format 0xR.

10.4 PLL Configuration Commands

Command	Description

`pll load <config>`	Load the pll configuration to PLL device
	`<config>: current | <filename>`
	`current`
	Load the configuration that was determined by the user via using the pll config set of commands.
	`<filename>`
	Manually load a custom configuration set into the Si5348. The file should be in the same format as the “Registers” export file from Silicon Labs Clock Builder Pro software.
	This allows a customer implementing a non-standard configuration and should only be used if the desired configuration is not achievable via the CLI command set provided and only on advice from Silicon Labs Apps.

`pll config print`	Print current configuration settings.

Command	Description
`pll config dspll <dspll_num> dco <on|off>`	Enable or disable the DCO Control of the specified DSPLL. The outputs derived from a DSPLL whose DCO is turned on will derive their frequency from the PTP with assist from the physical layer input to that DCO. If there are no inputs configured for a specific DSPLL, and it is desired that the DSPLLs outputs are “on frequency” (traceable to PTP), then DCO mode should be turned on. DCO Mode should be turned off if the output should be frequency traceable to the input signal in use by that DSPLL rather than be frequency traceable to the PTP domain.
`pll config dspll <dspll_num> freqplan <1G|10G|SDH|PDH> [bandwidth_option]`	Selects one of 4 predefined frequency plans for the DSPLL. DSPLL A can only use frequency plan 1G while DSPLL C and D can use any of the four plans. Each of the frequency plans correspond to a different DSPLL output frequency: 1G = 1 GHz 10G = 1.25 GHz SDH = 933.12 MHz PDH = 790.528 MHz The DSPLL frequency plan affects the options of possible output frequencies that can be derived from them: 1G - 8 kHz, 10 MHz, 20 MHz, 25 MHz, 125 MHz 10G - 8 kHz, 25 MHz, 125 MHz, 156.25 MHz PDH - 8 kHz, 1544 kHz, 2048 kHz SDH - 8 kHz, 19.44 MHz, 155.52 MHz This command also allows the option of setting different bandwidths for the DSPLL. This can be specified as an optional parameter. If not specified, the default OPT1 will be selected. Bandwidth options: OPT1 - 10 Hz, 100 Hz fastlock OPT2 - 100 mHz, 10 Hz fastlock T4 - 80 Hz, 100 Hz fastlock EEEC - 3 Hz, 100 Hz Fastlock

Command	Description

`pll config dspll <dspll_num> insel <params...>`	This command specifies the input selection mode for the DSPLLs.
	There are 3 input selection modes: manual, none, auto.
	Depending on which mode needs is desired, the syntax for this command will change.
	Manual selection
	Command syntax:
	`pll config dspll <dspll_num> insel manual [inpin_num]`
	Where `inpin_num is 1..3` for DSPLLs A and C and 1..5 for DSPLL D. Default is 1.
	To switch to a different input for the DSPLL under manual input selection mode, the runtime command
	`pll control dspll <dspll_num> insel <inpin_num>`
	should be used. In manual selection mode, all other inputs to the specified DSPLL are disabled. So, if the chosen input is invalidated, then the DSPLL will go into holdover/freerun.
	Auto selection
	Command syntax:
	`pll config dspll <dspll_num> insel auto [prio1_inpin_num] [prio2_inpin_num] [prio3_inpin_num]`
	Where `prio1_inpin_num is 1..3 (default 1),`
	`prio2_inpin_num is 1..3 (default 2),`
	`prio3_inpin_num is 1..3 (default 3)`
	In automatic selection mode, the Si5348 chip will be responsible for the validation and selection of the inputs. The priority of the inputs will be specified by this command, with the first input pin specified holding the highest priority and the last specified input pin will hold the lowest priority. Any input pins to the specified DSPLL, not specified in this command will be disabled.
	`pll config dspll <dspll_num> insel autonr [prio1_inpin_num] [prio2_inpin_num] [prio3_inpin_num]`
	Where `prio1_inpin_num is 1..3 (default 1),`
	`prio2_inpin_num is 1..3 (default 2),`
	`prio3_inpin_num is 1..3 (default 3)`
	Same as above but non-revertive (nr) mode.
	No input selection:
	Command syntax:
	`pll config dspll <dspll_num> insel none`
	The DSPLL will use the reference XO signal as the input. All input signals to the specified DSPLL will be disabled.

`pll config input <inpin_num> freq <freq>`	Configure the input frequency. `inpin_num is 1..3` Frequency options: <8K|1544K|2048K|10M|19.44M|20M|25M|125M|155.52M|156.25M>

Command	Description
`pll config input <inpin_num> <enable | disable>`	Enable or disable the use of a particular input. `inpin_num is 1..3` The user can choose to disable any of the inputs at any time regardless of which input selection mode is configured for DSPLLs. The user can issue this command at configuration time.
`pll config output <outpin_num> dspllsrc <dspll_num>`	Configure the DSPLL which will drive this output pin. This should be the first command issued in configuring the desired output configuration. This command will reset the frequency of the output to default 8 kHz.
`pll config output <outpin_num> freq <freq>`	Configure the output frequency. Frequency options: <8K|1544K|2048K|10M|19.44M|20M|25M|125M|155.52M|156.25M> The option of available frequencies for the output is dependent on the frequency plan chosen for the DSPLL. DSPLL Frequency Plan 1G SyncE/GPS: 8kHz, 10 MHz, 20 MHz, 25 MHz, 125 MHz DSPLL Frequency Plan 10G SyncE: 8 kHz, 25 MHz, 125 MHz, 156.25 MHz DSPLL Frequency Plan SDH: 8 kHz, 19.44 MHz, 155.52 MHz DSPLL Frequency Plan PDH: 8 kHz, 1.544 MHz, 2.048 MHz If an output frequency is specified that is not supported by the current DSPLL configuration, this command will return an error saying so. Use the command pll config output <outpin_num> dspllsrc <dspll> to drive the output from the appropriate DSPLL.
`pll config output <outpin_num> type <output_type>`	Configure the output type. Output type options: <LVDS 3.3|LVDS 2.5|LVDS 1.8| LVPECL 3.3|LVPECL 2.5| LVCMOS 3.3|LVCMOS 2.5|LVCMOS 1.8> Remember that the appropriate electrical connections must be done for the outputs.
`pll config output <outpin_num> <enable | disable>`	The user can issue this command at configuration time to enable any of the outputs.

10.5 Runtime Commands

Commands	Description
`pll control dspll <dspll_num> insel <inpin_num>`	This command is used when the input selection mode for a specific DSPLL is “manual” to specify which input pin should be selected as the input for the DSPLL. `inpin_num` is 1..3 for DSPLLs A and C and 1..5 for DSPLL D. The user can issue this command anytime. This command will only be accepted if the DSPLL is configured to use manual input selection mode. If the selected input is invalidated for whatever reason (OOF, LOS), the DSPLL will use the reference XO as a fallback.
`pll control input <inpin_num> <enable | disable>`	Enable or disable the use of a specific input. `inpin_num` is 1..3 The user can choose to disable any of the inputs at any time regardless of which input selection mode is configured for DSPLLs.
`pll control output <outpin_num> <enable | disable>`	The user can issue this command at runtime to enable any of the outputs.

11. System Software Overview

The System Software consists of a number of tightly integrated components. Each software component implements its own piece of functionality and can provide an interface to other components and to application programs. A description of each software component group follows.

They could be logically organized into the following groups:

Hardware Drivers – handles the hardware-related operations and provide an access to hardware resources, such as DMA, interrupts, timers, etc.

Operating System – supplies a real-time multithreaded operating environment for the rest of the system, including application programs.

Communication Drivers – provides a well-defined access to the facilities of different communication interfaces, such as COM.

File Subsystem – supplies a file-based access to the data stored on different media types, such as FLASH memory, SD/MMC memory cards, RAM-disk.

Network Subsystem – provides the support for TCP/IP network communications over Ethernet and serial links.

Shell Environment – provides a UNIX-like command shell as well as Telnet and FTP services.

Below is a description of each system software component.

12. Hardware Drivers

Hardware drivers are the thin layer of software, which hides the hardware-specific implementation details and provides a simple interface to the hardware resources. They are also responsible for low-level system initialization, such as setting pin directions, initializing DMA controller, installing low-level interrupt handlers and so on.

The System Software includes the system driver, a driver for the base hardware platform, and interface drivers, drivers for the following different hardware I/O interfaces:

- Ethernet
- Serial

Hardware drivers are mostly invisible for applications, as applications normally do not have a direct access to the underlying hardware, but uses facilities provided by higher level components, such as an operating system or a file system, to perform an I/O and other tasks.

13. Network Subsystem

The Network Subsystem, as a part of the System Software is responsible for the networking support and network communications. Its major part is TCP/IP protocol stack software, which provides the support for TCP/IP environment and TCP/IP communications over Ethernet and serial links.

The TCP/IP stack software was designed to be fully reentrant and multithreaded safe, as well as scalable and highly configurable. It is compliant with standards.

13.1 TCP/IP Stack Architecture

In general, functional architecture of the TCP/IP stack is the same as in any other TCP/IP implementations. It comprises four major layers: link layer, network layer, transport layer and application layer. These layers interact with each other via well-defined interfaces.

A Link layer provides an abstract view of a network interface device (or adapter) and isolates its details from upper layers. Link layer includes device drivers for real or virtual (pseudo) hardware and implementations of underlying physical network protocols. Currently, TCP/IP link layer software provides following components: driver for internal loopback adapter (pseudo-device), driver for the Ethernet Adapter and implementations of loopback and Ethernet II protocols.

A Network layer provides the basic packet transmission service as well as addressing and routing services. It uses the link layer interfaces to communicate with network devices. The TCP/IP network layer software includes an implementation of Internet Protocol (IP), as the major protocol for packet transmission, and an implementation of Address Resolution Protocol (ARP) as the protocol for the remote host's hardware address discovery. Note that architecturally ARP is implemented as the network layer module, while it's functionally belongs rather to the link layer than to the network layer.

A Transport layer provides for applications a number of various transport services to exchange data over network. It uses network layer interfaces to request an address, routing and control information, a packet transmission and so on. The most common transports are: a datagram transport, which provides mechanisms for unreliable datagram exchange, and a stream transport, which provides reliable and sequential data transfer. The TCP/IP software implements User Datagram Protocol (UDP) as datagram transport and Transmission Control Protocol (TCP) as stream transport. It also implements Internet Control Message Protocol (ICMP) and Internet Group Management Protocol (IGMP) as "raw" transport modules. Any application can send and receive data in ICMP and IGMP format. An additional transport module called "raw wildcard" transport allows applications to access packet transmission services of the IP module, i.e. to send and receive raw IP datagrams.

An Application layer provides unified access to the transport layer features, independently of underlying transport protocol's semantics and hides each protocol implementation details. The TCP/IP software includes reach protocol-independent application programming interface, compatible with BSD sockets.

13.2 Application Layer Components

The TCP/IP software also includes a number of application layer components. They implement application layer protocols which are parts of a TCP/IP suite, such as Dynamic Host Configuration Protocol and Domain Name System.

13.2.1 DHCP Client

The DHCP Client plays an important role in the system initialization. To operate in the TCP/IP environment the system needs to know its IP address, network mask and, optionally, a default gateway. This information can be configured manually or distributed through the DHCP server. So, the DHCP client dynamically obtains these parameters from the DHCP server and automatically configures TCP/IP stack software thus eliminating the need for manual configuration. In the absence of a DHCP server on the network the system is connected to, the DHCP client uses a so-called Zero-Config protocol to select an IP address from a well-known address range and negotiate this selection with other nodes on the network.

13.2.2 DNS Client

Any node on the TCP/IP network is identified by its unique IP address. But it is more convenient to use for identification a human-readable name instead of an IP address. The node name to the node address translation is performed by a DNS client. In order to perform this translation the DNS client interacts with one or more DNS servers, which store and maintain a distributed global name-to-address mapping database.

13.3 Network Initialization

Before communication facilities can be used, the network subsystem must be initialized and configured. Normally it is done during the initialization of the shell environment. The shell startup code reads configuration files and initializes the TCP/IP stack software. When the target system does not require the shell to be running it can initialize and configure the network subsystem by using a network initialization routine. It will do the following:

- If TCP/IP configuration parameters were not provided, it tries to read them from a permanent storage such as on-board flash memory.
- It initializes the link layer by calling each network interface driver's entry point.
- It initializes the network layer by invoking IP and ARP initialization routines.
- It initializes the transport layer by calling each transport module initialization routine.
- It configures the internal loopback interface.
- It either configures the Ethernet interface manually if configuration parameters were specified, or requests the DHCP client to configure it dynamically.
- Finally it sets the hostname and parameters for a name resolution client.

This routine has to be called after the OS has been initialized and started.

14. Using the Managed Timing Engine

14.1 PTP Engine Modes

The PTP Engine is capable of operating in five different modes. The operational mode defines the functionality supported by the engine, PTP clock behavior and its properties in different operating conditions. The operational mode is specified upon startup and can only be changed by restarting the engine.

- Mode 0 – PTP-only mode;
- Mode 1 – GPS/GNSS-only mode;
- Mode 2 – GPS/GNSS-primary, PTP-secondary;
- Mode 3 – PTP-primary, GPS/GNSS-secondary;
- Mode 4 – PTP-only, GPS/GNSS-debug;

The M88 supports all five modes.

In addition to Mode 0-4 a Slave-only mode is supported by the M88. The clock can be switched to the slave-only mode and back at any time and from any of above operational modes.

14.1.1 Mode 0

This is an ordinary PTP master-slave mode. The GPS/GNSS interface is disabled.

In this mode the clock normally acts as a PTP slave, but may also become a PTP master if no better clock exists on the network.

The clock class is initialized to DEFAULT (248) and is not changed by the engine while operating. So the manual control via HMI commands (see clock quality command).

14.1.2 Mode 1

This is the default mode for the M88. The clock is GPS/GNSS-clock and the GPS/GNSS is the only source of synchronization. It can never become a slave to another clock regardless of its clock class.

In this mode the clock class is automatically controlled by the engine. The clock is initialized with class DEFAULT (248) and as soon as the engine detects the presence of a stable GPS/GNSS signal it raises the class to PRC_SYNC (6) or APP_SYNC (13). If only the PPS-input signal is available then the class is selected depending on the configured timescale (see time scale command). If the TOD-input signal is available as well then the timescale is automatically switched to PTP and the clock class is PRC_SYNC (6).

If later the GPS/GNSS-signal is lost the clock is switched to the holdover mode and lowers its class to PRC_HOLDOVER (7) or APP_HOLDOVER (14). If after the holdover period the GPS/GNSS-signal is still not available the clock downgrades its class PRC_DEGRADATION_A (52) or APP_DEGRADATION_A (58) and stays as the PTP master in the free-running mode. If a better clock exists on the network the clock will switch to the PTP passive state.

14.1.3 Mode 2

This mode is almost the same as Mode 1, but after the holdover interval the clock degrades its class to PRC_DEGRADATION_B (187) or APP_DEGRADATION_B (193), so it can potentially become a PTP slave if a better clock appears on the network.

It means that the clock has the GPS/GNSS-signal as its primary source of synchronization and the PTP as a backup source, i.e. when no GPS/GNSS-signal is present.

14.1.4 Mode 3

This mode is designed for unstable GPS/GNSS-reception environments, where the node having a better signal reception becomes a PTP master and all others become PTP slaves, even if they have their own GPS/GNSS-signal.

The clock is initialized with class DEFAULT (248) and the class is not changed by the engine while operating. Instead after detecting the stable GPS/GNSS-signal the engine increases the priority2 member of the Default Dataset (lowers its value) by some small margin, which might depend on the reception quality. That clock which has a higher priority2 (better GPS/GNSS signal reception) becomes the PTP master on the network and all others synchronize with it.

14.1.5 Mode 4

This mode is identical to Mode 0 in respect to the clock’s behavior. But in this mode the GPS/GNSS interface is initialized and the PPS-input signal if present can be used to measure the accuracy of the clock being synchronized over the PTP network.

14.1.6 Slave-Only Mode

In this mode the clock can act as a PTP slave only. If there is no PTP master on the network the clock will stay in the listening state waiting for the master to appear.

When the clock is switched to this mode (see clock slave command) the engine changes the clock class to SLAVEONLY (255) and the clock accuracy to UNKNOWN (0xFE). Both values are then restored to the previous state when the clock switched back to its normal mode. If any manual or automatic changes to the clock quality were done while in the slave-only mode, those changes are remembered and come to effect as soon as the clock is back to normal mode.

14.2 GPS/GNSS Interface

The M88 supports the GPS/GNSS interface in form of PPS and TOD input signals.

Both of these signals are enabled by default but either of them can be disabled at any time (this might be useful for test purposes).

The reception of the PPS input signal is only possible from a dedicated PPS_IN pin, while the TOD input signal can be received either from a dedicated TOD_IN pin (4800 or 9600 bauds) or from a COM-port (any available baud rate).

Three message formats are currently supported for TOD input: NMEA (ZDA and RMC), ASCII and China Mobile.

The current status and configuration of GPS/GNSS interface can be viewed and altered though the HMI interface (see gps set of commands).

14.3 PTP Clock States

The PTP clock at any instance of time can be in one of four following states:
- FREE
- SYNTONIZING
- SYNCHRONIZING
- HOLDOVER

In PTP modes 1-3 the clock class mapping for the FREE and HOLDOVER states can be changed using the gps class command.

14.3.1 FREE State

The PTP clock comes into this state upon initialization.

Its time is taken from the system RTC, the clock class is DEFAULT (248), clock accuracy is UNKNOWN (0xFE).

The timescale is PTP, the UTC offset is initially set to 36 sec, leap flags are FALSE and the time source is INTERNAL_OSCILLATOR.

The clock time and all clock properties can be changed manually in this state.

14.3.2 SYNTONIZING State

This state is only possible when the PPS-input signal from the GPS/GNSS interface is available, but not the TOD-input signal and the clock becomes a PTP master.

When the PTP Engine is running in Mode 1 and 2 the clock class is automatically changed to either PRC_SYNC (6) or APP_SYNC (13) according to timescale parameter and the clock accuracy is set to WITHIN_100_NS. In Mode 3 the clock quality remains unchanged.

The frequency traceable flag is set to TRUE and the time traceable flag is set to FALSE. The time source remains unchanged.

Manual change of the timescale (see time scale command) will cause the corresponding change in the clock class. Changing the time of the clock (see time ptp/arb/ntp commands) will cause the time source to become HAND_SET. The UTC offset (see time offset command) and leap flags (see time leap command) are also changeable.

As soon as TOD-input signal becomes available the clock switches to SYNCHRONIZING state.

14.3.3 SYNCHRONIZING State

The PTP clock comes into this state when it starts to synchronize its time and frequency with either a PTP or GPS/GNSS source.

If the synchronization source is the GPS/GNSS, then both frequency traceable and time traceable flags are set to TRUE. The timescale is changed to PTP, the clock class is changed to PRC_SYNC (6) and the clock accuracy is set to WITHIN_100_NS. The time source is GPS/GNSS.

Manual changes of clock time and timescale are not allowed, while it is still possible to change the UTC offset and leap flags.

If the TOD-input signal becomes unavailable, while the PPS-input still presents the clock switches to SYNTONIZED state.

If the synchronization source is a PTP master, then the clock quality remains untouched. The timescale is set according to what is distributed by the PTP master. If the timescale distributed is PTP than the UTC offset (if valid) and leap flags are also set to maser’s values. The time source is set to PTP.

Manual changes of clock time and timescale are not allowed. If the timescale distributed is PTP, changing the UTC offset (if valid) and leap flags are not allowed as well.

14.3.4 HOLDOVER State

The clock enters this state when the synchronization source is lost.

If the clock was synchronized with PTP master its quality remains unchanged. Otherwise the clock class is modified according the engine’s operational mode (see above) and the clock accuracy is changed based on the time spent in the holdover state.

There is a static parameter which defines the clock stability. Currently it is fixed to 1 ns/s for a temperature-stable environment. During the holdover state an estimated error value is calculated and the clock accuracy is set according to that value.

The maximum time the clock stays in holdover state is defined by a holdover interval – a configurable parameter expressed in seconds (see time holdover command). By default it is set to 1000 seconds which gives about 1 microsecond error at the end of holdover interval. After holdover interval expires, the clock switches to the FREE state, and its accuracy is reset to UNKNOWN (0xFE).

Manual change of the clock time will terminate the holdover and bring the clock to the FREE state.

14.4 PPS/TOD Output

The M88 is able to provide an external synchronization signal in form of PPS and TOD output.

The PPS/TOD-output signal properties are defined by a number of configurable parameters:

- **PPS period** – defines the interval between pulses. Expressed in microseconds, minimum value is 500 us.
- **PPS width** – defines the length of high phase of the pulse. Expressed in microseconds, minimum value is 250 us, maximum value is (pulse period – 250 us).
- **TOD enable** – defines whether the TOD-output signal should be generated in addition to PPS-output.
- **TOD delay** – defines the delay after the rising edge of the pulse before starting to output TOD-message. Expressed in milliseconds.
- **TOD format** – defines the format of the TOD-message. Supported formats are NMEA (ZDA and RMC), ASCII and China Mobile.
- **TOD interface** – defines which interface to use to output TOD-message. A dedicated TOD_OUT pin (only 4800 and 9600 bauds) and COM-ports (any available baud rate) are supported.
- **Mode** – defines the conditions in which PPS/TOD-output signal is generated.
- **Error** – defines error tolerance, expressed in nanoseconds.
- **Autorestart** – restart PPS/TOD-output automatically.

There are three modes of PPS/TOD output:

SYNC – in this mode the signal is generated only when the clock is either in SYNCHRONIZING or in SYNTONIZING state. As soon as the clock exits this state the signal is stopped. If autorestart is enabled then the signal is started again as soon as synchronization is reacquired.

HOLDOVER – prolongs the SYNC mode to the HOLDOVER state. I.e. the signal is generated in that state as well, but stopped as soon as holdover mode is over because of any reason (holdover interval is expired or time is manually changed).

ALWAYS – generates signal in any clock state.

In addition to mode parameter, the error tolerance affects PPS/TOD-output signal as well:

- If the mode is ALWAYS this parameter is simply ignored. For other two modes the error tolerance has the following effects:
- If this parameter is zero, then the signal is started/stopped as soon as the clock enters/leaves corresponding states.
- If this parameter is non-zero, and the clock is in the HOLDOVER state the signal is stopped as soon as either the estimated error becomes larger than the error tolerance or the clock exits the HOLDOVER state.
- If this parameter is non-zero and the clock is in SYNCHRONIZING or SYNTONIZING state, the signal is started when the clock is synchronized with an error below the error tolerance and stopped when the error increases above the error tolerance.

The initialization defaults are:

1PPS/100 ms, TOD-enable, 0, NMEA, TOD_OUT/4800, ALWAYS, 0, TRUE.

When the signal is scheduled using the HMI interface (see pulsetime start command), the start time (TAI) and the pulse count may optionally be specified. Without these parameters the start time is 0 (1970-01-01 00:00:00) and the number of pulses is unlimited.

14.5 Managing the two interfaces

M88 can support PTP on both it’s Ethernet interfaces. To distinguish between the two ports in PTP commands related to the port or to unicast, use 1 for the eth0 interface and 2 for the eth1 interface. For example_ ptp2 port 2 state to check the state on port 2 (eth1). If no port identifier is set, port 1 is used as default.

14.6 Unicast Operations

The PTP Engine supports unicast operations on its port.

The PTP port operating in unicast mode can be in either of three states:

1. Unicast master
2. Unicast slave
3. Unicast both

By default, unicast operations are disabled and the PTP port operates in multicast mode. After unicast is enabled, no multicast communications are possible.

The PTP port can be switched to unicast operations and back at any time using the following HMI command:

```
(p)port <port_number> (u)unicast <master|slave|both|disable>
```

14.6.1 Unicast Master

A PTP port in unicast master state can support the following:

- Slave nodes which can dynamically request unicast message transmission services from the master using the unicast negotiation mechanism, as well as
- Slave nodes which do not support the unicast negotiation and simply rely on the reception of unicast messages from the master.

By default, no requests are accepted from and no messages are sent to any slave nodes.

To accept unicast negotiation requests from slave nodes the master needs to be configured as follows:

- Unicast negotiation must be enabled,
- Slave acceptance filter must be populated.

To provide message transmission services to slave nodes which do not support the unicast negotiation the master needs to be manually configured with the list of static slave nodes.

14.6.1.1 Enabling Unicast Negotiation

The unicast negotiation state is controlled by the following HMI command:

```
(u)unicast <port_number> (n)negotiation <on|off>
```

When unicast negotiation is enabled the master accepts unicast transmission requests from negotiation-capable nodes. If a node is allowed by the acceptance filter and if enough resources are available the master grants message transmission services to that node.

If unicast negotiation is disabled no new requests are accepted, but all existing grants remain serviced until they are either expired or cancelled.

14.6.1.2 Maintaining the Slave Acceptance Filter

The slave acceptance filter is a mechanism to control which slave nodes may obtain unicast services from the master. If the filter table is empty no services will be granted to any node.

The following HMI command is used to manipulate the slave acceptance filter:

```
(u)unicast <port_number> (f)filter (s)slave [add|del]<address|*> [cid] [x | [ai][si][di|x]]
```

Where the first parameter is either a node's protocol address in corresponding transport protocol format, for example:

`192.168.1.10`	IPv4 address
`fe80:0000:0000:0000:a8ed:4c2f:fc6:335c`	IPv6 address
`B9-7F-C2-11`	Ethernet addresses
`*`	Stands for any address

The cid parameter is an optional clock identifier of the node.

The ai, si, di parameters are the minimum log message intervals (maximum message rates) for Announce, Sync and Delay Request/Response messages the master will grant to that node or 'x', which stands for denial of either any services or of only Delay Request/Response.

For example:

`u f s`	Prints the content of the slave acceptance filter.
`u 2 f s`	Prints the content of the slave acceptance filter on port 2.
`u f s add * -2 -4 -3`	Adds an entry to accept requests from any node and limits message rates to: 4 msg/s for Announce, 16 msg/s for Sync, 8 msg/s for Delay Request/Response.
`u f s add 192.168.1.100 -1 -2 x`	Adds an entry to accept requests from 192.168.1.100, limits the rates to: 2 msg/s for Announce, 4 msg/s for Sync, and denies requests for Delay Request/Response
`u f s add * 00:01:02:0F:FE:03:04:05 x`	Adds an entry to deny all requests from the node with clock identifier 00:01:02:0F:FE:03:04:05 transmitted from any address.
`u f s 192.168.1.100 -1 -2 -2`	Changes rate limits for the specified node.
`u f s del 192.168.1.100`	Removes the specified node from the filter table.

If, as the result of the filter table modification, a node becomes unacceptable or message rates of any active grants becomes beyond the newly configured limits, all affected grants will be cancelled.

14.6.1.3 Maintaining the Static Slaves List

To provide unicast services to slaves which do not support the unicast negotiation the master maintains a list of static slave nodes.

When a node is in this list the master can send Announce and Sync messages to that node and can reply to Delay Request messages received from that node.

The following HMI command is used to manipulate the static slave node list:

```
(u)unicast <port_number> node (s)slave [add|del] <address> <ai> <si> <di|x>
```

Where the address parameter is a node's protocol address in corresponding transport protocol format, for example: 192.168.1.10 – for IPv4 addresses, fe80:0000:0000:0000:a8ed:4c2f:fc6:335c – for IPv6 addresses, 00-0B-B9-7F-C2-11 – for Ethernet addresses,

Note: The node's protocol address format must match the transport protocol configured on the PTP port.

The ai and si parameters are the log message intervals for Announce and Sync messages the master sends to the node.

The di parameter is the Delay Request log message interval the slave node is configured with or 'x' which stands for not replying to Delay Requests from this node.

Note: The master cannot control how often Delay Request messages are transmitted by the slave, so the <di> value is used mainly for the master's resource estimation.

For example:

`u node`	Prints static slave nodes list
`u 2 node`	Prints static slave nodes list on port 2.
`u node slave add 192.168.1.100 1 0 0`	Adds a node to the static slave list with specified Announce, Sync and Delay Request/Response rates.
`u node slave 192.168.1.100 1 0 x`	Modifies the transmission rates for the node, so the master only transmits Announce and Sync messages, but does not reply to Delay Request messages.
`u node slave del 192.168.1.100`	Removes the node from the list.

14.6.2 Limiting the Total Message Rate

By default there is no limit on how much processing resources the master can use for servicing slave nodes. The master will try to accept all requests until its resources are exhausted and it becomes overloaded, which may cause performance degradation.

To avoid such situation the master can be configured with a limit on total number of unicast messages per second it is allowed to transmit.

For every new node requesting unicast services the master calculates the message rate required and adds it to the total. As soon as the total rate reaches the limit the master stops accepting requests from any new nodes.

To setup the limit the following HMI command should be used:

```
(u)unicast <port_number> (l)limit <value>
```

Where the value is the maximum number of messages per second or 0 which stands for no limit.

14.6.3 Unicast Slave

A PTP port in unicast slave state can work with both:

- Master nodes which can provide unicast services upon request, using the unicast negotiation mechanism and
- Master nodes which transmit unicast messages to a preconfigured set of slaves.

To obtain unicast services from master nodes supporting the unicast negotiation the slave needs to be configured as follows:

- Unicast negotiation must be enabled.
- Master discovery table must be populated.

To accept unicast messages from master nodes transmitting to a set of slaves the master acceptance filter needs to be properly configured.

When the new node is added to the master discovery table the slave first requests an Announce message transmission from that node. The requested transmission interval for Announce messages is the same for all master nodes and is taken from a portDS.logAnnounceInterval configured for the PTP port. The requested duration is the same for all messages (see below). If there is no reply or the request is denied, the slave will continue its requests every query interval (see below). As soon as the Announce message transmission is granted the slave is ready to accept them.

When the slave receives Announce messages from a node other than those configured in the master discovery table, received Announces are compared against the master acceptance filter. If such node is allowed by the filter the slave will accept them.

All accepted Announce messages are processed by the slave and as the result the best master is selected. From the best master the slave requests Sync and optionally Delay Response messages according to the settings specified for that node. Or, if the best master was not from the master discovery table, the slave just starts accepting Syncs from and sending Delay Requests to this master.

14.6.3.1 Enabling Unicast Negotiation

The unicast negotiation state is controlled by the following HMI command:

```
(u)unicast <port_number> (n)negotiation <on|off>
```

When unicast negotiation is enabled the slave is able to participate in unicast negotiation with negotiation-capable masters.

If unicast negotiation is disabled no new requests are transmitted, but all existing grants remain active until they are either expired or cancelled.

14.6.3.2 Maintaining the Master Discovery Table

The following HMI command is used to manipulate the master discovery table:

```
(u)unicast <port_number> node (m)master [add|del] <address> [cid] <priority> <si> <di|x> [domain]
```

Where the address parameter is a node's protocol address in corresponding transport protocol format.

For example:

`192.168.1.10`	for IPv4 addresses
`fe80:0000:0000:0000:a8ed:4c2f:fc6:335`	for IPv6 addresses
`00-0B-B9-7F-C2-11`	for Ethernet addresses

The node's protocol address format must match the transport protocol configured on the PTP port.

The priority parameter is the local priority of the master on a given port. The priority value should be between 0 and 255, 0 stands for highest priority. Local priority takes precedence over clock properties evaluated by dataset comparison algorithm when selecting best clock on a giver port (Er_best).

The si parameter is the log message interval for Sync messages the slave shall negotiate with the master.

The di parameter is the log message interval for Delay Request/Response messages the slave shall negotiate with the master or 'x' if Delay Request/Response messages shall not be used.

Note: Announce messages are always requested and the message interval is always taken from portDS.logAnnounceInterval configured for the PTP port.

For example:

`u node`	Prints the master discovery table.
`u 2 node`	Prints the master discovery table for port 2.
`u node master add 192.168.1.100 0 -1 -1`	Adds a node to the table with local priority 0 and with intervals -1 (2 msg/s) for Sync and Delay Request/Response messages
`u node master 192.168.1.100 0 0 x`	Modifies the node's parameters, so the slave requests only Sync messages and does not use Delay Request/Response.
`u node master del 192.168.1.100`	Deletes the specified node from the master discovery table.

14.6.3.3 Maintaining the Master Acceptance Filter

The master acceptance filter is a mechanism for control which nodes the slave should accept unicast messages from. If the filter table is empty no messages will be accepted from any nodes other than those specified in the master discovery table.

The following HMI command is used to manipulate the master acceptance filter:

```
(u)unicast <port_number> (f)filter (m)master [add|del] <address|*> [cid] [x | [priority][si][di|x]]
```

Where the first parameter is either a node's protocol address in corresponding transport protocol format.

For example:

`192.168.1.10`	For IPv4 address
`fe80:0000:0000:0000:a8ed:4c2f:fc6:335c`	For IPv6 address
`00-0B-B9-7F-C2-11`	For Ethernet address
`*`	Stands for any address

The cid parameter is an optional clock identifier of the node.

The 'x' as the next parameter stands for not accepting any messages from the node.

The priority parameter is the local priority of the master on a given port. The priority value should be between 0 and 255, 0 stands for highest priority. Local priority takes precedence over clock properties evaluated by dataset comparison algorithm when selecting best clock on a giver port (Er_best).

The si parameter is the log message intervals for Sync messages the master is configured to send to the slave.

Note: The slave cannot control how often Sync messages are transmitted by the master, so the si value is used only for information.

The di parameter is the log message interval for Delay Request messages the slave shall use, or 'x', if Delay Request/Response messages shall not be used.

For example:

`u f m`	Prints the content of the master filter table.
`u 2 f m`	Prints the content of the master filter table for port 2.
`u f m add * 255 -2 -2`	Adds an entry to accept requests from any master node. It indicates that the master is going to send 4 Sync messages per second, and instructs the slave to send 4 Delay Requests messages per second.
`u f m add 192.168.1.100 0 -2 x`	Adds an entry to accept requests from 192.168.1.100 and instructs the slave not to use Delay Requests.
`u f m add * 00:01:02:0F:FE:03:04:05 x`	Adds an entry to deny all messages from the node with specified clock identifier transmitted from any address.
`u f m del 192.168.1.100`	Removes the specified node from the filter table.

If as the result of the master acceptance filter table modification a node becomes unacceptable no more messages will be accepted from that node.

14.6.4 Unicast Both

A port is set up as "unicast both", means it can potentially switch between PTP slave and master states or between being grant port and request port, it is typically set up with one or more unicast masters in its discovery table and one or more acceptable unicast slave filter entries.

Assuming other relevant ports on the same network as this port are set up similarly, announce messages will be exchanged with them in both directions and whichever port is determined to be a PTP slave to another will request and be granted sync and delay response service from that port.

14.6.5 Message Transmission Duration

When the slave requests unicast transmission it specifies the duration, a time period in seconds for which the requested messages should be transmitted.

The requested duration is the same for all message types and for all masters. By default it is set to 300 seconds, but can be configured to any value between 60 and 3600 seconds.

The requested duration is changed with the following HMI command:

```
(u)unicast <port_number> (d)duration <value>
```

14.6.6 Discovery Query Interval

If there is no reply to the message transmission request issued by the slave or the request is denied, the slave will repeat the request every query interval.

By default it is set to 60 seconds, but can be configured to any value between 1 and 600 seconds.

The query interval is changed with the following HMI command:

```
(u)unicast <port_number> (q)query <interval>
```

14.6.7 Monitoring Unicast Operations

Besides unicast-related commands mentioned in previous chapters there is an HMI command to display the summary of unicast configuration parameters:

```
(u)unicast <port_number> (s)status
```

Another HMI command allows to see the list of all nodes with which unicast communications are established and the particular details of them:

```
(d)dataset (u)unicast
```

14.7 SyncE Operations

The SyncE implementation requires some external (outside PTP engine) configuration. Though it is possible to do this while the PTP engine is running, the correct result is not always guaranteed in this case. So, it is better to do it before starting the engine.

14.7.1 Set Master-Slave Relation for Copper Interface

If it matters, first configure the copper 1GB interfaces to insure proper frequency flow direction on the link with ifconfig synce command. See section 8.9 SyncE.

Make sure that the frequency output from one or both ports are connected to selected inputs of the PLL (e.g., by setting proper jumpers on M88EVB).

14.7.2 Set up the DSPLL A

Configure DSPLL A to a proper bandwidth (OPT1 or OPT2), set selected SyncE inputs to 125 MHz and assign them to DSPLL A in auto mode (together with other external frequency inputs, if used). Priorities of inputs should be selected with the assumption that all inputs have the same quality level. Apply the configuration with `pll load`. See section 10. PLL.

14.7.3 Configure Frequency-Related Parameters of PTP Engine

For this purpose, there is a new set of HMI commands, "freq" (or "f").

First, set frequency option to what DSLL A bandwidth is configured with:

```
freq option <opt1|opt2>
```

For example:

```
A:/root> ptp2 freq option opt1

A:/root> Frequency option: OPT1
```

OPT1 is default.

Set reference oscillator quality level:

freq ref <ql>

For example:

A:/root> ptp2 freq ref sec

A:/root> Reference QL: QL-SEC

Quality levels available and their names depends on the chosen frequency option.

Opt1: PRC, SSU-A, SSU-B, SEC, DNU

Opt2: PRS, STU, ST2, TNC, ST3E, ST3, SMC, DUS

Note: Changing frequency option resets reference quality level to DNU/DUS

14.7.4 Configure auto selection preference

If the best input has the same QL as the reference oscillator, this parameter determines what to select.

In case of best input QL= ref osc QL = DNU/DUS, reference oscillator will always be selected regardless of this parameter.

```
freq prefer <ref|input>
```

For example:

```
A:/root> ptp2 freq prefer ref

A:/root> Autoselection preference: REF
```

14.7.5 Configure frequency inputs table

This table is for inputs 1-3 assigned to DSPLL A in auto mode (see above).

There are three types which an input can be set to:

1. External unmanaged

   This is the default. Such inputs are not actively managed by PTP engine and their actual states are whatever they happen to be in (after pll commands or previous run of PTP engine or before switching input into this type).

   This type is generally for unconnected inputs or for inputs managed externally. They are not a subject of autoselection process based on quality level. But they can have an associated quality level and if such input is chosen by the DSPLL A to lock to, the system's QL will become the QL of that input, including DNU/DUS (default).

   To set the input to this type use the command freq input <1..3> ext <ql>

   For example:

```
A:/root> ptp2 freq input 1 ext dnu
A:/root> *** Frequency input 1 ****
{
 Type: External
 QL: QL-DNU
 Auto: NO
 State: active (SF)
 Source: NO
}
```

   Note: SF is for "Signal Fail", means LOS/OOF on specified input.

2. External managed (auto)

   This is for frequency inputs which are subjects of autoselection according to their QL.

   To set the input to this type use the command freq input <1..3> ext <ql> auto

   For example:

```
A:/root> ptp2 freq input 1 ext dnu auto
A:/root> *** Frequency input 1 ****
{
 Type: External
 QL: QL-DNU
 Auto: YES
 State: inactive
 Source: NO
}
```

3. SyncE

   This is simlar to 'external auto', except the input's quality level is taken from what is received via ESMC.messages on the corresponding SyncE port.

   If ESMC is disabled on that port or ESMC messages are not received in time the input's QL will become DNU/DUS automatically.

   Setting the frequency input to SyncE just gives the knowledge where to look for QL. It neither ensures that the frequency is actually coming from that port, nor requires using SyncE input type for inputs with recovered frequency. (Depending on application requirements recovered frequency inputs can be set to external auto or external unmanaged, e.g. when the peer does not support ESMC).

   To set the input to this type use the command

   freq input <1..3> synce <port_number>

```
A:/root> ptp2 freq input 1 synce 1
A:/root> *** Frequency input 1 ****
{
 Type: SyncE
 QL: QL-SSU-A
 Auto: YES
 State: inactive
 Source: NO
}
```

   Note: Changing frequency option sets all inputs to default - unmanaged external with QL=DNU/DUS.

14.7.6 Frequency selection process

The system determines the best QL of all managed inputs ('auto ext' and 'synce') and of the ref oscillator. It ensures that all inputs with QL= best QL are sources to DSPLL A. The actual active source is selected by DSPLL according to input priorities. The system's QL becomes the QL of the active input to DSPLL A or of the reference osc.

Frequency selection is independent process, it can be used with/without SyncE and/or ESMC.

To display the state of frequency input use the command freq input <1..3> or just freq input to display the state of all inputs:

```
A:/root> ptp2 freq input
A:/root> *** Frequency input 1 ****
{
 Type: SyncE
 QL: QL-SSU-A
 Auto: YES
 State: inactive
 Source: NO
}
*** Frequency input 2 ****
{
 Type: External
 QL: QL-PRC
 Auto: YES
 State: active
 Source: YES
}
*** Frequency input 3 ****
{
 Type: External
 QL: QL-DNU
 Auto: NO
 State: active (SF)
 Source: NO
}

To display general status information, use the command freq status
A:/root> ptp2 freq status
A:/root> *** Frequency status information ***
{
 Frequency option: OPT1
 Reference QL: QL-SEC
 Autoselection preference: REF
 Active source: Input 2
 Active QL: QL-PRC
}
```

14.7.7 Configure SyncE ports

Enable ESMC messaging on the port using the command

```
synce <port_number> esmc <enable|disable>
```

For example:

```
A:/root> ptp2 synce 1 esmc enable
A:/root> ESMC is enabled
```

`A:/root> ESMC` is enabled

Configure any QL overrides, if necessary, using the command

```
synce <port_number> quality in|out <auto|ql>
```

For example, enable override on input 1:

```
A:/root> ptp2 synce 1 quality in ssu-b
A:/root> QL input: QL-SSU-B
```

For example, disable override on output 1:

```
A:/root> ptp2 synce 1 quality out auto
A:/root> QL output: AUTO
```

Input override only replaces a valid QL coming in received ESMC messages. If cooper 1GB link is not in frequency slave mode (see 14.7.1 Set Master-Slave Relation for Copper Interface), the received valid QL will always be overriden with DNU/DUS regardless of configured override value. If received QL is invalid, ESMC message is malformed or no ESMC messages are received within the timeout interval of 5 s, the input QL will become QL-FAILED and the QL of the corresponding input will become DNU/DUS.

If the frequency input associated with this port is selected as the active source to DSPLL A, the output QL will always be DNU/DUS regardless of configured output override. If cooper 1GB link is not in frequency master mode (see 14.7.1 Set Master-Slave Relation for Copper Interface), the output QL will always be DNU/DUS regardless of configured output override. Otherwise, the output QL is either an output override, if configured, or the system's QL, if output override is set to auto.

Check the status of SyncE port using the command `synce <port_number> status`

For example:

```
A:/root> ptp2 synce 1 status
A:/root> *** SyncE port 1 information ***
{
 SSM channel (ESMC): enabled
 Link mode: master
 Input QL: QL-SSU-B (QL-DNU)
 Output QL: AUTO (QL-SEC)
 Active reference: NO
}
```

14.7.8 Limitation of the current version

The system's QL (QL of the physical frequency) neither affects nor is affected by PTP-related attributes, such as clock class. Therefore, it is primarily for the so-called "DCO off" mode, i.e. where DSPLL A is not controlled by the PTP engine.

14.8 Gateway and Boundary Clock

The M88 has the option of using both its Ethernet ports as PTP ports. This opens the possibility of using the M88 as a two port gateway or boundary clock.

14.8.1 The Gateway Clock

You can see the gateway clock as an ordinary clock with two ports. Figures below illustrate the difference between the gateway clock and the boundary clock.

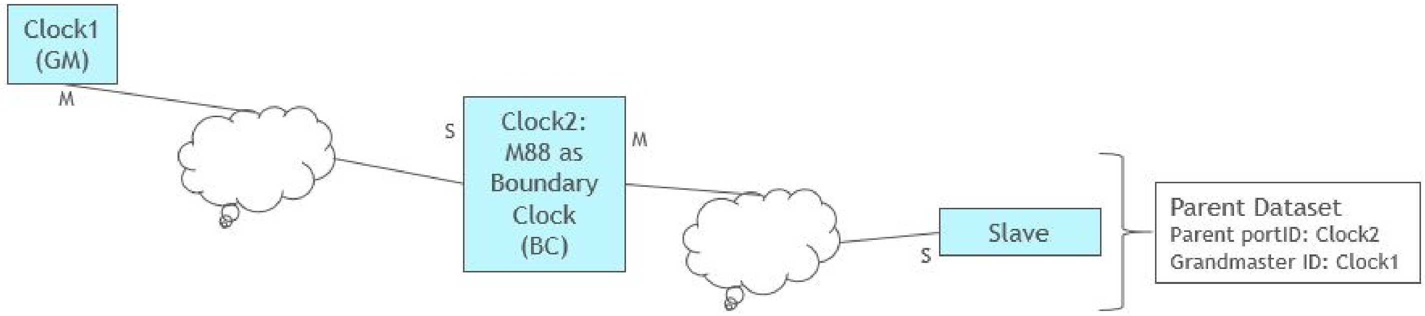


Figure 14.1. M88 as Boundary Clock – Slave Recognizes Clock1 as Grandmaster

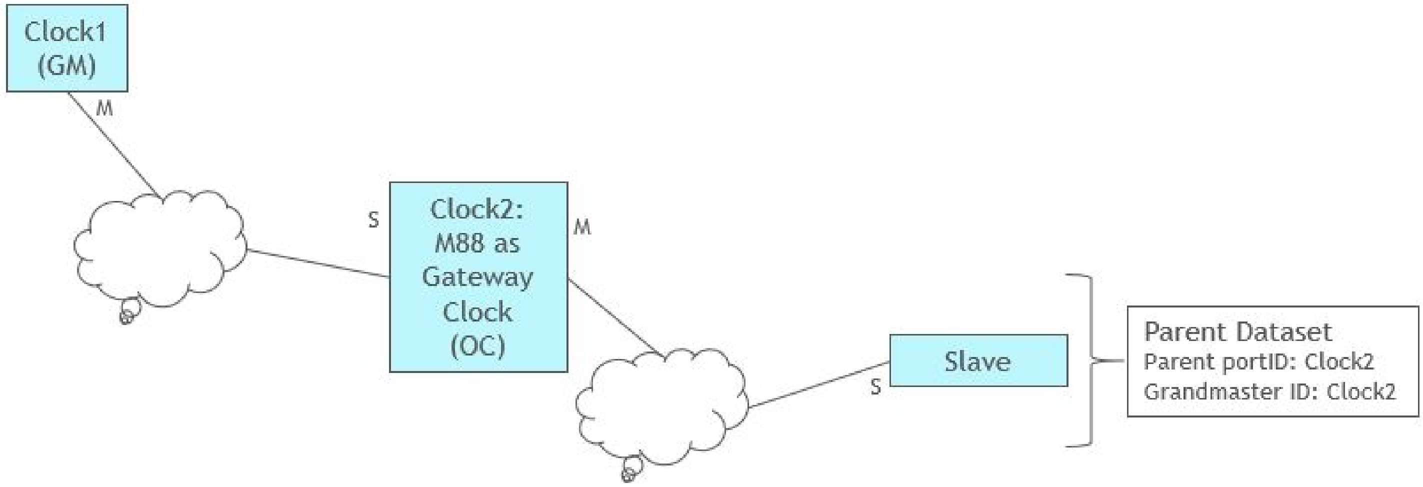


Figure 14.2. M88 as Gateway Clock – Slave Recognizes Clock2 as Grandmaster

Figures below illustrate the selection of the best master clock is on the same side of the gateway clock.

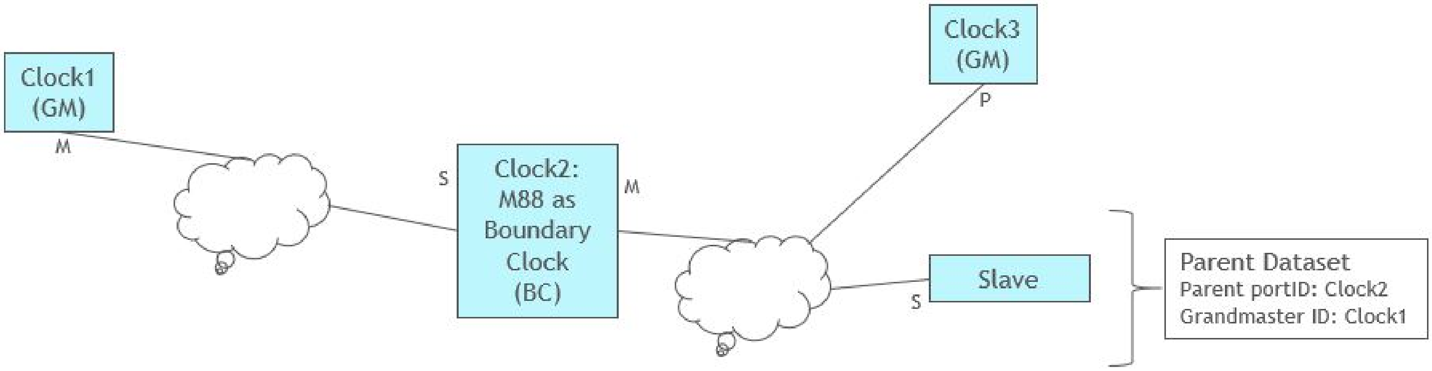


Figure 14.3. M88 as Boundary Clock: If Clock1 is Better than Clock3, Clock3 is Passive State

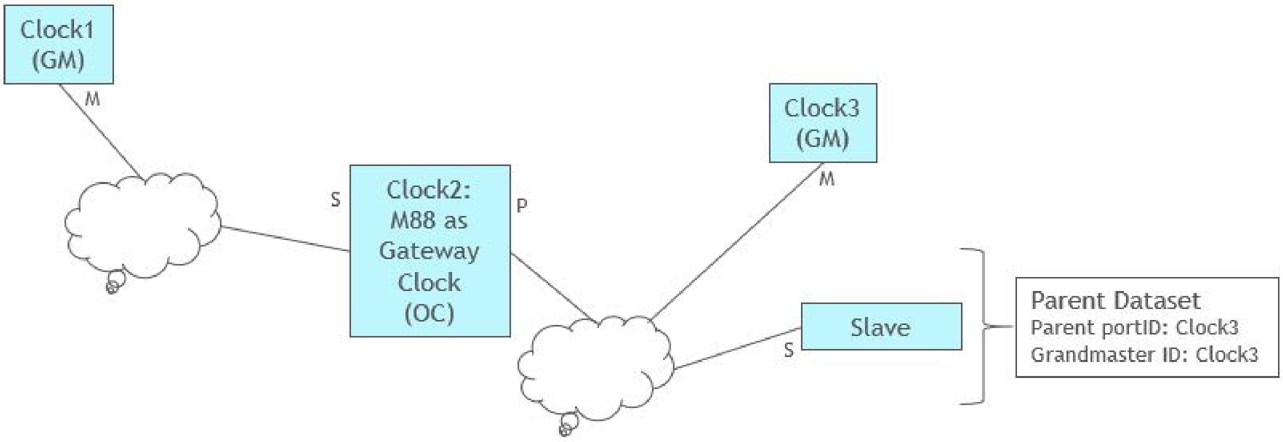


Figure 14.4. M88 as Gateway Clock – If Clock3 is Better than Clock2, Clock2 is Passive State

The type of clock is defined by the command ptp2 clock mode oc | bc where oc is the default mode.

Both the gateway and boundary clock can of course be combined with the possibility of synchronizing the clock by PPS and ToD (using PTP engine mode 2 or 3).

14.8.2 Managing the two ports

To enable both ports for PTP, the following needs to be added/changed in the system.ini file:

```
TCPIP both
```

To enable either of the interfaces as PTP port, use the following

```
TCPIP eth0
```

or

```
TCPIP eth1
```

The eth1 does currently not support DHCP but needs a static IP address.

In the ipconfig command the two ports are referred to as enet0 and enet1 as follows:

```
ipconfig [IFACE] [OPTIONS]
        ipconfig all
```

The PTP ports are referred to as 1 and 2 in commands such as defining message rates, e.g. ptp2 port 2 sync -2 which sets the synch rate on PTP port 2 (enet1) to 4 per second. If the PTP port number is omitted, port 1 is chosen by default.

The two PTP ports can be configured completely independent of each other but will of course operate on the same clock. Thus, it's impossible to configure both ports as slaves as only one of them can synchronize the clock.

On the other hand, it's fully possible to configure one port as a unicast slave running on L2 (Ethernet) while the other port is multicast running P2P over UDP.

14.8.3 Unicast

In unicast operation the identification of the port is put after the unicast option, e.g., `ptp2 unicast 2` negotiation on to turn on unicast negotiation on port 2.

14.9 Performance Optimization

There are number of parameters related to the local oscillator properties and loop control algorithm that affect the clock synchronization behavior and performance. These parameters are static, i.e. cannot be altered while the PTP Engine is up and running, so they need to be configured before it starts up.

All these parameters are set to reasonable defaults, which are suitable for most types of networks. Hence, there is no need to change them right away, but tuning them for particular network environment may dramatically improve the synchronization performance.

- VCO Control Range – defines the drift difference between the midpoint and the endpoint for the control signal to the oscillator. It is expressed in ns/s. The value suited for TCVCXO oscillator (mounted by default on the M88EVB) is 6000, which means that the controllable range of is +/- 6000 ns/s. On M88 this parameter is set to 0 as the default mode is to use a DCO for adjusting the frequency.

  Control DCO-enabled DSPLLs – mask specifying which DSPLL to control

  1.. - DSPLL D

  .1. - DSPLL C

  ..1 - DSPLL A

  000 – off

  default: 001 - DSPLL A only
- Voltage feedback – 1 (on) or 0 (off). Only used if VCO is used.
- VCO Static Drift – specifies the initial drift the oscillator should be configured with to get the desired frequency at startup. It is expressed in ns/s. The default value is zero, which corresponds to the middle point of the controllable range. After the system starts to synchronize the loop control algorithm automatically changes the oscillator frequency moving it to the correct point, but setting the initial drift closer to the correct point at startup will decrease the synchronization time. Despite the name of this parameter it's also valid when running in DCO mode.
- Main Time Constant – defines main time constant used by the control algorithm. It is expressed in seconds. A longer time constant makes the oscillator frequency change more slowly and less responsive to changes in an environment, such as the temperature or the network delays. For networks with low packet delay variation a short time constant (e.g. 30 sec) can be used. For networks with unknown or high traffic load it is better to use long time constant (e.g. 300 sec). The default value is 100. Remember that a longer time constant requires a more stable oscillator to be of any use. E.g. a time constant above 500 sec will need a good quality OCXO.
- Startup Time Constant – defines the time constant used during the period of obtaining a preliminary synchronization (startup phase). It is expressed in seconds. If this field is set to 0 the main time constant will be used. This parameter can help to shorten the synchronization time when the long main time constant is required. But too short values may lead to unwanted oscillations which increase the total synchronization time and eliminate any positive effects of shorter time constant. The default value is 0.
- Path Delay Time Constant – defines the time constant used by control algorithm for path delay calculations. This parameter is expressed in seconds. The default value is 300. For networks with low packet delay variation the smaller value can be used if the fast reaction on topology changes is necessary.
- Quality Threshold – defines the maximum allowed variation on a statistical measurement before the slave goes into hold-over. The default value is 1500.

- Square Threshold – this parameter can be used to keep the changes on the syntonized frequency small, while allowing slightly larger time offset. It is expressed in ns. The threshold can be disabled (set to zero) if the offset is the most important property. If it is enabled, the threshold value should be larger than the observed packet delay variation (excluding outliers) but smaller than the expected maximum time offset. The default value 0 (disabled).

  Network type optimization – this parameter adjusts the loop control algorithm behavior according to the underlying network characteristics. There are three types of networks currently supported: generic, engineered and networks with full on-path PTP support. “Generic” stands for a network with unknown or unspecified packet delay and delay variation or with delay distribution that may dramatically change its characteristics over the time.
  “Engineered” is for a network where the packet delay distribution always has a distinct “floor”. That ‘floor’ may vary over the time but it should still be present.
  "Full on-path" is the network with full timing support as described in G.8275.1 telecom profile. As all telecom boundary/slave clocks must have certain frequency response according to G.8273.2 this option must be combined with very short main time constant. See examples below.

  GPS/GNSS master main time constant – defines main time constant used by the control algorithm when synchronizing to GPS/GNSS. The default value is 3.

  GPS/GNSS master startup time constant – defines the time constant used during the period of obtaining a preliminary synchronization to GPS/GNSS. If set to 0 the main time constant will be used. The default value is 0.

  Minimize Frequency Change – this works similar to the “Square Threshold” parameter but for a device synchronizing to PPS. It can only be turned on (1) or off (0). In the firmware releases prior to v1.0.13, setting this parameter to “on” effectively changes GPS/GNSS main and startup time constants to 100 and 30 respectively. Starting with v1.0.13 this parameter, when set to on, keeps time constants as configured, but selects lower values for control algorithm gains instead. To preserve the old behavior of this option on newer releases one must need to set GPS/GNSS main and startup time constants to 100 and 30 respectively, while keeping this option off.

For viewing values currently assigned to static parameters and for changing them the ISH command ptp2 config should be used.

To optimize the performance for special network conditions, such as a direct connection with no traffic load, the loop controller parameters can be changed.

14.9.1 Direct Connection

A slave is connected to a master with a direct cable:

Set a short time constant, e.g., 30 s. The sync rate should be at least 1 Hz.

14.9.2 Low Traffic Network

A slave is connected to a master through a couple of switches or a router, with no or low traffic load:

Set a medium time constant, e.g., 100 s (default). The sync rate should be at least 1 Hz.

14.9.3 High Traffic Network

A slave is connected to a master through several switches or routers, with a traffic load of more than 50%:

Set a longer time constant, e.g., 300 s. The sync rate should be at least 16 Hz.

14.9.4 ITU-T G.8261, G.8265.1, G.8275.2 Settings

ITU-T G.8261 specifies a number of test cases in a 10-switch loaded network.

Set a long time constant, 300 s or longer (use a 100 s startup time constant) and set the network mode to engineered. Use a sync rate of at least 16 Hz.

14.9.5 ITU-T G.8273.2, G.8275.1 settings

Use a very short time constant, 1-3 s. Set the network mode to full on-path support.

14.10 Power Profile

Both versions of power profile, C37.238-2011 (version 1) and C37.238-2017 (version 2), are supported. To have the M88 working properly in a network adhering to these profiles, use the clock profile command:

```
(c)clock (f)profile power [v2]
```

For example,

```
c f power v2
```

sets the clock profile to C37.238-2017.

The following parameters will be changed on both ports when setting the clock profile to power or power v2:

- Network Protocol is set to 802.3
- Delay Mechanism is set to P2P
- Unicast communication is disabled
- Announce interval is set to 1, Sync interval to 0 and Peer Delay Request interval to 0

In addition, the clock domain is set to 0 for C37.238-2011 and 254 for C37.238-2017

There are several configuration parameters for the power profile. These are Grandmaster ID, Time Inaccuracy and Alternate Timescale information.

The following command configures the Grandmaster ID:

```
(pw)power (g)gmid <0..65535>
```

The default value for Grandmaster ID is 0.

As in version 1 of Power profile the Grandmaster ID must not be 0, a port set to this profile will not transmit any the profile-specific TLVs until the Grandmaster ID is configured to non-zero value in its low order byte.

The Time Inaccuracy is configured with this command:

```
(pw)power (i)inacc <grandmaster> <network>
```

Both values are 0 by default.

In version 2 of Power profile these two values are summed up and transmitted as a single Total Time Inaccuracy field in the profile-specific TLV.

Alternate timescale information is automatically taken from the currently configured system's timezone (see 'date' command). To view the profile-specific values obtained by a slave from its master the following command can be used:

```
(d)dataset (pw)power
```

14.11 ITU-T G.8265 Profile

To have the M88 working properly in a network adhering to this profile, use the clock profile command:

(c)clock (f)profile g8265

The following parameters will be changed on both ports when setting the clock profile to G.8265:

- Network Protocol is set to UDP over IPv4
- Delay Mechanism is set to E2E
- Unicast Master
- Announce interval is set to 1, Sync interval to 0 and Delay Request interval to 0

In addition, the clock domain is set to 4.

There are no profile specific parameters to be set for G.8265 profile.

14.12 ITU-T G.8275.1 Profile

To have the M88 working properly in a network adhering to this profile, use the clock profile command:

```
(c)clock (f)profile g8275.1
```

The following parameters will be changed on both ports when setting the clock profile to G.8275.1:

- Network Protocol is set to 802.3
- Delay Mechanism is set to E2E
- Unicast communication is disabled
- Announce interval is set to -3, Sync interval to -4 and Delay Request interval to -4

In addition, the clock domain is set to 24.

There are several profile specific parameters to be set for G.8275.1 profile. These are Local clock priority, Max steps removed, local port priority and master only attribute.

The local clock priority is configured using the command

```
(g2)g8275 (p)priority <1..255>
```

The default is 128.

The Max steps removed is configured using the command

```
(g2)g8275 (s)steps <1..255>
```

The default is 255.

The local port priority is configured using the command

```
(g2)g8275 <port_number> (p)priority <1..255>
```

The default is 128 for both ports.

The port master-only attribute is configured using the command

```
(g2)g8275 <port_number> (m)masteronly <on|off>
```

The default is off for both ports.

14.13 ITU-T G.8275.2 Profile

To have the M88 working properly in a network adhering to this profile, use the clock profile command:

```
(c)clock (f)profile g8275.2
```

The following parameters will be changed on both ports when setting the clock profile to G.8275.2:

- Network Protocol is set to UDP over IPv4
- Delay Mechanism is set to E2E
- Unicast Both
- Announce interval is set to 1, Sync interval to 0 and Delay Request interval to 0

In addition, the clock domain is set to 44.

There are several profile specific parameters to be set for G.8275.2 profile. These are Local clock priority, Max steps removed, local port priority and master only attribute.

The local clock priority is configured using the command

```
(g2)g8275 (p)priority <1..255>
```

The default is 128.

The Max steps removed is configured using the command

```
(g2)g8275 (s)steps <1..255>
```

The default is 255.

The local port priority is configured using the command

```
(g2)g8275 <port_number> (p)priority <1..255>
```

The default is 128 for both ports.

The port master-only attribute is configured using the command

```
(g2)g8275 <port_number> (m)masteronly <on|off>
```

The default is off for both ports.

14.14 Default Profile

To have the M88 working properly in a network adhering to this profile, use the clock profile command:

```
(c)clock (f)profile default
```

The following parameters will be changed on both ports when setting the clock profile to default:

- Network Protocol is set to UDP over IPv4
- Delay Mechanism is set to E2E
- Unicast communication is disabled
- Announce interval is set to 1, Sync interval to 0 and Delay Request interval to 0

In addition, the clock domain is set to 0.

There are no profile specific parameters to be set for the default profile.

15. Command Reference

All commands can be issued by a user from a serial terminal or a telnet session. The output from any command is redirected to the output device it was issued from.

In contrast to commands the debug output can have only one output device. So, enabling it on one device (or in one session) will automatically disable it on another.

The commands can be sent either from the command prompt of the shell, or, inside of the MTE.

A full list of commands is provided in 22. Appendix 3: PTP Command Reference.

The most commonly used shell commands are listed here.

Note: The choice of start parameter decides the basic functionality of the product, i.e., master, slave with a master capability or grandmaster.

15.1 Shell Commands

15.1.1 ptp2 start

```
ptp2 start <mode> <option>
```

Starts PTP Engine in the following mode:

0 – GPS disabled, only PTP (master-slave),

1 – GPS reference only (master only). Default mode,

2 – GPS primary, PTP secondary (master-slave),

3 – GPS secondary, PTP primary (master-slave),

4 – GPS debug.

Note: In this context "GPS" means GPS/GNSS.

Supported options are:

--silent: no unsolicited console output until HMI debug is turned on

15.1.2 ptp2 stop

```
ptp2 stop
```

Stops PTP Engine.

15.1.3 ptp2 hmi

```
ptp2 hmi
```

Enters the HMI command processing mode. To quit the HMI command processing mode type q.

15.1.4 ptp2 config

```
ptp2 config <options>
```

Configures oscillator and loop control related static parameters. Configuration options are:

-v [value] – VCO control range, in ns/s (default 0),

-c [mask] – control DCO-enabled DSPLLs, mask specifies DSPLL to control

1.. - DSPLL D
.1. - DSPLL C
..1 - DSPLL A
000 – off
default: 001 - DSPLL A only

-u [1|0]: voltage feedback, 1 - on (default 0)

-d [value] – VCO static drift, in ns/s (default 0),

-t [value] – slave main time constant, in sec (default 100),

-s [value] – slave startup time constant, in sec, 0 - off (default 0),

-m [value] – master main time constant, in sec (default 3),

-l [value] – master startup time constant, in sec, 0 - off (default 0),

-p [value] – path delay time constant, in seconds (default 300),

-q [value] – quality threshold, in ns, (default 1500),

-e [value] – square threshold, in ns, 0 - off (default 0).

-f [0|1] – minimize frequency change, 1 – on, 0 – off (default 0).

-n [g|e|f] – optimize for either generic (‘g’), engineered (‘e’) or full on-path support (‘f’) network (default ‘g’).

15.1.5 ptp2

```
ptp2 <command>
```

Sends a single HMI command to the PTP Engine.

16. JSON Usage

As a machine-to-machine interface, JSON has several advantages over the current CLI implementation:

- JSON is designed to be easy to parse
- The interface information for each command is now documented (see Appendix 9: JSON Interface Definition
- JSON is very human readable

Be cautioned that the command port (typically COM3) can be switched between JSON and CLI/HMI, but the switch is not automatic. The scope of the JSON commands is the ptp2 engine commands.

Example: Using the ptp2 clock info command as an example.

- Before JSON:

```
A:/root> ptp2 clock info
A:/root> *** Clock description ***
{
 Clock type: ORDINARY CLOCK
 Ports number: 2
 Physical layer protocol: IEEE 802.3
 Port 1:
  Physical address: FC:AF:6A:02:EA:28
  Network protocol: UDP/IPv4
  Network address: 0.0.0.0
  Profile ID: 00-1B-19-00-01-00
 Port 2:
  Physical address: FC:AF:6A:01:EA:28
  Network protocol: UDP/IPv4
  Network address: 192.168.2.99
  Profile ID: 00-1B-19-00-01-00
 Manufacturer ID: 90 FD 9F
 Product description: Silicon Laboratories;PTPv2 Engine;02-EA-28
 Revision data: ;;3.0.0
 User description: ;
}
```

- After enabling JSON:

```
A:/root> ptp2 engine json on
A:/root> ptp2 clock info
A:/root> {
    "clockInformation":
    {
        "clockType": "ORDINARY CLOCK",
        "physicalLayerProtocol": "IEEE 802.3",
        "numberPorts": 2,
        "portTable":
        [
            {
                "portNumber": 1,
                "physicalAddress": "FC:AF:6A:02:EA:28",
                "protocolAddress":
                {
                    "networkProtocol": "UDP/IPv4",
                    "networkAddress": "0.0.0.0"
                },
                "profileIdentity": "00-1B-19-00-01-00"
            },
            {
                "portNumber": 2,
                "physicalAddress": "FC:AF:6A:01:EA:28",
                "protocolAddress":
                {
                    "networkProtocol": "UDP/IPv4",
                    "networkAddress": "192.168.2.99"
                },
                "profileIdentity": "00-1B-19-00-01-00"
            }
        ]
        "manufacturerIdentity": "90 FD 9F",
        "productDescription": "Silicon Laboratories;PTPv2 Engine;02-EA-28",
        "revisionData": ";;3.0.0",
        "userDescription": ";"
    }
}
```

16.1 Enabling JSON

- If the JSON interface is being used for M2M communications, the host software must be updated with the JSON commands and responses - see Appendix 9: JSON Interface Definition.
- After the ptp2 engine is running JSON can be enabled with:

```
ptp2 engine json on
```

- Until the JSON capability is turned off, all responses from the ptp2 engine are in JSON format.
- The JSON capability is turned off with:

```
ptp2 engine json off
```

17. Product Documentation

The following documents can be downloaded from the https://www.silabs.com/. Registration may be required. Any documents not available at the website can be requested from the Silicon Labs support Website.

M88 Evaluation Board User’s Guide

18. Part Numbers

Ordering Part Numbers:

- M88-NNN-Axxxxx-GM

where

- NNN is one of 32, 128, or 256 for the number of supported slave connections
- A is the product revision
- xxxxx is either:
  - 0xxxx where xxxx is the software revision, e.g., M88-128-A01912 stands for software release 1.9.12
  - 1xxxx where the xxxx is a custom part number
- GM is for -40C to 85C operating temperature range

An optional “R” suffix may be used for tape and reel ordering.

19. Customer and Technical Support

For the latest product information, see https://www.silabs.com/.

20. Appendix 1: System Files

File	Description
access.ini	Access rules for telnet and ftp server.
boot.ini**	Specifies what program shall be started by the boot loader.
group.ini	Contains the group definitions.
hostname.ini	Specifies system host name.
ish.ini	Common session configurations.
_ish.ini	User specific configurations.
passwd.ini	The user database.
ptp.ini	PTP protocol engine configurations. Currently not supported.
startup.ini	Contains startup commands.
system.ini	System configurations.
leapsec.ini	This file contains information about passed and upcoming leapseconds.
hostkey	Private RSA key for SSH server.
system.ver**	Firmware version file.
system.gpx**	The runtime environment.
M80.bit**	Binary file containing HW specific information.

** The following files contain the system image and control the boot process and should not be modified in any way:

- system.gpx
- boot.ini
- system.ver
- any file that ends in .bit

Modifying any of these files may render the system unbootable. Contact Silicon Labs for more information.

access.ini

This file contains the access rules for the telnet and ftp server. Each line may either contain an allow entry or a deny entry. The order option defines which of the entries allow and deny that has the highest priority. If the order is allow, deny, the default is to allow connections from all hosts except those that matches a deny entry. If the order is deny, allow the default is to deny all connections, except those that matches an allow entry.

Example:

```
allow: 192.168.1.0/255.255.255.0
    deny: 192.168.1.90/255.255.255.255
    order: deny, allow
```

Which will allow all hosts from the 192.168.1.0 network to connect, except for 192.168.1.90 who will be declined access.

boot.ini

The boot.ini file contains information of what executable file that will be started by the boot loader. The executable can be explicitly specified or a probe program can be started. The probe programs exit code will then be used by the boot loader to select which program to start.

The lines in the boot.ini file that specifies boot files starts with a one letter label followed by a colon character. The letters d and p are reserved for the default startup program and the probe program respectively.

In the following example the /system/system.gpx will be started by the boot loader.

```
d: /system/system.gpx
```

Using a Probe Program

A probe program can for example sense an external signal and decide whether the system should be booted with ordinary system program or some other program. In the following example, the system will be booted with system.gpx if the probe program (probe.gpx), returns the exit code 'd' and with setup.gpx, if the exit code is 'a'.

```
d: /system/system.gpx
    p: /system/probe.gpx
    a: /system/setup.gpx
```

group.ini

This file contains the group definitions. Each line is an entry for a group. Every field is delimited with a ';':

Group name	The name of the group.
Password	This field is ignored.
Group ID	The numeric value associated with the group

The following groups will exist from the beginning:

- root
- guest
- user
- ppp

The root group is special since it enables administrator privileges.

hostname.ini

The hostname of the system. You can either edit this file by hand or use the hostname command.

The default name is **localhost.localdomain**.

ish.ini

This file contains common configuration data for all login sessions. This file will be read when a new session is initiated.

By default it contains some alias definitions and the CLASSPATH variable.

See also _ish.ini.

_ish.ini

When the /system/ish.ini has been parsed, the users home directory, $HOME, is searched for a _ish.ini file. Each user may store his/hers personal settings in this file.

passwd.ini

This file contains the user database. It is in a standard UNIX format, where each line consists of an entry for a user.

Each line consists of the following fields separated with a semicolons:

Field	Description
User name	The user name, up to 16 characters.
Password	DES encrypted password.
User id	A numeric value in the range [0-255]. 0 is reserved for the root account.
Group id	A numeric value in the range [0-255]. 0 is reserved for the root group. See the group.ini file.
Full user name	The user’s full name.
Home directory	The user’s home directory. This is where the shell will try to read the users ish.ini file.
Shell to start	This is only to be compatible with the standard UNIX format, and is currently not used.

To modify this file, use the useradd and userdel commands. To alter a password, use the passwd command.

In the beginning there exists two accounts, root and guest, which has the following passwords:

- root: root

- guest: guest

ptp.ini

This file contains PTP protocol engine configuration settings. The protocol engine reads this file during the initialization phase when it is started.

Note: At the moment this file is not supported by the PTP engine.

startup.ini

This file may contain commands to start an application automatically. This file will be read and executed after system.ini has been read and the system has been initialized.

Commands executed in this file will have root permissions. The starting directory will be set to "A:/".

Example:

```
mount c
date
```

system.ini

This file contains the system configuration and will be read and executed at boot time. This file should contain the system wide configuration variables. See Environment Variables for more information.

leapsec.ini

This file contains information about passed and upcoming leapseconds. This file is read by the PTP engine and should be used to schedule upcoming leapseconds. This file can be modified by the PTP commands related to removing and adding leapseconds. See Appendix 3: PTP Command Reference.

hostkey

This file contains the SSH server's private RSA key.

By default the firmware comes with a hostkey file containing 1536 bits RSA key generated at Silicon Labs for demonstration and testing purpose. If the system is going to be deployed to the secure live environment this file should be replaced with another one containing the customer's own secure private key.

If the hostkey file is missing the SSH server will try to generate a temporary 1024 bits key upon startup. This is a slow process and may take up to several minutes. The temporary key will be used by SSH server only during current session (i.e. until system restart or SSH server shutdown) and will not be saved into the hostkey file.

system.ver

This file contains a string reflecting the current version of the firmware.

system.gpx

The runtime environment. This executable which contains the ISH, telnet server, ftp server etc. will be started by the boot loader.

See also boot.ini.

21. Appendix 2: System CLI Commands

● about on page 84	Print a short description about the system.
● alias on page 86	Define or print aliases.
● cat on page 86	Print contents of a file.
● cd on page 87	Change directory.
● chgrp on page 87	Change group owner of a file.
● chmod on page 88	Change file permissions.
● clear on page 89	Clear screen.
● cmp on page 89	Compare two files.
● cp on page 90	Copy file.
● date on page 91	Get/set date and time.
● debug on page 92	Enable/disable debug output.
● df on page 93	Print information about device usage.
● echo on page 93	Print a line to the terminal.
● exit on page 93	End an interactive session.
● find on page 94	Search for a file in the file system.
● ftp on page 95	FTP client.
● hd on page 96	Print contents of a file in hexadecimal.
● help on page 97	Print help about command.
● history on page 97	Show the ish command history.
● hostname on page 98	Print/set hostname.
● id on page 98	Print information about the current user.
● ifconfig on page 99	Configure Ethernet interface
● in on page 101	Read a byte from an I/O port.
● ipconfig on page 102	Print/set the settings for the TCP/IP stack.
● kill on page 103	Kill a thread.
● ls on page 104	List directory contents.
● mkdir on page 104	Create directory.
● mkrd on page 105	Create a ramdisk.
● more on page 105	Show contents of a file.
● mount on page 106	Mount FAT drive.
● mv on page 106	Move file.
● netstat on page 106	Show information of current network connections.
● nslookup on page 107	Resolve a hostname through DNS.
● od on page 107	Print contents of a file in octal.
● out on page 108	Write a byte to an I/O port.
● passwd on page 108	Change password for user.
● pd on page 109	Print current drive.

● ping on page 109	Ping a node on the Internet.
● pll on page 110	PLL control and configuration.
● ps on page 111	Show information about processes/threads.
● ptp2 on page 112	PTP version 2 protocol engine.
● pwd on page 113	Print current directory.
● reboot on page 114	Reboot system.
● rm on page 114	Remove file.
● rmdir on page 115	Remove directory
● route on page 115	Print routing table information.
● setenv on page 115	Define an environment variable.
● sleep on page 116	Make process sleep.
● source on page 116	Execute the contents of a file.
● startserver on page 117	Start firmware servers.
● stats on page 118	Show information/statistics about the system.
● stopserver on page 118	Stop firmware servers.
● su on page 119	Become another user.
● touch on page 119	Update time stamp of a file.
● umount on page 119	Unmount a drive.
● unalias on page 120	Remove an alias definition.
● update on page 120	Update the firmware through TFTP.
● useradd on page 121	Add a user to the user database.
● userdel on page 121	Remove a user from the user database.
● wall on page 122	Send message to all users.
● who on page 122	Show a list on logged in users.
● write on page 123	Send message to a specific user.

about

Syntax: `about`

Print a short description about the system.

Description

Print a short description about the system. Prints a copyright message and what third party software that are used.

alias

Syntax: `alias [ALIAS] [DEFINITION]`

Define or print aliases.

Description:

Define or print aliases. Without any arguments all current defined aliases will be printed.

If one argument is available, that argument will be treated as an alias, and the corresponding definition will be printed.

If two or more arguments are available a new alias will be defined (or replaced if the alias already exists). The first argument will be treated as the alias name, and all other arguments will be put in the definition.

Aliases are defined in ish.ini.

Examples:

Print all defined aliases.

```
alias
```

Print the definition of the "ls" alias.

```
alias ls
```

Define alias "monkey" to find the file "monkey.txt".

```
aliasmonkey find / monkey.txt
```

See also

● unalias on page 120

cat

Syntax`cat FILE ...`

Print contents of a file.

Options

FILE The file to print.

Description

Print contents of a file. Every argument will be treated as a filename and the files will be printed in order.

Examples

Print the contents of one file.

```
cat/system/system.ini
```

Print the contents of several files.

```
Cat/system/system.ini /system/ish.ini
```

See also

● hd on page 96 | ● more on page 105 | ● od on page 107

cd

Syntax `cd [DIRECTORY]`

Change directory.

Options

DIRECTORY The directory to go to.

Description

Change directory. If the directory is omitted, the current directory will be set to the value of the HOME variable. The current directory is stored in the PWD variable.

Examples

Go to home directory.

```
cd
```

Go to root directory

```
cd /
```

See also

● pwd on page 113 | 25. Appendix 6: Environment Variable.

chgrp

Syntax: `chgrp GROUP FILE`

Change group owner of a file.

Description

Change group owner of a file. Change group owner of a file. The first argument must either be a group ID or a group name. The second argument is the name of the file to alter.

Examples

Change group of system.ini to group '1'

```
chgrp1 /system/system.ini
```

Change group of system.ini to group "ppp"

```
chgrpppp /system/system.ini
```

See also

● chmod on page 88 | ● chown on page 89

chmod

Syntax: `chmod MODE FILE`

Change file permissions.

Options

MODE

The file mode.

FILE

The path to the file to alter.

Description

Change file permissions. MODE is an octal number in the range 000 to 777. The first digit maps to the user's rights, the second digit to the group's rights and the last digit to other's rights. Bit 0 is X, bit 1 is W, bit 2 R.

Examples

Set write bit for all users

```
chmod 222 /system/system.ini
```

Set execution bit for owner

```
chmod 100 /system/system.ini
```

Set execution bit for group

```
chmod 010 /system/system.ini
```

Set execution bit for others

```
chmod 001 /system/system.ini
```

Clear all bits for all users

```
chmod 0 /system/system.ini
```

See also

● chgrp on page 87| ● chown on page 89

chown

Syntax: `chown OWNER FILE`

Change owner of a file.

Description

Change owner of a file. The first argument must either be a user id or a group name. The second argument is the name of the file to alter. If the owner is a name and ends with ":" the group of the file will be set to the users group.

Examples

Change owner of system.ini

```
chown 1 /system/system.ini
```

Change owner of system.ini

```
chown root /system/system.ini
```

Change owner and group of system.ini

```
chown root: /system/system.ini
```

See also

● chgrp on page 87| ● chmod on page 88

clear

Syntax: `clear`

Clear screen.

Description

Clear screen. Clears the terminal screen.

Examples

Clear screen

```
clear
```

cmp

Syntax: `cmp [OPTIONS] FILE1 FILE2`

Compare two files.

Options

-l

Print each mismatching byte and offset.

Description

Compare two files. By default cmp will stop comparing at the first mismatch and print the offset and values at the mismatching byte. If the -l option is specified all differences will be printed.

Examples

Compare ish.ini and system.ini

```
cmp /system/ish.ini /system/system.ini
```

Compare ish.ini and system.ini printing all bytes that differ

```
cmp -l /system/ish .ini /system/system.ini
```

cp

Syntax: `cp [OPTIONS] SRC DEST`

Copy file.

Options

-R

Recursive copy, SRC and DEST must be directories.

-v

Verbose.

Description

Copy file. If -v is specified each file copied will be printed.

Examples

Make backup copy of system.ini

```
cp /system/system.ini system.bak
```

See also

- mv on page 106

date

Syntax: `date [OPTIONS]`

Get/set date and time.

Options

-n Host:

Acquire date and time through NTP.

-p

Print supported time zones.

-s YYYYMMDDhhmmss

Set date and time.

-d MMODhhmm-MMODhhmm

Set daylight saving rules.

-z TIMEZONE

Set time zone.

+ FORMAT

Set the print format for date and time.

Description

Get/set date and time. The command will print the current time after executing any options, the printed string may be formatted by the +FORMAT option.

HOST may be a dot notation ip number, or a hostname if the system is configured with a valid DNS server.

YYYYMMDDhhmmss must have all fields included, on the following format. YYYY - year (1900-9999), MM - month (01-12), DD - Day (01-31) hh - hour (0-23), mm - minute (00-59), ss - second (00-59). Every field must be exactly as long as specified by the letters.

MMODhhmm-MMODhhmm must have all fields included, or entirely omitted, on the following format. Specify start of daylight saving before the '-', end after. MM - month (01-12), O - occurrence (0=last, 1=1st, 2=2nd, ..), D - day (0=Sun, 1=Mon, 2=Tue, ..), hh - hour (0-23), mm - minute (00-59). Every field must be exactly as long as specified by the letters. If all fields are omitted (only the '-' left) then daylight saving is turned off.

TIMEZONE should be a three letter abbreviation, an offset in hours, or a string like CET+1CEST, specifying both names and offset.

The *+FORMAT* string will be used by the strftime() function to create the string printed. No options can follow the FORMAT string, since it can contain single spaces. See documentation on the ANSI C function strftime() for details.

Examples

Print all valid time zones

```
date -p
```

Set date using a NTP service

```
date -n 192.168.1.9
```

Set date to 26th april 1986 1:26

```
date -s 19860426012600
```

Set timezone to GMT

```
date -z GMT
```

Set timezone to CET (using both names and offset)

```
date -z CET+1CEST
```

Set the daylight saving start to last Sunday in March at 1:00, and DST end to last Sunday in October at 2:00

```
date -d 03000100-10000200
```

Just print the local time

```
date
```

Print the date as YYYYMMDD

```
date +%Y%m%d
```

debug

Syntax: `debug [OPTIONS]`

Enable/disable debug output.

Options

-a

Enable debugging for all modules.

-d

Enable debugging for DHCP.

-h

Print help text.

-I

Enable debugging for IP layer.

-l LEVEL

Set debug level.

-n

Enable debugging all network protocols.

-p

Enable debugging of PPP.

Description

Enable/disable debug output. Without any arguments the debug levels for the modules will be printed.

Examples

Enable debug information of PPP

```
debug -l 3 -p
```

Enable all possible debug information

```
debug -l 999 -a
```

Disable all debug information

```
debug -l 0 -a
```

See also

● netstat on page 106| ● route on page 115| ● debug on page 92

df

Syntax: `df`

Print information about device usage.

Description

Print information about device usage. Information about all mounted devices will be printed.

Examples

Print the mounted devices

```
df
```

echo

Syntax: `echo STRING ...`

Print a line to the terminal.

Options

STRING The string to print.

Description

Print a line to the terminal. When parsing the arguments, variables will be substituted for their values.

Examples

Print hello, world

```
echo hello, world
```

Print the value of the HOME variable

```
echo $HOME
```

Print the exit status of last command

```
echo $?
```

exit

Syntax: `exit`

End an interactive session.

Description

End an interactive session. If a su session was entered, that session will be exited, else the user will be logged off.

Examples

Exit this session

```
exit
```

See Also

- su on page 119

find

Syntax: `find DIRECTORY FILE`

Search for a file in the file system.

Options

FILE

The file to search for.

DIRECTORY

The directory to start in.

Description

Search for a file in the file system. FILE may contain wild cards ('*' matches several characters and '?' matches only one character). The search will start in DIRECTORY and will also go through all subdirectories.

Examples

Find monkey.txt in the file system

```
find / monkey.txt
```

Find all .txt files

```
find / *.txt
```

Find all .class files starting with "my"

```
find / my*.class
```

ftp

Syntax: `ftp [HOST]`

FTP client.

Options

HOST The host to connect to.

Description

FTP client. This is a simple FTP client similar to those found in U**X or MS Windows systems. The following commands are available

`Ascii`

Put transfer in ASCII mode.

`Bin`

Put transfer in binary mode.

`Bye`

Quit ftp.

`cd DIR`

Change directory.

`dir [DIR]`

List directory.

`Exit`

Quit ftp.

`get FILE`

Download file.

`Help`

Show help text

`list [DIR]`

List directory.

`ls [DIR]`

List directory.

`Open Host`

Connect to HOST.

`put FILE`

Upload file.

`Pwd`

Print current directory.

`Quit`

Quit ftp.

`user USER`

Login as USER.

Examples

Just start the FTP client

```
ftp
```

Start and try to connect to a server

```
ftp ftp.sunet.se
```

hd

`Syntax`: `hd [OPTIONS] FILE ...`

Print contents of a file in hexadecimal.

Options

-o

Print octal dump instead of hexadecimal.

-c

Print printable characters, and the rest as numbers.

Description

Print contents of a file in hexadecimal. 16 bytes will be printed on every line. The offset into the file will be printed in the leftmost column.

Examples

Look at the hex dump of system.gpx

```
hd /system/system.gpx
```

See what non-printable characters system.ini contains

```
hd -c /system/system.ini
```

See Also

● od on page 107 | ● cat on page 86 | more

help

Syntax: `help [OPTIONS] [CMD]`

Print help about command.

Options

-s

Print a short description on all functions.

Description

Print help about command. Without any arguments a list of all available commands will be printed.

With the -s option a short description of each command will be printed together with the command name.

Any other argument on the command line will be treated as a command and the corresponding help text will be printed.

Examples

List all commands

```
help
```

List all commands with a short description

```
help -s
```

Show help on the "ipconfig" command

```
help ipconfig
```

history

Syntax: `history [OPTIONS]`

Show the ish command history.

Options

-c

Clear history.

Description

Show the ish command history. Lists all entries in the history, these can be accessed with the up-arrow.

Examples

Show the history

```
history
```

Clear the history list

```
history -c
```

hostname

Syntax: `hostname [NAME]`

Print/set hostname.

Options

NAME The name to set.

Description

Print/set hostname. Without any arguments the current hostname will be printed.

If a hostname is present on the command line, the current host name will be exchanged for this. If the hostname is fully qualified domain name both the hostname and the domain name will be exchanged. If only a hostname is present, the old domain name will be reused.

Examples

Print the hostname

```
hostname
```

Set the FQDN

```
hostname monkey.say.monkey.do
```

Set the hostname keeping the domain name

```
hostname gorilla
```

id

Syntax: `id`

Print information about the current user.

Description

Print information about the current user. The user id, group id and the corresponding names will be printed.

Examples

Print user information

```
id
```

ifconfig

Syntax: `ifconfig frwd [OPTIONS]`

Configure Ethernet interface

Options

On

Enables pass-through operations between two Ethernet interfaces

Off

Disables pass-through operations.

Description

The pass-through mode allows the M88 (see NOTE 1 below) and other M88-based system with two Ethernet interfaces

On its primary Ethernet port such "gateway" is connected to a network which transports data and PTP synchronization. To its secondary Ethernet port the non-PTP system is connected. The "gateway" participates in PTP activity acting as PTP slave and synchronizing its local clock. The PTP traffic is filtered out while non-PTP data are passed through to the host along with synchronization signals in form of PPS/TOD/FREQ-out.

Note: Before the pass-through mode can be used on M88 the command must be entered.

Syntax: `ifconfig [IFACE] vlan [OPTIONS]`

Configure VLAN support on specified network interface.

If no IFACE parameter is specified the command is applied to 'enet0'.

Options

Off

Send and receive untagged frames only

`None`

Send untagged frames, receive untagged and priority tagged frames.

`0 [prio_code]`

Send priority-tagged frames, receive untagged and priority tagged frames.

`<vlan_id> [prio_code]`

Send and receive vlan-tagged frames only

Description

tbc

Syntax: `ifconfig [IFACE] link [OPTIONS]`

Configure link properties on specified network nterface.

If no IFACE parameter specified the command is applied to 'enet0'.

Options

[mode]

Disable autonegotiation and force into one of the following modes: 1000F, 1000H, 100F, 100H, 10F, 10H

auto [mode_mask]

Enable autonegotiation and optionally set advertised modes. If mode_mask is not given all supported modes will be advertised, i.e., 1000F|1000H|100F|100H|10F|10H.

Description

tbc

Syntax: `ifconfig [IFACE] synce [OPTIONS]`

Configure 1000BASE-T SyncE frequency direction on specified network interface.

If no IFACE parameter specified, the command is applied to 'enet0'.

Options

master|slave

Disable autonegotiation and force into either master or slave mode.

auto master|slave

Enable autonegotiation with either master or slave preference.

If no option given, current resolved state will be reported.

Description

tbc

Syntax: `ifconfig [IFACE] mdio [OPTIONS]`

Read/write directly from/to MDIO registers of specified network interface.

If no IFACE parameter specified, the command is applied to 'enet0'.

Options

<reg>

Perform single read from MDIO register.

<reg> <value>

Perform single write to MDIO register

If no option given, enter into exclusive MDIO read/write mode to perform an uninterrupted series of read/writes by just specifying register addresses and values. In this mode, no other MDIO access is allowed which can cause disruption in normal operations, such as link status interrupt handling. 'q' quits exclusive MDIO read/write mode.

Description

tbc

Syntax: `ifconfig [IFACE] reset [OPTIONS]`

Reset PHY on specified network interface.

If no IFACE parameter specified, the command is applied to 'enet0'.

Options

sw

Software reset only. Only relevant when PHY's MDIO interface lines are connected.

noinit

Do not perform PHY initialization. Can be used when PHY needs to be configured manually using MDIO.

If no option given, HW reset will be performed.

Description

tbc

Syntax: `ifconfig [IFACE] sfp [OPTIONS]`

Manage SFP connected to the specified network interface

If no IFACE parameter specified, the command is applied to 'enet0'.

Options

raw

Prints SFP information in raw hex format

state

Shows state of LOS, enable, presence and fault

enable

Enable SFP transmitter

disable

Disable SFP transmitter

mdio <reg>

Perform single read from MDIO register in SFP PHY

mdio <reg> <value>

Perform single write to MDIO register in SFP PHY

If no option given, formatted SFP information will be printed.

Description

tbc

See Also

- stats on page 118

in

Syntax: in PORT

Read a byte from an I/O port.

Description

Read a byte from an I/O port.

The PORT is a two-character value constructed as [cd][a-p]. The first character specifies if it is a data port (d) or a control port (c).

The data port is the actual data read from the port, while the control port defines which bits that are output and which that are input.

The second character defines which port is read from. Valid port values are a – p.

Ports a - j correspond to external GPIO ports

Ports k - p are internal.

Examples

Read the control register of port A

```
in ca
```

See Also

- out on page 108

ipconfig

Syntax: `ipconfig [IFACE] [OPTIONS]`

```
ipconfig all
```

Print/set the settings for the TCP/IP stack.

If no IFACE parameter specified, the command is applied to 'enet0'.

Options

-a ADDRESS

Specify the IP address.

-c

Commit changes to flash.

-d

Acquire an IP address through DHCP.

-e MAC

Set Ethernet MAC address.

-g GATEWAY

Specify the gateway address.

-h MAILHOST

Specify the mail host address.

-m SUBNETMASK

Specify the netmask.

-p DNS

Specify the primary DNS address.

-q DNS

Specify the secondary DNS address.

-r

Release DHCP address.

-t TIMEOUT

Specify the DNS timeout.

-u

Brings interface up without assigning IP address.

Description

Print/set the settings for the TCP/IP stack. Without any arguments the current settings are printed. Observe that the settings will only last for one session unless the -c flag is specified.

Several options can be given at the same time, but the order of the arguments is important. The order should be address, netmask, gateway, and then any others.

If the MAC parameter is omitted or invalid with the -e option, the MAC address for the selected interface will be returned to the factory programmed one. Still only volatilely, unless the -c flag is also used.

Examples

Show settings for all interfaces

```
ipconfig all
```

Acquire a DHCP address

```
ipconfig -d
```

Release a DHCP address

```
ipconfig -r
```

Set static ip address

```
ipconfig -a 192.168.1.127 -m 255.255.255.0 -g 192.168.1.1
```

Set static ip address and store it to flash

```
ipconfig -a 10.0.0.7 -m 255.0.0.0 -c
```

Set MAC address and store it to flash

```
ipconfig -e fc:af:6a:12:34:56 -c
```

Revert MAC address for enet1 back to factory setting

```
ipconfig -e -c
```

Store current settings to flash

```
ipconfig -c
```

See Also

25. Appendix 6: Environment Variable| system.ini

kill

Kill a thread.

Options

ID The identifier of the thread to terminate

Description

Kill a thread. Terminate a thread with the given ID.

CAUTION!! Using this command may lead to unstable system behavior.

Examples

Kill thread with ID 10

```
kill 10
```

See Also

- ps on page 111

ls

Syntax: `ls [OPTIONS] [DIRECTORY]`

List directory contents.

Options

-a

Also print files starting with '.'.

-l

Long output.

-R

Recursive output.

-F

Classify output.

Description

List directory contents. Without any arguments, the current directory will be listed.

Examples

List all files in the current directory

```
ls
```

List all files in the root directory

```
ls /
```

List all files in the file system

```
ls -R /
```

mkdir

Syntax: `mkdir DIR ...`

Create directory.

Description

Create directory. All items available on the command line will be created as directories.

Examples

Create a directory

```
mkdir foobar
```

See Also

mkrd

Syntax: `mkrd [OPTIONS] DRIVE`

Create a ramdisk.

Options

-f

Free an already created ramdisk

-s [SIZE]

Create a ramdisk with a specified size.

DRIVE

Drive number (A, B, ...).

Examples

Create a ramdisk and mount is as drive C

```
mkrd -s 100000 C
```

more

Syntax: `more FILE`

Show contents of a file.

Options

FILE

The file to view.

Description

Show contents of a file. The file will be shown one page at a time. Keyboard controls:

`Space`

Scroll down one page.

`Return`

Scroll down one row.

`Q`

Quit.

`1`

Rewind to line 1.

`Ctrl-C`

Quit.

Examples

View the contents of system.ini

```
more /system/system.ini
```

See Also

● cat on page 86 | ● hd on page 96| ● od on page 107

mount

Syntax: `mount DRIVE`

Mount FAT drive.

Options

DRIVE

The drive to mount (A, B, ...).

PATH

Where to mount the device.

Description

Mount FAT drive. Mount a FAT drive. For example an MMC or SD card.

Examples

Mount an MMC drive as volume D

```
mount D
```

See Also

● umount on page 119

mv

Syntax: `mv OLDNAME NEWNAME`

Move file.

Description

Move file. This also works for entire directories.

OLDNAME and NEWNAME must be on the same volume.

Examples

Move the file "foo" to file "bar"

```
mv foo bar
```

See Also

● cp on page 90

netstat

Syntax: `netstat`

Show information of current network connections.

Description

Show information of current network connections. It's not possible to alter any information through this command, it only shows the state.

Examples

Print network connection status

```
netstat
```

See Also

● debug on page 92| ● route on page 115

nslookup

Syntax: `nslookup HOST ...`

Resolve a hostname through DNS.

Options

HOST

The host to resolve.

Description

Resolve a hostname through DNS. Every item on the command line will be resolved, if the item is a dot notation IP address the hostname will be resolved. If the item is a hostname the IP address will be resolved.

Examples

Resolve the IP address of the host www.mycompany.com

```
nslookup www.mycompany.com
```

Resolve the name of the host 129.42.19.99

```
nslookup 129.42.19.99
```

od

Syntax: `od [OPTIONS] FILE ...`

Print contents of a file in octal.

Options

-c

Print printable characters, and the rest as numbers

Description

Print contents of a file in octal. 16 bytes will be printed on every line. The offset into the file will be printed in the leftmost column.

Examples

Look at the octal dump of system.gpx

```
od /system/system.gpx
```

See what non-printable characters system.ini contains

```
od -c /system/system.ini
```

See Also

● cat on page 86| ● hd on page 96| ● more on page 105

out

Syntax: `out PORT DATA`

Write a byte to an I/O port.

Options

PORT

The port to write to.

DATA

The value to write.

Description

Write a byte to an I/O port.

The PORT is a two character value constructed as [cd][a-p]. The first character specifies if it is a data port (d) or a control port (c).

The data port is the actual data written/read to/from the port, while the control port defines which bits that are output and which that are input.

The second character defines which port that is to be written to, valid values are a - p. Ports a - j correspond to external GPIO ports A - J, ports k - p are internal.

Examples

Make port C all outputs and output 0xaa on it

```
out cc 0xff;out dc 0xaa
```

Make port C all inputs

```
out cc 0
```

See Also

- in on page 101

passwd

Syntax: `passwd [USER]`

Change password for user.

Options

USER

The user to change the password for.

Description

Change password for user. A regular user can only change his/hers password, while root can change any users password.

Examples

Change my password

```
passwd
```

Change password for user "guest"

```
passwd guest
```

See Also

- useradd on page 121

pd

Syntax: `pd`

Print current drive.

Description

Print current drive. The current drive is stored in the PD variable.

Examples

Print current directory

```
pd
```

Print current directory

```
echo $PD
```

See Also

● pd on page 109 | ● cd on page 87

ping

Syntax: `ping`

Description:

Ping a node on the Internet.

Options

HOST

Either a host name or a dot notation ip address.

COUNT

The number of packets to send (default is 4).

Description

Ping a node on the Internet. The round trip time will be printed if a response is received.

Examples

Ping host

```
ping 192.168.1.1
```

Send many ICMP packets

```
ping 192.168.1.1 9999999
```

pll

Syntax: `pll [OPTIONS]`

Configure and control the pll.

Options

configure

Configure inputs, dspll’s and outputs.

control

Enable and disable inputs and outputs.

Description

For a detailed description of controlling the PLL see chapter 11.

Examples

Set input 1 to 10 MHz

```
pll config input 1 10m
```

Connect output 5 to DSPLL A

```
pll config output 5 dspllsrc a
```

ps

Syntax: `ps [OPTIONS]`

Show information about processes/threads.

Description

Show information about processes/threads. The following list describes the information found in each column:

1. **Priority**

The priority of the thread

2. **ID**

The unique number which identifies the thread.

3. **UID**

The ID of the user that created the thread.

4. **Type – C**

C runtime thread.

5. **tty**

The tty of the thread (for threads created within interactive login session).

6. **State**

The current execution state of the thread.

7. **Name**

A thread name/description.

Examples

Print all threads

```
ps -a
```

See Also

- kill on page 103

ptp2

Syntax: `ptp2 [OPTION]`

PTP version 2 protocol engine.

Options

start MODE

Starts PTP V2 engine in the following mode:

0 – GPS disabled, only PTP (master-slave);

1 – GPS reference only (master only), DEFAULT

2 – GPS primary, PTP secondary (master-slave)

3 – GPS secondary, PTP primary (master-slave)

stop

Stops PTP V2 engine.

config OPTIONS

Configures static parameters of PTP V2 Engine. If static parameters need to be changed, it should be done before starting the engine.

Options supported are:

(none)

Prints current configuration;

-v VALUE

vco control range, in ns/s (default 0)

-u VALUE

Voltage feedback, 1 - on, 0 - off (default 0).

-c VALUE

DCO control mask for PLL D, C respectively A. 1 – DCO control, 0 – No DCO control (default 001)

-d VALUE

vco static drift, in ns/s (default 0)

-t VALUE

slave main time constant, in sec (default 100)

-s VALUE

slave startup time constant, in sec, 0 - off (default 0)

-m VALUE

master main time constant, in sec (default 3)

-l VALUE

master startup time constant, in sec, 0 - off (default 0)

-p VALUE

path delay time constant, in sec (default 300)

-q VALUE

quality threshold, in ns, 0 - off (default 1500);

-e VALUE

square threshold, in ns, 0 - off (default 0).

-f VALUE

Minimize frequency change, 1 - on, 0 - off (default 0).

-n VALUE

Optimize for network type, generic, engineered or full on-path support (default generic).

Hmi

Enters the command processing mode of the PTP V2 engine. To print a list of available commands type "h" or "help". To leave the command processing mode and return to the shell type "q" or "quit".

COMMAND

Sends a command to the PTP V2 engine without entering the command processing mode.

Description

PTP version 2 protocol engine. This command can be used to start/stop the PTP protocol engine, and to set up a pulse train output. Commands can also be sent to the protocol engine's HMI interface. Try "ptp2 help" to print a list of available HMI commands.

The parameters to the pulse train are start time, length of the high phase of the period, length of the period and number of pulses. The first three are specified in seconds, the fourth is an integral number. If the start time is in the past, the pulse train will start with the first pulse that is in the future. If the count is set to zero, an infinite number of pulses are generated.

Examples

Turn on verbose loop control printouts from the engine

```
ptp2 engine debug on
```

```
ptp2 engine verbose 13
```

or

```
ptp2 e d on
```

```
ptp2e v 13
```

pwd

Syntax: `pwd`

Print current directory.

Description

Print current directory. The current directory is stored in the PWD variable.

Examples

Print current directory

```
pwd
```

Print current directory

```
echo $PWD
```

See Also

● pwd on page 113 | ● cd on page 87

reboot

Syntax: `reboot [OPTIONS]`

Reboot system.

Options

-h

Hang system (don't restart) after power down.

-f

Force reboot (don't require user to acknowledge reboot).

-q

Quick shutdown. Only do the most necessary before power down.

-r

Reboot system after power down (default).

-t TIME

Wait TIME seconds before shutdown.

Description

Reboot system. When -h is specified, the execution will stop and the red LED D300 will light up when the power down is complete.

The usage of this command is limited to the root user.

Examples

Reboot system, requiring an acknowledge

```
reboot
```

Reboot system, without asking any questions

```
reboot -f
```

Bring system down without rebooting

```
reboot -f –h
```

rm

Syntax: `rm [OPTIONS] FILE ...`

Remove file.

Options

-r Remove files recursively.

Description

Remove file. The files on the command line will be removed. If the -r option is available and a directory is present on the command line the directory and its contents will be removed recursively.

Examples

Remove foo.bar

```
rm foo.bar
```

Remove /root directory and contents recursively

```
rm -r /root
```

rmdir

Syntax: `rmdir DIR ...`

Remove directory.

Description

Remove directory. All directories available on the command line will be removed.

Examples

Remove directory

```
rmdir /root
```

See Also

● mkdir on page 104 | ● rm on page 114

route

Syntax: `route`

Print routing table information.

Description

Print routing table information. It's not possible to alter the routing information through this command. When debugging PPP connections this command may give additional information.

Examples

Print routing information

```
route
```

See Also

● debug on page 92 | ● netstat on page 106

setenv

Syntax: `setenv [NAME] [VALUE] ...`

Define an environment variable.

Options

NAME The variable name.

VALUE The variable value.

Description

Define an environment variable. Without any arguments all defined variables will be printed. If only one argument is available, the corresponding variable will be removed.

If two or more arguments are available, the first will be treated as the variable name and the rest will be the variable value.

Examples

Print all variables

```
setenv
```

Clear the value of the HOME variable

```
setenv HOME
```

Reconfigure your HOME

```
setenv HOME /system
```

sleep

Syntax: `sleep SECONDS`

Make process sleep.

Description

Make process sleep. Delay execution of the current process for the specified time. Useful primarily in scripts.

Examples

Sleep for 10 seconds

```
sleep 10
```

source

Syntax: `source FILE`

Execute the contents of a file.

Description

Execute the contents of a file. The contents of FILE will be read and every line will be interpreted as an ish (shell) command and executed.

Another way to achieve this functionality is to set the execute bit of the script file (with chmod) and simply type its name. There is no PATH variable, so the absolute path to the script must be specified or standing in the same directory as the script will also work.

Examples

Execute the contents of /system/startup.ini

```
source /system/startup.ini
```

Execute the contents of /system/startup.ini

```
cd /system;chmod 733 startup.ini;startup.ini
```

See Also

- chmod on page 88

startserver

Syntax: `startserver [OPTIONS]`

Start firmware servers.

Options

-s Start the serial server.

-t Start the telnet server.

-f Start the FTP server.

-d Start the SSH server.

Description

Start firmware servers. The corresponding server will be started (if not already running). The configuration will be read from the system.ini file.

Examples

Start serial and telnet servers

```
startserver -s -t
```

See Also

● stats on page 118|● startserver on page 117|system.ini

25. Appendix 6: Environment Variable

stats

Syntax: `stats [OPTIONS]`

Show information/statistics about the system.

Options

-b Show build date.

-c Show C heap information.

-d Show disk usage information.

-h Show hardware version information.

-f Show firmware version information.

-n Show software version information.

-r Show when system was rebooted.

-s Show server information.

-u Show uptime information.

-v Show version information (same as -h -f -n).

-w Show disk wear information.

Description

Show information/statistics about the system. By default all information will be shown.

Examples

Show uptime and version information

```
stats -v -u
```

See Also

● df on page 93

stopserver

Syntax: `stopserver [OPTIONS]`

Stop firmware servers.

Options

-s Stop the serial server.

-t Stop the telnet server.

-f Stop the FTP server.

-d Stop the SSH server.

Description

Stop firmware servers. The process that receives incoming calls will be killed. Already running sessions will not be terminated, these sessions will end when the user logs off.

Examples

Stop all servers

```
stopserver -s -f -t
```

See Also

● startserver on page 117| ● stats on page 118

su

Syntax: `su [USER]`

Become another user.

Options

USER The user to become.

Description

Become another user. If no user is specified on the command line, root is assumed. If the current user is root, "su" won't prompt for the new user's password.

Examples

Become root

```
su
```

Become "guest"

```
su guest
```

touch

Syntax: c

Update time stamp of a file.

Options

FILE The file to update.

Description

Update time stamp of a file. The "last modified" time stamp of the file(s) will be set to the current time.

Examples

Change time stamp of system.ini

```
touch /system/system.ini
```

umount

Syntax: `umount DRIVE`

Unmount a drive.

Options

DRIVE The drive to unmount.

Description

Unmount a drive. The DEVICE must be a device node such as: /dev/mmca0.

Examples

Unmount drive C

```
umount C
```

See Also

- mount on page 106

unalias

Syntax: `unalias ALIAS ...`

Remove an alias definition.

Options

ALIAS The alias to remove.

Description

Remove an alias definition. All arguments on the command line will be treated as aliases and attempted to be removed.

Examples

Remove alias for "ls"

```
unalias ls
```

See Also

● alias on page 86 | ● setenv on page 115

update

Syntax: `update [OPTIONS] [HOST] PATH`

Update the firmware through TFTP or FTP.

Options

-t TIMEOUT

Receive data timeout in milliseconds. Default is 10000 ms.

-f USER:PASSWORD

Username and password if HOST is an FTP server.

HOST

Can either be a hostname or a dot notation IP address.

PATH

The path on the TFTP or FTP server.

Description

Update the firmware through TFTP or FTP. This is an alternative way to update the firmware. The file to download must be a valid .snp or .snp2 file. Before starting the updating procedure, a "magic" number will be checked in the downloaded file, if the magic number is bad the update will halt.

While downloading the file there will be no output to the terminal (such as a progress bar). The downloading takes about 30 seconds (depending on network load).

If HOST is omitted, FILE is assumed to be on the local file system. In this case, the full path must be specified.

Examples

Fetch a myupdate1.snp file from a server

```
update 192.168.1.9 /myupdate1.snp
```

Update from local file myupdate2.snp

```
update A:/root/myupdate2.snp
```

useradd

Syntax: `useradd [OPTIONS] USER`

Add a user to the user database.

Options

-d DIR The users home directory.

-u UID The user ID (numeric).

-g GID The group ID (numeric).

-s SHELL The shell.

-c COMMENT A comment.

Description

Add a user to the user database. By default the user will be assigned the next ID in sequence and the GID for the user group.

If not specified, the home directory for the user will be left empty.

The SHELL field isn't used at all on the system, this is only available to be compatible with other systems. The COMMENT field is simply comment in the passwd.ini file.

Examples

Add user "ford" to the user database

```
useradd ford
```

See Also

● userdel on page 121| passwd.ini| group.ini

userdel

Syntax: `userdel USER`

Remove a user from the user database.

Description

Remove a user from the user database. Removes the user from the passwd.ini file.

Examples

Remove user "ford" from the user database

```
userdel ford
```

See Also

● useradd on page 121 | passwd.ini

wall

Syntax: `wall [OPTIONS]`

Send message to all users.

Options

-n Suppress the automatic header that normally is sent.

Description

Send message to all users. This command works like the write command, but with the difference that the message is sent to all logged in users.

Examples

Send message to all logged in users

```
wall
```

See Also

- write on page 123

who

Syntax: `who`

Show a list on logged in users.

Description

Show a list on logged in users. The list will contain information about all logged in users.

The user name, the controlling tty and the time of login.

Examples

Show who are logged on

```
who
```

Show who I am

```
who am i
```

write

Syntax: `write USER [TTY]`

Send message to a specific user.

Options

USER The user who should receive the message.

TTY If the user is logged in with several sessions, this option chooses which tty to send the message to.

Description

Send message to a specific user. Each line will be sent to the receiving user when return is pressed. The message will end Send message to a specific user. Each line will be sent to the receiving user when return is pressed. The message will end when the sequence 'CR', '.', 'CR' is read from the keyboard.

Examples

Send a message to user "guest"

```
write guest
```

Send a message to user "guest" who is logged in at several ttys, among them tty3

```
write guest tty3
```

See Also

● wall on page 122 | ● who on page 122

22. Appendix 3: PTP Command Reference

All commands can be issued by a user from a serial terminal or a telnet session. The output from any command is redirected to the output device it was issued from.

In contrast to commands, the debug output can have only one output device. So enabling it on one device (or in one session) will automatically disable it on another.

PTP Commands

ptp2 start

```
ptp2 start <mode> <option>
```

Starts PTP Engine in the following mode:

0 – GPS disabled, only PTP (master-slave),

1 – GPS reference only (master only). Default mode,

2 – GPS primary, PTP secondary (master-slave),

3 – GPS secondary, PTP primary (master-slave),

4 – GPS debug.

Supported options are:

--silent: no unsolicited console output until HMI debug is turned on

ptp2 stop

```
ptp2 stop
```

Stops PTP Engine.

ptp2 hmi

```
ptp2 hmi
```

Enters the HMI command processing mode.

To quit the HMI command processing mode type q.

ptp2 config

```
ptp2 config <options>
```

Configures oscillator and loop control related static parameters. Configuration options are:

-v [value] – VCO control range, in ns/s (default 0),

-c [mask] – control DCO-enabled DSPLLs, mask specifies DSPLL to control

1.. - DSPLL D
.1. - DSPLL C
..1 - DSPLL A
000 – off
default: 001 - DSPLL A only

-u [1|0]: voltage feedback, 1 - on (default 0)

-d [value] – VCO static drift, in ns/s (default 0),

-t [value] – slave main time constant, in sec (default 100),

-s [value] – slave startup time constant, in sec, 0 - off (default 0),

-m [value] – master main time constant, in sec (default 3),

-l [value] – master startup time constant, in sec, 0 - off (default 0),

-p [value] – path delay time constant, in seconds (default 300),

-q [value] – quality threshold, in ns, (default 1500),

-e [value] – square threshold, in ns, 0 - off (default 0).

-f [0|1] – minimize frequency change, 1 – on, 0 – off (default 0).

-n [g|e|f] – optimize for either generic (‘g’), engineered (‘e’) or full on-path support (‘f’) network (default ‘g’).

ptp2

```
ptp2 <command>
```

Sends a single HMI command to the PTP Engine.

HMI Commands

The HMI command set is a part of the PTP Protocol implementation. They can be issued either directly from the HMI processing mode or through the ptp2 prefix from the ISH command prompt.

At the prompt, you can type either `hmi` or `help`:

```
A:/root>ptp2 hmi
```

or

```
A:/root> ptp2 help
```

Each command and subcommand has its short form or alias (given in parentheses in front of each command). An alias can be used in the same manner as full form of command.

For example:

```
A:/root>ptp2 hmi
```

or

```
A:/root> ptp2 h
```

Clock Commands

clock

Print the list of clock subcommands.

```
(c)clock
```

clock info

Prints clock description.

```
(c)clock (i)info
```

clock user

Change user description.

```
(c)clock (u)user <string>
```

With this command it is possible to change "user description" "product description", "revision data" and mfg OUI. `<string>` is defined as:

```
<user description> | prod <company> <product> <identifier> | rev <hw_ver> <fw_ver> | mfg <oui>
```

See the following table for the mapping of these fields to IEEE 1588 TLV fields. All of these can be viewed/confirmed with the ptp2 clock info command.

Field	IEEE 1588 TLV	Length (bits)	Description
<User description>	userDescription	Max: 128	A user defined name

Field	IEEE 1588 TLV	Length (bits)	Description
<Company> <Product> <Identifier>	productDescription	Max 64	The <company>,<product>, and <Identifier> are concatenated with a ";" separator to form the productDescription. If either <Product> or <Identifier> are omitted, the default system values will be used.
<hw_Ver> <fw_ver>	revisionData	Max 32	These two fields, plus the internal software version information form the PTP field < revisionData> with ";" separators.
<oui>	clockIdentity	64	This is the manufacturer's owned OUI. Please refer to IEEE 1588 sections 7.5.2.2.2 and 7.5.2.2.3.

If any of the text phrases has a space, the phrase must be enclosed in quotes.

clock profile

Change clock profile.

```
(c)clock (f)profile <default|g8265|g8275.1|g8275.2|power [v2]>
```

Changing the clock profile will set the clock and all ports to work according to the specified profile. Use this command rather than the port profile command for proper operation according to the desired profile.

clock mode

Change clock mode.

```
(c)clock (m)mode <oc | bc>
```

clock twostep

Change twostep mode.

```
(c)clock (t)twostep <on | off>
```

clock quality

Change clock quality.

```
(c)clock (q)quality <class> <accuracy> <variance>
```

clock priority

Change priority 1 or 2.

```
(c)clock (p)priority 1 | 2 <value>
```

clock domain

Change domain number.

```
(c)clock (d)domain <number>
```

clock slaveonly

Change slave-only mode.

```
(c)clock (s)slaveonly <on | off>
```

Port Commands

port

Print the list of port subcommands.

```
(p)port <port_number>
```

port state

Print port state.

```
(p)port <port_number> (s)state
```

port mechanism

Change or disable delay mechanism.

```
(p)port <port_number> (m)mechanism <e2e | p2p | disable>
```

port protocol

Change network protocol.

```
(p)port <port_number> (p)protocol <udp | eth | udp6>
```

port compatibility

Change V1 HW compatibility mode.

```
(p)port <port_number> (c)compatibility <on | off | auto <timeout>>
```

port asymmetry

Change delay asymmetry. Value is expressed in seconds.

```
(p)port <port_number> (a)asymmetry <value>
```

port sync

Change log sync interval.

```
(p)port <port_number> (si)sync <value>
```

port delay

Change min log delay request interval.

```
(p)port <port_number> (di)delay <value>
```

port pdelay

Change min log pdelay request interval.

```
(p)port <port_number> (pi)pdelay <value>
```

port announce

Change log announce interval.

```
(p)port <port_number> (ai)announce <value>
```

port receipt

Change announce receipt timeout.

```
(p)port <port_number> (rt)receipt <value>
```

port unicast

Enable unicast operation.

```
(p)port <port_number> (u)unicast <master | slave | disable>
```

port profile

Change PTP profile for the specified port. For proper operation, use the same profile on both ports, in which case it’s more convenient to use the clock profile command.

```
(p)port <port_number> (f)profile <default|g8265|g8275.1|g8275.2|power [v2]>
```

port dscp

Differentiated Services Code Point in PTP messages.

```
(p)port <port_number> (d)dscp <value>
```

Unicast Commands

See 14.6 Unicast Operations for more details.

unicast

Print the list of unicast subcommands.

```
(u)unicast <port_number>
```

unicast status

Print unicast port status information.

```
(u)unicast <port_number> (s)status
```

unicast negotiation

Change unicast negotiation state.

```
(u)unicast <port_number> (n)negotiation <on|off>
```

unicast node

Change master discovery table or static slave table.

```
(u)unicast <port_number> node (m)master [add|del] <address> [cid] <pri> <si> <di|x> [domain]
```

or

```
(u)unicast <port_number> node (s)slave [add|del] <address> <ai> <si> <di|x>
```

unicast query

Change unicast discovery query interval.

```
(u)unicast <port_number> (q)query <value>
```

unicast duration

Change unicast transmission duration.

```
(u)unicast <port_number> (d)duration <value>
```

unicast timeout

Change cancel acknowledge receipt timeout.

```
(u)unicast <port_number> (t)timeout <value>
```

unicast limit

Change total unicast messages rate limit.

```
(u)unicast <port_number> (l)limit <value>
```

unicast filter master

Change master acceptance filter.

```
(u)unicast <port_number> (f)filter (m)master [add|del] <address|*> [cid] [x|priority][si][di|x]]
```

unicast filter slave

Change slave acceptance filter.

```
(u)unicast <port_number> (f)filter (s)slave [add|del] <address|*> [cid] [x|[ai][si][di|x]]
```

Power Profile Commands

Before using these commands, set the clock to power profile using the clock profile command.

```
(c)clock (f)profile power [v2]
```

power

Print the list of power profile subcommands.

```
(pw)power
```

power gmid

Change the grandmaster ID.

```
(pw)power (g)gmid <0..65535>
```

power gmid

Change grandmaster and network time inaccuracy (in ns).

```
(i)inacc <grandmaster> <network>
```

G.8265 Profile Commands

Before using these commands, set the clock to G.8265 profile using the clock profile command.

```
(c)clock (f)profile g8265
```

g8265

There are no profile-specific parameters to configure for G.8265.

```
(g1)g8265
```

G.8275.1 and G.8275.2 Profile Commands

Before using these commands, set the clock to G.8275.1 or G.8275.2 profile using the clock profile command.

```
(c)clock (f)profile g8275.1
```

or

```
(c)clock (f)profile g8275.2
```

g8275

Print the list of G.8275 profile subcommands.

```
(g2)g8275
```

g8275 priority

Change clock local priority.

```
(g2)g8275 (p)priority <1..255>
```

g8275 steps removed

Change max steps removed.

```
(g2)g8275 (s)steps <1..255>
```

g8275 port priority

Change port local priority.

```
(g2)g8275 <port_number> (p)priority <1..255>
```

g8275 port masteronly

Turn master-only attribute on or off.

```
(g2)g8275 <port_number> (m)masteronly <on|off>
```

Dataset Commands

dataset

Print the list of dataset subcommands.

```
(d)dataset
```

dataset default

Print default dataset.

```
(d)dataset (d)default
```

dataset current

Print current dataset.

```
(d)dataset (c)current
```

dataset parent|master

Print parent dataset.

```
(d)dataset (m)parent | master
```

dataset time

Print time properties dataset.

```
(d)dataset (t)time
```

dataset port

Print port dataset.

```
(d)dataset (p)port <port_number>
```

dataset foreign

Print the list of foreign master datasets.

```
(d)dataset (f)foreign <port_number>
```

dataset unicast

Print the list of unicast master/slave node datasets.

```
(d)dataset (u)unicast <port_number>
```

dataset power

View the profile-specific values obtained by a slave from its master

```
(d)dataset (pw)power
```

dataset g8265

Print G.8265 profile dataset.

```
(d)dataset (g1)g8265
```

dataset g8275

Print G.8275 profile default dataset.

```
(d)dataset (g2)g8275
```

dataset g8275 port

Print G.8275 profile port dataset.

```
(d)dataset (g2)g8275 <port_number>
```

Time Commands

time

Print the list of time subcommands.

```
(t)time
```

time info

Print time information.

```
(t)time (i)info
```

time sync

Print synchronization status.

```
(t)time (s)sync
```

time ptp

Change time of the PTP clock.

```
(t)time ptp <YYYY-MM-DD HH:MM:SS.NNNNNNNNN>
```

The time parameter should represent the PTP (TAI) time in date-time format. If the time parameter is missing the command prints current time in the same format.

When the clock is synchronizing with either a PTP master or with a GPS/GNSS time this command will have no effect.

time arb

Change time of the PTP clock.

```
(t)time arb <+/-SSSSSSSSS.NNNNNNNNN>
```

The time parameter should represent the PTP (TAI) time in seconds-nanoseconds format. If the time parameter is missing the command prints current time in the same format.

When the clock is synchronizing with either a PTP master or with a GPS/GNSS time this command will have no effect.

time utc

Change time of the PTP clock.

```
(t)time utc YYYY-MM-DD HH:MM:SS.NNNNNNNNN
```

The time parameter should represent the UTC time in date-time format. Then it converts the received time to the PTP (TAI) time using the UTC offset value configured locally and sets the time of the clock. If the parameter is missing the command prints current time converted to UTC.

When the clock is synchronizing with either a PTP master or with a GPS/GNSS time this command will have no effect.

time ntp

Change time of the PTP clock.

```
(t)time ntp <server>
```

This command obtains the current time and leap second indicators from an NTP server specified by its name or IP address. Then it converts the received time to the PTP (TAI) time using the UTC offset value configured locally and sets the time of the clock. If the parameter is missing the command prints current time converted to UTC.

When the clock is synchronizing with either a PTP master or with a GPS/GNSS time this command will have no effect.

time scale

Change timescale.

```
(t)timescale <ptp | arb>
```

time offset

Change UTC offset.

```
(t)time (o)offset <value>
```

time leap

Change leap second indications.

```
(t)time (l)leap 59|61 <0 | 1>
```

Print UTC leap table or save/load it into/from file.

```
(t)time (l)leap <save | load>
```

All scheduled leap seconds are stored in the leapsec.ini file in the /system directory on the target system.

time update

Keep system RTC in sync with clock time.

```
(t)time (u)update <on | off>
```

time holdover

Change holdover interval.

```
(t)time (h)holdover <interval>
```

Frequency commands

freq

Print the list of frequency subcommands.

```
(f)freq
```

freq status

Print frequency status.

```
(f)freq (s)status
```

freq option

Change frequency option.

```
(f)freq (o)option <opt1|opt2>
```

This setting should correspond to the bandwidth setting made on DSPLL A.

freq ref

Change reference oscillator QL.

```
(f)freq (r)ref <ql>
```

freq input synce

Input is from SyncE port. Always subject of autoselection by QL.

```
(f)freq (i)input <1..3> synce <port_number>
```

freq input ext

Input is from external source of specified QL NOTEREF _Ref13820001 \f \h [2].

```
(f)freq (i)input <1..3> ext <ql> [auto](f)freq (p)prefer <input|ref>
```

SyncE commands

synce

Print the list of synce subcommands.

```
(se)synce
```

synce status

Print SyncE port status.

```
(se)synce <port_number> (s)status
```

synce esmc

Enable/disable ESMC.

```
(se)synce <port_number> (e)esmc <enable|disable>
```

synce quality

Change input/output quality level NOTEREF _Ref13820001 \f \h 2.

```
(se)synce <port_number> (q)quality in|out auto|<ql>
```

GPS Interface Commands

gps

Note: The command is `gps`, but applies equally to GPS or GNSS receivers.

Print the list of GPS Interface subcommands.

```
(g)gps
```

gps status

Print the GPS Interface status and configuration.

```
(g)gps (s)status
```

gps nmea

Print NMEA position/satellites information.

```
(g)gps (n)nmea
```

gps ppsin

Enable PPS-input signal reception.

```
(g)gps (p)ppsin <enable | disable>
```

gps todin

Enable TOD-input signal reception.

```
(g)gps (t)todin <enable | disable>
```

gps todin

Change non-present or invalid TOD-in handling.

```
(g)gps (t)todin <required|optional>
```

The presence of a valid TOD-input is required by default for the system to synchronize to the PPS/TOD-input and to become a GPS/GNSS-based master. To make the TOD-input optional, i.e. to allow the system to synthonize to the PPS-input use gps todin optional. This affects the behavior of the NMEA RMC Void flag handling (see gps void). If configured to 'synthonize' while the syntonization is now allowed, the result will be the same as 'holdover', i.e. TOD-input is considered invalid and the system goes to holdover.

gps delay

Change PPSIN cable delay compensation. Value is expressed in nanoseconds.

```
(g)gps (d)delay <value>
```

gps format

Change TOD-input format.

```
(g)gps (f)format <nmea | ascii | cm>
```

gps void

Changes NMEA RMC void flag handling.

```
(g)gps (v)void <ignore | syntonize | holdover>
```

gps interface

Change TOD-input interface.

```
(g)gps (i)interface <default | com[n]> <baudrate>
```

gps class

Change clock class mapping.

```
(g)gps (c)class <active> <holdover> <free>
```

It is possible to set the clock class mapping for holdover and free-running states to 255. This will make the system to stop being the master even if no better clock available to prevent distributing its time/freq to slave-only clocks which may present on the network. This feature makes sense in mode 1 only.

gps message

Send message to GPS receiver via TOD interface.

```
(g)gps (m)message <string>
```

`<string>` may be:

- NMEA ASCII command, starting with a $ and enclosed in single quotes (')
- Binary string, encoded in hexadecimal (upper or lower case), starting with 0x, spaces maybe added. The message is converted to binary and sent as is, no adding of checksum, <CR>, <LF>, and so on.

Examples

`ptp2 g m 0x010203aabb` will send the binary bytes 0x01, 0x02, 0x03, 0xAA, 0xBB

`ptp2 g m "0x010203 AABB"` will send the binary bytes 0x01, 0x02, 0x03, 0xAA, 0xBB

`ptp2 g m "0x1 2 3 aa bb"` will send the binary bytes 0x01, 0x02, 0x03, 0xAA, 0xBB

PPS/TOD-Output Interface Commands

pulsetime

Print the list of PPS/TOD-output Interface subcommands.

```
(pt)pulsetime
```

pulsetime status

Print the PPS/TOD-output status and configuration.

```
(pt)pulsetime (s)status
```

pulsetime pulse

Change PPS-output pulse parameters. Period and width are expressed in microseconds (μs).

```
(pt)pulsetime (p)pulse <period> <width>
```

pulsetime delay

Change TOD-output delay.

```
(pt)pulsetime (d)delay <value>
```

pulsetime format

Change TOD-output format.

```
(pt)pulsetime (f)format <nmea | ascii | cm>
```

pulsetime void

Change NMEA RMC Active/Void flag behavior.

```
(pt)pulsetime (v)void <never | free | holdover>
```

pulsetime zone

Change NMEA ZDA timezone/daylight field.

```
(pt)pulsetime (z)zone <none | tz | dst>
```

pulsetime interface

Change TOD-output interface.

```
(pt)pulsetime (i)interface <default | com[n]> <baudrate>
```

pulsetime todout

Enable TOD-output.

```
(pt)pulsetime (t)todout <enable | disable>
```

pulsetime mode

Change PPS/TOD-output mode.

```
(pt)pulsetime (m)mode <1 | 2 | 3>
```

pulsetime error

Change PPS/TOD-output error tolerance.

```
(pt)pulsetime (e)error <value>
```

pulsetime autor

Turn on/off automatic restart.

```
(pt)pulsetime (a)auto <on | off>
```

pulsetime start

Start PPS/TOD-output.

```
(pt)pulsetime start <YYYY-MM-DD HH:MM:SS.NNNNNNNNN> <count>
```

pulsetime stop

Stop PPS/TOD-output.

```
(pt)pulsetime stop
```

pulsetime cm

Change clock class to CM status mapping.

```
(pt)pulsetime cm <class> <status>
```

If no parameters are given, the current mapping is printed.

SNTP Server Commands

nettime

Print the list of SNTP server subcommands.

```
(nt)nettime
```

nettime status

Print the SNTP server status and configuration.

```
(nt)nettime (s)status
```

nettime mode

Change the SNTP server mode.

```
(nt)nettime (m)mode <1..4>
```

1 = unicast, 2 = manycast, 3 = broadcast, 4 = mixed

nettime poll

Change poll/broadcast interval.

```
(nt)nettime (p)poll <1..64>
```

nettime start

Start the SNTP server.

```
(nt)nettime start
```

nettime stop

Stop the SNTP server.

```
(nt)nettime stop
```

Engine Commands

engine

Print the list of engine subcommands.

```
(e)engine
```

engine init

Reinitialize clock. Currently not supported.

```
(e)engine (i)init default | nvm
```

engine port

Change port operational status.

```
(e)engine (p)port enable | disable
```

engine esmc

Enable ESMC message transmission.

```
(e)engine (e)esmc <port_number> <auto |0..15 | off>
```

Please note this command is for backwards compatibility only. Use the SyncE commands instead See section 14.7 SyncE Operations.

engine esmc map

Change clock class to SSM code mapping.

```
(e)esmc map <class> <ssm>
```

If no parameters are given, the current mapping is printed.

Note this command is for backwards compatibility only. Use the SyncE commands instead. See section 14.7 SyncE Operations.

engine nvm

Change configuration in non-volatile storage. Currently not supported.

```
(e)engine (n)nvm save | reset
```

engine debug

Turns on/off debug output.

```
(e)engine (d)debug <on | off>
```

engine verbose

Change verbose level for debug output.

```
(e)engine (v)verbose <level>
```

Note that for modules with HW assisted message processing (Turbo), e.g. M88, verbose level 8 will only show announce messages.

engine monitor

Enable clock monitor program.

```
(e)engine (m)monitor <off | on <port>>
```

engine freqout

Selects frequency on the FREQOUT pin.

```
(e)engine (f)freqout <5 | 10 | 20 | 25>
```

engine asymmetry

Change PHY asymmetry compensation. Value is expressed in nanoseconds.

```
(e)engine (a)asymmetry <value>
```

LOCK Command

lock

Use the PF3/LOCK pin to indicate the lock state of the PTP servo.

`(l)lock (p)pin <enable|disable>`: Enable/disable lock indicator. The default is disable.

`(l) lock (s)status`: Lock indicator status

`(l) set <auto|<error> <slope>>`: Change set conditions. The default is auto.

`(l) lock clear <auto|<error> <slope>>`: Change clear conditions. The default is auto.

23. Appendix 4: Troubleshooting LED Error Codes

This section explains the behavior of the green LED (D102) on the M88 module and how to troubleshoot a problem encountered. The LED signals an error condition at boot up, if the boot loader cannot load a valid executable. The error code is a number of green pulses, then a slightly longer delay, then the error code, etc.

Number of Pulses	Description
2	The boot loader can't find a valid file system on the flash. Solution: Try to reformat the flash.
3	Error initializing the flash or error reading a page from the flash. Solution: Try to reformat the flash.
4	Error reading boot sectors. Solution: Try to reboot.
5	Malloc error for some reason. malloc() returned a NULL pointer. Solution: Try to reboot.
6	The /system/system.gpx file can't be read Solution: Try to reboot.
7	The /system/system.gpx file can't be found. Solution: Try to reboot.
8	Error reading data from the serial port. Solution: Try to reboot.
9	Can't find /system/boot.ini Solution: Try to reboot.
10	Can't read /system/boot.ini Solution: Try to reboot.
11	/system/boot.ini has bad format

24. Appendix 5: Command Shell Limitations

There are a number of limitations to the command shell:

1. There is no possibility to redirect input/output.
2. stdout and stderr are identical.
3. The checking of file permissions (read/write) is only done in some cases so it may be possible to overwrite a file by accident.
4. The command line length is limited to 200 characters, and can only contain a maximum of 29 arguments.
5. It is only possible to have 10 simultaneously interactive shells.
6. Command line flags can't be bundled.

25. Appendix 6: Environment Variable

The system contains a number of predefined environment variables. These variables can be set in configuration files that are read and parsed at boot time and when logging on to the system.

Predefined Environment Variables

The following table lists the predefined environment variables. Some of the variables are configuration variables and effects the system. These variables can be set in system.ini. Others only effects the logon session and they can be set in ish.ini and _ish.ini.

Most of the variables can be changed through shell commands. If a variable in system.ini is changed by hand, the system must be rebooted to make the changes take effect.

All TCP/IP settings can be altered through the ipconfig command, which won't require a reboot

Name	File	Description
?	N/A	The return value from the latest command. A return value of zero is a successful return, while a value != zero indicates an error.
DAYLIGHT	system.ini	Defines how the daylight saving is used. See DAYLIGHT for a description.
DEBUG	system.ini	Sets the initial debug level. If the value is zero, or the variable doesn't exist at all, debugging is disabled (can be enabled by hand by using the debug command). The higher the number is, the more verbose the output will be.
FTP	system.ini	Defines if the FTP server should be enabled or disabled at boot time. Possible values: enable or disable. Default is enable. To manually start or stop the FTP server use the startserver and stopserver commands.
FTP_CMD_PORT	system.ini	Defines TCP port number for FTP control channel. Default value is 21.
FTP_DATA_PORT	system.ini	Defines TCP port number for FTP data channel. Default value is 20.
FTP_PRIO	system.ini	Defines the priority of the FTP server. Default value is 104. The priority of each FTP session will be the FTP server's priority + 1.
GID	N/A	The users group id according to group.ini. This variable will reflect the current user.
HOME	N/A	The user's home directory. Read from passwd.ini. This is what the current directory will be when executing cd without any arguments. This is also the starting directory for every login session. If the directory doesn't exist the staring directory will be set to /.
LOGIN_TIMEOUT	system.ini	The number of seconds before automatically logging out. Set to zero to disable. This variable defines the timeout for both Telnet and FTP sessions. Default is 900 seconds (15 minutes).
MAC_ADDRESS	system.ini	The Ethernet MAC address, such as fc:af:6a:12:34:56. If this environment variable is not set, the MAC address will be the factory programmed one.
MAC_ADDRESS_SEC	system.ini	The Ethernet MAC address for the secondary interface. If this environment variable is not set, the MAC address will be the factory programmed one.
PS1	ish.ini, $HOME/.ish.ini	The prompt to use. Default is "> ". Other popular settings might be: setenv PS1 "\$PD:\$PWD> " setenv PS1 "\$USER:\$PWD> "

Name	File	Description
PWD	N/A	The current directory.
ROWS	ish.ini, $HOME/.ish.ini	Specifies the number of rows in a terminal window.
SERIAL	system.ini	Defines the state of the serial server at boot time. Possible values: enable or disable. Default is enable. To manually start or stop the serial server use the 21. Appendix 2: System CLI Commands and 21. Appendix 2: System CLI Commands commands.
SERIAL_LOGIN	system.ini	Set to enable if logging in via the serial port should require a username and password. Possible values are enable or disable. Default is enable. It is recommended to keep this set to enable.
SERIAL_PORT	system.ini	The port that the serial server should use. Possible values: COM[1-4]. Default is COM1.
SERIAL_SPEED	system.ini	The speed of the serial port. Numeric value of the baud rate, such as 9600, 19200 etc. Default is 115200.
SSH	N/A	Unlike other servers the SSH server can only be started manually using 21. Appendix 2: System CLI Commands command.
SSH_PRIO	system.ini	Defines the priority of the SSH server. Default value is 104. The priority of each SSH session will be the SSH server's priority + 1.
SSH_PORT	system.ini	Defines TCP port number for SSH server. Default value is 22.
TCPIP_ADDRESS	system.ini	The IP address. May be one of the following values: Static ip, such as 192.168.1.222 The string "dhcp" which indicates the use of DHCP. The special value 255.255.255.255 which also indicates the use of DHCP. The string "disable" disables all TCP/IP communication. The string "enable" enables TCP/IP communication, but doesn't initialize the Ethernet interface. By default an address is will be acquired through DHCP. If a DHCP request fails the system will fall back to a zero configuration scheme.
TCPIP_PRIM_DNS	system.ini	The DNS in dot notation. Set to 0.0.0.0 to disable the use of DNS. If the IP address is acquired through DHCP and the DHCP server supplies a DNS server, the DNS will be set to the value fetched via DHCP.
TCPIP_SEC_DNS	system.ini	The DNS in dot notation. Set to 0.0.0.0 to disable the use of a secondary DNS. This value will not be set by the DHCP client.
TCPIP_SEC_TO	system.ini	The DNS timeout in seconds. Set to 0 to disable timeout. Default is 10 seconds.
TCPIP_GATEWAY	system.ini	The gateway in dot notation. Set to 0.0.0.0 to disable. For DHCP configured systems this will be supplied by the DHCP server.
TCPIP_MAILHOST	system.ini	The mail host in dot notation. Set to 0.0.0.0 to disable. If this value is to be used it must be set explicitly, it is not acquired via DHCP for DHCP configured systems.
TCPIP_NETMASK	system.ini	The netmask in dot notation. For DHCP configured systems this will be supplied by the DHCP server.

Name	File	Description
TELNET	system.ini	Defines the state of the TELNET server at boot time. Possible values: enable or disable. Default is enable. To manually start or stop the TELNET server use the startserver and stopserver commands.
TELNET_PORT	system.ini	Defines the TCP port number for the TELNET server. Default value is 23.
TELNET_PRIO	system.ini	Defines the priority of the TELNET server. Default value is 104. The priority of each TELNET session will be the TELNET server's priority + 1.
TERM	ish.ini, $HOME/.ish.ini	Specifies terminal emulation. Could be set to vt100 or DUMB.
TIMEZONE	system.ini	The time zone. See DAYLIGHT for a description.
UID	N/A	The user’s id according to passwd.ini. This variable will reflect the current user.
USER	N/A	The user’s name, taken from the login.

26. Appendix 7: Clock Setup

This section describes how to set up the system time and date including time zones and daylight saving.

Time Zones, Daylight Savings, and Setting the Clock

Introduction

To make the clock work correctly these things must be set up:

Time zone

Daylight saving

Set time (manually or via NTP)

The following sections describe how this is done.

Time Zones

The time zone is configured either by editing the system.ini file or by executing the date -z command (which will alter the system.ini file for you). The whole time zone concept is based on the environment variable TIMEZONE defined in the system.ini file. This variable can either have a valid three-letter abbreviation from the list below or a numeric value specifying the offset from GMT in hours. Note that half-hour offsets must be written as "3.5", not "3:30".

The TIMEZONE variable can also be entered as a string like "PST-8PDT". In that case, the number in the middle specifies the offset, the string before it the abbreviation for the standard time zone, and the string after it the abbreviation for the time zone during daylight saving time. Neither abbreviations nor offset need to be in the list, abbreviations can be longer than three letters.

Valid Abbreviations

The following table lists all available time zones on the system. It can also be printed with the date -p command. When there are more than one abbreviation for a time zone, the one listed first will be used by the date command to display the time.

Offset	Abbreviation	Description
-11	MIT	Samoa
-10	HST	Hawaii
-9	AST	Alaska
-8	PST	Pacific Standard Time
-7	MST,PNT	Mountain Standard Time
-6	CST	Central Standard Time
-5	EST,IET	Eastern Standard Time
-4	PRT	Atlantic Standard Time
-3.5	CNT	Newfoundland
-3	AGT,BET	Eastern South America
0	UTC,GMT,WET	Coordinated Universal Time
+1	ECT	European Central Time
+2	EET,CAT,ART	European Eastern Time
+3	EAT	Saudi Arabia
+3.5	MET	Iran
+4	NET	
+5	PLT	West Asia
+5.5	IST	India
+6	BST	Central Asia

Offset	Abbreviation	Description
+7	VST	Bangkok
+8	CTT	China
+9	JST	Japan
+9.5	ACT	Central Australia
+10	AET	Eastern Australia
+11	SST	Central Pacific
+12	NST	New Zealand

Examples

Any of the following lines in system.ini will set the time zone for central Europe.

```
setenv TIMEZONE ECT

setenv TIMEZONE 1

setenv TIMEZONE CET1CST
```

This can also be accomplished by executing one of the following.

```
date -z ECT

date -z 1

date -z CET1CST
```

Daylight Saving

Daylight saving is difficult to handle in a generic way, since it is handled differently between countries (and even within countries), continents, southern and northern hemisphere and in some countries it even differs from year to year.

The environment variable DAYLIGHT in the system.ini file contains rules for when the daylight saving starts and stops. It can be altered by editing the system.ini file or by executing the date -d command. The format of the DAYLIGHT variable might seem quite complex, but it allows specifying the correct daylight saving rules for almost all locations in the world.

The rule of the DAYLIGHT variable looks like: MMODHHmm-MMODHHmm. The section before the '-' is the daylight saving start condition and the section after the '-' is the end condition.

The fields are defined in the following table:

Field	Meaning	Possible values
MM	Month	01 - January 02 - February etc.
O	Occurrence	0 - Last occurrence in month 1 - First occurrence 2 - Second occurrence etc.
D	Day of week	0 - Sunday 1 - Monday etc.
HH	Hour	00-23
mm	Minute	00-59

The times should be specified in local time.

Changing to and from Daylight Saving

The transitions to and from daylight saving time are done automatically, when the system time reaches the transition times specified by the DAYLIGHT variable. If the time is set (by the date -s command), the daylight saving status is immediately recalculated. If the daylight saving status cannot be determined (when the time is set within the hour that exists twice because daylight saving time ends), it is considered to be in effect.

The date -d command without additional parameters or options will have no effect, to make it backward compatible with earlier implementations which used this command to evaluate the daylight saving status.

Disabling daylight saving

If daylight saving time is not used at all in the present location, it can be disabled by removing the DAYLIGHT variable or setting its value to an empty string. This can also be accomplished using the date -d "" command.

Examples

The following line will set up the daylight saving for European standard, in the ECT time zone.

```
setenv DAYLIGHT 03000200-10000300
```

This can also be accomplished by executing the following command.

```
date -d 03000200-10000300
```

Which will be interpreted as: daylight saving starts at the last Sunday of March 02:00 local time, and ends the last Sunday of October 03:00 local summer time. Note that both transitions are at 1:00 UTC.

Setting the Clock

When the two variables above has been set up correctly, it is possible to set the clock. This can be done in two ways:

Set the clock via the command line (date -s command)

Acquire the time via NTP (date -n command)

Setting Time via Command Line

This is done by executing the `date -s YYYYMMDDhhmmss` command, where the `YYYYMMDDhhmmss` string has the following meaning:

Field	Meaning
YYYY	The year including century (such as 2003)
MM	The month with two digits (such as 03 for march)
DD	The day in the month with two digits
hh	The hour on 24 H format (two digits)
mm	The minute (two digits)
ss	The second (two digits)

Setting Time via NTP

If you have access to a NTP server, the system can acquire the time via the network. Try:

```
date -n host.name.com
```

The `host.name.com` can either be a hostname or an IP number in dot notation.

```
The following is a list of some NTP servers from where the time can be acquired:
Norway - fartein.ifi.uio.no
Scotland - ntp0.strath.ac.uk
Switzerland - swisstime.ethz.ch
USA - ntp.ucsd.edu
Japan - clock.nc.fukuoka-u.ac.jp
```

Information Resources

The following links may give a hint on what it's all about:

About http://www.timeanddate.com/time/aboutdst.html

More information about http://www.sunrisesunset.com/dst_info.html

In https://en.wikipedia.org/wiki/Daylight_saving_time

27. Appendix 8: Firmware Upgrade

Users can update and upgrade modules to the latest firmware version. A detailed description of how to upgrade the firmware on the target module is available from the Silicon Labs support Website.

28. Appendix 9: JSON Interface Definition

The software definition for the JSON interface follows:

```
****************************
JSON Interface Specification
****************************

Version
-------
0.3


Definitions
-----------

boolean: one_of[ true, false ]
u8:  decimal number in range 0..255 (8-bit unsigned)
i8:  decimal number in range -128..127 (8-bit signed)
u16: decimal number in range 0..65535 (16-bit unsigned)
i16: decimal number in range -32768..32767 (16-bit signed)
u32: decimal number in range 0..4294967295 (32-bit unsigned)
i32: decimal number in range -2147483648..2147483647 (32-bit signed)
x8: string in "0x%02x" format representing 8-bit unsigned integer (ex. "0x0a")
x16: string in "0x%04x" format representing 16-bit unsigned integer (ex. "0x000a")
x32: string in "0x%08x" format representing 32-bit signed integer (ex. "0x0000000a")
octet_string[N] string of N octets in "%02X" format separated by 'space' (ex. "FC AF 6A")

clock_id: octet_string[8] (ex. "FC AF 6A FF FE 02 E0 CE")
port_id:
{
    "clockIdentity": clock_id,
    "portNumber": u16
}
profile_id:   string   in   "%02X-%02X-%02X-%02X-%02X-%02X"   format   representing   PTP   profile   ID   (ex.
"00-1B-19-00-01-00")

sec: number in range -18446744073709551615..18446744073709551615 (sign-extended 64-bit unsigned integer)
nsec: number in range 000000000..999999999
time: {"sec": sec, "nsec": nsec} (ex. {"sec": -0, "nsec": 1}, {"sec": 10, "nsec": 999999})

phys_addr: string in "%02X:%02X:%02X:%02X:%02X:%02X" format representing MAC address (ex. "FC:AF:6A:01:E0:CF")
ipv4_addr: string in "%u.%u.%u.%u" format representing IPv4 addres (ex. "192.168.1.10")
ipv6_addr:    string    in    "%x:%x:%x:%x:%x:%x:%x:%x"    format    representing    IPv6    address    (ex.
"fe80:0:0:0:feaf:6aff:fe01:e0ce")
8023_addr: string in "%02X-%02X-%02X-%02X-%02X-%02X" format representing IEEE 802.3 address (ex. "FC-AF-6A-01-
E0-CF")

protocol_address: one_of[
    {
        "networkProtocol": "UDP/IPv4",
        "networkAddress": ipv4_addr
    },
    {
        "networkProtocol": "UDP/IPv6",
        "networkAddress": ipv6_addr
    },
    {
        "networkProtocol": "IEEE 802.3",
        "networkAddress": 8023_addr
    }
]

clock_quality:
{
    "clockClass" : u8,
    "clockAccuracy" : x8,
    "offsetScaledLogVariance": x16
}

unicastNode:
{
    "nodeType": one_of[ "MASTER", "SLAVE" ]
    "isStatic": boolean,
    "clockIdentity": clock_id,
    "protocolAddress": prtocol_address,
    "localPriority": u8,
    "alternateDomain": boolean,
    "domainNumber": u8,
    "messageNegotiation": boolean,
    "announceGranted": boolean,
    "announceInterval": i8,
    "announceDuration": i32,
    "syncGranted": boolean,
    "syncInterval": i8,
    "syncDuration": i32,
    "delayRespGranted": boolean,
    "delayRespInterval": i8,
    "delayRespDuration": i32
}

quality_level: one_of[ "QL-PRC", "QL-SSU-A", "QL-SSU-B", "QL-SEC", "QL_DNU",
                       "QL-PRS", "QL-STU", "QL-ST2", "QL-TNC", "QL-ST3E", "QL-ST3", "QL-SMC", "QL-DUS" ]


Commands
--------
```

28.1 Commands

28.1.1 Clock Commands

```
Common Errors
{
    "Error": format_string("Command '%s' not found", command_name)
}
```

28.1.1.1 "clock info"

```
Format
{
    "clockInformation":
    {
        "clockType": one_of[ "ORDINARY CLOCK", "BOUNDARY CLOCK" ],
        "physicalLayerProtocol": "IEEE 802.3",
        "numberPorts": u16,
        "portTable": array_of[
            {
                "physicalAddress": phys_addr,
                "protocolAddress": protocol_addr,
                "profileIdentity": profile_id
            }
        ],
        "manufacturerIdentity": octet_string[3],
        "productDescription": "manufacturerName;modelNumber;instanceIdentifier",
        "revisionData": "hardwareRevision;firmwareRevision;softwareRevision",
        "userDescription": "userDeviceName;userDeviceLocation"
    }
}
```

Example

```
"clockInformation":
    {
        "clockType": "BOUNDARY CLOCK",
        "physicalLayerProtocol": "IEEE 802.3",
        "numberPorts": 2,
        "portTable":
        [
            {
                "physicalAddress": "FC:AF:6A:02:E0:CD",
                "protocolAddress":
                {
                    "networkProtocol": "UDP/IPv4",
                    "networkAddress": "192.168.1.10"
                },
                "profileIdentity": "00-1B-19-00-01-00"
            },
            {
                "physicalAddress": "FC:AF:6A:01:E0:CE",
                "protocolAddress":
                {
                    "networkProtocol": "UDP/IPv6",
                    "networkAddress": "fe80:0:0:0:feaf:6aff:fe01:e0ce"
                },
                "profileIdentity": "00-1B-19-00-01-00"
            }
        ],
        "manufacturerIdentity": "FC AF 6A",
        "productDescription": "Qulsar Inc;C34-M5x/M6x/M8x;02-E0-CD",
        "revisionData": ";;1.0.18",
        "userDescription": ""
    }
}
```

28.1.1.2 "clock type"

```
Format
{
    "clockType": one_of[ "ORDINARY CLOCK", "BOUNDARY CLOCK" ]
}

Errors
{
    "Error": "Clock type must be 'oc' or 'bc'"
}
```

28.1.1.3 "clock twostep"

```
Format
{
    "twoStep": boolean
}

Errors
{
    "Error": "Two-step mode must be 'on' or 'off'"
}
```

28.1.1.4 "clock slaveonly"

```
Format
{
    "slaveOnly": boolean
}

Errors
{
    "Error": "Slave-only mode must be 'on' or 'off'"
}
```

28.1.1.5 "clock domain"

```
Format
{
    "domainNumber": u8
}

Errors
{
    "Error": "Domain number must be 0..255"
}
```

28.1.1.6 "clock priority"

```
Format
{
    one_of[ "priority1": u8, "priority2": u8 ]
}

Errors
{
    "Error": "Parameter is missing"
}
{
    "Error": "Parameter must be '1' or '2'"
}
{
    "Error": "Priority must be 0..255"
}
```

28.1.1.7 "clock quality"

```
Format
{
    "clockQuality": clock_quality
}

Errors
{
    "Error": "Parameter is missing"
}
{
    "Error": "Clock class must be 0..254"
}
{
    "Error": "Clock accuracy must be 0x20..0x31 or 0xfe"
}
{
    "Error": "Clock variance must be 0x0000..0xffff"
}
```

28.1.1.8 "clock profile"

```
Format
{
    "clockProfile": one_of[ "UNDEFINED",
                            "DEFAULT",
                            "POWER V1",
                            "POWER V2",
                            "G8265",
                            "G8275.1",
                            "G8275.2" ]
}

Errors
{
    "Error": "Profile must be 'default', 'g8265', 'g8275.1', 'g8275.2', 'power'"
}
{
    "Error": "Parameter must be 'v1' or 'v2'"
}
```

28.1.2 Port Commands

```
Common Errors
{
    "Error": format_string("Command '%s' not found", command_name)
}
{
    "Error": format_string("Port %d not found", port_number)
}
```

28.1.2.1 "port state"

```
Format
{
    "portState": one_of[ "PTP2_STATE_NOT_DEFINED",
                         "PTP2_STATE_INITIALIZING",
                         "PTP2_STATE_FAULTY",
                         "PTP2_STATE_DISABLED",
                         "PTP2_STATE_LISTENING",
                         "PTP2_STATE_PRE_MASTER",
                         "PTP2_STATE_MASTER",
                         "PTP2_STATE_PASSIVE",
                         "PTP2_STATE_UNCALIBRATED",
                         "PTP2_STATE_SLAVE" ]
}
```

28.1.2.2 "port announce"

```
Format
{
    "logAnnounceInterval": i8
}

Errors
{
    "Error": "Log announce interval must be -4..5"
}
```

28.1.2.3 "port receipt"

```
Format
{
    "announceReceiptTimeout": u8
}

Errors
{
    "Error": "Announce receipt timeout must be 2..10"
}
```

28.1.2.4 "port sync"

```
Format
{
    "logSyncInterval": i8
}

Errors
{
    "Error": "Log sync interval must be -8..2"
}
```

28.1.2.5 "port delay"

```
Format
{
    "logMinDelayReqInterval": i8
}

Errors
{
    "Error": "Log min delay request interval must be -7..7"
}
```

28.1.2.6 "port pdelay"

```
Format
{
    "logMinPdelayReqInterval": i8
}

Errors
{
    "Error": "Log min pdelay request interval must be -7..7"
}
```

28.1.2.7 "port mechanism"

```
Format
{
    "delayMechanism": one_of[ "E2E", "P2P", "DISABLED" ]
}

Errors
{
    "Error": "Delay mechanism must be 'e2e', 'p2p', 'disable'"
}
```

28.1.2.8 "port protocol"

```
Format
{
    "networkProtocol": one_of[ "UDP/IPv4", "UDP/IPv6", "IEEE 802.3" ]
}

Errors
{
    "Error": "Network protocol must be 'udp', 'udp6', 'eth'"
}
```

28.1.2.9 "port compatibility"

```
Format
{
    "compatibilityMode": one_of[ "ON", "OFF", format_string("AUTO/%d sec", timeout) ]
}

Errors
{
    "Error": "Compatibility mode must be 'on', 'off', 'auto'"
}
{
    "Error": "Parameter is missing"
}
{
    "Error": "Compatibility timeout must be 0..600 s"
}
```

28.1.2.10 "port asymmetry"

```
Format
{
    "delayAsymmetry": time
}
```

28.1.2.11 "port unicast"

```
Format
{
    "unicastState": one_of[ "PTP2_UNICAST_STATE_DISABLED",
                            "PTP2_UNICAST_STATE_SLAVE",
                            "PTP2_UNICAST_STATE_MASTER",
                            "PTP2_UNICAST_STATE_MASTER_SLAVE" ]
}

Errors
{
    "Error": "Parameter must be: 'master', 'slave', 'both', 'disable'"
}
```

28.1.2.12 "port profile"

```
Format
{
    "portProfile": one_of[ "UNDEFINED",
                           "DEFAULT",
                           "POWER V1",
                           "POWER V2",
                           "G8265",
                           "G8275.1",
                           "G8275.2" ]
}

Errors
{
    "Error": "Profile must be 'default', 'g8265', 'g8275.1', 'g8275.2', 'power'"
}
{
    "Error": "Parameter must be 'v1' or 'v2'"
}
```

28.1.3 Unicast Commands

```
Common Errors
{
    "Error": format_string("Command '%s' not found", command_name)
}
{
    "Error": format_string("Port %d not found", port_number)
}
```

28.1.3.1 "unicast status"

```
Format
{
    "portUnicastInformation":
    {
        "unicastState": one_of[ "PTP2_UNICAST_STATE_DISABLED",
                                "PTP2_UNICAST_STATE_SLAVE",
                                "PTP2_UNICAST_STATE_MASTER",
                                "PTP2_UNICAST_STATE_MASTER_SLAVE" ],
        "negotiationEnabled": boolean,
        "cancelTimeout": u32,
        "transmissionDuration": u32,
        "queryInterval": u32,
        "messageRateLimit": u32,
        "currentMessageRate": u32
    }
}
```

28.1.3.2 "unicast negotiation"

```
Format
{
    "negotiationEnabled": boolean
}

Errors
{
    "Error": "Parameter must be 'on' or 'off'"
}
```

28.1.3.3 "unicast query"

```
Format
{
    "queryInterval": u32
}

Errors
{
    "Error": "Query interval must be 1..600 s"
}
```

28.1.3.4 "unicast duration"

```
Format
{
    "transmissionDuration": u32
}

Errors
{
    "Error": "Transmission duration must be 60..3600 s"
}
```

28.1.3.5 "unicast timeout"

```
Format
{
    "cancelTimeout": u32
}

Errors
{
    "Error": "Cancel timeout must be 1..10 s"
}
```

28.1.3.6 "unicast limit"

```
Format
{
    "messageRateLimit": u32
}

Errors
{
    "Error": "Message rate limit must be 0..1000 msg/s"
}
```

28.1.3.7 "unicast filter"

```
filterEntry: one_of[
    {
        "networkAddress": one_of[ "any", ipv4_addr, ipv6_addr, 8023_addr ],
        "clockIdentity": one_of[ "any", clock_id ],
        "action": "ALLOW",
        "announceLimit": one_of[ "deny", i8 ],
        "syncLimit": one_of[ "deny", i8 ],
        "delayReqLimit": one_of[ "deny", i8 ],
        "localPriority": u8
    },
    {
        "networkAddress": one_of[ "any", ipv4_addr, ipv6_addr, 8023_addr ],
        "clockIdentity": one_of[ "any", clock_id ],
        "action": "DENY"
    }
]

Format
{
    "unicastSlaveFilter": array_of[ filterEntry ]
}
{
    "unicastMasterFilter": array_of[ filterEntry ]
}
{
    "filterEntry": filterEntry
}
{
    "Success": "Filter entry is deleted"
}

Errors
{
    "Error": "Filter type is missing"
}
{
    "Error": "Address is missing"
}
{
    "Error": "Address format is incorrect"
}
{
    "Error": "Address format does not match network protocol"
}
{
    "Error": "Clock identity is too short"
}
{
    "Error": "Filter entry already exists"
}
{
    "Error": "Filter entry not found"
}
{
    "Error": "Priority must be 0..255"
}
{
    "Error": "Announce interval limit must be -4..4"
}
{
    "Error": "Sync interval limit must be -7..4"
}
{
    "Error": "Delay interval limit must be -7..4 or 'x'"
}
{
    "Error": "Unable to add filter entry"
}

Example
```

```
{
    "unicastSlaveFilter":
    [
        {
            "networkAddress": "any",
            "clockIdentity": "any",
            "action": "ALLOW",
            "announceLimit": -4,
            "syncLimit": -7,
            "delayReqLimit": -7,
            "localPriority": 255
        }
        {
            "networkAddress": "192.168.1.120",
            "clockIdentity": "any",
            "action": "ALLOW",
            "announceLimit": 0,
            "syncLimit": -1,
            "delayReqLimit": "deny",
            "localPriority": 255
        }
        {
            "networkAddress": "any",
            "clockIdentity": "FC AF 6A FF FE 02 E0 CE",
            "action": "DENY"
        }
    ]
}
```

28.1.3.8 "unicast node"

```
Format
{
    "unicastNodeTable": array_of[ unicastNode("isStatic" == true) ]
}
{
    "unicastSlaveTable": array_of[ unicastNode("isStatic" == true && "nodeType" == "SLAVE")  ]
}
{
    "unicastMasterTable": array_of[ unicastNode("isStatic" == true && "nodeType" == "SLAVE") ]
}
{
    "unicastNode": unicastNode
}
{
    "Success": "Unicast node is deleted"
}

Errors
{
    "Error": "Unicast operations are disabled"
}
{
    "Error": "Node type is missing"
}
{
    "Error": "Only slave nodes are allowed on unicast master port"
}
{
    "Error": "Only master nodes are allowed on unicast slave port"
}
{
    "Error": "Address is missing"
}
{
    "Error": "Address format does not match network protocol"
}
{
    "Error": "Clock identity is too short"
}
{
    "Error": "Unicast node already exists"
}
{
    "Error": "Unicast node not found"
}
{
    "Error": "Cannot modify or delete dynamic node"
}
{
    "Error": "Priority must be 0..255"
}
{
    "Error": "Announce interval must be -4..4 or 'x'"
}
{
    "Error": "Sync interval must be -7..4 or 'x'"
}
{
    "Error": "Delay Req interval must be -7..4 or 'x'"
}
{
    "Error": "Domain number must be 0..255"
}
{
    "Error": "Unable to add unicast node"
}

Example
{
    "unicastNode":
```

```
    {
        "nodeType": "MASTER",
        "isStatic": true,
        "clockIdentity": "FC AF 6A FF FE 02 E0 CE",
        "protocolAddress":
        {
            "networkProtocol": "UDP/IPv4",
            "networkAddress": "192.168.1.1"
        }
        "localPriority": 128,
        "alternateDomain": true,
        "domainNumber": 4,
        "messageNegotiation": true,
        "announceGranted": true,
        "announceInterval": 0,
        "announceDuration": 600,
        "syncGranted": true,
        "syncInterval": 0,
        "syncDuration": 600,
        "delayRespGranted": true,
        "delayRespInterval": 0,
        "delayRespDuration": 600
    }
}
```

28.1.4 Power Profile Commands

```
Common Errors
{
    "Error": format_string("Command '%s' not found", command_name)
}
```

28.1.4.1 "power gmid"

```
Format
{
    "grandmasterID": u16
}
```

28.1.4.2 "power inacc"

```
Format
{
    "timeInaccuracy": { "grandmaster": u32, "network": u32 }
}
```

28.1.5 G8265 Profile Commands

```
Common Errors
{
    "Error": format_string("Command '%s' not found", command_name)
}
```

28.1.6 G8275 Profile Commands

```
Common errors
{
    "Error": format_string("Command '%s' not found", command_name)
}
```

28.1.6.1 "g8275 priority"

```
Format
{
    "clockLocalPriority": u8
}

Errors
{
    "Error": "Local priority must be 1..255"
}
```

28.1.6.2 "g8275 steps"

```
Format
{
    "maxStepsRemoved": u8
}

Errors
{
    "Error": "Max steps must be 1..255"
}
```

28.1.6.3 "g8275 [port_number] priority"

```
Format
{
    "localPriority": u8
}

Errors
{
    "Error": format_string("Port %d not found", port_number)
}
{
    "Error": "Local priority must be 1..255"
}
```

28.1.6.4 "g8275 [port_number] masteronly"

```
Format
{
    "masterOnly": boolean
}

Errors
{
    "Error": format_string("Port %d not found", port_number)
}
{
    "Error": "Master-only must be 'on' or 'off'"
}
```

28.1.7 Dataset Commands

```
Common Errors
{
    "Error": format_string("Command '%s' not found", command_name)
}
```

28.1.7.1 "dataset default"

```
Format
{
    "defaultDS":
    {
        "clockIdentity": clock_id,
        "numberPorts": u16,
        "twoStep": boolean
        "domainNumber": u8,
        "clockQuality": clock_quality
        "priority1": u8,
        "priority2": u8,
        "slaveOnly": boolean
    }
}

Example
{
    "defaultDS":
    {
        "clockIdentity": "FC AF 6A FF FE 02 E0 CE",
        "numberPorts": 2,
        "twoStep": false,
        "domainNumber": 0,
        "clockQuality":
        {
            "clockClass" : 248,
            "clockAccuracy" : "0xfe",
            "offsetScaledLogVariance": "0xffff"
        },
        "priority1": 128,
        "priority2": 128,
        "slaveOnly": false
    }
}
```

28.1.7.2 "dataset current"

```
Format
{
    "currentDS":
    {
        "stepsRemoved": u8,
        "offsetFromMaster": time,
        "meanPathDelay": time
    }
}

Example
{
    "currentDS":
    {
        "stepsRemoved": 255,
        "offsetFromMaster": {"sec": -0, "nsec": 1025},
        "meanPathDelay": {"sec": 0, "nsec": 624}
    }
}
```

28.1.7.3 "dataset parent"

```
Format
{
    "parentDS":
    {
        "parentPortIdentity": port_id
        "parentStats": boolean,
        "observedParentOffsetScaledLogVariance": x16,
        "observedParentClockPhaseChangeRate": x32,
        "grandmasterClockIdentity": clock_id,
        "grandmasterClockQuality": clock_quality
        "grandmasterPriority1": u8,
        "grandmasterPriority2": u8
    }
}

Example
{
    "parentDS":
    {
        "parentPortIdentity":
        {
            "clockIdentity": "FC AF 6A FF FE 02 E0 CE",
            "portNumber": 1
        },
        "parentStats": false,
        "observedParentOffsetScaledLogVariance": "0xffff",
        "observedParentClockPhaseChangeRate": "7fffffff",
        "grandmasterClockIdentity": "FC AF 6A FF FE 02 E0 CE",
        "grandmasterClockQuality":
        {
            "clockClass" : 248,
            "clockAccuracy" : "0xfe",
            "offsetScaledLogVariance": "0xffff"
        },
        "grandmasterPriority1": 128,
        "grandmasterPriority2": 128
    }
}
```

28.1.7.4 "dataset time"

```
Format
{
    "timePropertiesDS":
    {
        "ptpTimescale" : boolean,
        "currentUtcOffset": i16,
        "currentUtcOffsetValid": boolean,
        "leap59": boolean,
        "leap61": boolean,
        "timeTraceable": boolean,
        "frequencyTraceable": boolean,
        "timeSource": one_of[ "ATOMIC CLOCK",
                              "GPS",
                              "TERRESTRIAL RADIO",
                              "PTP",
                              "NTP",
                              "HAND SET",
                              "UNDEFINED",
                              "OTHER",
                              "INTERNAL OSCILLATOR" ]
    }
}

Example
{
    "timePropertiesDS":
    {
        "ptpTimescale" : true,
        "currentUtcOffset": 37,
        "currentUtcOffsetValid": true,
        "leap59": false,
        "leap61": false,
        "timeTraceable": false,
        "frequencyTraceable": false,
        "timeSource": "INTERNAL OSCILLATOR"
    }
}
```

28.1.7.5 "dataset port [port_number]"

```
Format
{
    "portDS":
    {
        "versionNumber": 2,
        "portIdentity": port_id,
        "portState": one_of[ "PTP2_STATE_NOT_DEFINED",
                             "PTP2_STATE_INITIALIZING",
                             "PTP2_STATE_FAULTY",
                             "PTP2_STATE_DISABLED",
                             "PTP2_STATE_LISTENING",
                             "PTP2_STATE_PRE_MASTER",
                             "PTP2_STATE_MASTER",
                             "PTP2_STATE_PASSIVE",
                             "PTP2_STATE_UNCALIBRATED",
                             "PTP2_STATE_SLAVE" ],
        "logAnnounceInterval": i8,
        "announceReceiptTimeout": u8,
        "logSyncInterval": i8,
        "logMinDelayReqInterval": i8,
        "logMinPdelayReqInterval": i8,
        "delayMechanism": one_of[ "E2E", "P2P", "DISABLED" ],
        "peerMeanPathDelay": time
    }
}

Errors
{
    "Error": format_string("Port %d not found", port_number)
}

Example
{
    "portDS":
    {
        "versionNumber": 2,
        "portIdentity":
        {
            "clockIdentity": "FC AF 6A FF FE 02 E0 CE",
            "portNumber": 1
        },
        "portState": "PTP2_STATE_SLAVE",
        "logAnnounceInterval": 1,
        "announceReceiptTimeout": 3,
        "logSyncInterval": 0,
        "logMinDelayReqInterval": 0,
        "logMinPdelayReqInterval": 0,
        "delayMechanism": "E2E",
        "peerMeanPathDelay": {"sec": 0, "nsec": 624}
    }
}
```

28.1.7.6 "dataset foreign [port_number]"

```
Format
{
    "foreignMasterTable":
    array_of[
        {
            "portIdentity": port_id,
            "announceMessages": u8,
            "recentAnnounce":
            {
                "sequenceId": u16,
                "grandmasterClockIdentity": clock_id,
                "grandmasterClockQuality": clock_quality,
                "grandmasterPriority1": u8,
                "grandmasterPriority2": u8,
                "stepsRemoved": u8
            }
            "unicastNodeAddress": one_of[ null, protocol_address ]
        }
    ]
}

Errors
{
    "Error": format_string("Port %d not found", port_number)
}

Example
{
    "foreignMasterTable":
    [
        {
            "portIdentity":
            {
                "clockIdentity": "FC AF 6A FF FE 02 E0 CE",
                "portNumber": 1
            },
            "announceMessages": 2,
            "recentAnnounce":
            {
                "sequenceId": 195,
                "grandmasterClockIdentity": "FC AF 6A FF FE 02 E0 CE",
                "grandmasterClockQuality":
                {
                    "clockClass" : 248,
                    "clockAccuracy" : "0xfe",
                    "offsetScaledLogVariance": "0xffff"
                },
                "grandmasterPriority1": 128,
                "grandmasterPriority2": 128,
                "stepsRemoved": 255
            }
            "unicastNodeAddress": null
        },
        {
            "portIdentity":
            {
                "clockIdentity": "FC AF 6A FF FE 02 E0 CF",
                "portNumber": 2
            },
            "announceMessages": 1,
            "recentAnnounce":
            {
                "sequenceId": 20056,
                "grandmasterClockIdentity": "FC AF 6A FF FE 02 E0 CF",
                "grandmasterClockQuality":
                {
                    "clockClass" : 248,
                    "clockAccuracy" : "0xfe",
                    "offsetScaledLogVariance": "0xffff"
                },
                "grandmasterPriority1": 128,
                "grandmasterPriority2": 128,
                "stepsRemoved": 255
            }
            "unicastNodeAddress":
            {
                "networkProtocol": "UDP/IPv4",
                "networkAddress": "192.168.1.1"
            }
        }
    ]
}
```

28.1.7.7 "dataset unicast [port_number]"

```
Format
{
    "unicastNodeList": array_of[ unicastNode ]
}

Errors
{
    "Error": format_string("Port %d not found", port_number)
}

Example
{
    "unicastNodeList":
    [
        {
            "nodeType": "MASTER",
            "isStatic": true,
            "clockIdentity": "FC AF 6A FF FE 02 E0 CE",
            "protocolAddress":
            {
                "networkProtocol": "UDP/IPv4",
                "networkAddress": "192.168.1.1"
            }
            "localPriority": 128,
            "alternateDomain": true,
            "domainNumber": 4,
            "messageNegotiation": true,
            "announceGranted": true,
            "announceInterval": 0,
            "announceDuration": 600,
            "syncGranted": true,
            "syncInterval": 0,
            "syncDuration": 600,
            "delayRespGranted": true,
            "delayRespInterval": 0,
            "delayRespDuration": 600
        },
        {
            "nodeType": "SLAVE",
            "isStatic": false,
            "clockIdentity": "FC AF 6A FF FE 02 E0 CF",
            "protocolAddress":
            {
                "networkProtocol": "UDP/IPv4",
                "networkAddress": "192.168.1.2"
            }
            "localPriority": 255,
            "alternateDomain": false,
            "domainNumber": 0,
            "messageNegotiation": true,
            "announceGranted": true,
            "announceInterval": 0,
            "announceDuration": 900,
            "syncGranted": true,
            "syncInterval": -1,
            "syncDuration": 900,
            "delayRespGranted": true,
            "delayRespInterval": -1,
            "delayRespDuration": 900
        }
    ]
}
```

28.1.7.8 "dataset power"

```
Format
{
    "powerProfileDS":
    {
        "grandmasterID": u16,
        "timeInaccuracy": { "grandmaster": u32, "network": u32 },
        "alternateTimeOffsetIndicator":
        {
            "displayName": string,
            "currentOffset": i32,
            "nextJump": one_of[ null,
            {
                "jumpSeconds": i32,
                "timeOfNextJump": sec
                "displayTimeOfNextJump": "YYYY-MM-DD HH:MM:SS TAI"
            }
        }
    }
}

Example
{
    "powerProfileDS":
    {
        "grandmasterID": 1,
        "timeInaccuracy": { "grandmaster": 50, "network": 1500 },
        "alternateTimeOffsetIndicator":
        {
            "displayName": "CET",
            "currentOffset": 3562,
            "nextJump":
            {
                "jumpSeconds": 3600,
                "timeOfNextJump": 1585447237
                "displayTimeOfNextJump": "2020-03-29 02:00:37 TAI"
            }
        }
    }
}
```

28.1.7.9 Dataset g8275 Commands

28.1.7.9.1 "dataset g8275"

```
Format
{
    "g8275ProfileDS":
    {
        "clockLocalPriority": u8,
        "maxStepsRemoved": u8
    }
}

Example
{
    "g8275ProfileDS":
    {
        "clockLocalPriority": 128,
        "maxStepsRemoved": 255
    }
}
```

28.1.7.9.2 "dataset g8275 [port_number]"

```
Format
{
    "g8275ProfilePortDS":
    {
        "portNumber": u16,
        "masterOnly": boolean,
        "localPriority": u8,
        "signalFail": boolean
    }
}

Errors
{
    "Error": format_string("Port %d not found", port_number)
}

Example
{
    "g8275ProfilePortDS":
    {
        "portNumber": 1,
        "masterOnly": true,
        "localPriority": 128,
        "signalFail": false
    }
}
```

28.1.8 Time Commands

```
Common Errors
{
    "Error": format_string("Command '%s' not found", command_name)
}
```

28.1.8.1 "time info"

```
Format
{
    "timeInformation":
    {
        "clockSyncState": one_of[ "FREE",
                                  "SYNTONIZING",
                                  "SYNCHRONIZING",
                                  "HOLDOVER" ],
        "clockSynchronized": boolean,
        "timeSource": one_of[ "ATOMIC CLOCK",
                              "GPS",
                              "TERRESTRIAL RADIO",
                              "PTP",
                              "NTP",
                              "HAND SET",
                              "UNDEFINED",
                              "OTHER",
                              "INTERNAL OSCILLATOR" ],
        "timeScale": one_of[ "PTP", "ARB" ],
        "currentTime": time,
        "currentUtcOffset": i16,
        "leap59": boolean,
        "leap61": boolean,
        "displayTimeARB": "[-]SSSSSSSSSS.NS",
        "displayTimePTP": "YYYY-MM-DD HH:MM:SS.NS",
        "displayTimeUTC": "YYYY-MM-DD HH:MM:SS",
        "displayTimeLocal": "YYYY-MM-DD HH:MM:SS TZ",
        "autoUpdateRTC": boolean,
        "holdoverInterval": u32
    }
}

Example
{
    "timeInformation":
    {
        "clockSyncState": "SYNCHONIZING",
        "clockSynchronized": true,
        "timeSource": "GPS",
        "timeScale": "PTP",
        "currentTime": { "sec": 1581329920, "nsec": 204466328 },
        "currentUtcOffset": 37,
        "leap59": false,
        "leap61": false,
        "displayTimeARB": "1581329920.204466328",
        "displayTimePTP": "2020-02-10 10:18:40.204466328",
        "displayTimeUTC": "2020-02-10 10:18:03",
        "displayTimeLocal": "2020-02-10 10:18:03 GMT",
        "autoUpdateRTC": true,
        "holdoverInterval": 1000
    }
}
```

28.1.8.2 "time sync"

```
Format
{
    "syncStatus":
    {
        "clockSynchronized": boolean,
        "clockSyncState": one_of[ "FREE",
                                  "SYNTONIZING",
                                  "SYNCHRONIZING",
                                  "HOLDOVER" ]
    }
}
```

28.1.8.3 "time arb|ptp|utc|ntp"

```
Format
{
    one_of[
        "displayTimeARB": "[-]SSSSSSSSSS.NS",
        "displayTimePTP": "YYYY-MM-DD HH:MM:SS.NS",
        "displayTimeUTC": "YYYY-MM-DD HH:MM:SS"
    ]
}

Errors
{
     "Error": format_string("Time can not be set. Clock is synchronizing with %s time source", one_of[ "GPS",
"PTP" ])
}
{
    "Error": "Nanoseconds must be 0..999999999"
}
{
    "Error": "Date is missing"
}
{
    "Error": "Time is missing"
}
{
    "Error": "Year is not correct"
}
{
    "Error": "Month is not correct"
}
{
    "Error": "Day is not correct"
}
{
    "Error": "Hours must be 0..23"
}
{
    "Error": "Minutes must be 0..59"
}
{
    "Error": "Seconds must be 0..59"
}
{
    "Error": "Unable to resolve NTP server name"
}
{
    "Error": "Unable to obtain time from NTP server"
}
{
    "Error": "NTP server is not synchronized"
}
```

28.1.8.4 "time offset"

```
Format
{
    "currentUtcOffset": i16
}

Errors
{
    "Error": "Offset must be -32768..32767 s"
}
{
    "Error": "Unable to set UTC offset"
}
```

28.1.8.5 "time leap"

```
Format
{
    "leapSecondTable":
    array_of[
        format_string("%04d-%02d-%02d %d %+d", year, month, day, offset, leap)
    ]
}

Errors
{
    "Error": "Parameter must be 'load', 'save', '59' or '61'"
}

Example
{
    "leapSecondTable":
    [
        "2008-12-31 33 +1",
        "2012-06-30 34 +1",
        "2015-06-30 35 +1",
        "2016-12-31 36 +1",
        "default 37 0"
    ]
}
```

28.1.8.5.1 "time leap save"

```
Format
{
    "Success": "UTC leap seconds table is saved"
}

Errors
{
    "Error": "Unable to save UTC leap seconds table"
}
```

28.1.8.5.2 "time leap load"

```
Format
{
    "Success": "UTC leap seconds table is loaded"
}

Errors
{
    "Error": "Unable to load UTC leap seconds table"
}
```

28.1.8.5.3 "time leap 59"

```
Format
{
    "leap59": boolean
}
```

28.1.8.5.4 "time leap 61"

```
Format
{
    "leap61": boolean
}
```

28.1.8.5.5 "time leap 59|61 YYYY-MM-DD"

```
Format
{
    "Success": format_string("Leap second is scheduled: %04d-%02d-%02d %d %+d", year, month, day, offset, leap)
}

Errors
{
    "Error": "Year is not correct"
}
{
    "Error": "Month is not correct"
}
{
    "Error": "Day is not correct"
}
{
    "Error": "UTC leap seconds table is corrupted"
}
{
    "Error": "Date must be later than of any already defined leap seconds"
}
{
    "Error": "Unable to schedule leap second"
}
```

28.1.8.5.6 "time timescale"

```
Format
{
    "timeScale": one_of[ "PTP", "ARB" ]
}

Errors
{
       "Error":  format_string("Timescale  can  not  be  set.  Clock  is  synchronizing  with  %s  time  source",
one_of[ "GPS", "PTP" ])
}
{
    "Error": "Timescale must be 'ptp' or 'arb'"
}
```

28.1.8.5.7 "time update"

```
Format
{
    "autoUpdateRTC": boolean
}

Errors
{
    "Error": "Parameter must be 'on' or 'off'"
}
```

28.1.8.5.8 "time holdover"

```
Format
{
    "holdoverInterval": u32
}

Errors
{
    "Error": "Interval must not be negative"
}
```

28.1.9 Frequency Commands

```
Common Errors
{
    "Error": format_string("Command '%s' not found", command_name)
}
```

28.1.9.1 "freq status"

```
Format
{
    "frequencyInformation":
    {
        "frequencyOption": one_of[ "OPT1", "OPT2" ],
        "referenceQL": quality_level,
        "autoselectionPreference": one_of[ "INPUT", "REF" ],
        "activeSource": one_of[ "REF", format_string("IN_%d", input_number) ],
        "activeQL": quality_level
    }
}

Example
{
    "frequencyInformation":
    {
        "frequencyOption": "OPT1",
        "referenceQL": "QL-SSU-B",
        "autoSelectPreference": "REF",
        "activeSource": "IN_1"
        "activeQL": "QL-PRC"
    }
}
```

28.1.9.2 "freq option"

```
Format
{
    "frequencyOption": one_of[ "OPT1", "OPT2" ]
}

Errors
{
    "Error": "Parameter must be 'opt1' or 'opt2'"
}
```

28.1.9.3 "freq ref"

```
Format
{
    "referenceQL": quality_level
}

Errors
{
    "Error": one_of[ "Quality level must be 'prc', 'ssu-a', 'ssu-b', 'sec', 'dnu'",
                     "Quality level must be 'prs', 'stu', 'st2', 'tnc', 'st3e', 'st3', 'smc', 'dus'" ]
}
```

28.1.9.4 "freq prefer"

```
Format
{
    "autoSelectPreference": one_of[ "INPUT", "REF" ]
}

Errors
{
    "Error": "Parameter must be 'input' or 'ref'"
}
```

28.1.9.5 "freq input [input_number]"

```
frequencyInput:
{
    "inputNumber": u8,
    "inputType": one_of[ "EXTERNAL", format_string("SYNCE_%d", port_number) ],
    "autoSelect": boolean,
    "inputEnabled": boolean,
    "signalFail": boolean,
    "currentQL": quality_level,
    "activeSource": boolean
}

Format
{
    "frequencyInputTable": array_of[ frequencyInput ]
}
{
    "frequencyInput": frequencyInput
}

Errors
{
    "Error": "Input must be 1..3"
}
{
    "Error": "Input type must be 'synce' or 'ext'"
}
{
    "Error": "Port number is missing"
}
{
    "Error": format_string("Port %d not found", port_number)
}
{
    "Error": "Quality level is missing"
}
{
    "Error": one_of[ "Quality level must be 'prc', 'ssu-a', 'ssu-b', 'sec', 'dnu'",
                     "Quality level must be 'prs', 'stu', 'st2', 'tnc', 'st3e', 'st3', 'smc', 'dus'" ]
}

Example
{
    "frequencyInputTable":
    [
        {
            "inputNumber": 1,
            "inputType": "SYNCE_1",
            "autoSelect": true,
            "inputEnabled": true,
            "signalFail": false
            "currentQL": "QL-PRC",
            "activeSource": true
        },
        {
            "inputNumber": 2,
            "inputType": "SYNCE_2",
            "autoSelect": true,
            "inputEnabled": true,
            "signalFail": false
            "currentQL": "QL-DNU",
            "activeSource": false
        },
        {
            "inputNumber": 3,
            "inputType": "EXTERNAL",
            "autoSelect": false,
            "inputEnabled": false,
            "signalFail": true
            "currentQL": "QL-DNU",
            "activeSource": false
        }
    ]
}
```

28.1.10 SyncE Commands

```
Common Errors
{
    "Error": format_string("Command '%s' not found", command_name)
}
{
    "Error": format_string("Port %d not found", port_number)
}
```

28.1.10.1 "synce status"

```
Format
{
    "syncePortInformation":
    {
        "portNumber": u16,
        "esmcEnabled": boolean,
        "inputQL": one_of[ "AUTO", quality_level ],
        "outputQL": one_of[ "AUTO", quality_level ],
        "currentLinkMode": one_of[ "NONE", "MASTER", "SLAVE", "MASTER-SLAVE" ],
        "effectiveInputQL": quality_level,
        "effectiveOutputQL": quality_level,
        "activeSource": boolean
    }
}

Example
{
    "syncePortInformation":
    {
        "portNumber": 1,
        "esmcEnabled": true,
        "inputQL": "AUTO",
        "outputQL": "AUTO",
        "currentLinkMode": "SLAVE"
        "effectiveInputQL": "QL-PRC",
        "effectiveOutputQL": "QL-DNU",
        "activeSource": true
    }
}
```

28.1.10.2 "synce esmc"

```
Format
{
    "esmcEnabled": boolean
}

Errors
{
    "Error": "Parameter must be 'enable' or 'disable'"
}
```

28.1.10.3 "synce quality"

```
Format
{
    one_of[
        "inputQL": one_of[ "AUTO", ql ],
        "outputQL": one_of[ "AUTO", ql ]
    ]
}

Errors
{
    "Error": "Parameter is missing"
}
{
    "Error": "Parameter must be 'in' or 'out'"
}
{
    "Error": one_of[ "Quality level must be 'auto', 'prc', 'ssu-a', 'ssu-b', 'sec', 'dnu'",
                     "Quality level must be 'auto', 'prs', 'stu', 'st2', 'tnc', 'st3e', 'st3', 'smc', 'dus'" ]
}
```

28.1.11 GPS (PPS/TOD-Input) Commands

```
Common Errors
{
    "Error": format_string("Command '%s' not found", command_name)
}
{
    "Error": "GPS interface is disabled"
}
```

28.1.11.1 "gps status"

```
Format
{
    "gpsInterfaceInformation":
    {
        "operationMode": one_of[ "GPS ONLY", "GPS PRIMARY", "GPS SECONDARY", "DEBUG" ]
        "ppsSignalStable": boolean,
        "todSignalStable": boolean,
        "ppsInputEnabled": one_of[ boolean, { "0": boolean, "1": boolean} ],
        "ppsDelay": u32,
        "todInputEnabled": boolean,
        "todInputRequired": boolean,
        "todInputInterface": { "name": one_of["DEFAULT", format_string("COM%d", port) ], "baudrate": u32 }
        "todInputFormat": one_of[ "NMEA", "ASCII", "CM" ],
        "mmeaRmcVoidFlag": one_of[ "IGNORE", "SYNTONIZE", "HOLDOVER" ],
        "clockClassMapping":
        {
            "active": u8,
            "holdover": u8,
            "free": u8
        }
    }
}

Example
{
    "gpsInterfaceInformation":
    {
        "operationMode": "GPS ONLY",
        "ppsSignalStable": true,
        "todSignalStable": true,
        "ppsInputEnabled": { "0": true, "1": false },
        "ppsDelay": 60,
        "todInputEnabled": true,
        "todInputRequired": true,
        "todInputInterface": { "name": "DEFAULT", "baudrate": 9600 }
        "todInputFormat": "NMEA",
        "mmeaRmcVoidFlag": "HOLDOVER",
        "clockClassMapping": {
            "active": 6,
            "holdover": 7,
            "free": 52
        }
    }
}
```

28.1.11.2 "gps ppsin"

```
Format
{
    "ppsInputEnabled": one_of[ boolean, { "0": boolean, "1": boolean } ]
}

Errors
{
    "Error": "Parameter must be 'enable' or 'disable'"
}
```

28.1.11.3 "gps todin"

```
Format
{
    one_of[
        "todInputEnabled": boolean,
        "todInputRequired": boolean
    ]
}

Errors
{
    "Error": "Parameter must be 'enable', 'disable', 'required', 'optional'"
}
```

28.1.11.4 "gps delay"

```
Format
{
    "ppsDelay": u32
}

Errors
{
    "Error": "Delay must be 0..999999999 ns"
}
```

28.1.11.5 "gps class"

```
Format
{
    "clockClassMapping":
    {
        "active": u8,
        "holdover": u8,
        "free": u8
    }
}

Errors
{
    "Error": "Clock class must be 0..255"
}
```

28.1.11.6 "gps interface"

```
Format
{
    "todInputInterface": { "name": one_of[ "DEFAULT", format_sting("COM%d", port) ], "baudrate": u32 }
}

Errors
{
    "Error": "Interface must be 'default' or 'com[n]'"
}
{
    "Error": "COM port must be 1..3"
}
{
    "Error": format_string("Unable to select interface: %s %d", interface_name, baudrate)
}
```

28.1.11.7 "gps format"

```
Format
{
    "todInputFormat": one_of[ "NMEA", "ASCII", "CM" ]
}

Errors
{
    "Error": "Format must be 'nmea', 'ascii', 'cm'"
}
```

28.1.11.8 "gps void"

```
Format
{
    "mmeaRmcVoidFlag": one_of[ "IGNORE", "SYNTONIZE", "HOLDOVER" ],
}

Errors
{
    "Error": "Parameter must be 'ignore', 'syntonize', 'holdover'"
}
```

28.1.11.9 "gps message"

```
Format
{
    "Success": "Message is sent"
}

Errors
{
    "Error": "Not supported on default interface"
}
```

28.1.11.10 "gps cm"

```
cmStatusToClockClassMapping:
{
    "cmStatus": x8,
    "clockClass": u8,
    "clockAccuracy": x8,
    "offsetScaledLogVariance": x16,
    "timeSource": x8,
    "timeTraceable": boolean,
    "frequencyTraceable": boolean
}

Format
{
    "cmStatusToClockClassMappingTable": array_of[ cmStatusToClockClassMapping ]
}
{
    "cmStatusToClockClassMapping": cmStatusToClockClassMapping
}

Errors
{
    "Error": "Status must be 0x00..0x0f"
}
{
    "Error": "Clock class must be 0..255"
}

Example
{
    "cmStatusToClockClassMappingTable":
    [
        {
            "cmStatus": "0x00",
            "clockClass": 6,
            "clockAccuracy": "0x21",
            "offsetScaledLogVariance": "0x4e5d",
            "timeSource": "0x20",
            "timeTraceable": true,
            "frequencyTraceable": true
        },
        {
            "cmStatus": "0x01",
            "clockClass": 140,
            "clockAccuracy": "0xfe",
            "offsetScaledLogVariance": "0xffff",
            "timeSource": "0xa0",
            "timeTraceable": false,
            "frequencyTraceable": true
        },
        {
            "cmStatus": "0x03",
            "clockClass": 160,
            "clockAccuracy": "0xfe",
            "offsetScaledLogVariance": "0xffff",
            "timeSource": "0xa0",
            "timeTraceable": false,
            "frequencyTraceable": false
        },
        {
            "cmStatus": "0x05",
            "clockClass": 150,
            "clockAccuracy": "0xfe",
            "offsetScaledLogVariance": "0xffff",
            "timeSource": "0xa0",
            "timeTraceable": false,
            "frequencyTraceable": false
        }
    ]
}
```

28.1.11.11 "gps nmea"

```
Format
{
}

Errors
{
    "Error": "Only available in NMEA mode"
}
```

28.1.12 Pulsetime (PPS/TOD-Output) Commands

```
Common Errors
{
    "Error": format_string("Command '%s' not found", command_name)
}
```

28.1.12.1 "pulsetime status"

```
Format
{
    "pulsetimeOutputInformation":
    {
        "outputStatus": one_of[ "RUNNING", "PENDING", "STOPPED" ],
        "startTime": time,
        "displayStartTime": "YYYY-MM-DD HH:MM:SS.NS",
        "pulseCountLimit": u32,
        "pulseCount": u32,
        "outputMode": one_of[ "SYNC", "HOLDOVER", "ALWAYS" ],
        "errorTolerance": u32,
        "autoRestart": boolean,
        "pulseProperties": { "period": u32, "width": u32 },
        "timeOutputEnabled": boolean,
        "timeOutputDelay": u32,
        "timeOutputInterface": { "name": one_of[ "DEFAULT", format_sting("COM%d", port) ], "baudrate": u32 },
        "timeOutputFormat": one_of[ { "format": "NMEA", "options": one_of[ "RMC", "ZDA", "RMC+ZDA" ] },
                                    { "format": "ASCII", "options": one_of[ "LOCAL", "UTC"] },
                                    "CM",
                                    "CUSTOM" ],
        "nmeaRmcVoidFlag": one_of[ "NEVER", "FREE", "HOLDOVER" ],
        "nmeaZdaTzInfo": one_of[ "NONE", "TZ", "TZ+DST" ]
    }
}

Example
{
    "pulsetimeOutputInformation":
    {
        "outputStatus": "RUNNING",
        "startTime": { "sec": 1581329920, "nsec": 0 },
        "displayStartTime": "2020-02-10 10:18:40",
        "pulseCountLimit": 0,
        "pulseCount": 621,
        "outputMode": "ALWAYS",
        "errorTolerance": 0,
        "autoRestart": true,
        "pulseProperties": { "period": 1000000, "width": 1000 },
        "timeOutputEnabled": true,
        "timeOutputDelay": 0,
        "timeOutputInterface": { "name": "DEFAULT", "baudrate": 9600 },
        "timeOutputFormat": { "format": "NMEA", "options": "RMC+ZDA" },
        "nmeaRmcVoidFlag": "FREE",
        "nmeaZdaTzInfo": "NONE"
    }
}
```

28.1.12.2 "pulsetime mode"

```
Format
{
    "outputMode": one_of[ "SYNC", "HOLDOVER", "ALWAYS" ]
}

Errors
{
    "Error": "Parameter must be 'sync', 'holdover', 'always'"
}
```

28.1.12.3 "pulsetime error"

```
Format
{
    "errorTolerance": u32
}
```

28.1.12.4 "pulsetime auto"

```
Format
{
    "autoRestart": boolean
}

Errors
{
    "Error": "Parameter must be 'on' or 'off'"
}
```

28.1.12.5 "pulsetime pulse"

```
Format
{
    "pulseProperties": { "period": u32, "width": u32 }
}

Errors
{
    "Error": "Period must be at least 500 us"
}
{
    "Error": "Parameter is missing"
}
{
    "Error": "Width must be at least 250 us"
}
{
    "Error": "Width must be at least 250 us shorter than period"
}
```

28.1.12.6 "pulsetime todout"

```
Format
{
        "timeOutputEnabled": boolean
}

Errors
{
    "Error": "Parameter must be 'enable' or 'disable'"
}
{
    "Error": "TOD output cannot be enabled. Pulse period is not an integral number of seconds"
}
```

28.1.12.7 "pulsetime delay"

```
Format
{
    "timeOutputDelay": u32
}

Errors
{
    "Error": "Delay must not be negative"
}
```

28.1.12.8 "pulsetime interface"

```
Format
{
    "timeOutputInterface": { "name": one_of[ "DEFAULT", format_sting("COM%d", port) ], "baudrate": u32 }
}

Errors
{
    "Error": "Interface must be 'default' or 'com[n]'"
}
{
    "Error": "COM port must be 1..3"
}
{
    "Error": format_string("Unable to select interface: %s %d\n", name, baudrate)
}
```

28.1.12.9 "pulsetime format"

```
Format
{
    "timeOutputFormat": one_of[ { "format": "NMEA", "options": one_of[ "RMC", "ZDA", "RMC, ZDA" ] },
                                { "format": "ASCII", "options": one_of[ "LOCAL", "UTC"] },
                                "CM",
                                "CUSTOM" ]
}

Errors
{
    "Error": "Format must be 'nmea', 'ascii', 'cm', 'custom'"
}
{
    "Error": "Parameter must be 'rmc', 'zda', 'both'"
}
{
    "Error": "Parameter must be 'utc' or 'local'"
}
```

28.1.12.10 "pulsetime void"

```
Format
{
    "nmeaRmcVoidFlag": one_of[ "NEVER", "FREE", "HOLDOVER" }
}

Errors
{
    "Error": "Parameter must be 'never', 'free', 'holdover'"
}
```

28.1.12.11 "pulsetime zone"

```
Format
{
    "nmeaZdaTzInfo": one_of[ "NONE", "TZ", "TZ+DST" ]
}

Errors
{
    "Error": "Parameter must be 'none', 'tz', 'dst'"
}
```

28.1.12.12 "pulsetime cm"

```
clockClassToCmStatusMapping:
{
    "clockClass": u8,
    "cmStatus": x8
}

Format
{
    "clockClassToCmStatusMappingTable": array_of[ clockClassToCmStatusMapping ]
}
{
    "clockClassToCmStatusMapping": clockClassToCmStatusMapping
}

Errors
{
    "Error": "Clock class must be 0..255"
}
{
    "Error": "Status code must be 0x00..0x0f"
}

Example
{
    "clockClassToCmStatusMappingTable":
    [
        {
            "clockClass": 6,
            "cmStatus": "0x00"
        },
        {
            "clockClass": 140,
            "cmStatus": "0x01"
        },
        {
            "clockClass": 150,
            "cmStatus": "0x05"
        },
        {
            "clockClass": 160,
            "cmStatus": "0x03"
        },
        {
            "clockClass": 165,
            "cmStatus": "0x04"
        },
        {
            "clockClass": 248,
            "cmStatus": "0x07"
        }
    ]
}
```

28.1.12.13 "pulsetime stop"

```
Format
{
    "Success": one_of[ "PPS-TOD output is stopped",
                       "PPS-TOD output is cancelled" ]
}
```

28.1.12.14 "pulsetime start"

```
Format
{
    "Success": one_of[ "PPS-TOD output is started",
                       "PPS-TOD output is scheduled" ]
}

Errors
{
    "Error": "Nanoseconds must be 0..999999999"
}
{
    "Error": "Time is missing"
}
{
    "Error": "Year is not correct"
}
{
    "Error": "Month is not correct"
}
{
    "Error": "Day is not correct"
}
{
    "Error": "Hours must be 0..23"
}
{
    "Error": "Minutes must be 0..59"
}
{
    "Error": "Seconds must be 0..59"
}
```

28.1.13 Nettime (SNTP Service) Commands

```
Common Errors
{
    "Error": format_string("Command '%s' not found", command_name)
}
```

28.1.13.1 "nettime status"

```
Format
{
    "sntpServerInformation":
    {
        "serverRunning": boolean,
        "onPortNumber": one_of[ "all", format_string("%d", port_number) ],
        "serverMode": one_of[ "UNICAST", "MANYCAST", "BROADCAST", "MIXED" ],
        "logPollInterval": u8
    }
}


Example
{
    "sntpServerInformation":
    {
        "serverRunning": true,
        "onPortNumber": "all",
        "serverMode": "UNICAST",
        "logPollInterval": 4
    }
}
```

28.1.13.2 "nettime mode"

```
Format
{
    "serverMode": one_of[ "UNICAST", "MANYCAST", "BROADCAST", "MIXED" ]
}

Errors
{
    "Error": "Server mode must be 'unicast' 'manycast', 'broadcast', 'mixed'"
```

28.1.13.3 "nettime poll"

```
Format
{
    "logPollInterval": u8
}

Errors
{
    "Error": "Log Poll/Broadcast interval must be 0..16"
}
```

28.1.13.4 "nettime stop"

```
Format
{
    "Success": "SNTP server is stopped"
}
```

28.1.13.5 "nettime start"

```
Format
{
    "Success": "SNTP server is started"
}

Errors
{
    "Error": "SNTP server is already running"
}
{
    "Error": format_string("Port %d not found", port)
}
{
    "Error": "Unable to start SNTP server"
}
```

28.1.14 Engine Commands

```
Common Errors
{
    "Error": format_string("Command '%s' not found", command_name)
}
```

28.1.14.1 "engine json on|off|ver"

```
Format
{
    one_of[
        "jsonMode": boolean,
        "jsonVersion": "version_string"
    ]
}

Errors
{
    "Error": "Parameter must be 'on', 'off', 'ver'"
}
```

28.1.14.2 "engine init <key>"

```
Format
{
    "Success": format_string("Clock initialisation requested with key: %s", key)
}

Errors
{
    "Error": "Parameter is missing"
}
{
    "Error": "Parameter must be 'default' or 'nvm'"
}
```

28.1.14.3 "engine nvm"

```
Format
{
    "Success": one_of["Current configuration is saved in NVM",
                      "NVM is reset to default configuration" ]
}

Errors
{
    "Error": "Parameter is missing"
}
{
    "Error": "Parameter must be 'save' or 'reset'"
}
```

28.1.14.4 "engine debug"

```
Format
{
    "debugEnabled": boolean
}

Errors
{
    "Error": "Parameter must be 'on' or 'off'"
}
```

28.1.14.5 "engine verbose"

```
Format
{
    "verboseOn": array_of[ u8 ]
}

Errors
{
    "Error": "Debug output needs to be turned on"
}
{
    "Error": "Level must be 0..23"
}

Example
{
    "verboseOn": [ 8, 15 ]
}
```

28.1.14.6 "engine monitor"

```
Format
{
    "clockMonitor": one_of[ format_string("COM%d", port), "OFF" ]
}

Errors
{
    "Error": "Parameter is missing"
}
{
    "Error": "Parameter must be 'on' or 'off'"
}
{
    "Error": "COM port must be 1..3"
}
{
    "Error": format_string("Unable to open COM%d", port)
}
```

28.1.14.7 "engine port [port_number]"

```
Format
{
    "portEnabled": boolean
}

Errors
{
    "Error": format_string("Port %d not found", port_number)
}
{
    "Error": "Parameter must be 'enable' or 'disable'"
}
```

28.1.14.8 "engine asymmetry [port_number]"

```
Format
{
    "portAsymmetry": i16
}

Errors
{
    "Error": format_string("Port %d not found", port_number)
}
{
    "Error": "Asymmetry compensation must be -10000..10000 ns"
}
```

28.1.14.9 "engine freqout"

```
Format
{
    "freqOut": u8
}

Errors
{
    "Error": "Frequency must be 5, 10, 20, 25 MHz"
}
{
    "Error": "Unable to change frequency output"
}
```

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