ONET1130EC-EVM 11.7-Gbps transceiver with dual CDRs and modulator driver

User's Guide

Literature Number: SNLU245
February 2019

Contents

ONET1130EC-EVM 11.7-Gbps transceiver with dual CDRs and modulator user's guide

This document describes the main features and functionality of the evaluation module (EVM) board for the part numbers ONET1130EC and ONET1130EP.

The ONET1130EC and ONET1130EP are 11.7-Gbps transceivers with integrated limiting amplifier and modulator driver. The ONET1130EC includes dual CDRs and the ONET1130EP does not.

The EVM can be used to evaluate the performance of the parts in conjunction with an electroabsorptive modulated laser (EML) transmit optical subassembly (TOSA) and a receive optical subassembly (ROSA) in standard XMD compliant packages.

The EVM is controlled with USB2ANY graphic user interface (GUI). This software can be downloaded at www.ti.com.

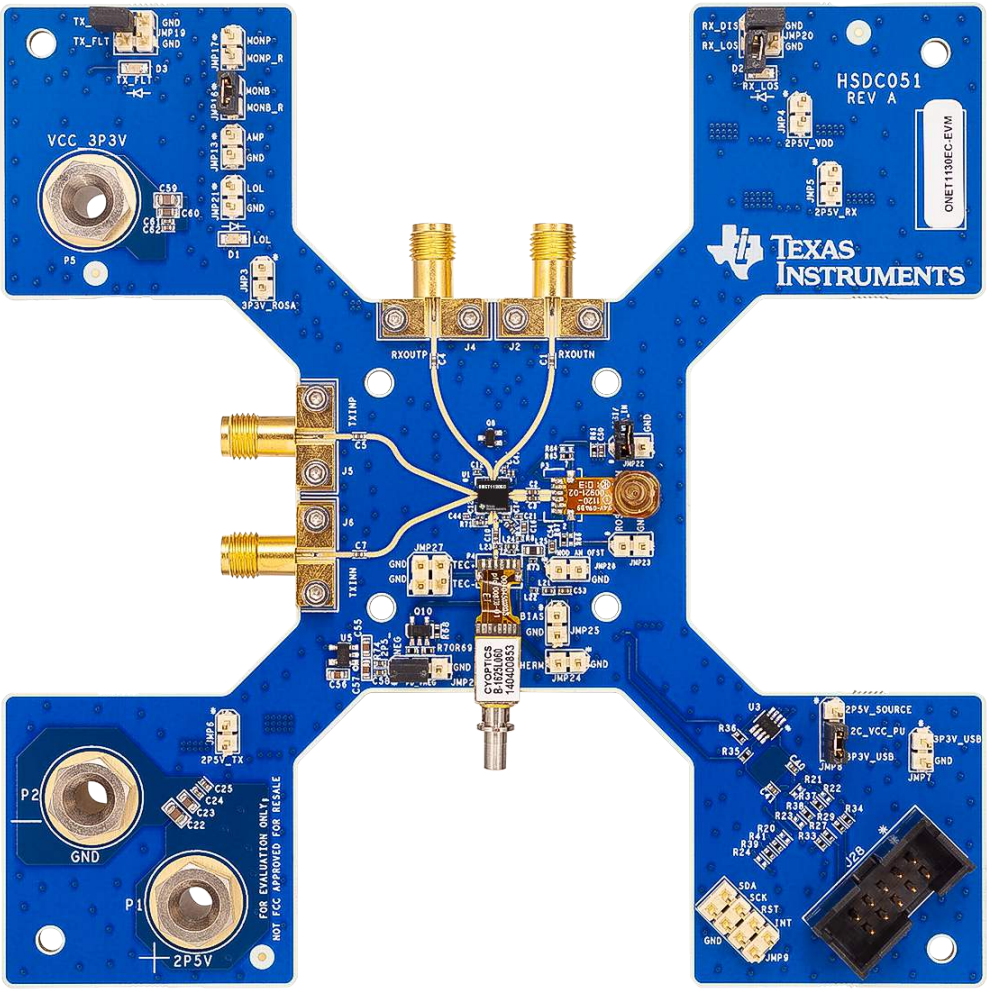

Figure 1. ONET1130EC-EVM

1 Trademarks

All trademarks are the property of their respective owners.

2 Hardware and Equipment

The following hardware and equipment are required to evaluate the EVM:

- An ONET1130EC-EVM
- An XMD-compliant EML TOSA
- An XMD-compliant PIN or APD ROSA
- TI USB2ANY Interface Adaptor
- TI USB2ANY Explorer Software
- A USB cable with standard-A to Mini-B connector
- A PC with a USB A port
- RF cables with SMA connectors
- External thermoelectric controller
- Single-mode fiber patch cords
- Electrical cables with banana jack connections

3 EVM Block Diagram

Figure 2 represents the block diagram of the ONET1130EC-EVM. The board is designed to be powered from a 2.5-V supply using cables with banana jacks.

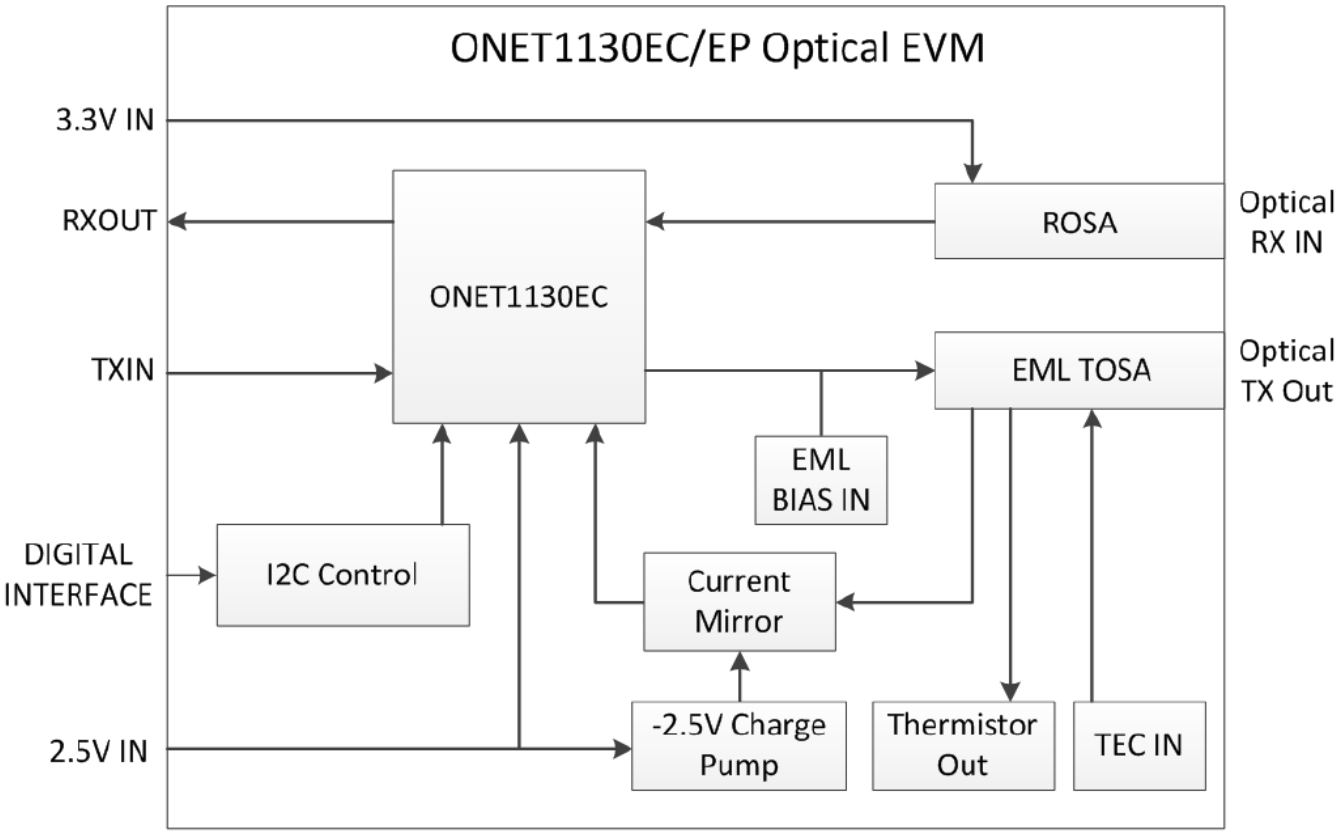

Figure 2. ONET1130EC-EVM Block Diagram

4 EVM Connections

Figure 3 shows the location of the major inputs and outputs on the EVM board.

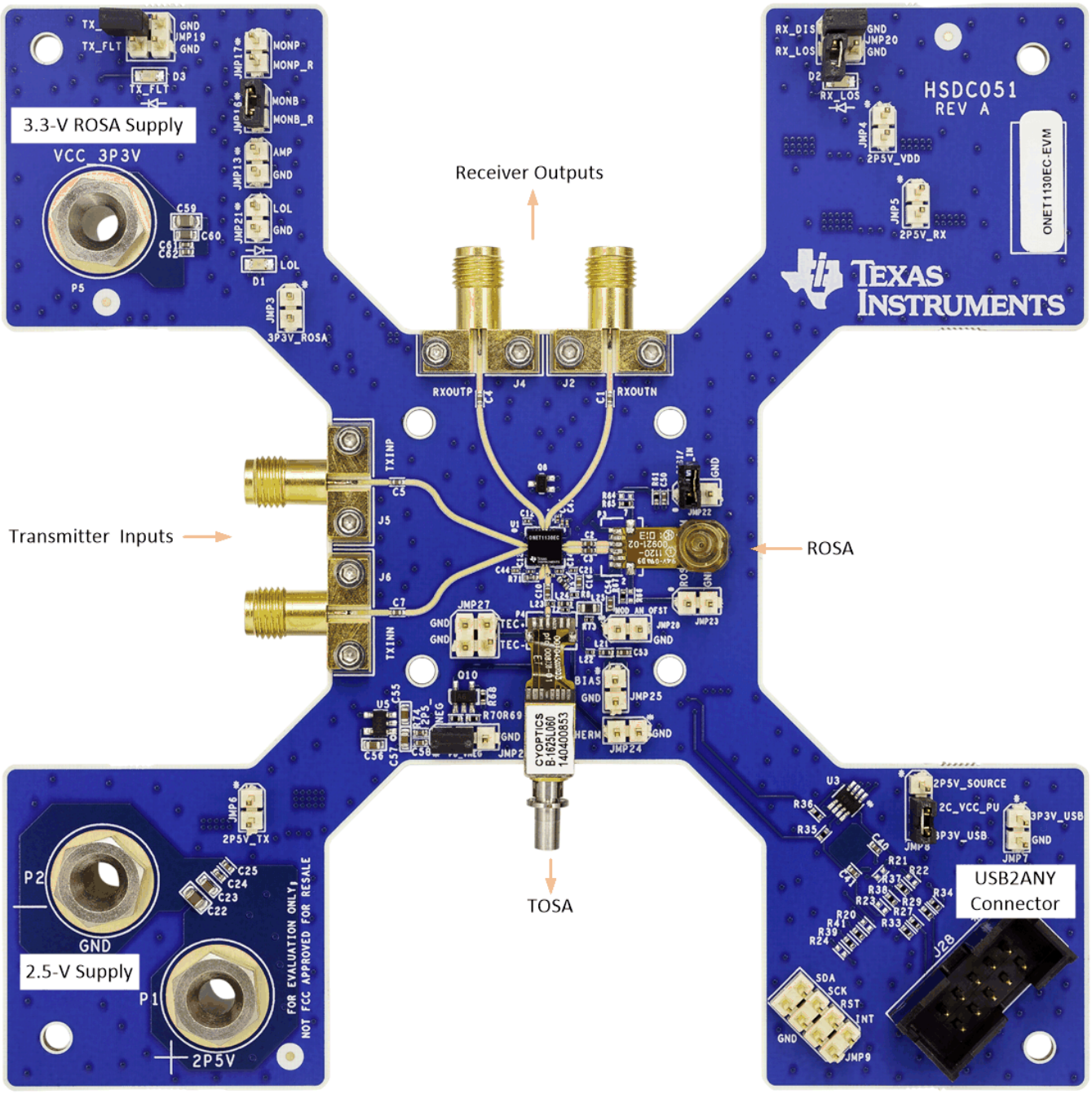

Figure 3. ONET1130EC-EVM Connections

A ROSA and TOSA are to be supplied by the user. In addition, connections for the EML bias voltage and TEC controller are also required. Figure 4 shows the locations for the ROSA and TOSA, EML bias voltage, TOSA thermistor, and the TEC+ and TEC– connections to the TEC controller.

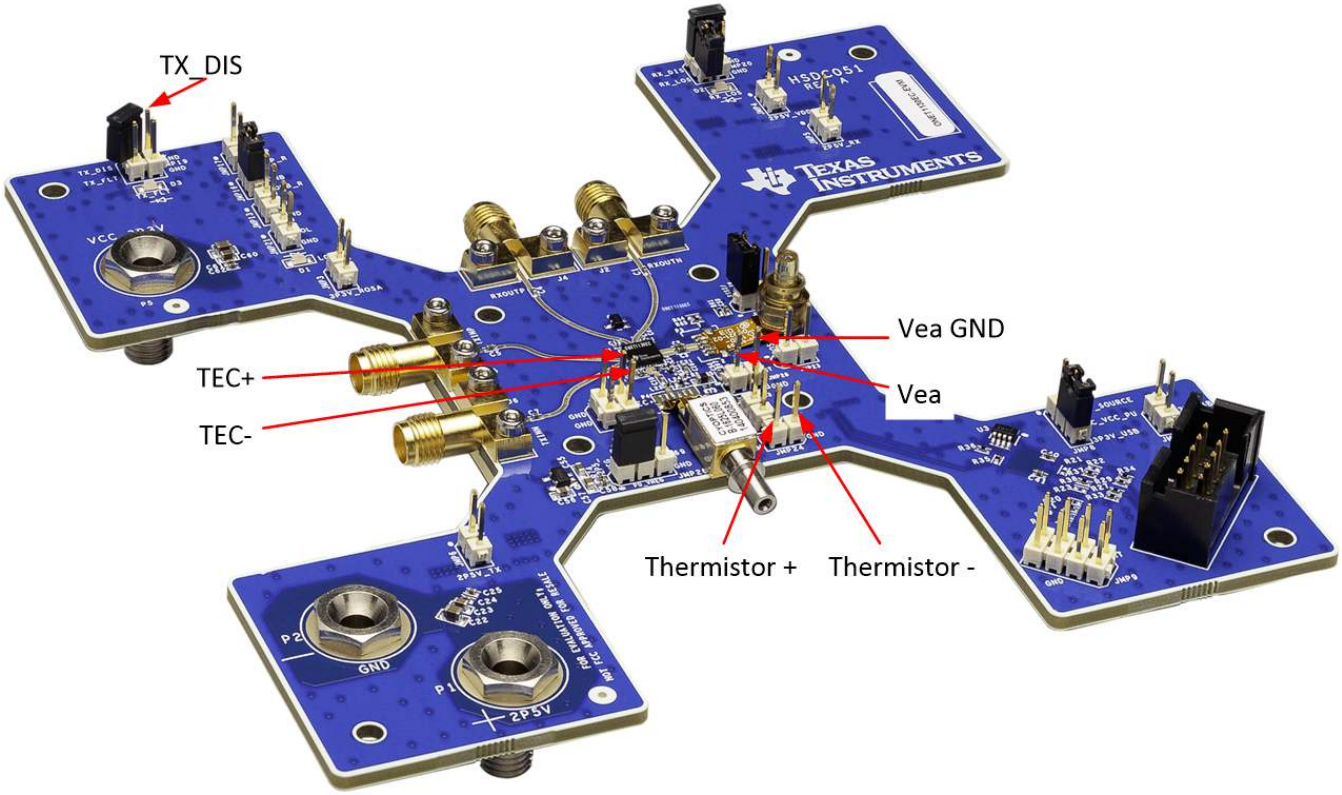

Figure 4. ONET1130EC-EVM Connections

5 Measurement Setup

Follow this procedure to quickly setup for measurements.

5.1 USB2ANY GUI Installation

Follow the steps below to install the USB2ANY software and confirm the GUI to ONET1130EC-EVM communication.

1. Install the USB2ANY GUI onto the computer and follow the instructions to install this software.
2. Check the USB2ANY packaging for the box and cables necessary to set up the ONET1130EC-EVM. Figure 5 shows the required USB2ANY hardware.

Figure 5. USB2ANY Box and Cables

3. Connect the USB2ANY 10-pin cable to the USB2ANY box as shown in Figure 6. Connect the other side of the 10-pin cable need to J28 on the ONET1130EC-EVM. Note that this cable is locked.

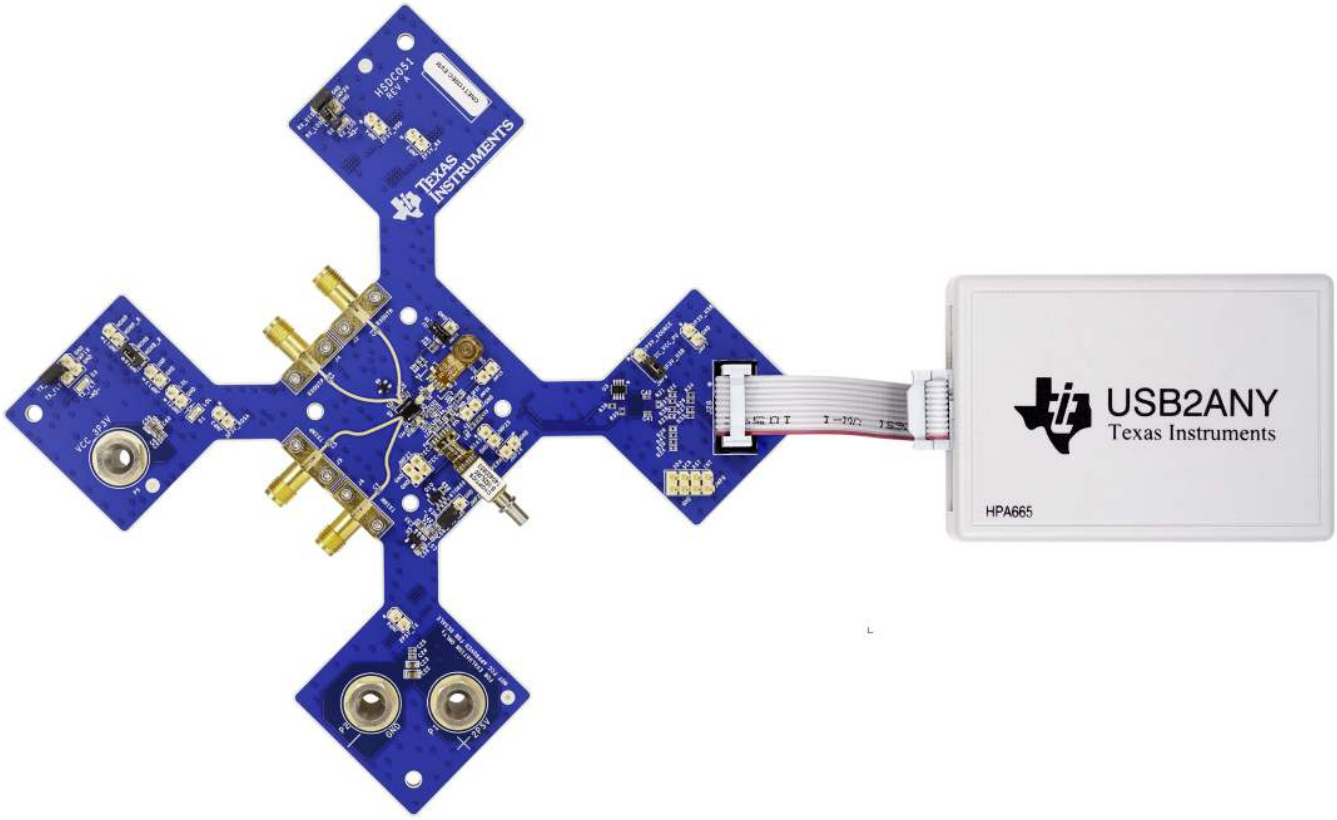

Figure 6. Cable Connected to USB2ANY

4. Start the USB2ANY GUI and make sure the GUI authenticates the USB2ANY box. The GUI should show the serial number and firmware revision as shown in Figure 7.

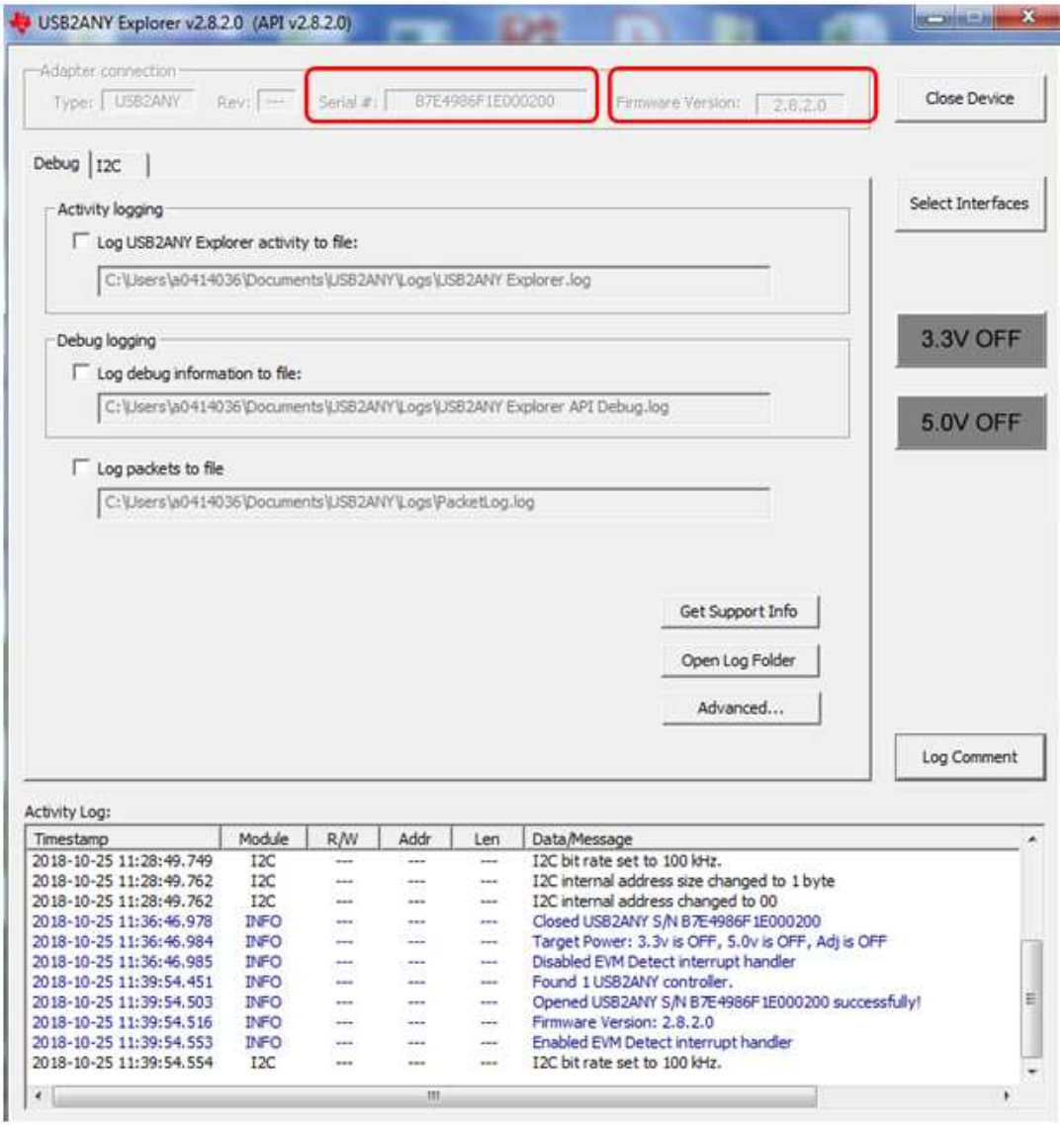

Figure 7. USB2ANY Box Serial Number and Firmware Revision

5. Click on the USB2ANY tab and change the slave address to 0x08 and turn on 3.3-V supply as shown in Figure 8.

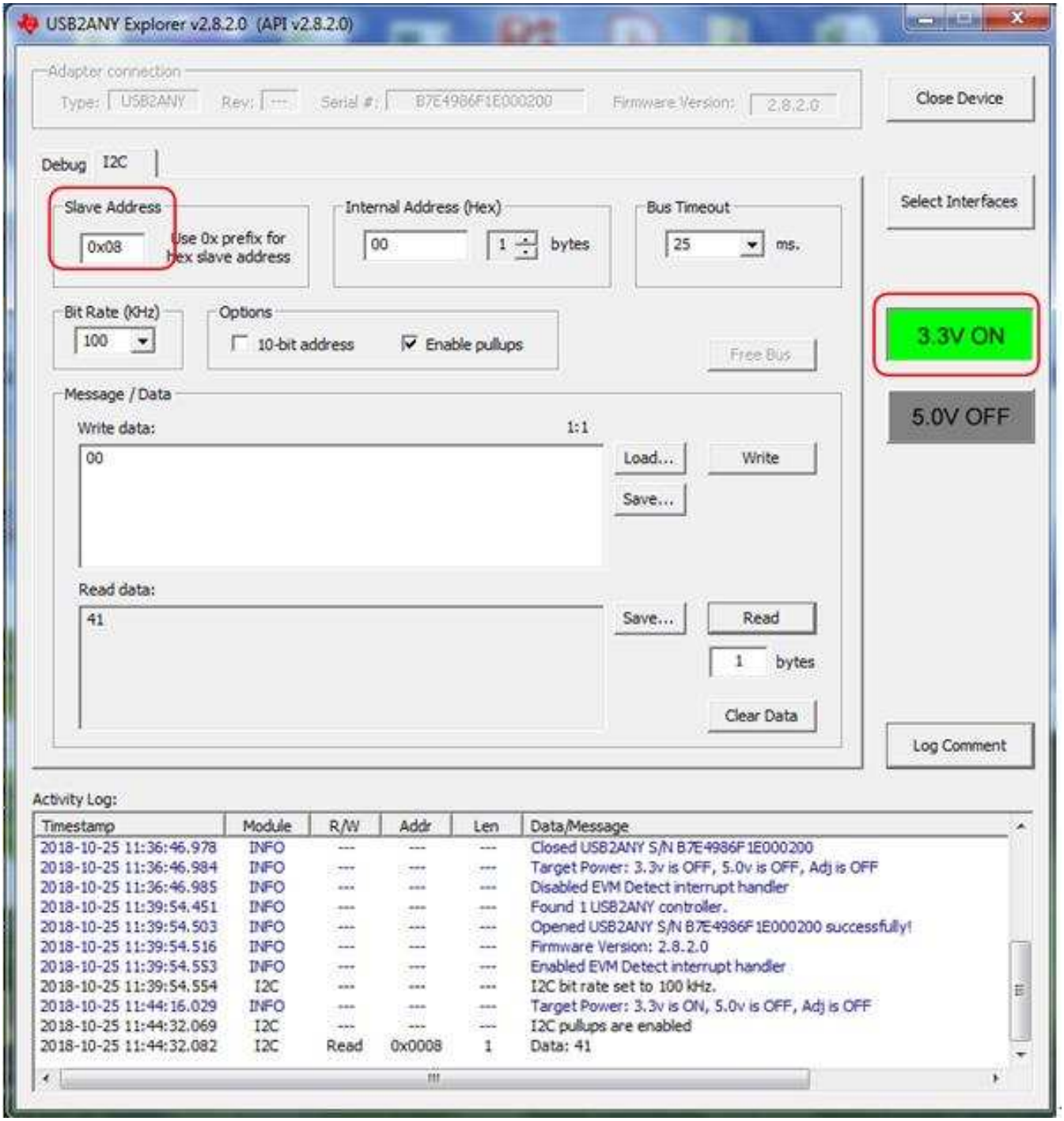

Figure 8. USB2ANY Slave Address

6. Make sure the internal address is set to 00 and click the "Read" button. If the read data is "41," the GUI and ONET1130EC-EVM have reliable communication. See Figure 9

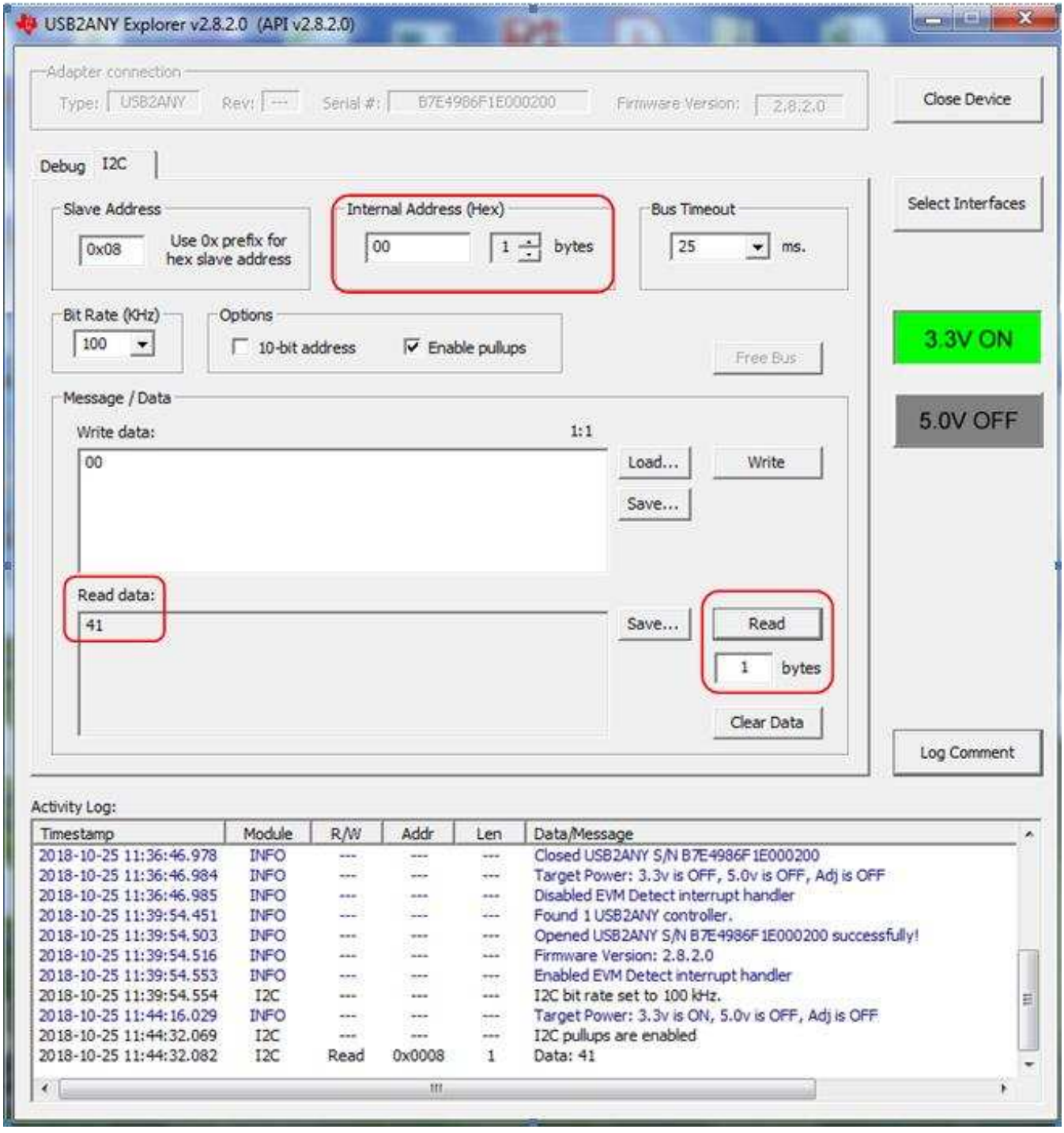

Figure 9. USB2ANY GUI to ONET1130EC-EVM Reliable Communication

Follow these steps to gather ONET1130EC-EVM measurements:

1. Solder the ROSA and TOSA onto the EVM.
2. Connect a differential data input signal source to the SMA connectors TXINP/TXINN through 50-Ω matched impedance cables. Set the data rate between 9.8 Gbps and 11.7 Gbps. Set the amplitude between 100mVp-p differential and 1000mVp-p differential.
3. Connect the output SMA connectors RXOUP/RXOUTN through 50-Ω matched impedance cables to a digital communications analyzer (DCA).
4. Connect the USB dongle to the EVM and attach the interface cable from the USB port of the computer to the mini-B USB port of the dongle.
5. Apply a +2.5-V supply to the +2.5-V banana jack and connect the supply ground to the GND banana jack.
6. Apply a negative bias voltage in the range of –0.4 V to –1.5 V for the EML to JMP28. The required voltage is TOSA-dependent.
7. Connect the TOSA thermistor at JMP24 to the TEC controller.
8. Connect the TEC+ and TEC– at JMP27 to the TEC controller.
9. Connect the TOSA to the optical input of a DCA through a single-mode fiber patch cord.
10. Connect an optical input source to the ROSA through a single-mode fiber patch cord.

Figure 10 shows a typical setup.

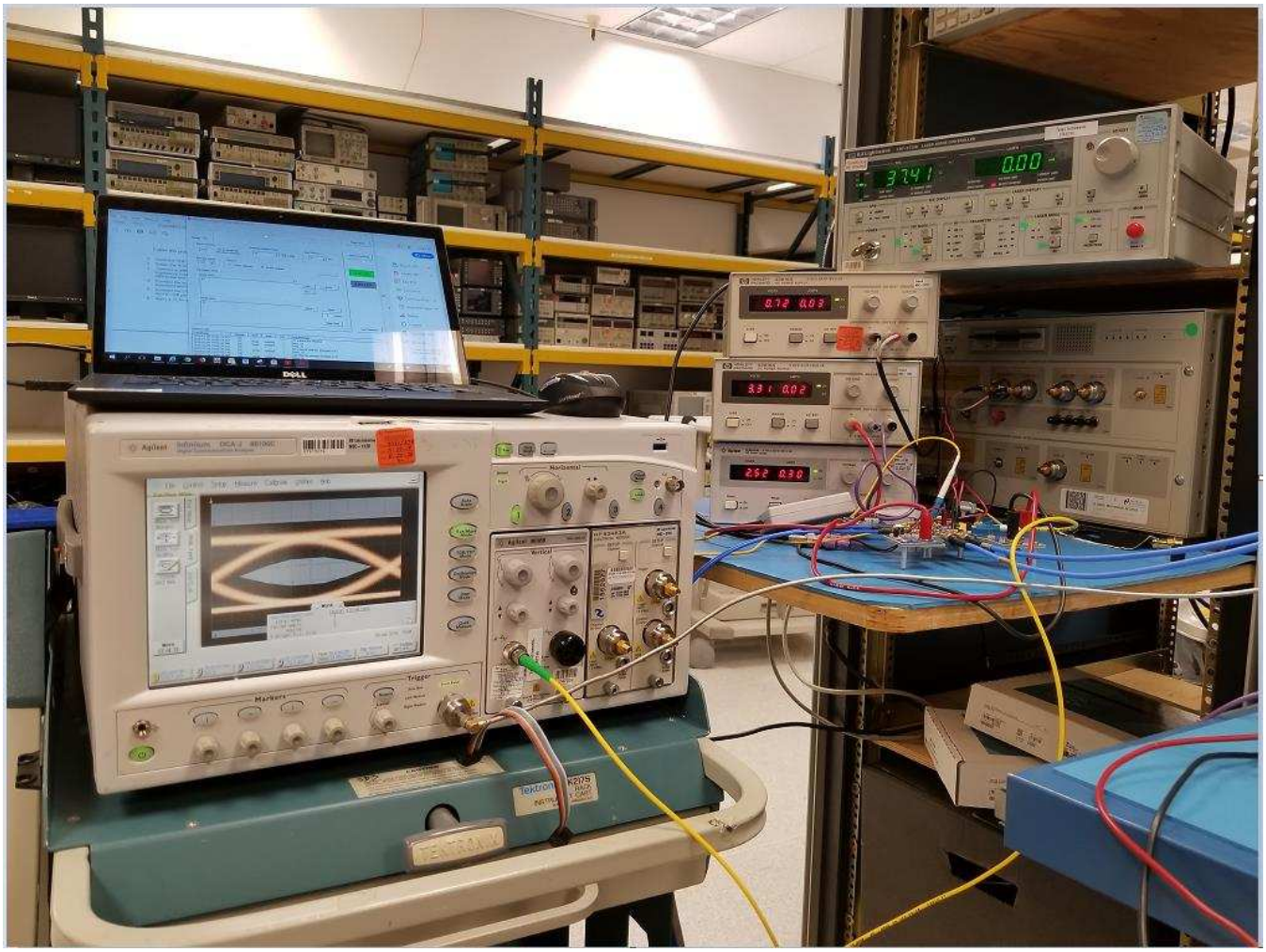

Figure 10. Typical ONET1130EC-EVM Setup

5.2 Open-Loop Operation Without Fault Detection or Digital Monitoring

With the USB2ANY GUI, write the register settings as shown in the following steps. After each write sequence, perform a read operation to make sure the change has gone into effect

NOTE: TI recommends to initially operate the TOSA in open-loop mode, with fault detection disabled, and enable the Laser Bias Current: Reg 0x01 = 0x14.

1. Set TX Output Mode to Single Ended Mode (OUTP): Reg 0x0D = 0x40
2. Set the desired TX Laser Bias Current: For example, in setup for Figure 10 we have Reg 0x0F = 0x60
3. Set the desired Transmitter Modulation Current: Reg 0x0C = 0x050
4. Use Reg 0x0E to adjust the cross point. For this setup, use reg 0x0E = 0xAF

NOTE: If the transmitter modulation current is less than approximately 0xC0, TI recommends that the designer use the slow edge speed mode (Reg 0x0D[4] = 1'b}. The need for this mode, however, is TOSA-dependent.

5. Disable and bypass the TX-CDR for ONET1130EP evaluation: Reg 0x0A = 0x10
6. Set the Desired RX Output Amplitude: Reg 0x08[3:0]
7. Set the Desired De-Emphasis: Reg 0x08[6:5] = 10'b
8. Disable and bypass the RX-CDR for ONET1130EP evaluation: Reg 0x04 = 0x18

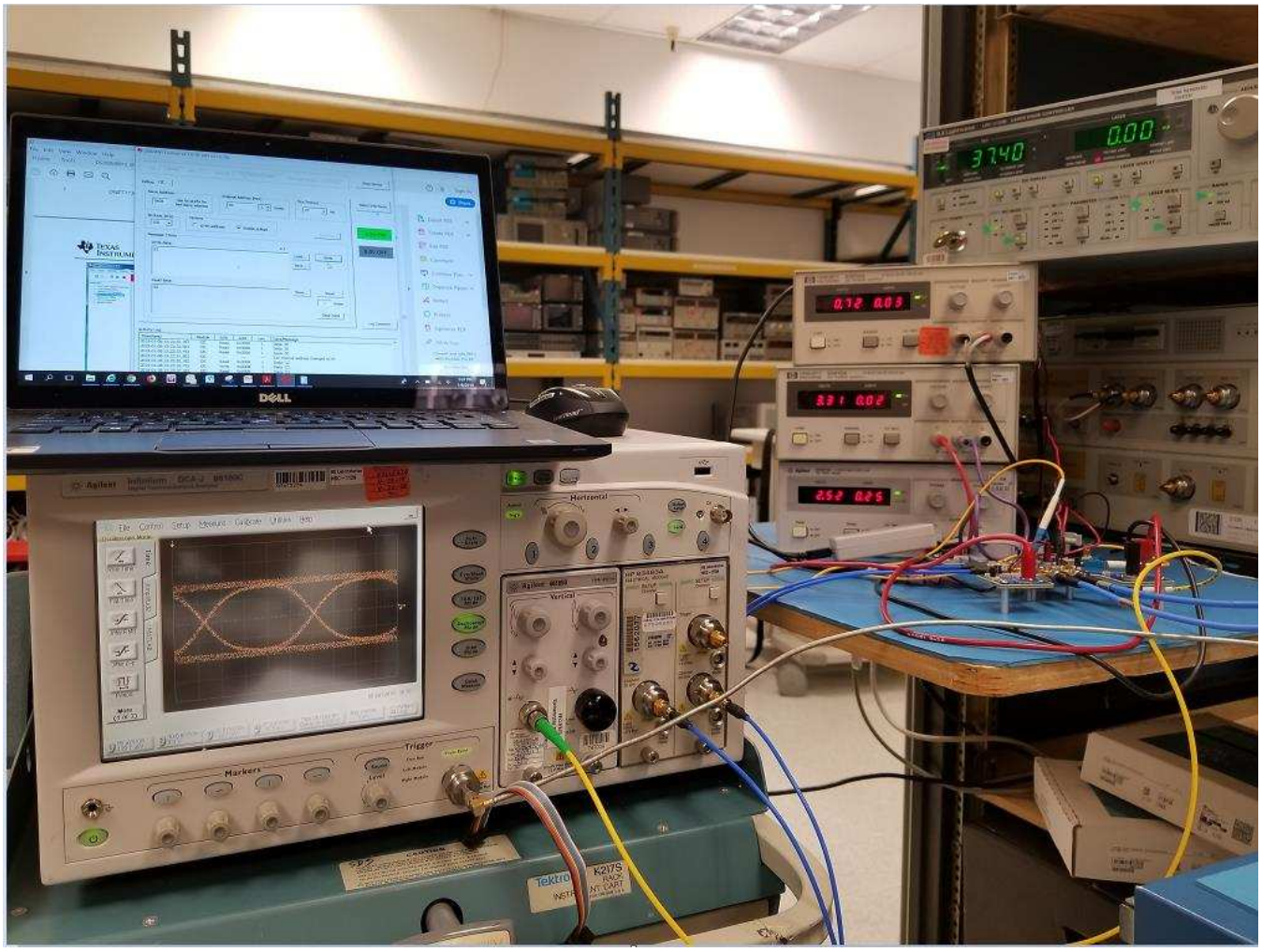

Figure 11. 10.3125-GBps Open-Loop RX Eye Diagram

5.3 Closed-Loop Operation With Fault Detection and Digital Monitoring

1. Place a jumper between pins 1 and 2 of JMP26 to supply -2.5V to the photodiode current mirror to configure the part for automatic power control with digital monitoring and fault detection.
2. Go to the Core Configuration page.
3. Disable the laser bias current to prevent a fault from occurring when the Fault Detection is enabled: Reg 0x01[2] = 0'b
4. Enable the Fault Detection (Reg 0x01[3] = 1'b) and enable the Fault Trigger on MONP Pin (Reg 0x01[7] = 1'b).
5. Set the TX Bias Current Control to Closed Loop (Reg 0x01[4] = 0'b) and initially use the default 770uA photodiode current range (Reg 0x01[6:5] = 00'b).
6. Enable the laser bias current: Reg 0x01[2] = 1'b
7. Enable the ADC (Reg 0x03[7] = 1'b) and ADC oscillator (Reg 0x03[6] = 1'b) in the Analog to Digital Conversion box and select the desired parameter to be monitored using reg 0x03[2:0]).
8. Set the bias current monitor fault threshold and power monitor fault threshold to max: TXBMF[7:0] Reg 0x11 = TXPMF[7:0] Reg 0x12 = 0xFF. To enable fault detection for these two conditions, set Reg 0x10 [6:5] = 11'b.
9. Select Digital Bias Current and Digital Photodiode current: Reg 0x10 [6:5] = 11'b.
10. Set the TX Output Mode to Single-Ended (OUTP): Reg 0x0D[6] = 1'b.
11. Set the desired TX laser bias current, transmitter modulation current, and TX cross point: Reg 0x0F[7:0] = 0x60, 0x0C[7:0] = 0x50, 0x0E[7:0] = 0xAF
12. Reduce bias current monitor fault threshold TXBMF[7:0] Reg 0x11 until fault occurs. When the TX_FLT goes high, increase TXBMF[7:0] by at least 16 steps.
13. Toggle the enable laser bias current by setting Reg 0x01[2] = 0'b followed by Reg 0x01[2] = 1'b to clear the fault and restore the transmit output.
14. Reduce the power fault threshold TXPMF[7:0] Reg 0x12 until a fault occurs. Increase the power fault threshold level by at least 16 steps.
15. Toggle the enable laser bias current by setting Reg 0x01[2] = 0'b followed by Reg 0x01[2] = 1'b to clear the fault and restore the transmit output.
16. Read Reg 0x28[9:2] and Reg 0x29[1:0] content to read the value from the ADC source.

6 LED Indicators

Table 1 shows the meaning of the 2 LEDs on the EVM.

Table 1. LED Indicators

LED	LED Color	Default state	Indication when On
D1	Red	On	The transmit CDR or the receive CDR has indicated Loss of Lock (LOL).
D2	Red	On	The receiver input signal level is set below the Loss of Signal (LOS) threshold.

7 Typical Performance Results

A typical set of conditions for operating the EVM are as follows:

- VCC = 2.5 V, ICC = 300 mA with ROSA
- 10.71 Gbps, PRBS31 Pattern
- Transmitter Single-Ended Mode of Operation
- TOSA Temperature = 37°C
- Vea = –0.65 V
- Laser Bias Current = 0xF0 (approximately 53m A)
- Transmitter Modulation Current = 0xB0
- Transmitter Cross Point = 0xB0
- TX and RX CDRs Enabled
- Receiver amplitude set to 600mVpp
- Receiver de-emphasis set to 0x02

Figure 12 shows a typical unfiltered eye diagram.

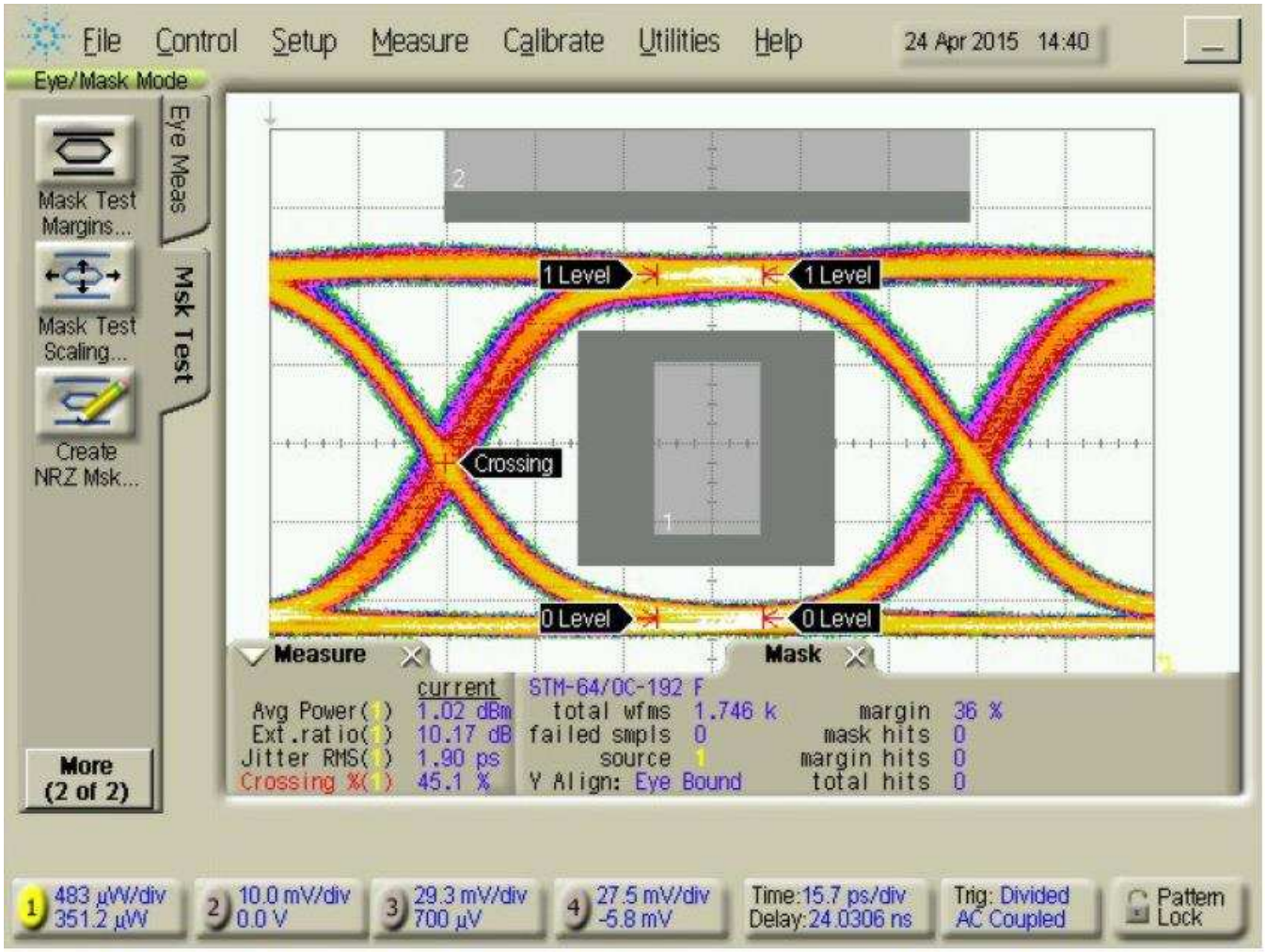

Figure 12. Unfiltered Transmitter Eye Diagram

Figure 13 shows a typical filtered eye diagram.

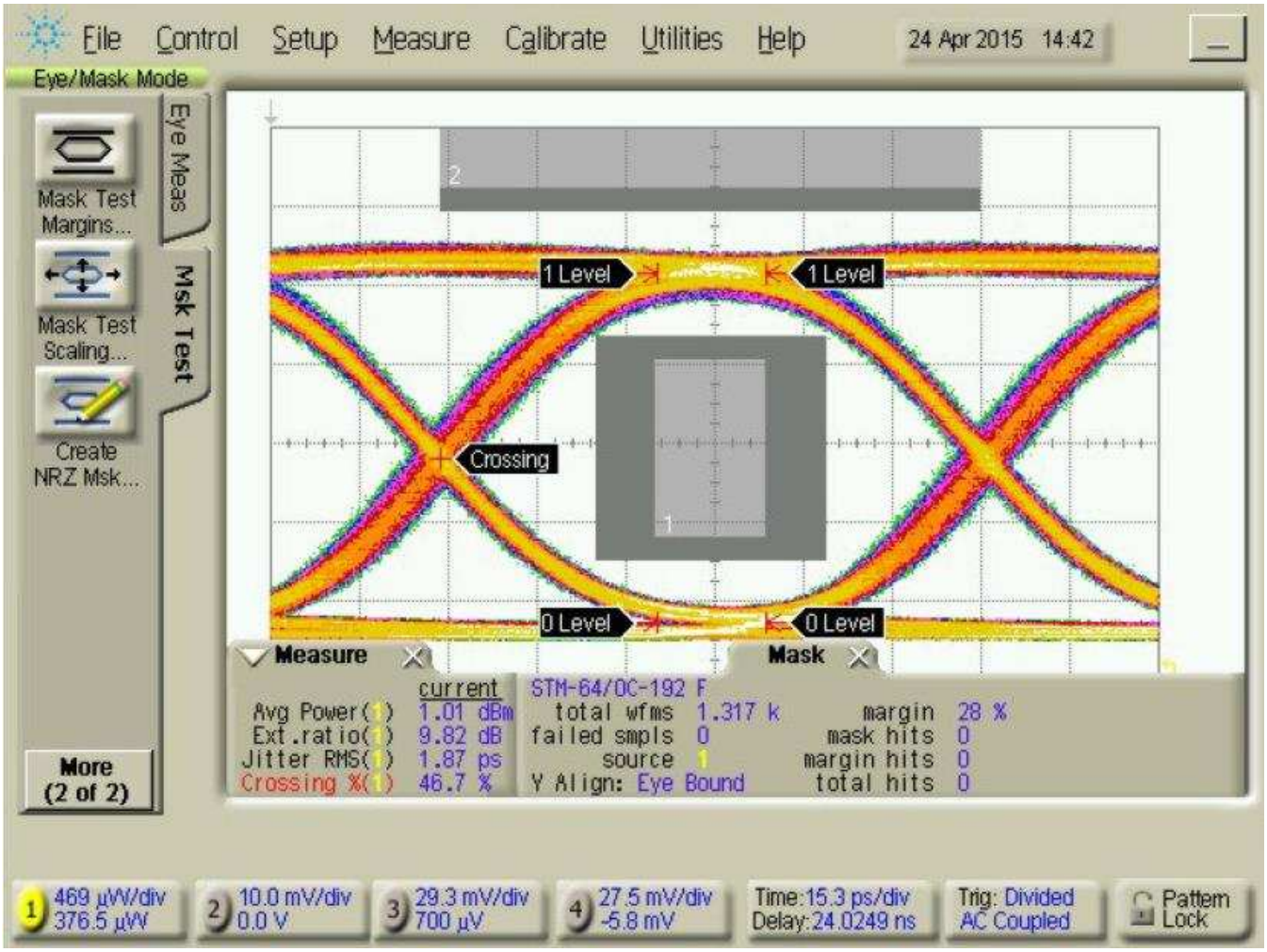

Figure 13. Filtered Transmitter Eye Diagram

Figure 14 shows a typical receiver eye diagram with the CDR enabled and -20dBm average optical input power to a PIN ROSA.

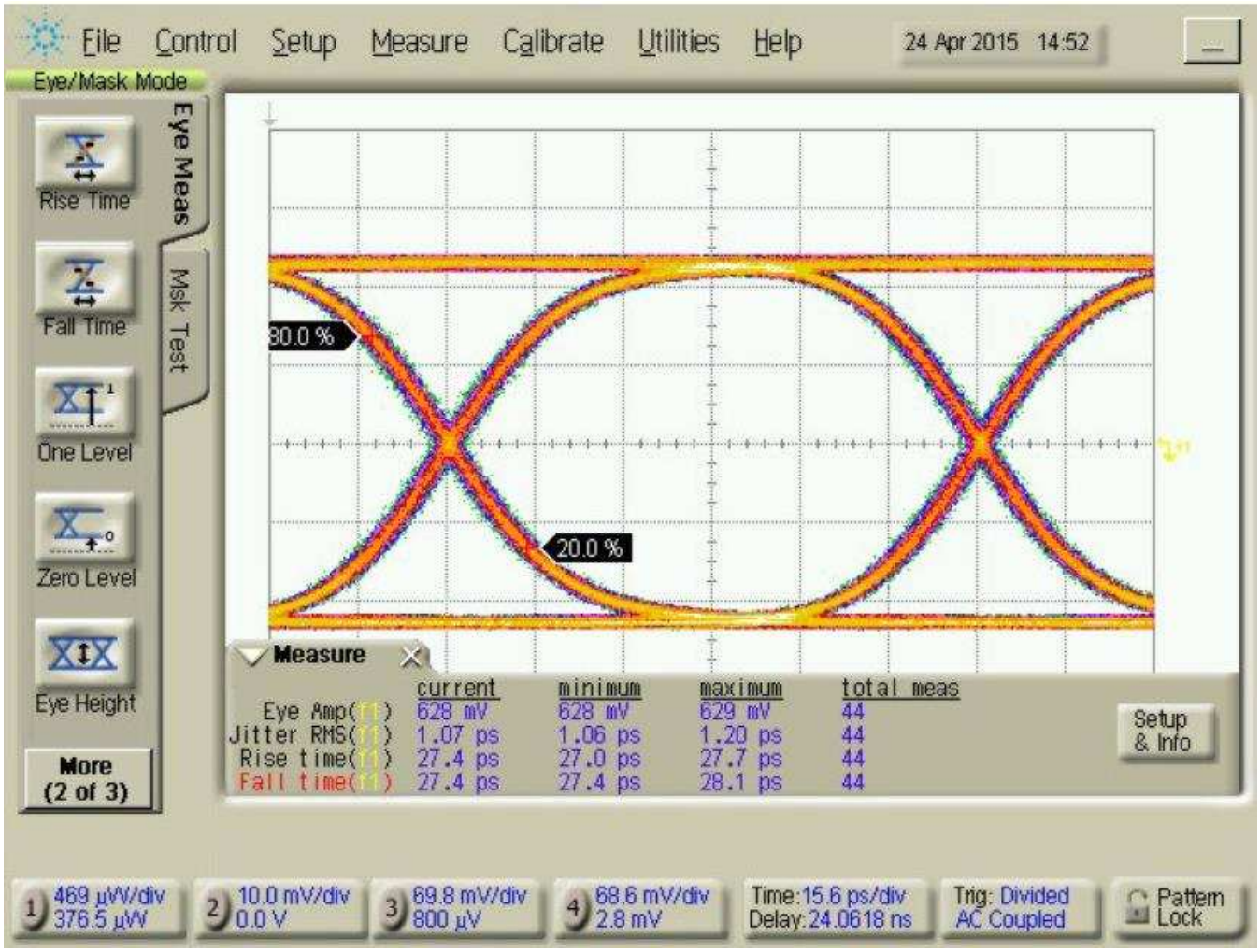

Figure 14. Receiver Eye Diagram With CDR Enabled

Figure 15 shows a typical receiver eye diagram with the CDR disabled and -20dBm average optical input power to a PIN ROSA.

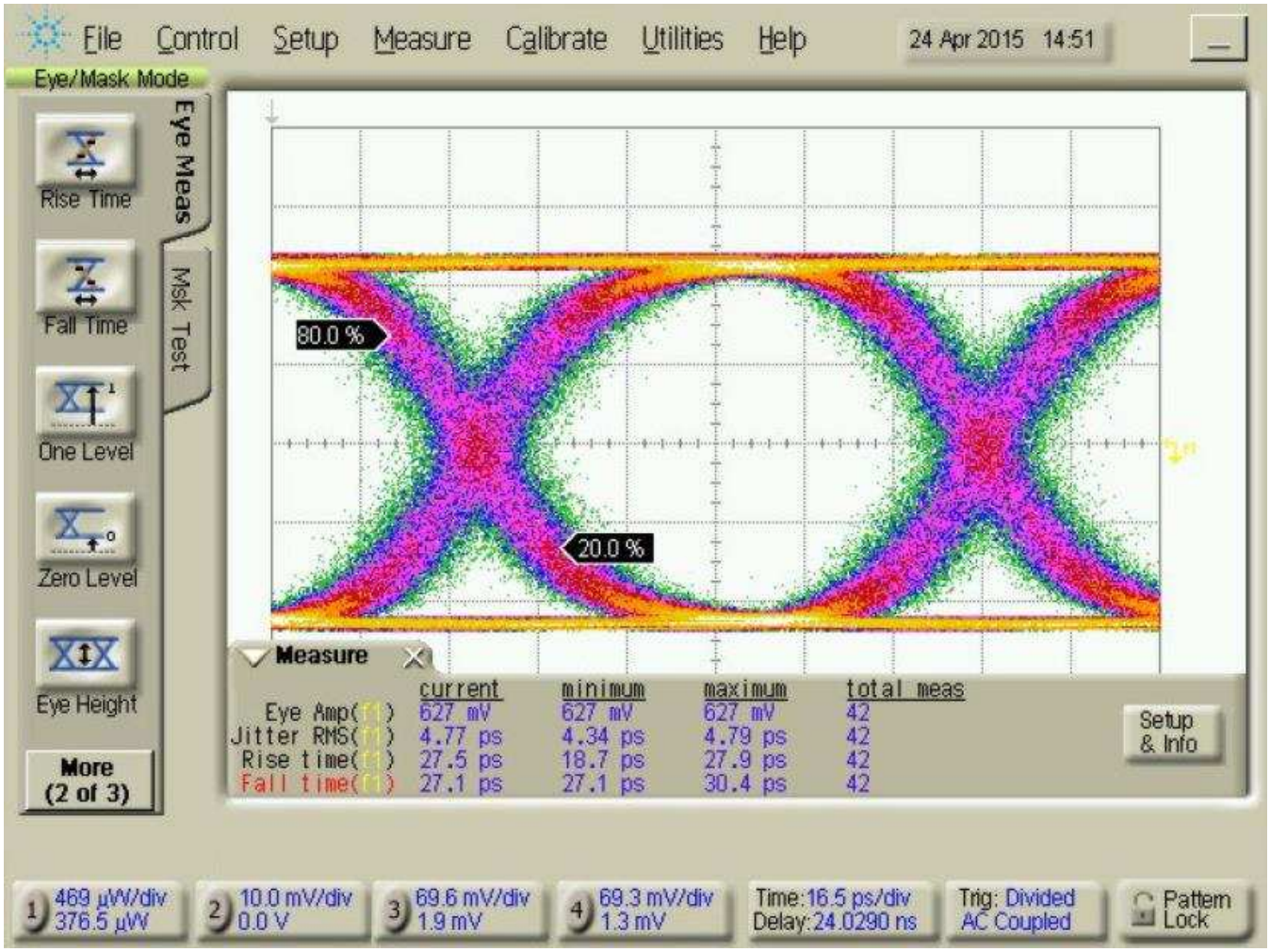

Figure 15. Receiver Eye Diagram With CDR Disabled

8 Schematics

Figure 16, Figure 17, and Figure 18 show ONET1130EC-EVM schematic.

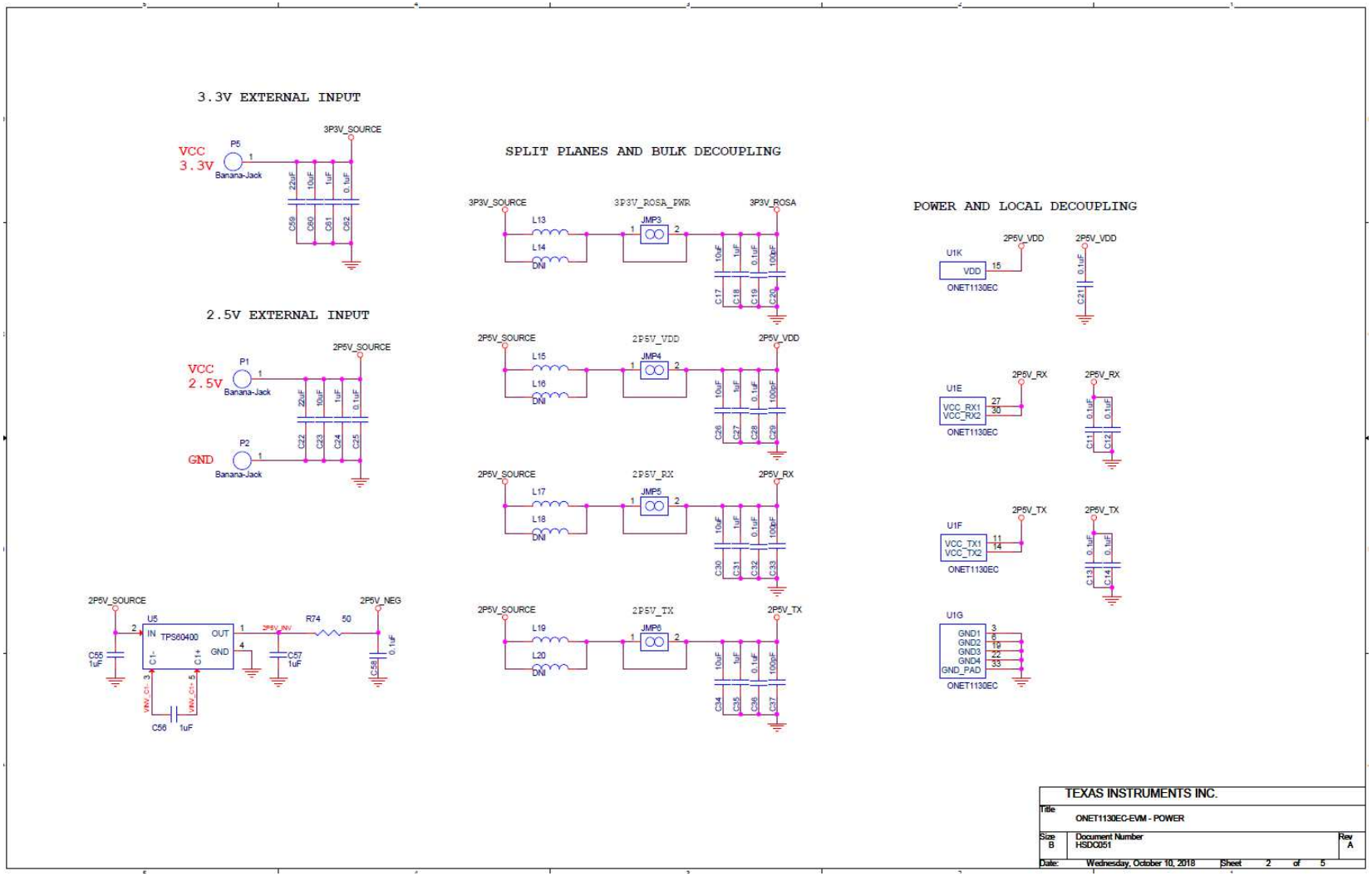

Figure 16. Schematic 1

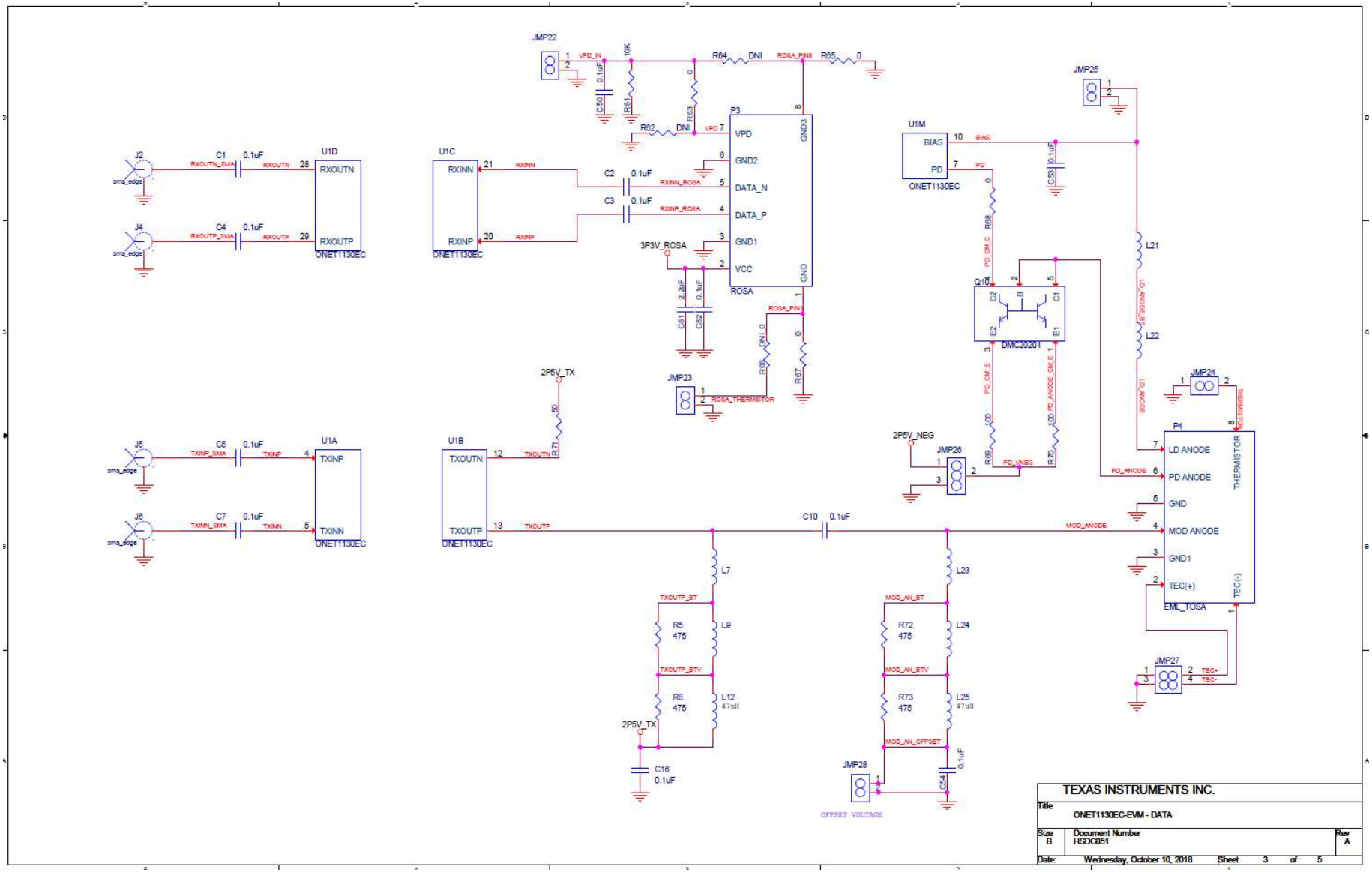

Figure 17. Schematic 2

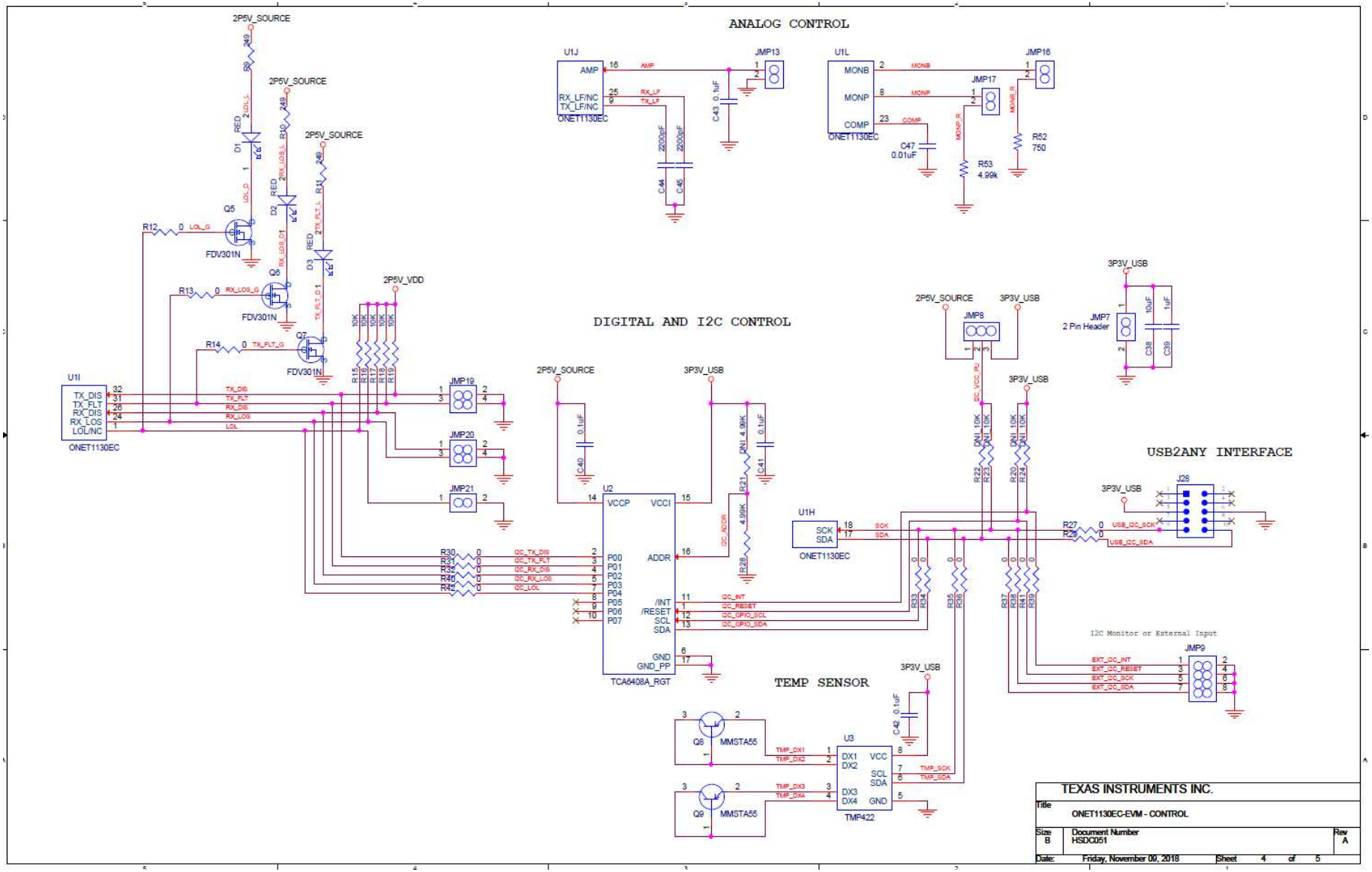

Figure 18. Schematic 3

9 ONET1130EC-EVM PCB Layout

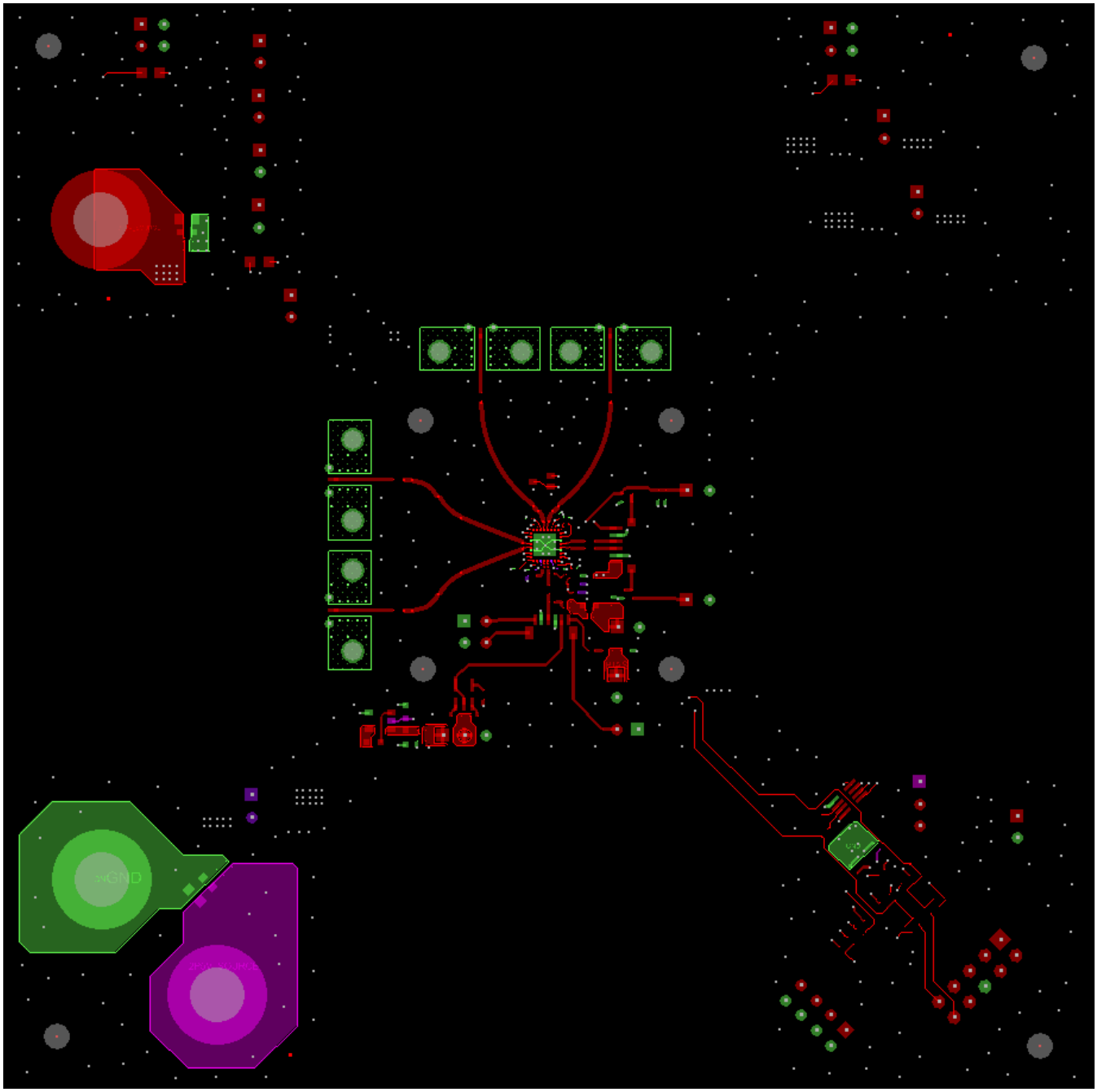

Figure 19. ONET1130EC-EVM Top Layer PCB Layout

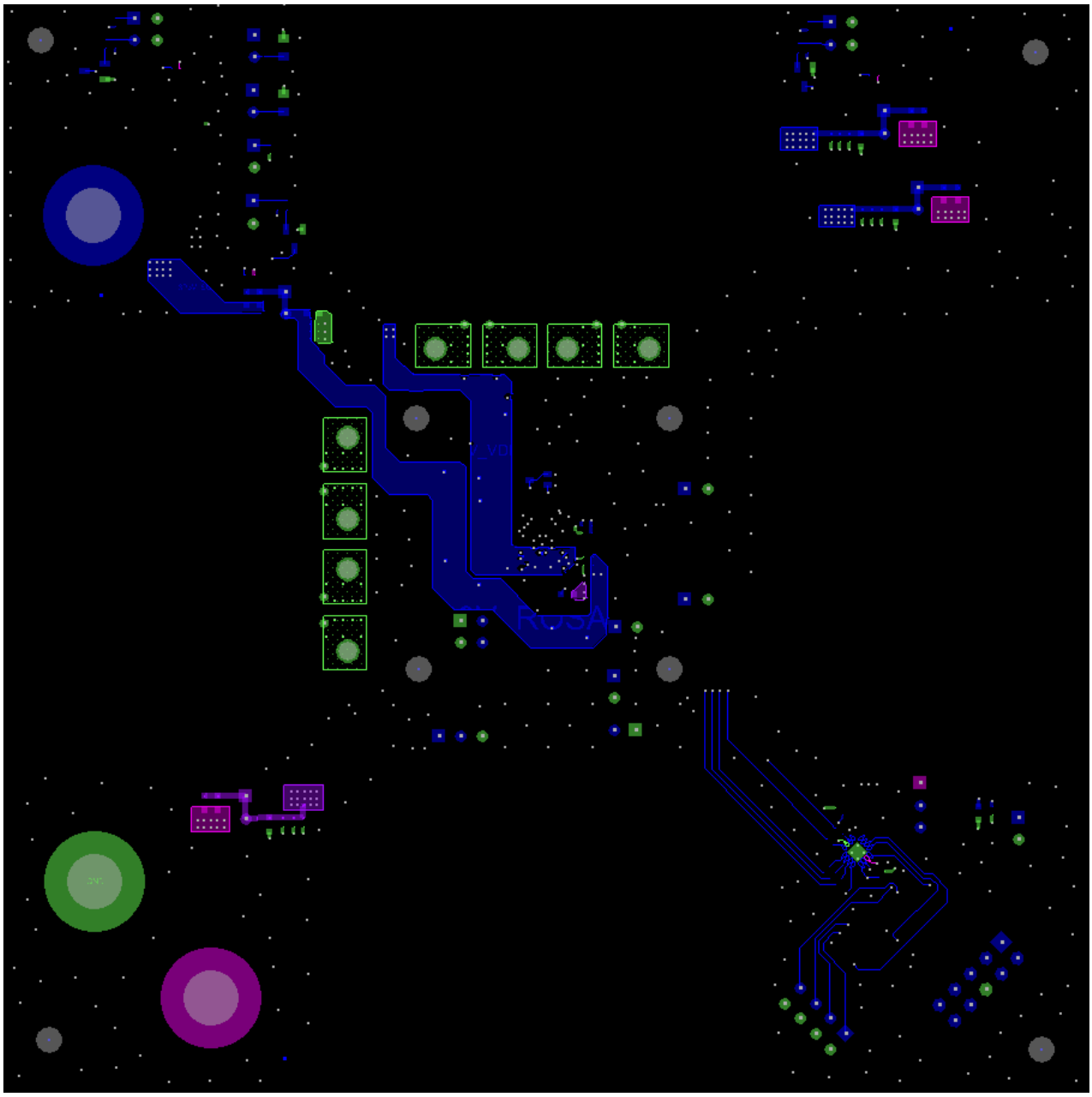

Figure 20. ONET1130EC-EVM Bottom Layer PCB Layout

10 Bill of Material

Table 2. ONET1130EC-EVM BOM

Item	Quantity	Reference	Value	Manufacturer Part Number	Manufacturer	PCB Footprint
1	2	C44, C45	2200pF	GRM033R71C222KA88D	Murata Electronics North America	0201
2	1	C47	0.01uF	GRM033R71A103KA01D	Murata Electronics North America	0201
3	5	C11, C12, C13, C14, C21	0.1uF	GRM033C71C104KE14D	Murata Electronics North America	0201
4	4	C20, C29, C33, C37	100pF	C0402C101K4GACTU	KEMET	0402
5	7	C1, C2, C3, C4, C5, C7, C10	0.1uF	GCM155R71C104KA55D	Murata Electronics North America	0402
6	16	C16, C19, C25, C28, C32, C36, C40, C41, C42, C43, C50, C52, C53, C54, C58, C62	0.1uF	GCM155R71C104KA55D	Murata Electronics North America	0402
7	7	C18, C24, C27, C31, C35, C39, C61	1uF	GRM153R61A105ME95D	Murata Electronics North America	0402
8	1	C51	2.2uF	GRM155C81C225ME15D	Murata Electronics North America	0402
9	3	C55, C56, C57	1uF	GRM188R61A105KA61D	Murata Electronics North America	0603
10	7	C17, C23, C26, C30, C34, C38, C60	10uF	ZRB18AD71A106KE01L	Murata Electronics North America	0603
11	2	C22, C59	22uF	GRM219R61C226ME15L	Murata Electronics North America	0805
12	4	R5, R8, R72, R73	475	RC0201FR-07475RL	Yageo	0201
13	24	R12, R13, R14, R27, R29, R30, R31, R32, R33, R34, R35, R36, R37, R38, R39, R40, R41, R42, R63, R65, R67, R68	0	RC0402JR-070RL	Yageo	0402
14	0	R62, R64, R66	DNI	RC0402JR-070RL	DNI	0402
15	2	R71, R74	50	504L50R0FTNCFT	American Technical Ceramics	0402
16	2	R69, R70	100	CRCW0402100RFKEDHP	Vishay Dale	0402
17	3	R9, R10, R11	249	ERJ-2RKF2490X	Panasonic Electronic Components	0402

Table 2. ONET1130EC-EVM BOM (continued)

Item	Quantity	Reference	Value	Manufacturer Part Number	Manufacturer	PCB Footprint
18	1	R28	4.99K	CRCW04024K99 FKEDHP	Vishay Dale	0402
19	0	R21	DNI	CRCW04024K99 FKEDHP	Vishay Dale	0402
20	6	R15, R16, R17, R18, R19, R61	10K	ERJ-2RKF1002X	Panasonic Electronic Components	0402
21	0	R20, R22, R23, R24	DNI	ERJ-2RKF1002X	DNI	0402
22	1	R52	750	ERJ-6ENF7500V	Panasonic Electronic Components	0805
23	1	R53	4.99K	RC0805FR-074K99L	Yageo	0805
24	3	D1, D2, D3	RED	HSMS-C170	Avago Technologies Us Inc	LED_SM_HSMB_C170
25	14	JMP3, JMP4, JMP5, JMP6, JMP7, JMP13, JMP16, JMP17, JMP21, JMP22, JMP23, JMP24, JMP25, JMP28	0.1" Header (1x2)	961102-6404-AR	3M	HDR_THVT_1x2_100
26	2	JMP8, JMP26	0.1" Header (1x3)	961103-6404-AR	3M	HDR_THVT_1X3_100
27	3	JMP19, JMP20, JMP27	0.1x0.1" Header (2x2)	961204-6404-AR	3M	HDR_THVT_2x2_100
28	1	JMP9	0.1x0.1" Header (2x4)	961208-6404-AR	3M	HDR_THVT_2X4_100
29	4	J2, J4, J5, J6	Edge Launch SMA	32K243-40ML5	Rosenberger	CON_02K243-40M
30	1	J28	5103308-1	5103308-1	TE Connectivity	CON_SHRD_THVT_5103308-1
31	2	L12, L25	Inductor 47uH, 35mA	GLFR1608T470 M-LR	Taiyo Yuden	0603
32	3	L9, L21, L24	Ferrite Bead 1.8kohm, 200mA	BLM15HD182SN 1D	MuRata	0402_2020MIL
33	3	L7, L22, L23	Ferrite Bead 1000ohm, 125mA	BLM03HG102S N1D	MuRata	0201
34	4	L13, L15, L17, L19	BLM18PG330SN 1D	BLM18PG330SN 1D	MuRata	0603
35	0	L14, L16, L18, L20	DNI	BLM18PG330SN 1D	DNI	0603
36	3	P1, P2, P5	Solderless Banana Jack	108-0740-001	Emerson Network Power	JACK_THVT_BANANA_500dia
37	0	P3	DNI	ROSA	DNI	MSA_XMD_ROSA_INV
38	0	P4	DNI	TOSA	DNI	162X_TOSA
39	3	Q5, Q6, Q7	FDV301N	FDV301N	Fairchild	SOT23_3
40	2	Q8, Q9	MMSTA55	MMSTA55-7-F	Diodes Inc.	SOT_323-3
41	1	Q10	DMC20201	DMC20201	Panasonic	SOT23_5
42	1	U1	ONET1130EC	ONET1130ECR SMT	Texas Instruments	ONET1130EC_QFN32

Table 2. ONET1130EC-EVM BOM (continued)

Item	Quantity	Reference	Value	Manufacturer Part Number	Manufacturer	PCB Footprint
43	1	U2	TCA6408A_RGT	TCA6408ARGTR	Texas Instruments	QFN_16_3MSQ
44	1	U3	TMP422	TMP422AIDCNT	Texas Instruments	DCN_SOT23-8
45	1	U5	TPS60400	TPS60400DBVT	Texas Instruments	SOT23-5
50	8	Standoff	ROUND STANDOFF #4-40 ALUM 3/4"	2029	Keystone Electronics	
51	4	SHNT1,SHNT2, SHNT3,SHNT4	QPC02SXGN-RC	QPC02SXGN-RC	Sullins	0.1
52	8	Screws	Round 4-40/0.25"	PMSSS 440 0025 PH	B&F Fastener	
53	1	LB1	PCB Label 0.650"H x 0.200"W	THT-14-423-10	Brady	rectangle
54	1	Laser safety tag	PCB tag	MCH042	Any	rectangle
55	1	H1	HPA665-001; CDDS # 6542513	USB2ANY	TI	n/a
56	1	PCB1	HSDC051	HSDC051	Any	n/a

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