M88 Evaluation Kit

USER GUIDE

STO-DEV7227-HB REV. 2.1

Revision History

Document: STO-DEV7227-HB M88 Evaluation Kit User Guide		
Rev	Date	Comment
1.0	2016-10-17	Included in FW release v1.0.0
1.1	2016-11-11	Included in FW release v1.0.1 and v1.0.2
1.2	2016-12-09	
1.3	2017-02-16	Included in FW release v1.0.6
1.4	2017-03-07	Included in FW release v1.0.7
1.5	2017-04-20	Included in FW release v1.0.8
1.6	2017-07-18	Included in FW release v1.0.9
2.0	2019-06-04	Released with new Eval Kit model
2.1	2019-12-12	Included in FW release v1.0.19

Changes in Rev 2.1	
Section	Changes since previous revision
7	Table 1. PPS out is 50 Ω
9.1	Pull-up is available on UTX and not on URX
10	Clarified jumper positions
Changes in Rev 2.0	
Section	Changes since previous revision
All	New document template
All	Removed references to enclosure as board is now delivered without
11	Added description on usage of GNSS add-on board
13	Added application examples
17	Added descriptions on how to update FW
Changes in Rev 1.6	
Section	Changes since previous revision
10	Corrected jumper selection for P308
Changes in Rev 1.5	
Section	Changes since previous revision
9	Added information on pin 1 for the Trace Adapter.
18	Added picture on how to connect Trace Adapter.
Changes in Rev 1.4	
Section	Changes since previous revision
12	Added picture of oscillator add-on board.
Changes in Rev 1.3	
Section	Changes since previous revision
10	P402 and P401 were switched
8, 9, 10	Sorted out confusion with respect to COM port numbers.
7, 8	Clarification on which connector to use for single ended.

16	Rewrote first section for clarity.
9.1	Added pin descriptions to on-board connectors
Changes in Rev 1.2	
Section	Changes since previous revision
10	Removed restrictions in previous FW version.
12.1	Added values for which voltage control range to use.

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1 About this Document

This document describes the use of the M88 Evaluation Kit. Its purpose is to help a user to set up the board electrically and mechanically and how to communicate to it. It's not a complete guide for all functionality provided by the M88 module it's carrying. For this we refer to [1].

2 Scope

This document covers the M88 Evaluation Kit Rev A carrying the M80 Rev B module and running M88 v1.0.19 FW and later. It also covers the oscillator add-on board that is mounted on the M88 Evaluation Kit.

3 General Description

The M88 Evaluation Kit is an evaluation board for the M88 module. The board makes it possible to control and monitor all functionality provided by the M88. The board is powered through a single 5V power supply (included) or through Power-over-Ethernet. It provides two Ethernet interfaces for communication to the network, including PTP. It has a USB port for serial communication, SMA connectors and ITU-T G.703 V.11 compliant RJ45 for PPSIN, PPSOUT, TODIN and TODOUT plus multiple SMA connectors for configurable input and output frequencies. It provides a debug interface that can be used with Silicon Labs' Trace Adapter (not included) for communication with Silicon Labs' Developer IDE and a SPI interface for programming of the Si5348 chip onboard the M88. It also provides several jumpers for configuration.

The M88 Evaluation Kit also have two expansion slots intended for alternative oscillators and GNSS receivers respectively.

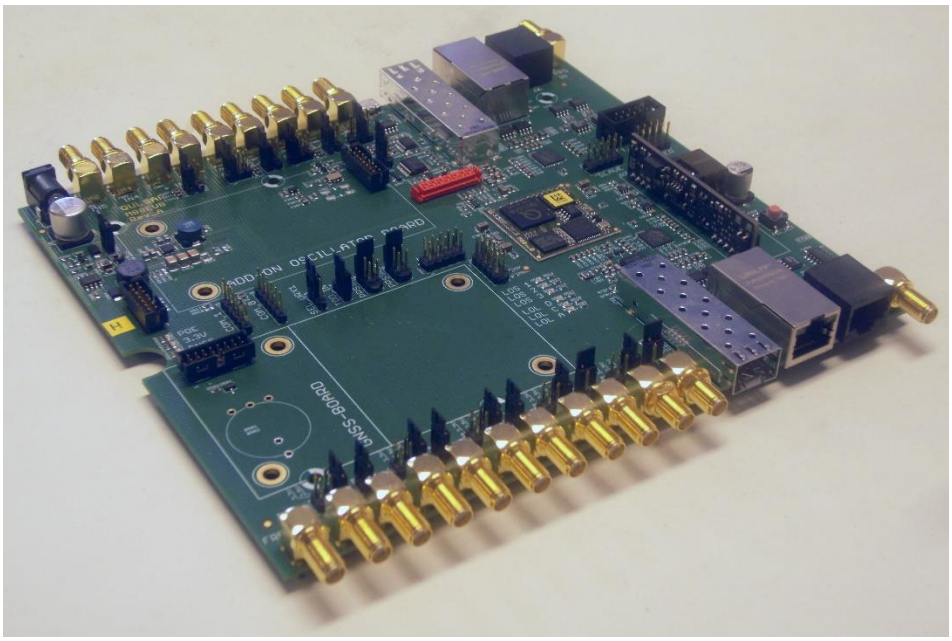


Figure 1. M88 Evaluation Kit (without Oscillator and GNSS add-on boards)

4 Before you begin

You will need the following to use the board:

- Power supply 5V, 3A – included
- Ethernet cables (SFP and fiber if you intend to use optical communication) – not included
- SMA cables – not included
- USB cable – included
- GNSS antenna – not included
- A PC with a terminal program such as TeraTerm or PuTTy – not included

Optional devices in case you plan to write and debug your own SW for the M88 and/or configure the Si5348 of the M88.

- Silicon Labs' Trace Adapter
- Silicon Labs Developer IDE
- SiLabs Trace Adapter

5 Power

The board only needs a single 5V supply and depending on what add-on boards that are used (some OCXO can consume considerable amount of current when warming up) we recommend using a power supply that can deliver 3A.

The board can also be powered by a PoE switch if connected to Port 1. This will supply adequate power in most cases except for when a large OCXO is used on an add-on board. The M88 Evaluation Kit has onboard regulators to provide all necessary voltages for the components on the M88 Evaluation Kit including the M88. There is a green LED indicating 3.3V to the left of the board when seen from the front panel and another LED indicating if power is supplied by PoE.

6 Block diagram

The block diagram below shows the connections the M88 Evaluation Kit and to some extent, for improved understanding the connections on the M88 module itself. In the picture JS means jumper select. See section 10.

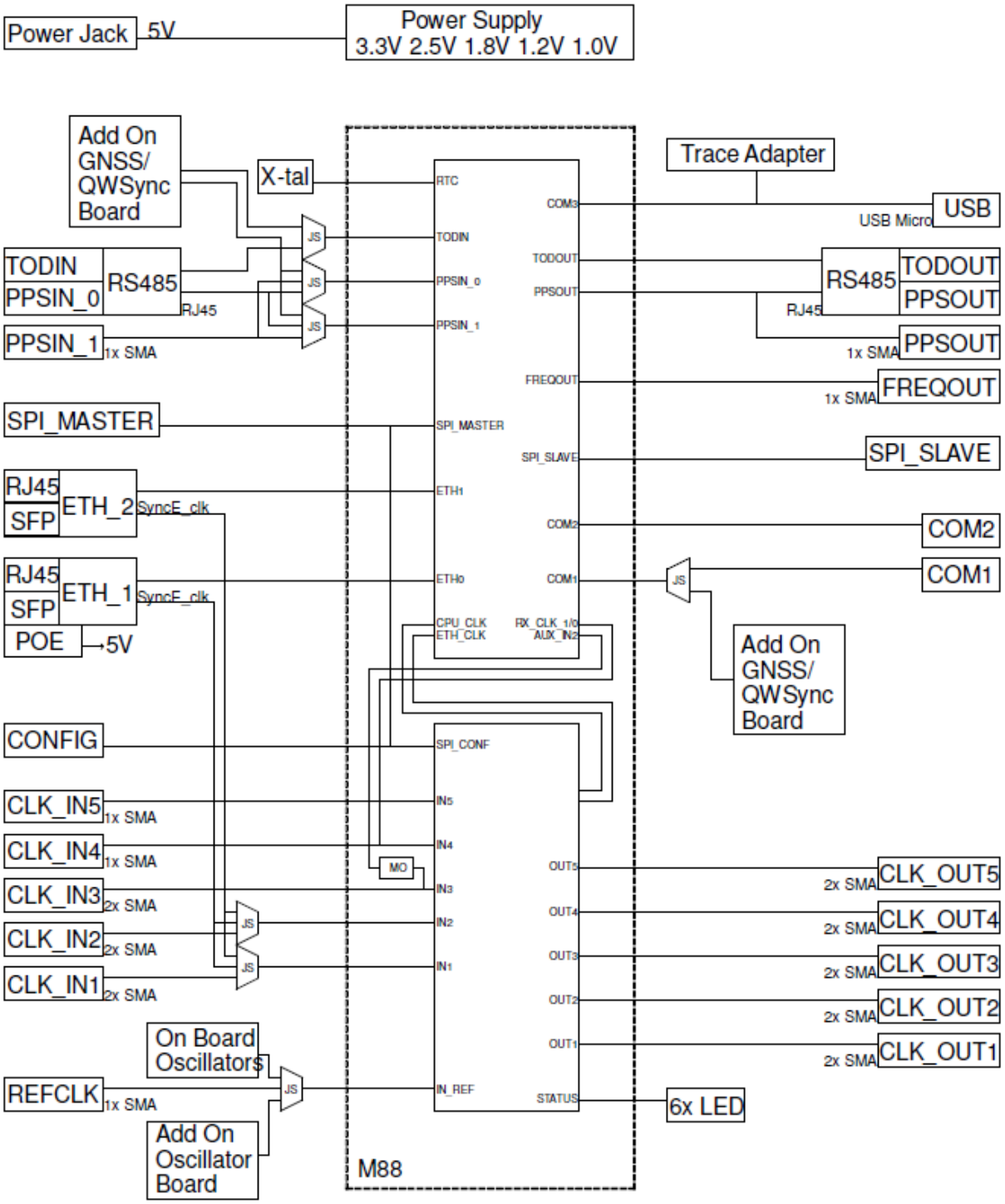


Figure 2. M88 Evaluation Kit block diagram

7 Front side connectors

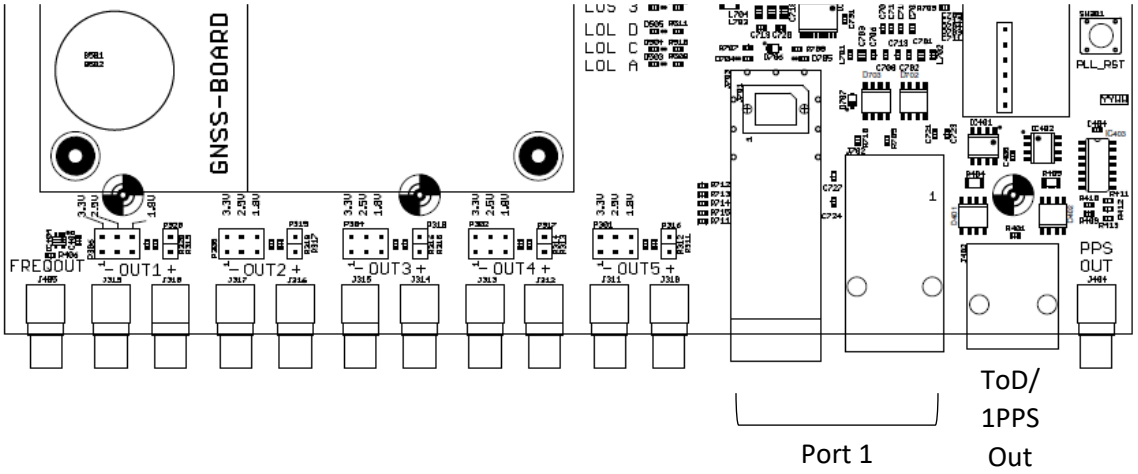


Figure 3. M88 Evaluation Kit front side connector placement.

Name	Type	Description
FREQOUT	SMA female	Synthonized frequency selectable through SW 5/10/20/25 MHz
OUT1 -/+	SMA female	Configurable low jitter frequency output. Use + for single ended.
OUT2 -/+	SMA female	Configurable low jitter frequency output. Use + for single ended.
OUT3 -/+	SMA female	Configurable low jitter frequency output. Use + for single ended.
OUT4 -/+	SMA female	Configurable low jitter frequency output. Use + for single ended.
OUT5 -/+	SMA female	Configurable low jitter frequency output. Use + for single ended.
Port 1	RJ45 with integrated LED and SFP slot	Primary Gigabit Ethernet. Use either RJ45 or SFP. RJ45 supports Power over Ethernet.
ToD/1PPS Out	RJ45	ToD and 1 PPS according to G.703 V.11. 1 PPS in RJ45 same signal as 1 PPS Out on SMA.
PPS Out	SMA female	Configurable PPS, default 1PPS 100ms positive pulse. 50 Ω

Table 1. M88 Evaluation Kit front side connector descriptions.

8 Back side connectors

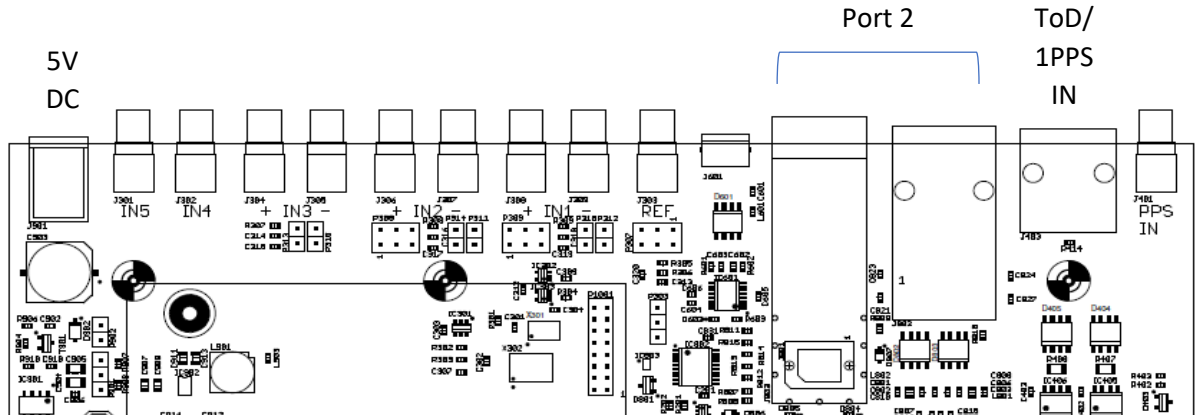


Figure 4. M88 Evaluation Kit back side connector placement.

Name	Type	Description
5V DC	DC jack 5.5/2.5 mm	5V power supply, center plus. Current needed depends on add-on boards.
IN5	SMA female	Frequency input, single ended.
IN4	SMA female	Frequency input, single ended.
IN3 +/-	SMA female	Frequency input, configurable as differential or single ended. Use + for single ended.
IN2 +/-	SMA female	Frequency input, configurable as differential or single ended. Use + for single ended.
IN1 +/-	SMA female	Frequency input, configurable as differential or single ended. Use + for single ended.
REF	SMA female	External reference frequency, e.g. for external oscillator.
Console	Micro USB	Console port for serial communication with M88 (COM3).
Port 2	RJ45 with integrated LED and SFP slot	Secondary Gigabit Ethernet. Use either RJ45 or SFP.
ToD/1PPS IN	RJ45	ToD and 1 PPS according to G.703 V.11. Alternate external time source.
1PPS IN	SMA female	1PPS input for synchronization to an alternate external time source, LVTTL

Table 2. M88 Evaluation Kit back side connector description.

9 Additional connectors

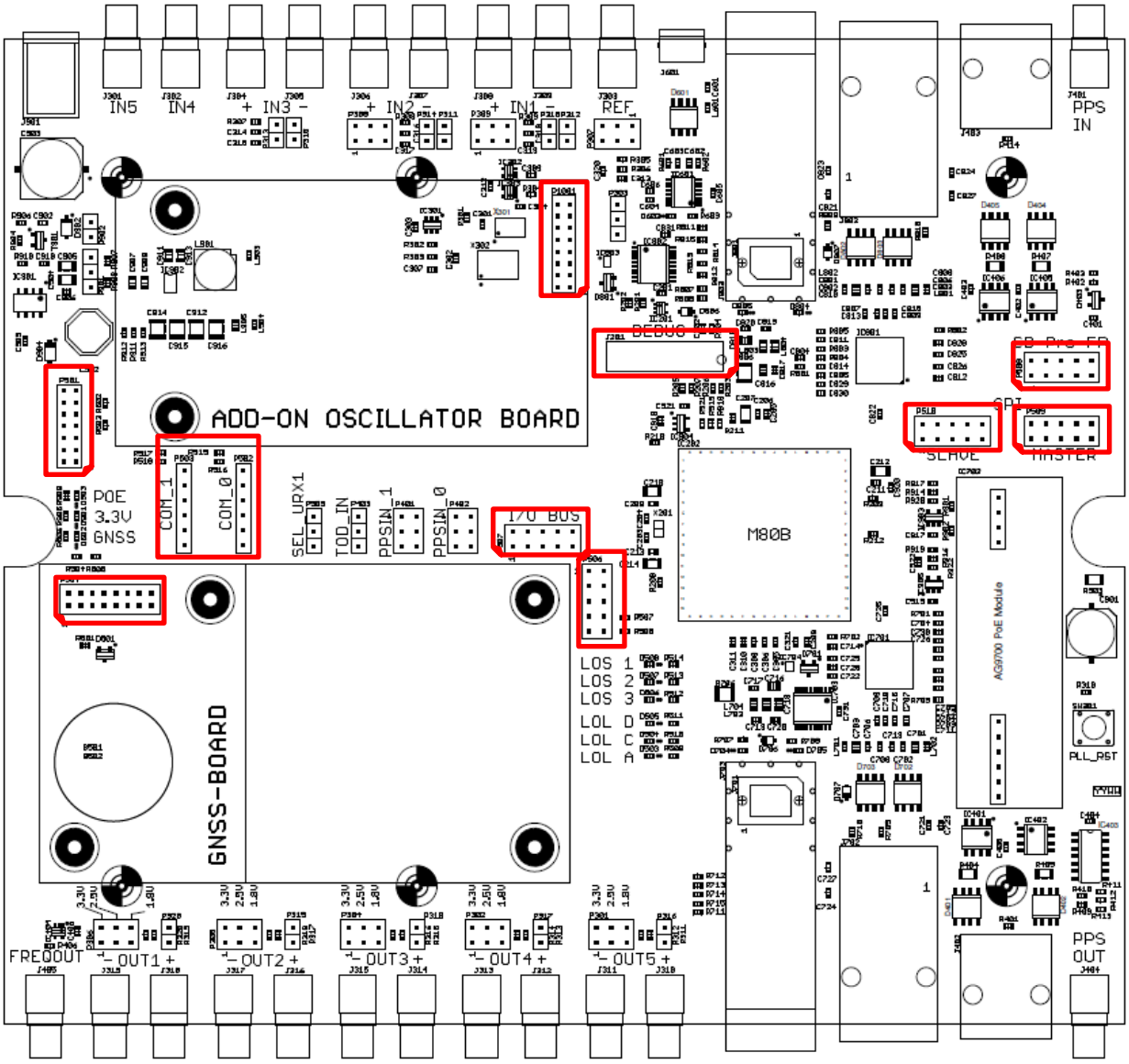


Figure 5. M88 Evaluation Kit board-top connector placement.

Name	Type	Description
J201	14-pin Micro-MaTch female	Debug port for connection to Silicon Labs' Trace Adapter. Please note polarity when connecting.
P502	6-pin header	COM2. *P502 is wrongly marked COM_0 on early PCB versions.*
P503	6-pin header	COM1
P508	10-pin header	CB Pro FP interface for the Si5348 on M88
P509	10-pin header	SPI MASTER. Connect a SPI slave here
P510	10-pin header	SPI SLAVE. Connect a SPI master here
P507	10-pin header	I/O BUS with Port F and MIRQ1
P501	14-pin header, 2 mm pitch	Reserved
P506	10-pin header	PLL Control
P504	16-pin header, 2 mm pitch	System connector GNSS add-on board
P1001	16-pin header, 2 mm pitch	System connector Oscillator add-on board

Table 3. M88 Evaluation Kit board-top connector description.

9.1 Connector pin descriptions

9.1.1 COM2

Pin	Signal	Comment
1	GND	
2	NC	
3	NC	
4	URX2	
5	UTX2	Pull-up
6	NC	

Table 4. COM2 connector pin description

9.1.2 COM1

Pin	Signal	Comment
1	GND	
2	URTS1	Pull-up
3	NC	
4	URX1	Jumper P505 decides if RX for COM1 is taken from here or from the GNSS add-on board system connector P504.
5	UTX1	Pull-up
6	UCTS1	

Table 5. COM1 connector pin description

9.1.3 CB Pro FP

Pin	Signal	Pin	Signal
1	GND	2	NC
3	GSICK	4	NC
5	GSSIN	6	NC
7	GSSIO	8	NC
9	PLL_SS_CS	10	NC

Table 6. CB Pro FP connector pin description

9.1.4 SPI Master

Pin	Signal	Pin	Signal
1	GND	2	NC
3	GSICK	4	NC
5	GSSIN	6	NC
7	GSSIO	8	NC
9	SPI_SS_CS	10	NC

Table 7. SPI Master connector pin description

9.1.5 SPI Slave

Pin	Signal	Pin	Signal
1	GND	2	NC
3	SPI_SCLK	4	NC
5	SPI_SDI	6	NC
7	SPI_SDO	8	NC
9	SPI_CS	10	NC

Table 8. SPI Slave connector pin description

9.1.6 I/O Bus

Pin	Signal	Pin	Signal
1	GND	2	MIRQ1
3	PF1	4	PF0
5	PF3	6	PF2
7	PF5	8	PF4
9	PF7	10	PF6

Table 9. I/O Bus connector pin description

9.1.7 PLL Control

Pin	Signal	Pin	Signal
1	GND	2	PLL_OE2
3	GND	4	PLL_OE1
5	GND	6	PLL_OE0
7	NC	8	PLL_FINC Pull down.
9	NC	10	PLL_FDEC Pull down.

Table 10. PLL Control connector pin description

9.1.8 GNSS Add-on Board System Connector

Pin	Signal	Pin	Signal
1	GND	2	GND
3	VBAT	4	3.3V
5	Reserved. NC	6	PF6 Pull-up
7	Reserved. NC	8	UTX1
9	Reserved. NC	10	URX1. Jumper P505 decides if RX for COM1 is taken from here or from the COM1 connector P503.
11	Reserved. NC	12	1PPS
13	Reserved. NC	14	3D sync. Have LED connected to PF7 for control.
15	NC	16	3.3V

Table 11. GNSS Add-on Board System Connector pin description

9.1.9 Oscillator Add-on Board System Connector

Pin	Signal	Pin	Signal
1	GND	2	3.3V
3	EXT_OSCCLK	4	3.3V
5	GND	6	GND
7	EXTREF	8	ACH0
9	GND	10	GND
11	AOUT0	12	ACH1
13	GND	14	GND
15	VREG_IN	16	VREG_IN

Table 12. Oscillator Add-on Board System Connector pin description

10 Jumpers

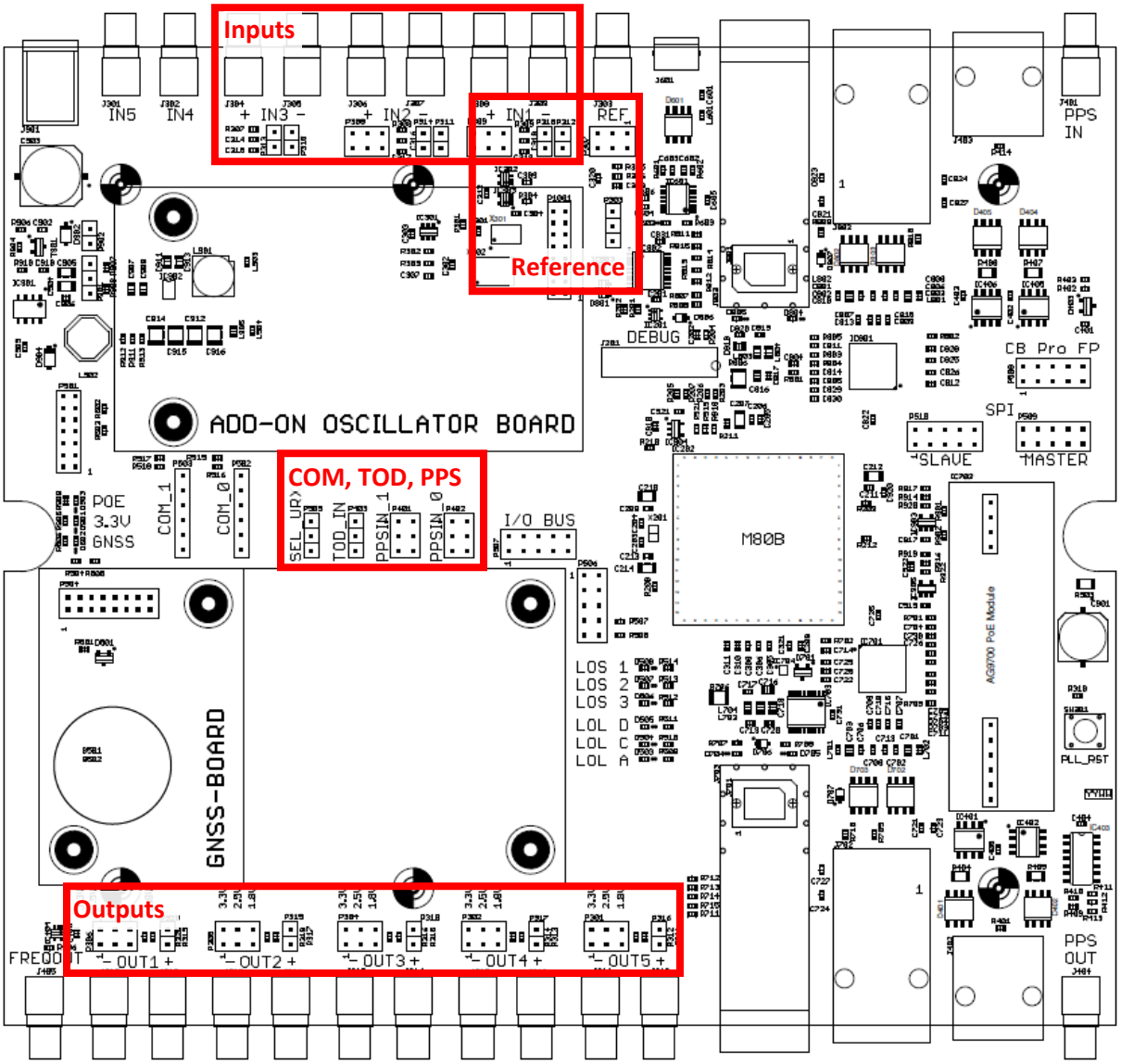


Figure 6. M88 Evaluation Kit jumper placement overview

10.1 Inputs

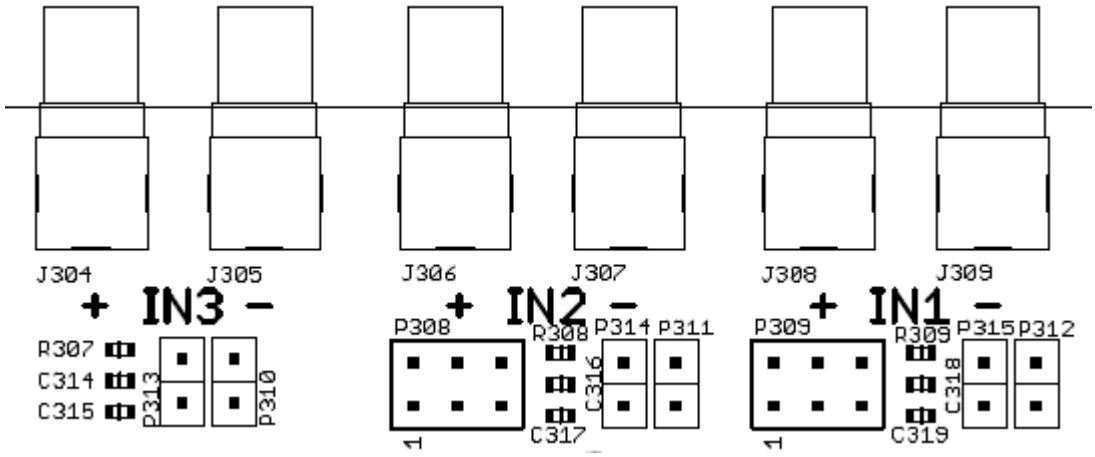


Figure 7. Input selection jumpers

Name	Description	Jumper position	Selects
P310, P313	Select single ended or differential input on IN3	P310	Single ended
		P313	Differential
P308	Selects M88 CLK_IN2	1-2	IN2+ on SMA
		3-4	125MHz from Port 1
		5-6	125 MHz from Port2
P311, P314	Select single ended or differential input on IN2	P311	Single ended
		P314	Differential
P309	Selects M88 CLK_IN1	1-2	IN1+ on SMA
		3-4	125MHz from Port 1
		5-6	125 MHz from Port2
P312, P315	Select single ended or differential input on IN1	P312	Single ended
		P315	Differential

Table 13. M88 Evaluation Kit input selection jumpers - Grey options are default factory settings

10.2 Reference

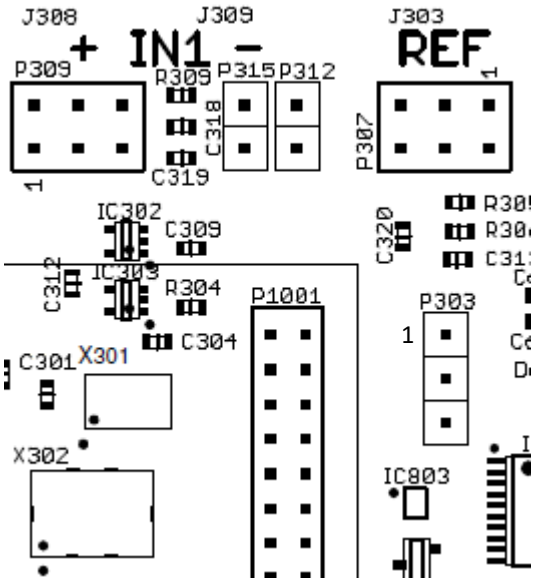


Figure 8. Reference selection jumpers – NB pin 1 position on P307

Name	Description	Jumper position	Selects
P307	Select M88 CLK_REF input	1-2	REF on SMA
		3-4	On-board oscillator
		5-6	Add-on board oscillator
P303	Select on-board oscillator	1-2	X301
		2-3	X302

Table 14. M88 Evaluation Kit reference selection jumpers - Grey options are default factory settings

10.3 Outputs

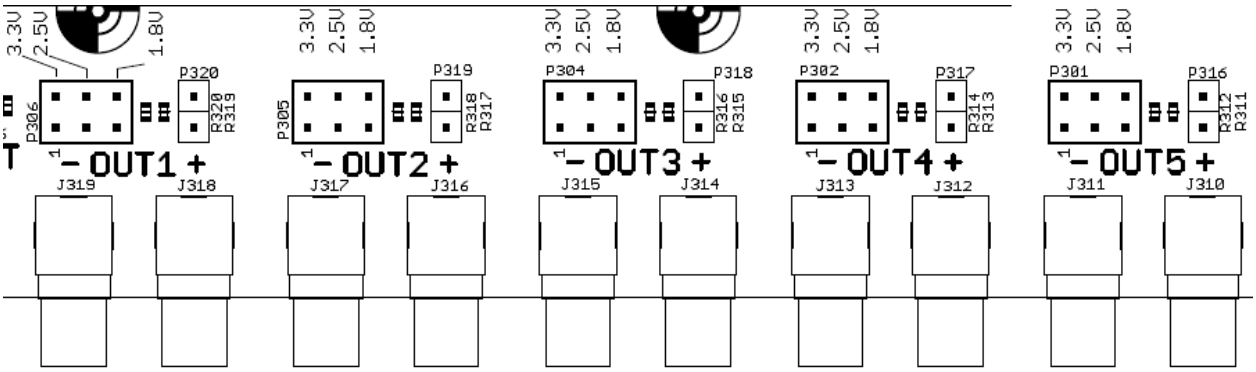


Figure 9. Output selection jumpers

Name	Description	Jumper position	Selects
P301, P302, P304, P305, P306	OUT1-5 voltage	1-2	3.3V
		3-4	2.5V
		5-6	1.8V
P316-P320	Select single ended or differential output on OUT5-1. Should match setting in SW.	On	Differential
		Off	Single ended

Table 15. M88 Evaluation Kit output selection jumpers - Grey options are default factory settings

10.4 COM, TOD, PPS

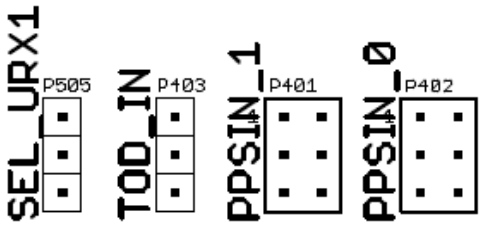


Figure 10. COM, TOD and PPS selection jumpers

Name	Description	Jumper position	Selects
P505	Select M88 COM1 RX	1-2	COM1 connector
		2-3	GNSS Add-on board
P403	Select M88 TODIN	1-2	GNSS Add-on board
		2-3	TOD/1PPSIN RJ45
P401	Select M88 PPSIN_1	1-2	1PPSIN SMA
		3-4	GNSS Add-on board
		5-6	TOD/1PPSIN RJ45
P402	Select M88 PPSIN_0	1-2	1PPSIN SMA
		3-4	GNSS Add-on board
		5-6	TOD/1PPSIN RJ45

Table 16. M88 Evaluation Kit COM, TOD and PPS selection jumpers - Grey options are default factory settings.

11 Add-on boards

11.1 Oscillator board

Silicon Labs provides optional oscillator board carrying a high-quality oscillator. To select the oscillator on the add-on board as reference source, move jumper P307 to pin 5-6. On the add-on board, allow for voltage control of the oscillator by moving the jumper P102 on the add-on board to pin 2-3.

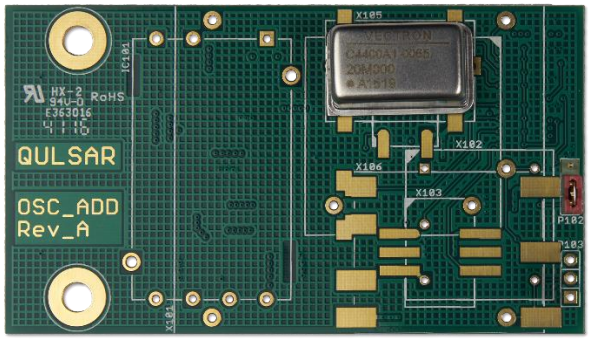


Figure 11. Oscillator add-on board

If voltage control is used, DCO control needs to be turned off for DSPLL A and the voltage control range needs to be set for the mounted oscillator. This is done using the command `ptp2 config -c 000 -v <value>` before the PTP engine is started.

Oscillator	Voltage control range
Vectron CA4400A1	1000

Table 17. Oscillator voltage control range

11.1 GNSS board

Silicon Labs provides an optional GNSS board for satellite-based reference time. The board comes with an antenna connector cable.

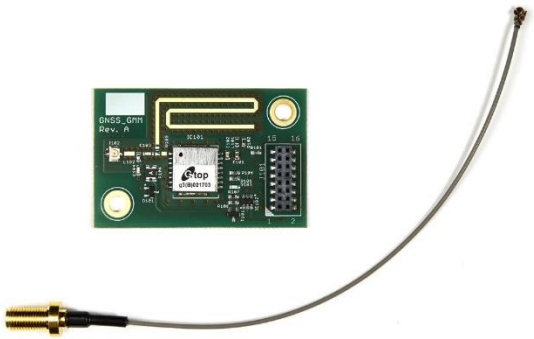


Figure 12. GNSS add-on board

Plug the GNSS board into connector P504 and a patch antenna to the antenna connector cable. Make sure the antenna has a clear view of the sky.

11.2 Enabling the GNSS LED

There is a LED situated close to P504 which can be used to indicate 3D fix on the GNSS receiver. To enable this function, the following commands needs to be given to the M88 (they can be put in the startup.ini for convenience).

`out cf 0x80` (set PF7 as output)

`out df 0xf3` (set PF7 to high)

This will result in the LED blinking green when the GNSS is acquiring a signal and change to fixed green when the GNSS receiver has a 3D fix.

11.3 Check GNSS reception on the M88

After starting the PTP engine (mode 1, 2 or 3) give the following commands to check the status.

`ptp2 gps status` (this will print GPS interface status)

`ptp2 gps nmea` (this will print satellite information)

12 Connecting to the board

- After powering the system, connect one end of the USB cable to the M88 Evaluation Kit and the other end to your computer. After connecting to the PC, the "Found New Hardware Wizard" will appear on the PC. Allow the wizard to install the USB driver automatically.
- Verify which communication port is assigned to the USB serial port by checking the Device Manager. You will need this information to configure the serial port being used.
- Open your terminal program application and connect it to the serial port using a baud rate of 115200, 8 bit data, no parity, 1 stop bit and no flow control.
- When you hit enter, you should see the following:

  ```
  localhost.localdomain (M88-128, v1.0.x)
  Login:
  ```

  Use the following credentials to login:

  ```
  Login: root
  Password: root
  ```

13 Application examples

These application examples are meant as a quick start guide and refers to the use of Silicon Labs' Qg 2 Carrier Grade Multi-Sync Gateway and PTP Grandmaster (see [2])

13.1 Set up the M88 Evaluation Kit as a E2E, Multicast PTP slave

Here's a guide on how to set up the Qg 2 as Grandmaster and get the M88 Evaluation Kit to synchronize to the Qg 2.

13.1.1 Setting up the Qg 2

Please refer to [3] for details on how to communicate to and configure the Qg 2.

1. On the Home page, select GNSS Only as Operating Mode, Start the engine (if it isn't already) and make sure PTP Sync Status is Locked (Status LED green).
2. On the PTP→Port page and for Port 1, make sure the State is Enable and select E2E Delay Mechanism and IPv4 Network Protocol. Set the Announce Interval to 1. If Multicast/Unicast operation is set to Unicast, go to PTP→Unicast and set Unicast Operation to Disabled.
3. On the PTP→Clock page, make sure Domain Number is set to 0.
4. On the Interface→PTP Timing Ports page and for Port 1, make sure the VLAN Configuration Type is set to Off.

13.1.2 Setting up the M88 Evaluation Kit

1. Connect Port 1 of the M88 Evaluation Kit to Port 1 of the Qg 2. Either directly or through a switch.
2. Make sure the M88 has a link (Port 1 refers to enet0 and Port 2 to enet1)

```
A:/root> ipconfig enet0
Interface "enet0":
Ip address      169.254.144.153 (DHCP)
Netmask         255.255.0.0
Gateway         N/A
MAC:            fc:af:6a:02:52:15
Link state:     1000M/Full

Primary DNS     N/A
Secondary DNS   N/A
DNS timeout     10
Mailhost        N/A
```

3. Start the PTP engine on the M88 Evaluation Kit in mode 0

```
A:/root> ptp2 start 0
PTP Time: 2019-02-15 13:24:40
UTC Offset: 37 s
*** PTPv2 up and running ***
```

4. Wait for the following message to appear

```
A new master time is received or the network topology was changed.
Update local clock with new offset: sec: -0 nsec: 866271987
```

13.2 Set up the M88 Evaluation Kit as a E2E, Unicast PTP slave

Here's a guide on how to set up the Qg 2 as Grandmaster and get the M88 Evaluation Kit to synchronize to the Qg 2.

13.2.1 Setting up the Qg 2

Please refer to [3] for details on how to communicate to and configure the Qg 2.

1. On the Home page, stop the engine if it's running.

2. On the Interface→PTP Timing Ports page and for Port 1, set DHCP to enabled if connected to a network which has a DHCP server or set DHCP to disabled and enter a proper IP address and mask. Click Apply.
3. On the Interface→PTP Timing Ports page and for Port 1, make sure the VLAN Configuration Type is set to Off.
4. On the Home page, select GNSS Only as Operating Mode, Start the engine and make sure PTP Sync Status is Locked (Status LED green).
5. On the PTP→Unicast page and for Port 1, set Unicast Operation to Master and make sure Negotiation is on. Click Apply.
6. On the PTP→Port page and for Port 1, make sure the State is Enable and select E2E Delay Mechanism and IPv4 Network Protocol. Set the Announce Interval to 1. Make sure Multicast/Unicast operation is shown as Unicast.
7. On the PTP→Clock page, make sure Domain Number is set to 0.

13.2.2 Setting up the M88 Evaluation Kit

1. Connect Port 1 of the M88 Evaluation Kit to Port 1 of the Qg 2. Either directly or through a switch.
2. Either use DHCP or set an IP address and mask for the same subnet as the Qg 2 master.

```
ipconfig enet0 -a 192.168.2.101 -m 255.255.255.0
```

3. Make sure the M88 has a link (Port 1 refers to enet0 and Port 2 to enet1)

```
A:/root> ipconfig enet0
Interface "enet0":
Ip address      192.168.2.101
Netmask         255.255.255.0
Gateway         N/A
MAC:            fc:af:6a:02:52:15
Link state:     1000M/Full

Primary DNS     N/A
Secondary DNS   N/A
DNS timeout     10
Mailhost        N/A
```

4. Verify the network connection by pinging the Qg 2.

```
A:/root> ping 192.168.2.100
Pinging 192.168.2.100 (192.168.2.100)
Reply from 192.168.2.100: bytes=72, time<10ms
Reply from 192.168.2.100: bytes=72, time<10ms
Reply from 192.168.2.100: bytes=72, time<10ms
Reply from 192.168.2.100: bytes=72, time<10ms
```

5. Start the PTP engine on the M88 Evaluation Kit in mode 0

```
A:/root> ptp2 start 0
PTP Time: 2019-02-15 13:24:40
UTC Offset: 37 s
```

```
*** PTPv2 up and running ***
```

6. Set Port 1 to Unicast Slave

```
A:/root> ptp2 port 1 unicast slave
A:/root> Unicast port state: PTP2_STATE_SLAVE
```

7. Add the Qg 2 to the list of accepted masters

```
A:/root> ptp2 unicast 1 node add 192.168.2.100 0 0 0
A:/root> *** Unicast node dataset ***
{
 Clock identity: FF:FF:FF:FF:FF:FF:FF:FF
 Network protocol: UDP/IPv4
 Network address: 192.168.2.100
 Node type: MASTER
 Announce granted: FALSE
 Announce interval: 1
 Announce duration: 300
 Sync granted: FALSE
 Sync interval: 0
 Sync duration: 0
 Delay response granted: FALSE
 Delay response interval: 0
 Delay response duration: 0
 Local priority: 0
}
```

8. Wait for the following message to appear

```
A new master time is received or the network topology was changed.
Update local clock with new offset: sec: -0 nsec: 866271987
```

Please refer to [1] for commands on how to further control and monitor the PTP communication.

14 Using the PTP engine

Detailed information about how to interact with the PTP engine can be found in [1] which can be downloaded from our web site.

Any commands that the M88 should execute at startup, such as setting message rates etc. can be stored in the startup.ini file under the systems folder.

Using the serial port, the startup.ini file can be transferred to your PC using the `kermit –s <filename>` command, edited on your PC and then downloaded to the M88 again using `kermit –r`. If the terminal program in Developer is used, the commands `send` and `recv` can be used to transfer files instead of Kermit. Type `help send` respectively `help recv` for more information. Alternatively, FTP can be used over the network to upload the startup.ini file, edit the contents of the file, and then download to the systems folder.

15 Using the PLL

In the same way that the PTP engine can be configured using the *ptp2* set of commands, there are many possibilities of configuring the onboard PLL functionality using the *pll* set of commands. Here's a general description of these commands. For brief information of the various commands, type `pll` help in the console. For more detailed information, we refer to [1].

15.1 Configuration

Similar to the PTP engine, some parameters need to be configured in advance, in the sense that all modifications to the configuration are stored in memory and will only take effect after they are loaded into the PLL (see section 15.2). There are three sections that needs to be configured: Inputs, DSPLLs and Outputs. The currently loaded configuration can be shown using the command `pll config print`.

15.1.1 Configure inputs

```
Usage: pll config input <inpin_num> <command> [parameters]
```

Configure the input frequency for the specified input or disable/enable the specified input.

15.1.2 Configure DSPLL

```
Usage: pll config dspll <dspll_num> <command> [parameters]
```

Configure what input should feed the DSPLL, any selection method, the frequency plan for the DSPLL and whether the DSPLL should be controlled by DCO or not.

15.1.3 Configure outputs

```
Usage: pll config output <outpin_num> <command> [parameters]
```

Configure which DSPLL should drive the specified output, what frequency the output should have and whether it's enabled or disabled.

15.2 Loading

When the configuration is done, this is made effective by the command `pll load current`.

15.3 Controlling

With the PLL running, some parameters can be changed in runtime. This include enabling and disabling inputs and outputs.

15.3.1 Control input

```
Usage: pll control input <inpin_num> <command> [parameters]
```

Enable or disable the specified input.

15.3.2 Control DSPLL

```
Usage: pll control dspll <dspll_num> <command> [parameters]
```

Assign a specified input to the specified DSPLL. Only possible if DSPLL is set to manual input selection.

15.3.3 Control Output

```
Usage: pll control output <outpin_num> <command> [parameters]
```

Enable or disable the specified output.

16 Further configuration of the M88 Evaluation Kit

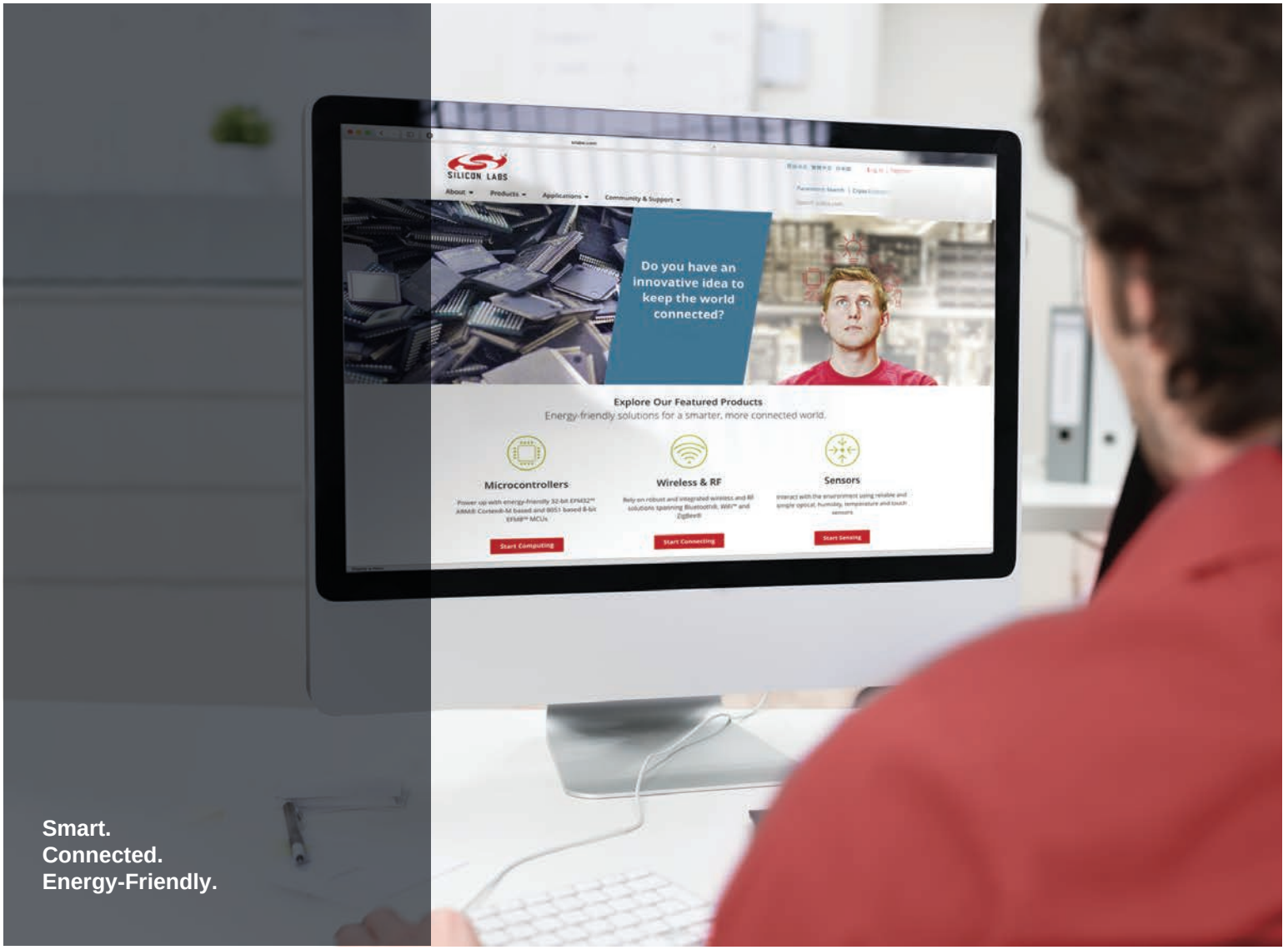
For details on how to configure and control the PLL section of the M88, see [1].

17 Updating firmware on M88 Evaluation Kit

Please refer to [4] on various ways to update the FW on the M88 Evaluation Kit.

18 References

[1] STO-DEV7210-AL M88 Module Design Manual
[2] Qg 2 Multi-Sync Gateway and PTP Grandmaster Datasheet
[3] STO-DEV7250-HR Qg 2 Multi-Sync Gateway User Guide
[4] STO-DEV7327-HB M64, M68 and M88 FW Update Guide



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