

OPT3101 Evaluation Module

This user's guide provides an overview of the OPT3101 time-of-flight (ToF) proximity sensor evaluation module (EVM). The OPT3101EVM is a single-pixel implementation of the OPT3101 device consisting of a printed-circuit board (PCB) and an accompanying software package. The EVM is intended for prototyping and evaluation. This user's guide includes an overview of the EVM hardware and software in addition to the schematic diagram, layout, and bill of materials. Throughout this document, the abbreviation *EVM* and the term *evaluation module* are synonymous with the OPT3101EVM.

The following related documents are available through the Texas Instruments web site at www.ti.com.

Table 1. Related Documentation

Document Name	Literature Number
OPT3101 Data Sheet	SBAS883
Introduction to Time-of-Flight and Optical Proximity Sensor System Design Guide	SBAU305
OPT3101 Distance Sensor System Calibration Guide	SBAU310

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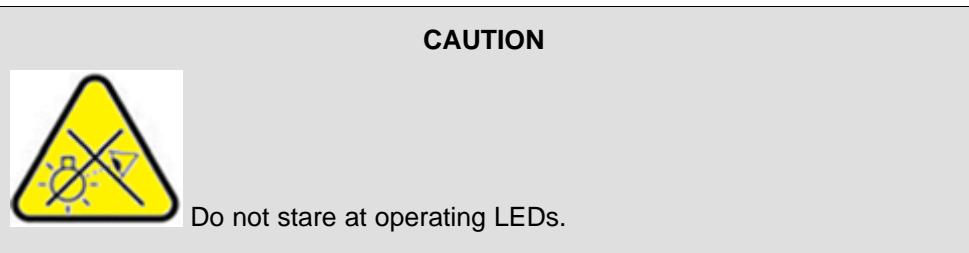
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Trademarks

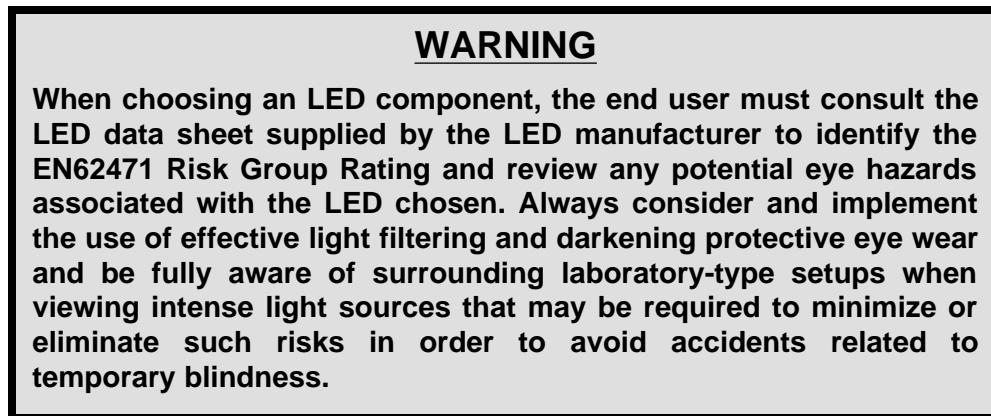
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Python is a registered trademark of Python Software Foundation (PSF).
All other trademarks are the property of their respective owners.

1 Disclaimers

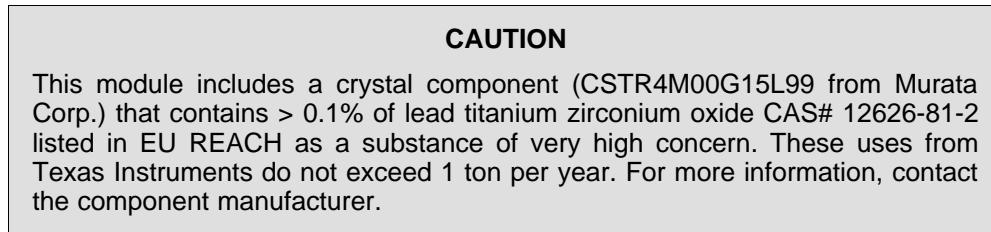
1.1 Eye Safety



NOTE: This evaluation module uses a high-power infrared LED from OSRAM (part number SFH 4550). Note from the LED manufacturer: "Depending on the mode of operation, these devices emit highly concentrated non visible infrared light which can be hazardous to the human eye. Products which incorporate these devices have to follow the safety precautions given in IEC 60825-1 and IEC 62471."



1.2 REACH



2 Introduction

OPT3101 device is a high-speed, high-resolution AFE for continuous wave, time-of-flight (ToF) based proximity sensing, and range finding. The purpose of the OPT3101EVM is to expedite evaluation and system development of the OPT3101. The evaluation kit consists of a printed-circuit board (PCB), available for purchase on the [OPT3101EVM page](#), and a software package called Latte, which is available for download on the [OPT3101EVM page](#) under software. The PCB is a single-pixel system that uses the OPT3101 device for ToF proximity sensing. The PCB connects to a computer running the Latte software through USB. The Latte software allows visualization and logging of the OPT3101 readings, setting different modes of operation, reading and writing of register settings on the device, and the creation of custom Python® scripts.

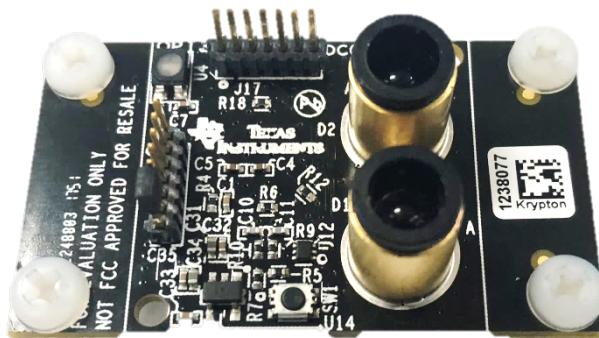


Figure 1. OPT3101EVM Printed-Circuit Board

The following sections are divided into hardware, software installation, using the EVM, and troubleshooting. The last section at the end of this guide includes the EVM schematic, layout, and bill of materials (BOM). The [OPT3101EVM Hardware](#) section gives an overview of the OPT3101EVM PCB, covering the different components of the board and outlining the functions of each. The [Section 4](#) section provides the steps needed to install and launch the Latte software package. The [Using the EVM](#) section describes how to use the Latte software to take readings on the EVM.

3 OPT3101EVM Hardware

Figure 2 shows the hardware block diagram for the OPT3101EVM. The block diagram includes all major components on the PCB and shows how they are connected. The direction of the arrow shows the flow of information between the components. **Figure 3** and **Figure 4** show the physical location of these components on the PCB. The following subsections describe each component in detail.

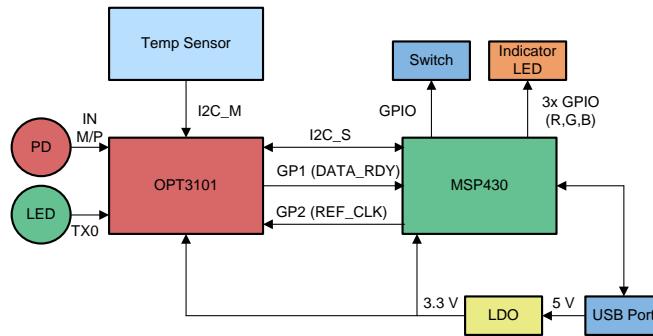


Figure 2. EVM Hardware Block Diagram

3.1 MSP430 Microcontroller

The MSP430F5503 has a USB interface, allowing connection to a PC, and acts as a communication bridge between the OPT3101 and the PC. The MSP430 microcontroller is loaded with C++ firmware for interfacing with the OPT3101 over I²C, in addition to the other components on the PCB. The MSP430 also has a calibration configuration for the board stored in onboard flash storage.

The MSP430 registers 2 USB COM ports with the PC it is plugged in to. The **OPT3101 Control Port** is used for sending control commands to the MSP430. This includes reading and writing registers on the OPT3101 and interfacing with the MSP430 flash storage. The **OPT3101 Data Port** is used only for streaming data from the EVM to the PC. This allows for maximum data rates when receiving real-time data from the OPT3101 during high-speed capture.

3.2 I²C Buses and Temperature Sensor

The OPT3101 has two I²C buses. On the main I²C bus, labeled I²C_S, the OPT3101 is a slave device. This bus is used to control the OPT3101 and read data by reading and writing registers on the device. The OPT3101 also has a secondary I²C bus, I²C_M, for which it is the master. This bus allows an external temperature sensor and an EEPROM to be controlled by the OPT3101. The OPT3101 contains an internal temperature sensor, which is used for temperature calibration. This sensor has 8-bit integer resolution. Adding an external temperature sensor, such as that used on the EVM, allows up to 12 bits of resolution to be obtained with one sign bit, 7 integer bits, and 4 fractional bits. This allows for more accurate temperature correction. An external EEPROM allows for an OPT3101 register configuration to be stored and loaded on power-up. This means that the device does not need an I²C master to configure it on power-up. On the EVM, only a temperature sensor is used on this bus.

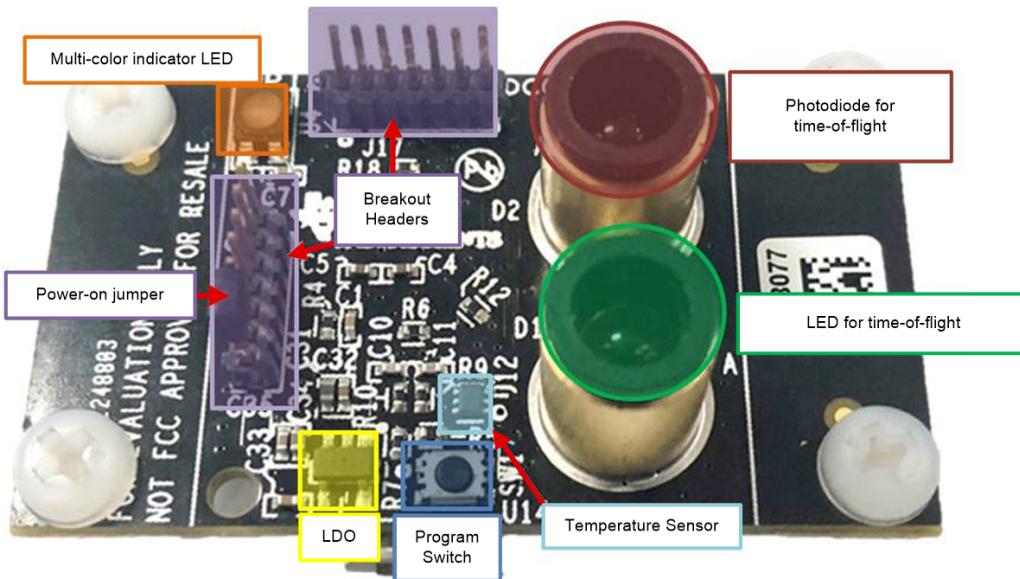


Figure 3. Labeled OPT3101EVM – Top Side

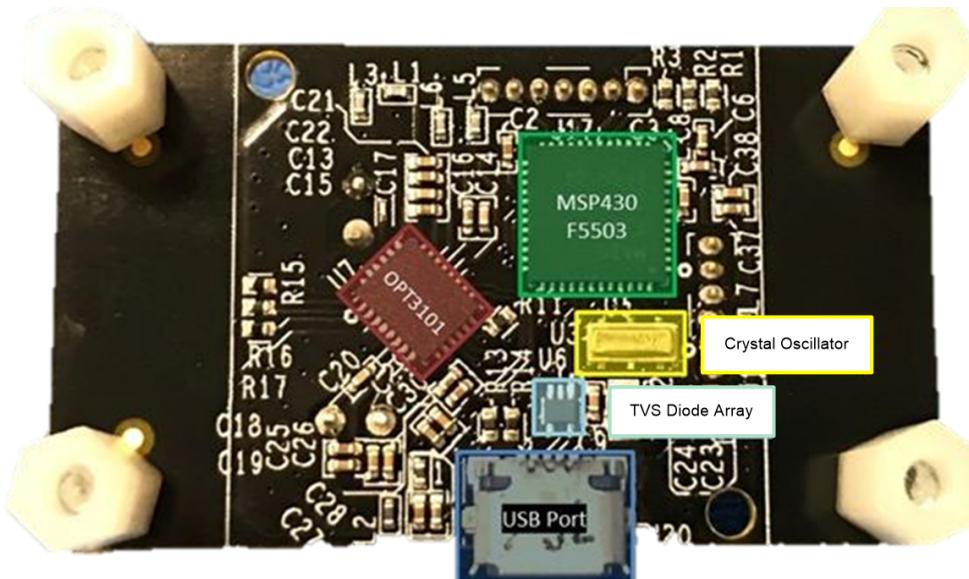


Figure 4. Labeled OPT3101EVM – Bottom Side

3.3 Light-Emitting Diode (LED) and Photodiode (PD) for ToF Measurements

As the introduction states, this EVM is a single-pixel system. There is a single LED-photodiode pair that connects to the OPT3101 and is used for ToF measurements. The EVM uses a 850-nm centroid (860-nm peak) wavelength IR LED (SFH 4550), and a 900-nm peak sensitivity IR photodiode (SFH 213 FA). Electroless nickel immersion gold (ENIG)cylinders on the EVM encircle both the LED and photodiode. The cylinders provide both optical and electrical shielding between the LED and photodiode, this reduces crosstalk.

3.4 Headers and Power-On Jumper

The headers break out a number of signals from the EVM for debug and to provide more flexibility in the ways the EVM can be used. [Figure 6](#) shows how to power the board by placing the power-on jumper on the bottom two pins of J19. This connects the 3.3-V output of the LDO to the rest of the components on the EVM. [Figure 5](#) and [Figure 6](#) show the complete list of signals that are broken out to the headers.

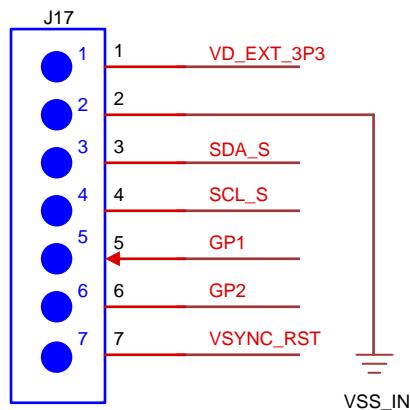


Figure 5. J17 Header

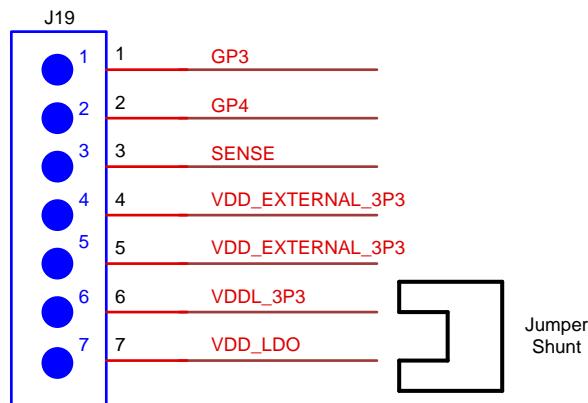


Figure 6. J19 Header With Power-On Jumper Shown

3.5 Other Components

The following components are also used on the PCB:

- The LDO creates a 3.3-V supply, which powers both the MSP430 and the OPT3101.
- The programming switch puts the EVM in bootloader mode. This works by holding down the switch during power up. This allows firmware to be flashed to the device.

CAUTION

Flashing new firmware to the EVM erases the calibration stored on the EVM. Never do this unless a firmware update is required, and if this is the case make sure to read the calibration out of the MSP430 flash and create a backup before flashing the new firmware.

- The indicator LED is an RGB multi-color LED, which is used by the MSP430 firmware to provide visual feedback. Currently the LED only glows green to signal that the device has firmware and is powered on. However, the firmware supports using different colors to indicate other functions.
- The micro USB port allows the device to be plugged into a computer using a micro USB cable. The device is powered off the 5-V supply from the USB.
- TVS diode array connected to all signals routed to the header pins and the USB. This helps with ESD protection.
- The crystal oscillator provides a 4-MHz clock for the MSP430.

4 Software Installation

4.1 Minimum Requirements

Before installing the software, verify that your PC meets the minimum requirements outlined in this section.

4.1.1 Required Setup for OPT3101EVM GUI Software

- A PC running Microsoft® Windows® 7 or Windows 10 operating system with at least 325MB of free space
- A display with screen resolution of 1200x720 pixels, or greater

4.1.2 Additional Requirements for use With Hardware

The following additional items are required:

- OPT3101EVM
- USB to MicroUSB cable (provided in kit)

4.2 Installing the Software (PC Application)

Download and extract OPT3101EVME3_Latte_v0p8.zip, or a newer released version, from the software section of the [OPT3101EVM page](#) on ti.com. Install the software by launching the exe file and using all the default install locations. The full installation steps are shown step by step in the following screenshots.

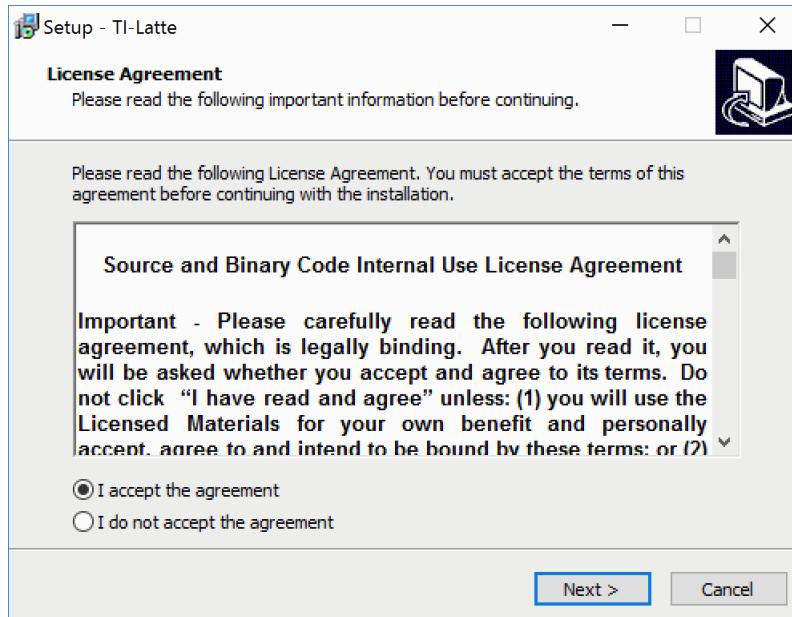


Figure 7. Accepting the License Agreement

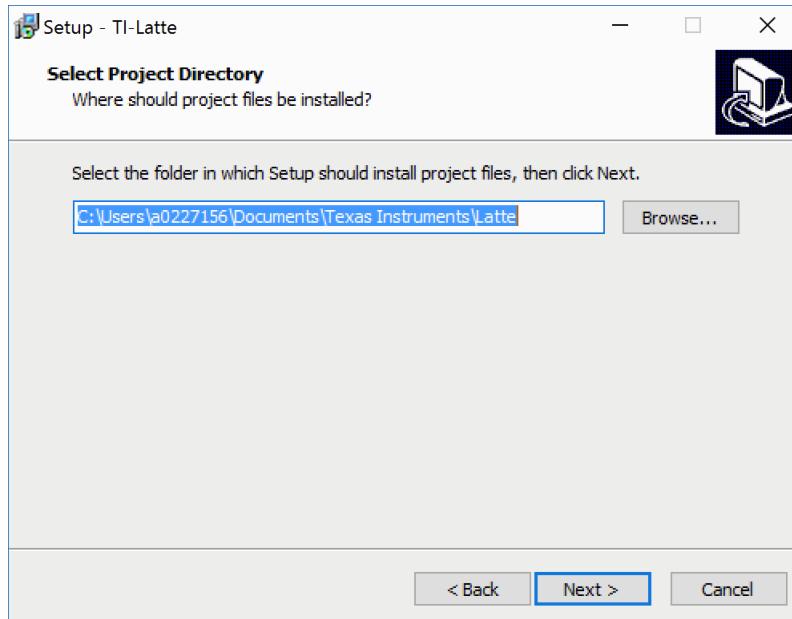


Figure 8. Installation Directory

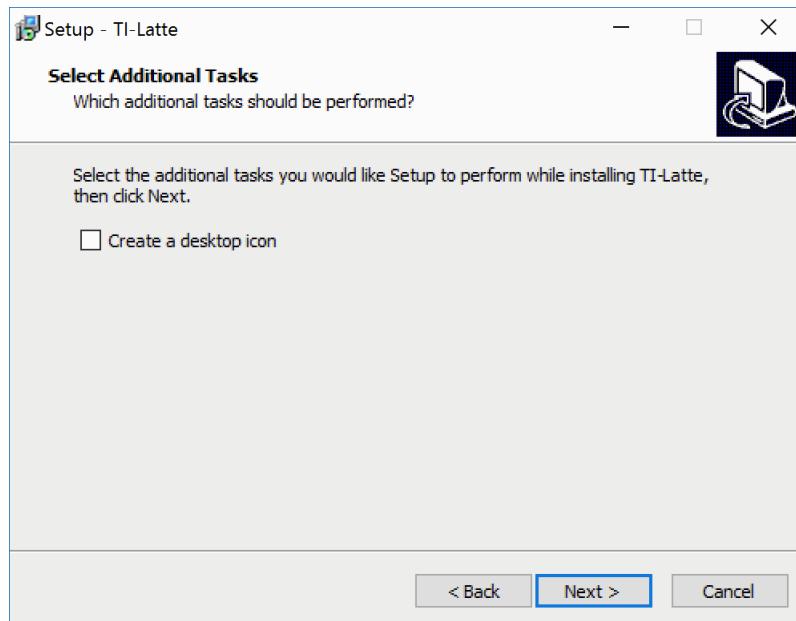


Figure 9. Additional Steps

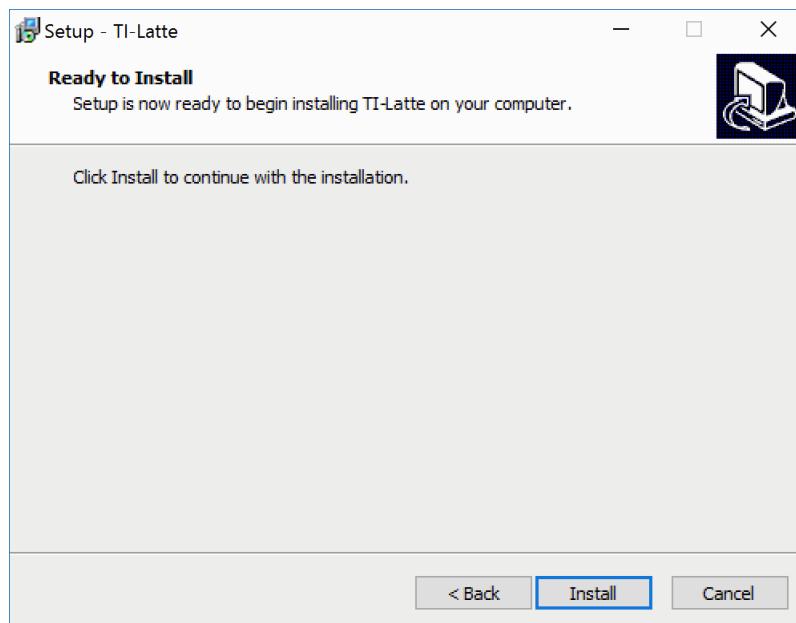


Figure 10. Installation Page

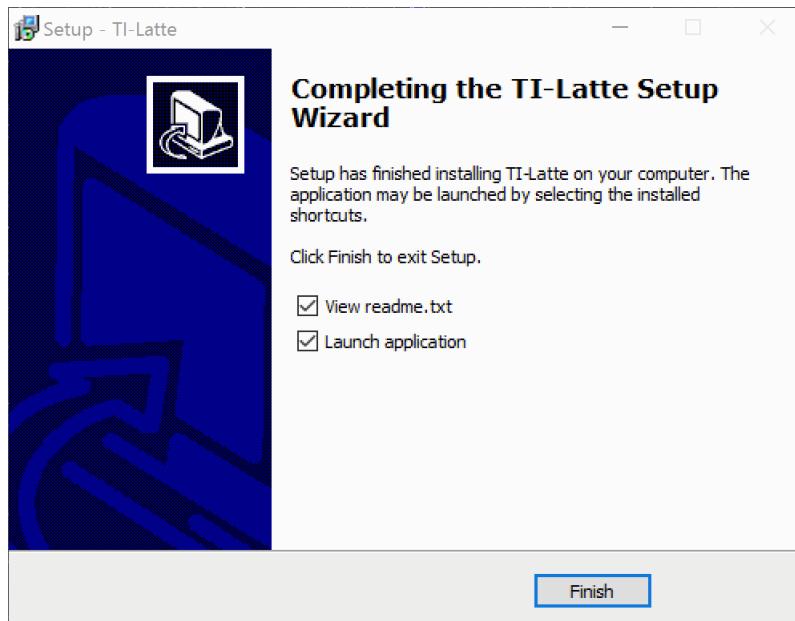


Figure 11. Installation Complete

Launch the program by running the Latte program.

5 Using the EVM

5.1 Connecting the OPT3101EVM

Connect the EVM via USB to the PC. If Windows shows a notification that a driver is not found for the device connected, see the instructions to manually install drivers in [Section 6.1](#) before proceeding.

5.2 Check for Correct Installation of the Device Drivers

[Figure 12](#) shows the *OPT3101 Control* and *OPT3101 Data* ports in the device manager when the drivers have been installed correctly. If the EVM creates two COM ports with no driver errors, as shown in [Figure 12](#), then no additional changes need to be made. Proceed to the next section.

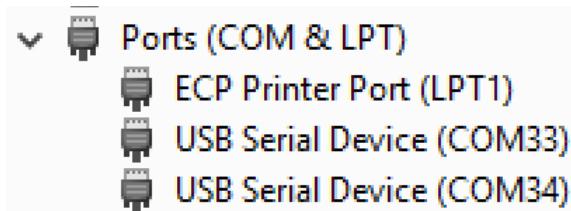


Figure 12. OPT3101 Control and Data Ports in Device Manager

If the *OPT3101 Control* and *OPT3101 Data* ports do **not** show up in the device manager when the board is plugged in or the device drivers show up differently than pictured in [Figure 12](#), go to [Section 6.1](#) for additional instructions on manual driver installation. It is okay if the COM port number is different than pictured in [Figure 12](#).

5.3 Launching Latte Software

After launching the Latte software, a GUI window with distance plot will be displayed if the EVM has been connected properly as shown in [Figure 15](#). If the EVM has not been connected to the PC or the drivers are not installed properly then the error message shown in [Figure 13](#). will be displayed.

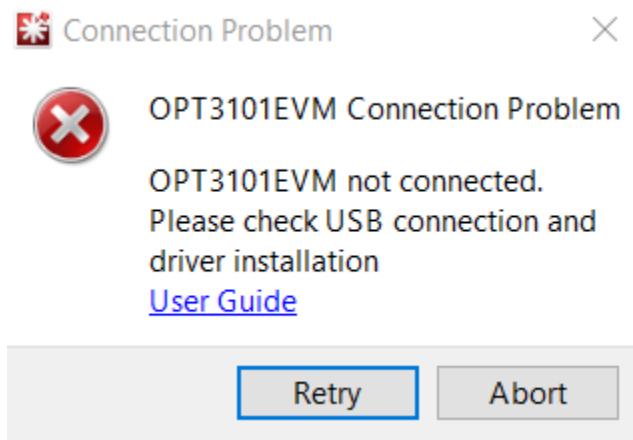


Figure 13. OPT3101EVM Connection Problem Error

If multiple OPT3101 profiles are downloaded and saved onto your PC, you will be asked to select a profile before the GUI will launch. [Figure 14](#) shows what the profile selector looks like.

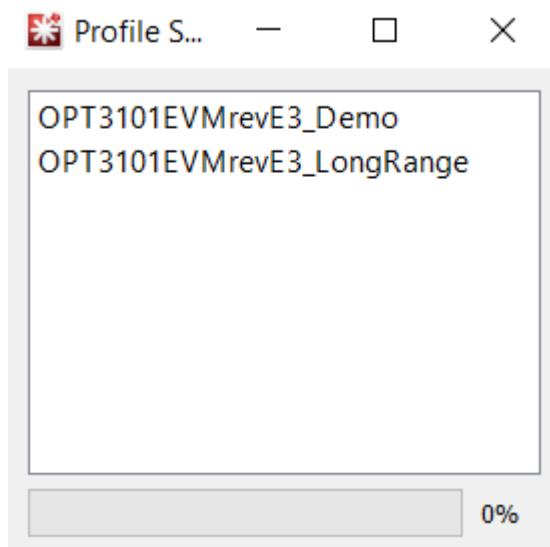


Figure 14. OPT3101 Profile Selector

5.4 Using Latte Software

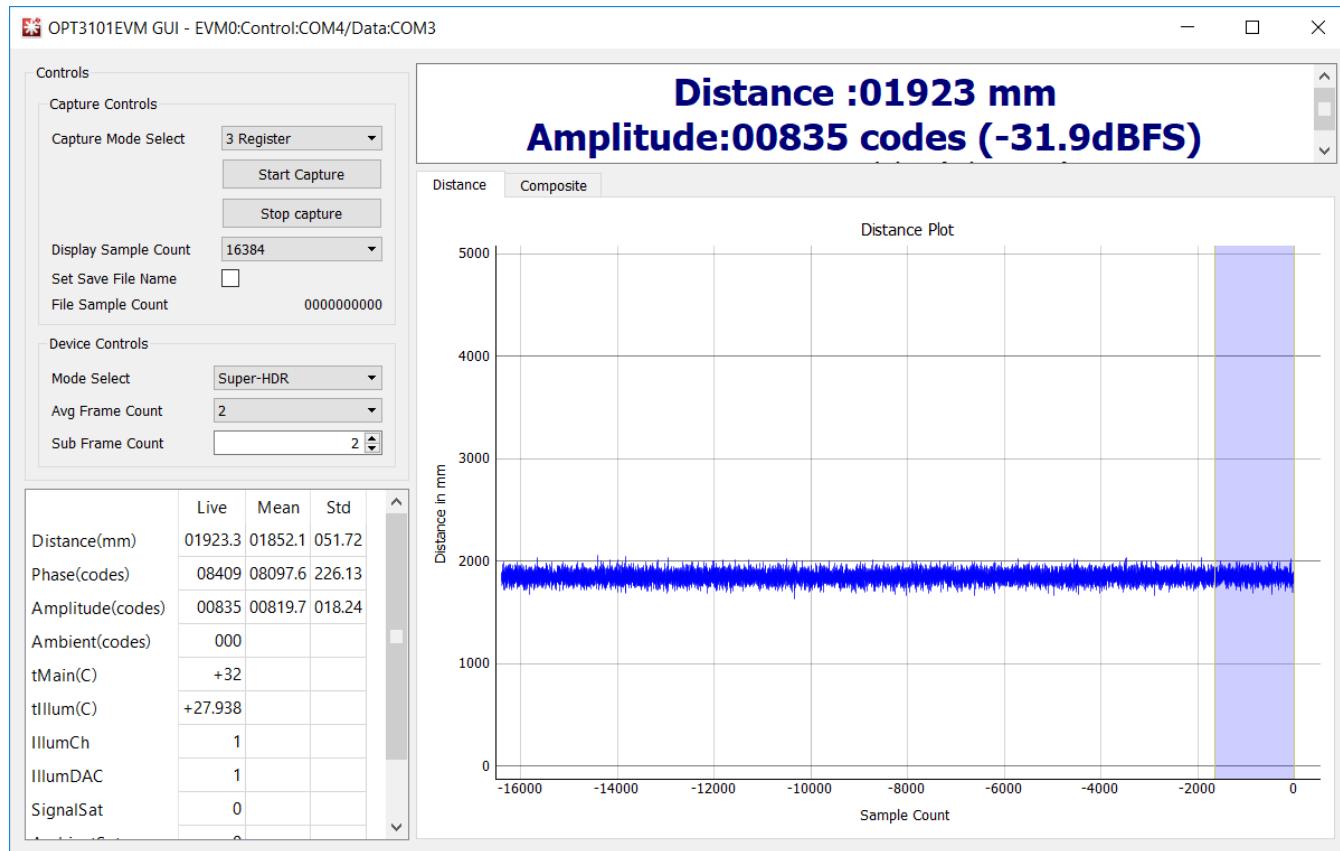


Figure 15. Gui Window

Clicking the **Start Capture** button begins capture. This sends a capture start command over the *OPT3101 Control Port* to the MSP430 on the EVM. The EVM then begins streaming data over the *OPT3101 Data Port*. This data is displayed live on the left side of the window. Distance is plotted on the graph. The axis of the plot can be changed by right clicking on the plot itself.

Clicking the **Stop Capture** button, or closing out the window stops streaming data from the EVM.

A number of key measurements are provided on this GUI. Distance, phase, amplitude, ambient, and temperature as well as a number of other parameters are all calculated internally on the OPT3101 and transmitted via I²C to the MSP430 and then to the PC over the data COM port. These values are all displayed in the table on the left hand side of the GUI window and summarized in [Table 3](#).

Frame Averaging

The *Sub Frame Count* and *Avg Frame Count* settings shown on the left of the GUI can be adjusted to decrease measurement noise or increase speed of measurement. An increase in avg frames will decrease the standard deviation in measurements while a decrease in avg frames will increase the data collection rate. Please note that these two fields correspond directly to register settings and *Sub Frame Count* must be greater than or equal to *Avg Frame Count*. An *Avg Frame Count* value of 0 corresponds to no averaging.

The frame rate is determined with [Equation 1](#):

$$\text{frame rate (fps)} = \frac{4000}{1 + \text{HDR mode} + \text{SUB_FRAME_CNT}} \quad (1)$$

For example, with HDRmode = True and sub frame count = 32:

$$\text{frame rate (fps)} = \frac{4000}{1 + 1 + 2^5} = 117.6 \text{ frames per second} \quad (2)$$

Streaming data at maximum datarate

To operate the EVM at the maximum datarate of 3 kspS the following steps need to be taken. First, the mode select must be set to one of the non-autoHDR and non-super-HDR modes. The capture mode select must be set to 2 register mode. Then the Avg Frame Count and Sub Frame Count fields must be set to 1. HDR mode uses an extra frame to determine when to switch LED currents, which limits the EVM to 2 kspS. In 3 register mode, there is too much data to send at higher speeds than 2 kspS. 2 register mode omits the 0Ah register. The OPT3101 device can run at up to 4 kspS, but due to the speed of the MSP430, the maximum speed of the EVM is 3 kspS.

[Table 2](#) describes all the fields in the *Controls* section of the GUI.

Table 2. GUI Controls Panel

Field	Function
Capture Mode Select: 3 Register mode	Reads all three data registers (08h, 09h, 0Ah) from the EVM. This allows all the data fields to be displayed.
Capture Mode Select: 2 Register mode	Only reads two data registers (08h, 09h) from the EVM. This should be selected for streaming data at speeds higher than 2 kspS and allows data to be captured at up to 3 kspS.
Start Capture	Start capture and display of data from the EVM
Stop Capture	Stop capture and display of data from the EVM
Display Sample Count	Number of samples (data points) to display on the plot
Set Save File Name	Clicking the check box allows data to be saved to a csv file. Logging to numpy files will start once Start Capture is clicked with the box checked. After Stop Capture is clicked, the logged data will be combined and saved to the specified csv file.
File Sample Count	Number of samples captured to be saved to the csv file
Mode Select: Super-HDR	Places the device in super-HDR mode allowing 4 LED current settings to be automatically selected by the device. See the <i>Super-HDR mode using Sequencer</i> section in OPT3101 ToF based Long Range Proximity and Distance Sensor AFE for more details.
Mode Select: AutoHDR-Long Range	Places the device in HDR mode allowing 2 of the larger LED current settings to be automatically selected by the device. For longer range measurements or low-reflectivity surfaces. See the <i>Auto HDR Mode</i> section in OPT3101 ToF based Long Range Proximity and Distance Sensor AFE for more details on Auto HDR mode.
Mode Select: AutoHDR-Short Range	Places the device in HDR mode allowing 2 of the smaller LED current settings to be automatically selected by the device. For shorter range measurements or highly reflective surfaces. See the <i>Auto HDR Mode</i> section in OPT3101 ToF based Long Range Proximity and Distance Sensor AFE for more details on Auto HDR mode.
Mode Select: Closeup	Selects a very small LED current for extremely-close measurements or very highly reflective surfaces at short range
Mode Select: ShortRange	Selects a small LED current for shorter-range measurements or highly reflective surfaces
Mode Select: MediumRange	Selects a medium LED current for medium-range measurements
Mode Select: LongRange	Selects a large LED current for large-range measurements or low-reflectivity surfaces
Sub Frame Count	Raw value of the SUB_FRAME_CNT register. This is the total number of sub-frames in a frame. The number of sub frames in a frame = SUB_FRAME_CNT + 1. This number must be equal or greater than NUM_AVG_IQ.
Ave Frame Count	Raw value of the NUM_AVG_IQ register. This specifies the number of sub-frames to be averaged in a frame. Averaging sub-frames = NUM_AVG_IQ + 1.

Table 3 describes the data that is displayed by the GUI when the software is capturing data from the EVM.

Table 3. GUI Data Capture Fields

Field	Corresponding register and description
Distance	The calculated distance derived from the phase and the calibration information in millimeters
Phase	The raw data from the PHASE_OUT register. The OPT3101 uses the phase shift between the LED signal emitted and photodiode signal received to determine distance. See the Introduction to Time-of-Flight Optical Proximity Sensor System Design Guide , for more details on time-of-flight operation.
Amplitude	The raw data from the AMP_OUT register. A 15-bit digital representation of the full-scale signal amplitude. This is the signal strength of the returning signal to the AFE. This number is related to the signal-to-noise ratio. The lower the amplitude, the noisier the signal will be. As the amplitude goes down, the standard deviation for distance and phase measurements will generally increase. As distance between the EVM and a target is increased or reflectivity of a target is decreased, the amplitude will decrease. <ul style="list-style-type: none"> • The HDR, and super-HDR functionality of the OPT3101 allows two or four LED current values to be used which allows an increased range while maintaining relatively high amplitude.
Ambient	The raw data from the AMB_DATA register. This is a measurement of the environmental IR light that is landing on the sensor. This measurement is used to reduce the effect of the ambient light on the signal and computed distance through the ambient rejection and ambient calibration functionality of the device.
tMain	The derived data from the TMAIN register. The temperature reading in degrees Celsius from the internal sensor on the OPT3101. The tMain and illum measurements are used in calibration to compensate for phase and crosstalk drift across temperature.
illum	The derived data from the TILLUM register. The temperature reading in degrees Celsius from the external temperature sensor soldered to the EVM PCB.
illumCh	The raw data from the TX_CHANNEL register. On Super-HDR mode this field indicates whether the 2 larger (illumCh=1) or 2 smaller (illumCh=0) current values are being used.
illumDAC	The raw data from the HDR_MODE register. In HDR mode this field indicates whether the larger (illumDAC=1) or smaller (illumDAC=0) current is being used. In Super-HDR mode this field indicates which of the 2 current values indicated by the illumCh field are being used.
SignalSat	The raw data from the SIG_OVL_FLAG register. A value of 1 indicates that the amplitude reading has saturated.
AmbientSat	The raw data from the AMB_OVL_FLAG register. A value of 1 indicates that the ambient reading has saturated.
SampleCounter	The derived data from the FRAME_COUNT0, FRAME_COUNT1, and FRAME_COUNT2 registers. Indicates the current data frame that is being received from the OPT3101. This value starts at 0 and increments with each frame the OPT3101 reads. After reaching 31 this value loops back to 0.

Plots

The GUI contains a distance plot [Figure 15](#) and a composite plot [Figure 16](#). These plots can be switched between, using the tab buttons above the plot. The distance plot is a graph of the distance reading in millimeters on the y-axis against the sample count on the x-axis. The composite plot overlays both distance data and amplitude data. The plot settings can be tweaked by right clicking on the plot. The x-axis and y-axis options under the right-click menu allow the range of x- and y-axes displayed to be changed. There is also an auto option that will dynamically change the range to match the data. Scrolling will zoom in to or zoom out from the plot. Left-clicking and dragging will display a yellow rectangle that will, upon releasing the mouse, zoom the data to the rectangle drawn. Right-clicking and dragging up or down zooms the y-axis. Right-clicking and dragging right or left will zoom the x-axis. Right clicking and selecting "View All" will reset the view.

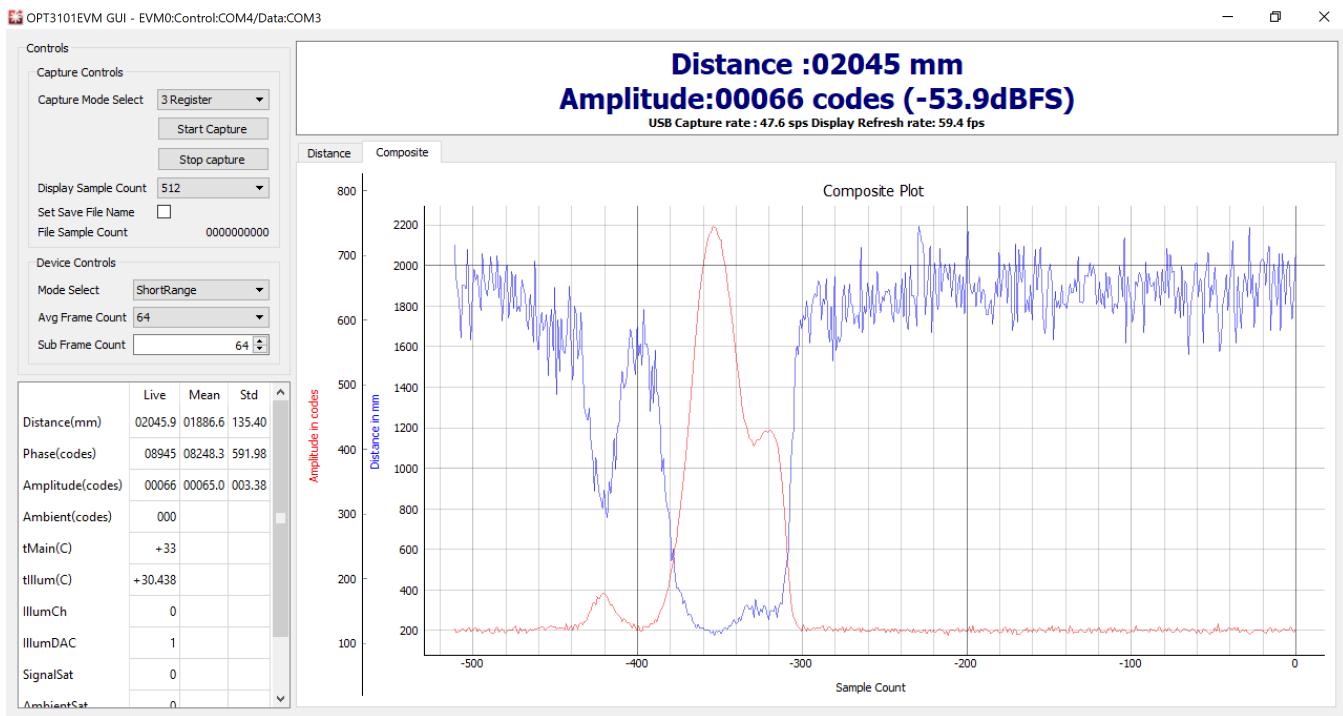


Figure 16. Composite Plot Showing Amplitude and Distance

Mean, Std, and the Blue Slider

There is a blue slider on the distance plot shown on the right side of the plot in [Figure 15](#). Mean and Std columns in the table where capture data is displayed are calculated from only the data within the blue slider. Left-clicking on the middle of this slider and dragging moves the slider. Left-clicking on the edge of either side of the slider and dragging will adjust the size of the slider. This allows the mean and standard deviation of the distance, phase, and amplitude to be computed for any continuous portion of the displayed data. If capture is running this data updates in real-time along with the data in the Live column.

6 Troubleshooting

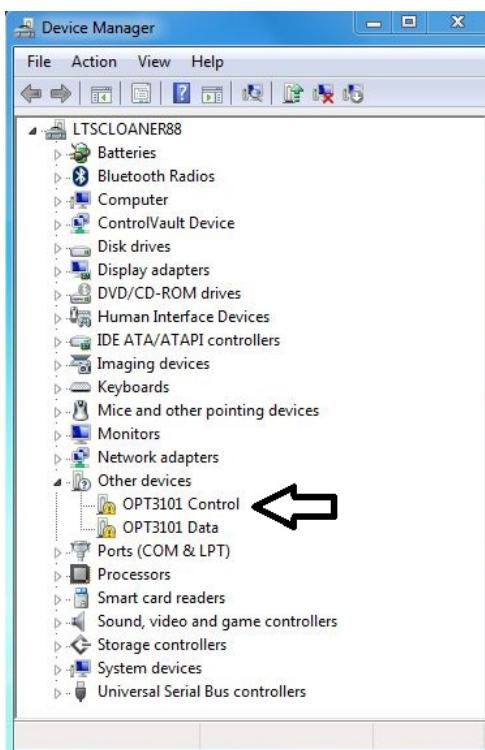
6.1 Microsoft® Windows® 7 Manual Driver Installation

This section outlines the manual driver installation process. If you are using Windows 7 or if the Windows device manager shows the *OPT3101 Control* and *OPT3101 Data* as *other devices* instead of COM ports as shown in [Figure 17](#), use the following steps. If *OPT3101 Control* and *OPT3101 Data* show up as COM ports automatically (as is the case with Windows 10), then this section can be skipped.



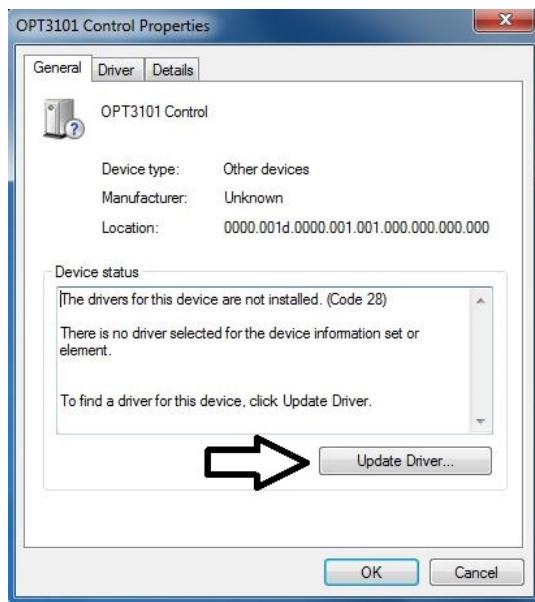
Figure 17. OPT3101 on Microsoft® Windows® 7 With Drivers not Installed

1. Open the device manager.

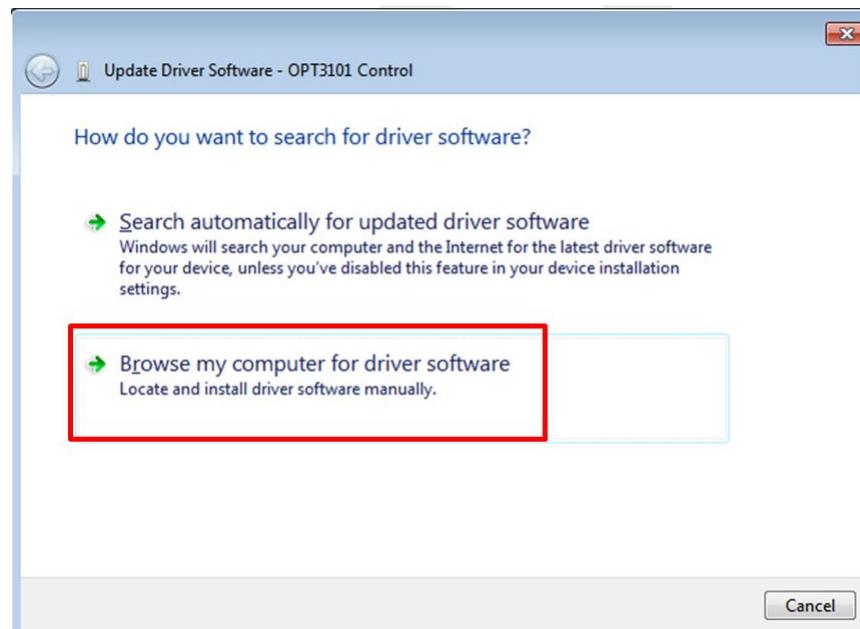


2. Right click on *OPT3101 Control* and select Properties.

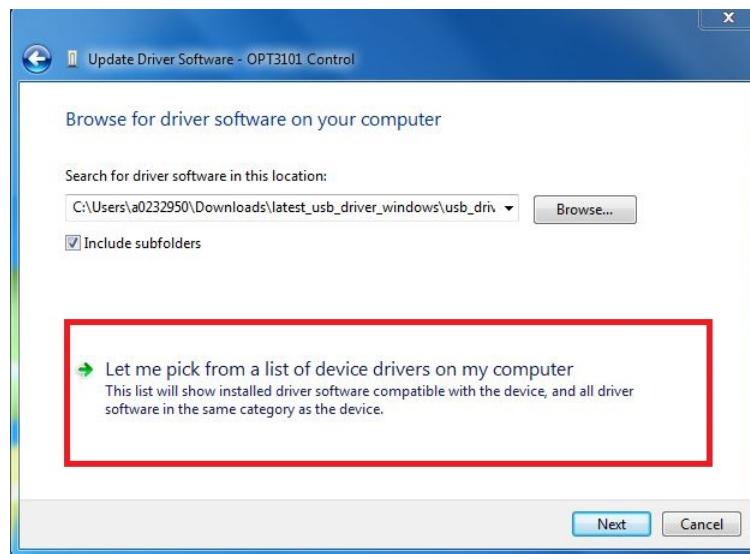
3. Click the **Update Driver...** button.



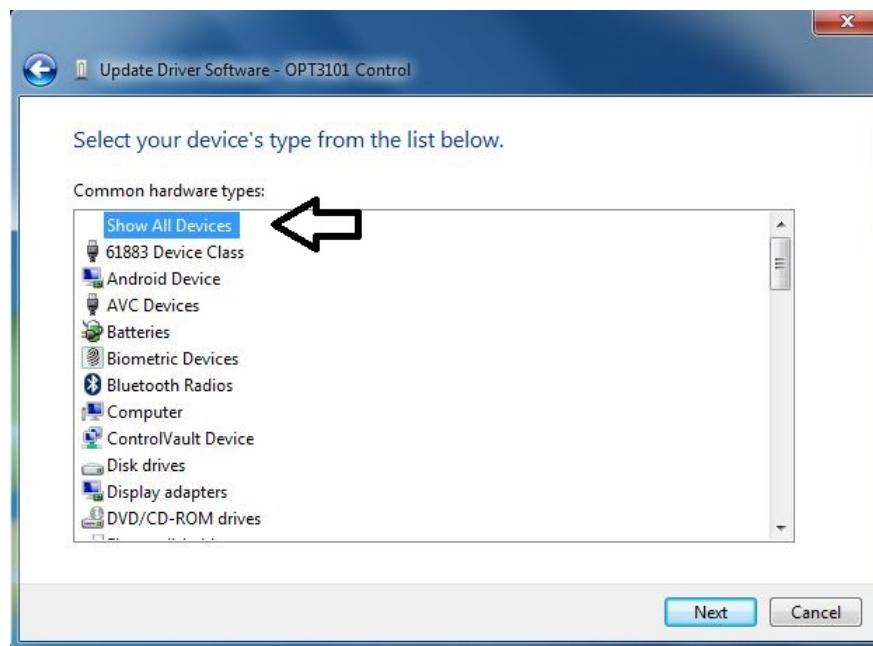
4. Click *Browse my computer for driver software*



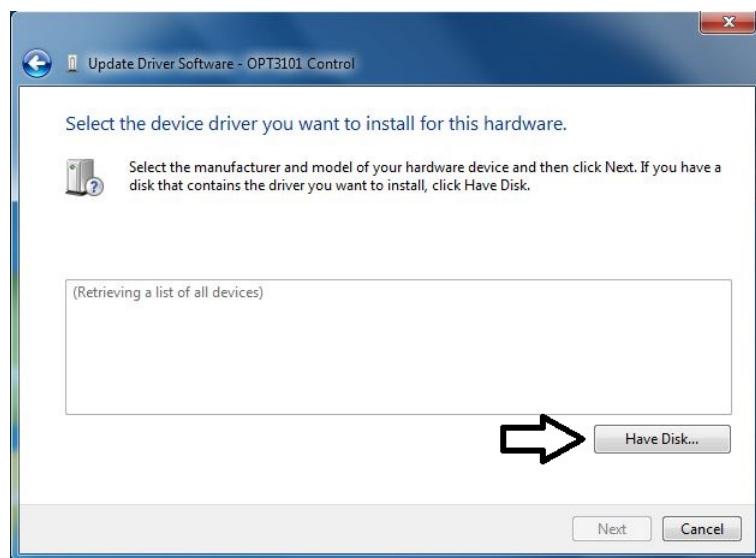
5. Click *Let me pick from a list of device drivers on my computer.*



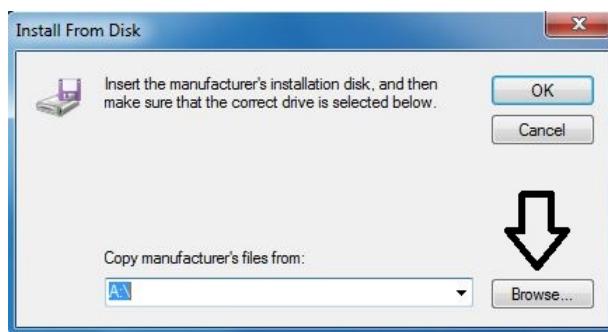
6. Select *Show All Devices* and click the **Next** button.



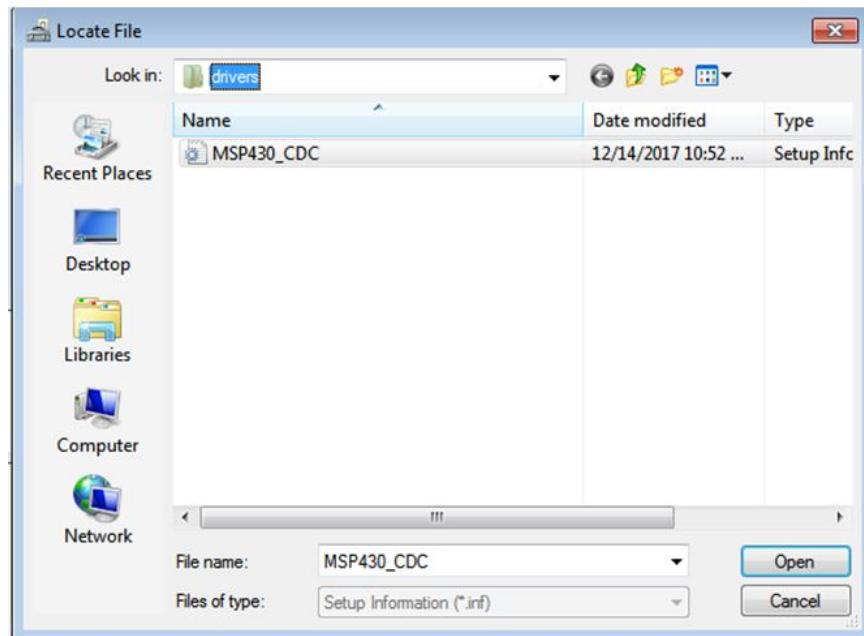
7. Click the **Have Disk...** button.



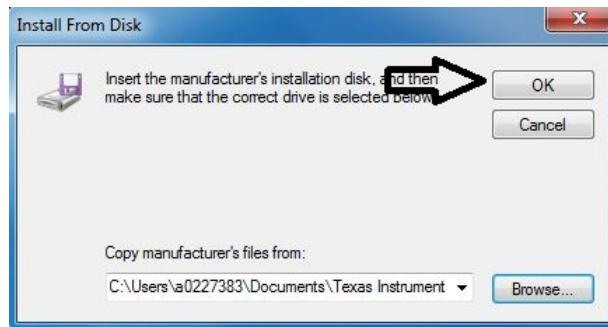
8. Click the **Browse...** button.



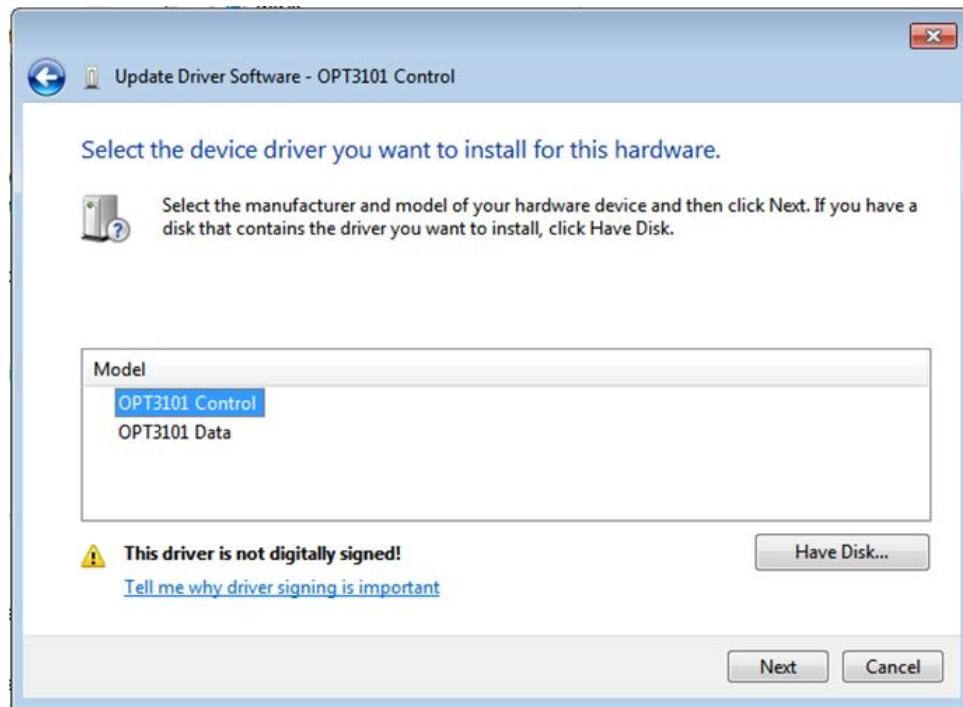
9. Navigate to “C:\Users\<username>\Documents\Texas Instruments\Latte\projects\opt3101\drivers” and choose MSP430_CDC. Click the **Open** button.



10. Click the **OK** button



11. Select **OPT3101 Control** and click the **Next** button.



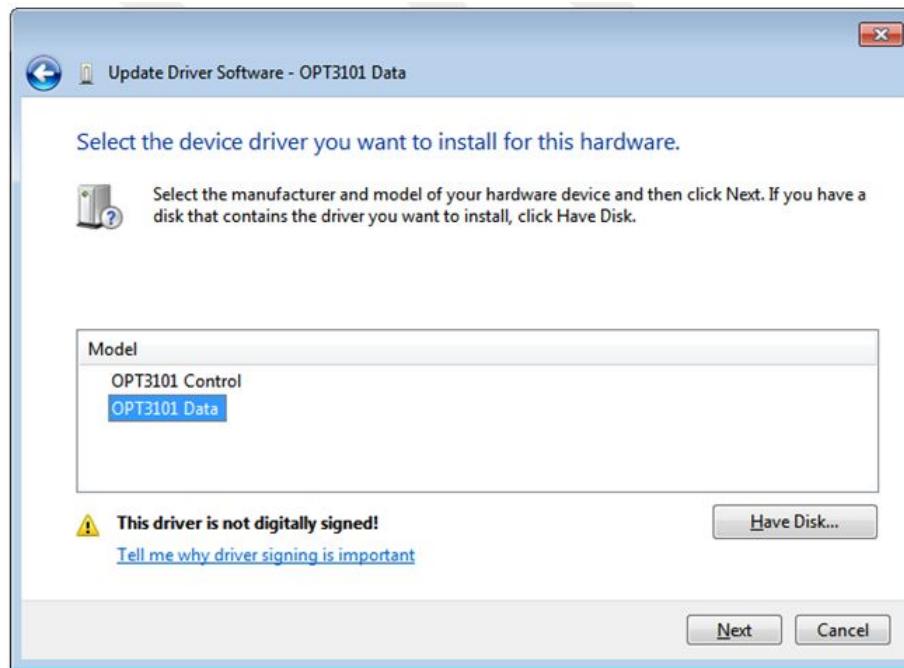
12. Click the **Yes** button.



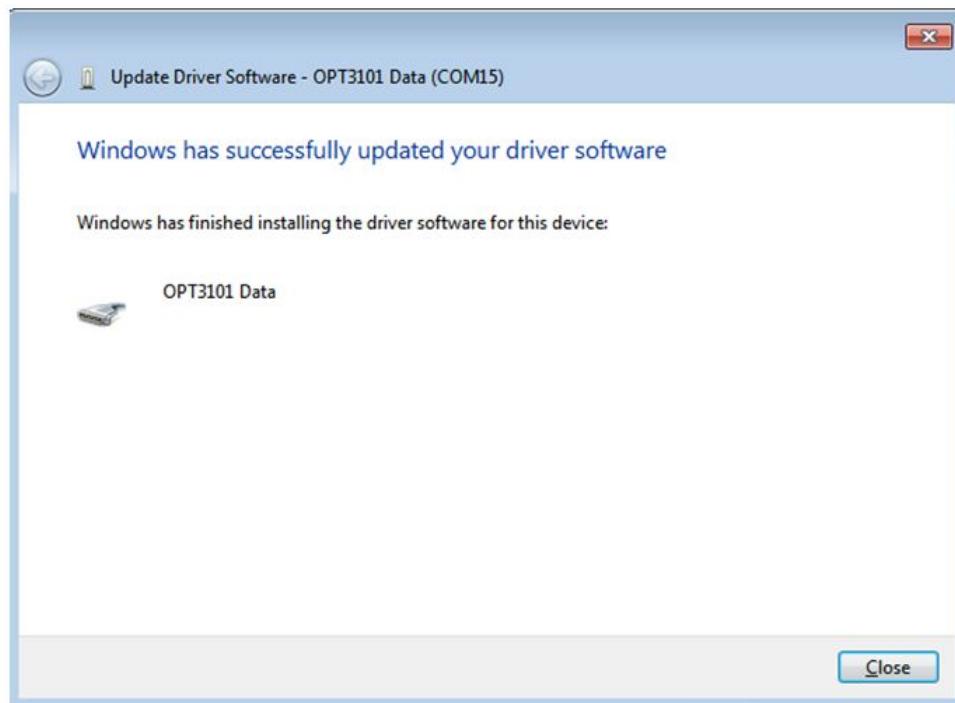
13. The driver should now install properly.



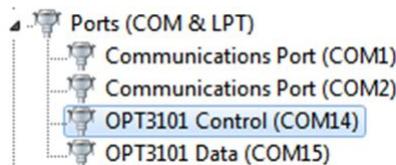
14. Now repeat this process (steps 1 to 13) for *OPT3101 Data*. All steps are the same except for step 2 and step 11. In step 2 make sure to right click *OPT3101 Data* instead of *OPT3101 Control*. Likewise, on step 11 make sure to select *OPT3101 Data* instead of *OPT3101 Control* when installing the driver as the following figure shows.



15. When the *OPT3101 Data* driver is installed, you will see the following message.



16. *OPT3101 Control* and *OPT3101 Data* should now appear in the device manager under Ports (COM & LPT) as the following image shows.



7 OPT3101EVM Schematics, Layout, and BOM

This section contains the schematic diagrams, printed circuit board (PCB) layouts and complete bill of materials for the OPT3101EVM.

7.1 OPT3101EVM Schematics

[Figure 18](#) illustrates the EVM schematics.

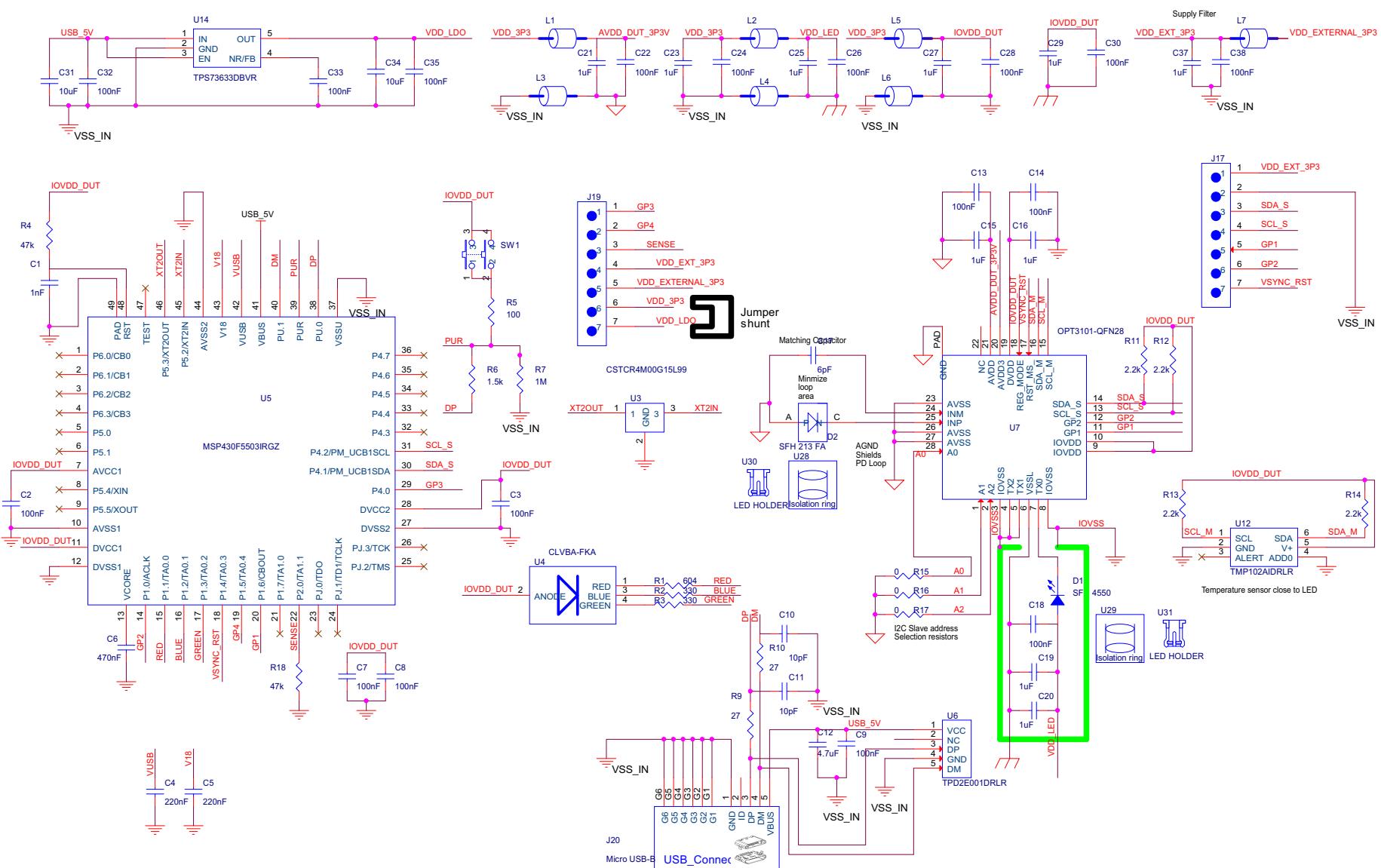


Figure 18. EVM Schematic

7.2 OPT3101EVM PCB Layout

Figure 19 through Figure 22 illustrate the EVM PCB layouts.

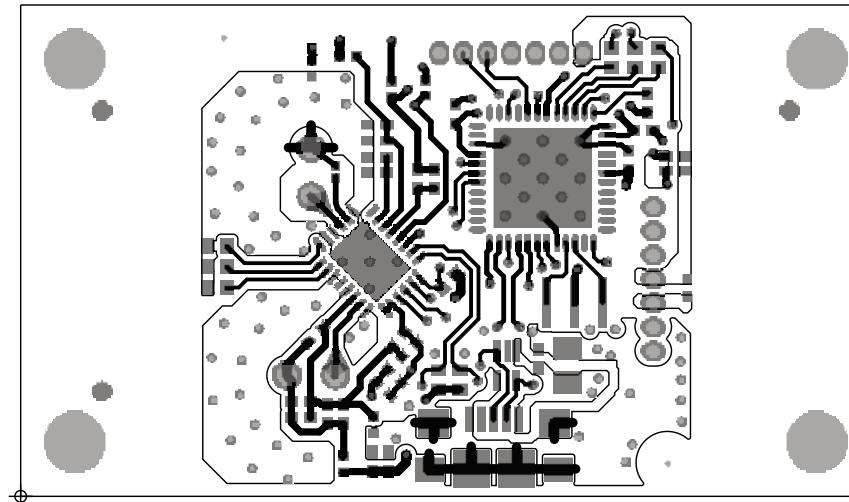


Figure 19. PCB Layout Top Layer

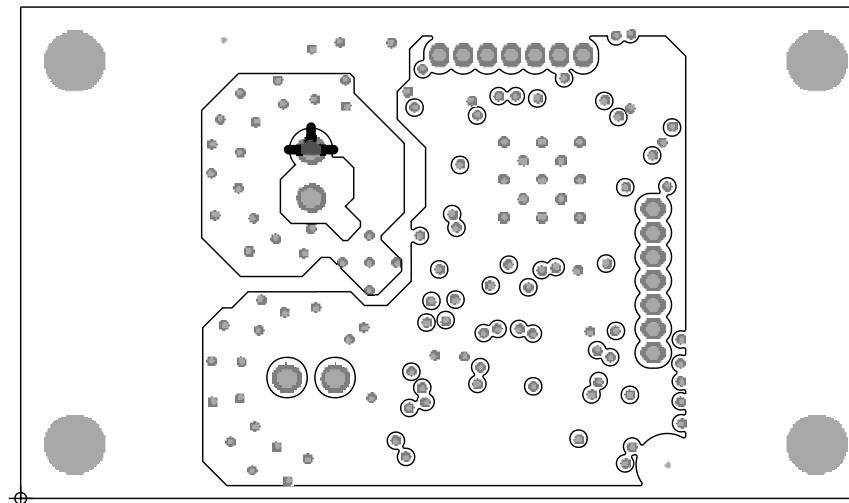


Figure 20. PCB Layout Inner Layer 1

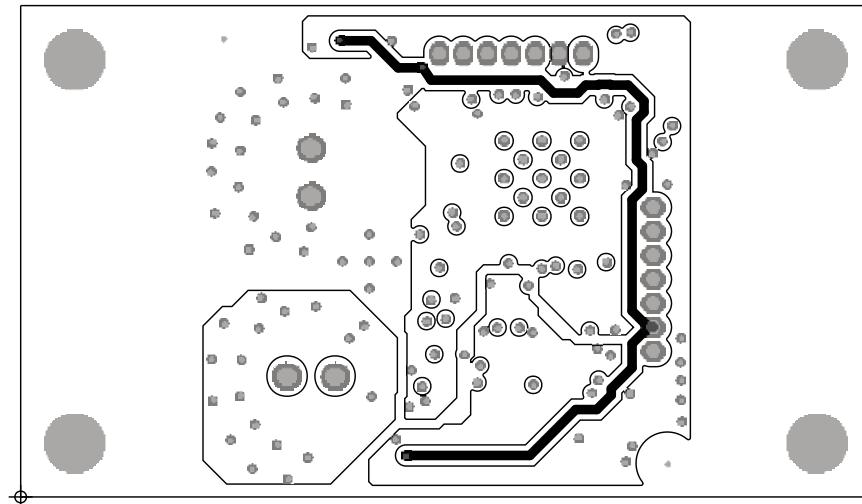


Figure 21. PCB Layout Inner Layer 2

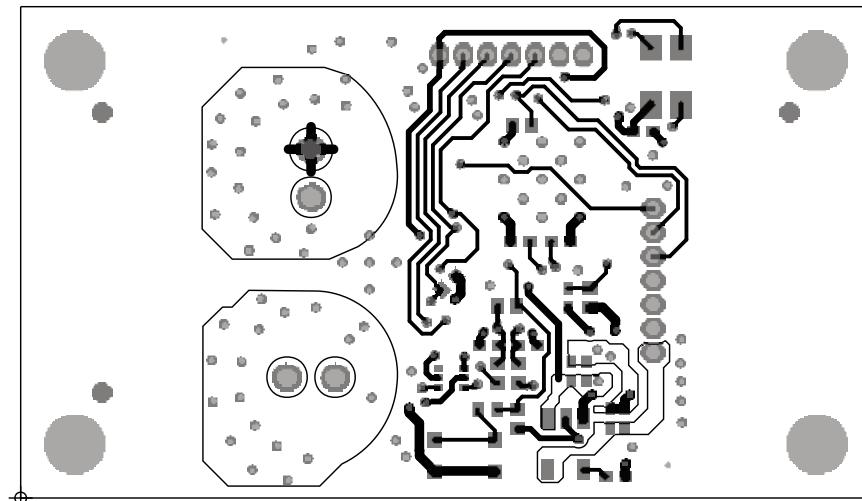


Figure 22. PCB Layout Bottom Layer

7.3 OPT3101EVM Bill of Materials

Table 4. OPT3101EVM Bill of Materials

Item	Quantity	Reference	Value	PCB Footprint	Part Number	Manufacturer	Description
1	1	C1	1 nF	C0402	C1005X7R1H102K050BA	TDK CORPORATION	1000pF ±10% 50V Ceramic Capacitor X7R 0402 (1005 Metric)
2	17	C2,C3,C7,C8,C9,C13, C14,C18,C22,C24,C26,C28,C30,C32,C33, C35,C38	100 nF	C0402	CL05A104KO5NNNC	SAMSUNG ELECTRO-MECHANICS	0.1µF ±10% 16V Ceramic Capacitor X5R 0402 (1005 Metric)
3	2	C4,C5	220 nF	C0402	C1005X5R1C224K050BB	TDK CORPORATION	0.22µF ±10% 16V Ceramic Capacitor X5R 0402 (1005 Metric)
4	1	C6	470 nF	C0402	GRM155R61A474KE15D	Murata	0.47µF ±10% 10V Ceramic Capacitor X5R 0402 (1005 Metric)
5	2	C10,C11	10 pF	C0402	C1005C0G1H100D050BA	TDK CORPORATION	10pF ±0.5pF 50V Ceramic Capacitor C0G, NP0 0402 (1005 Metric)
6	1	C12	4.7 µF	CC0805	C2012X5R1C475M125AC	TDK CORPORATION	4.7µF ±20% 16V Ceramic Capacitor X5R 0805 (2012 Metric)
7	10	C15,C16,C19,C20,C21,C23,C25,C27,C29, C37	1 µF	C0402	GRM155R61A105KE15D	Murata	1µF ±10% 10V Ceramic Capacitor X5R 0402 (1005 Metric)
8	1	C17	6 pF	RC0201	GJM0335C1E6R0CB01D	Murata	6pF ±0.25pF 25V Ceramic Capacitor C0G, NP0 0201 (0603 Metric)
9	2	C31,C34	10 µF	C0402	CL05A106MQ5NUNC	SAMSUNG ELECTRO-MECHANICS	10µF ±20% 6.3V Ceramic Capacitor X5R 0402 (1005 Metric)
10	1	D1	SFH 4550	SFH213FA	SFH 4550	OSRAM	EMITTER IR 860NM 100MA RADIAL
11	1	D2	SFH 213 FA	SFH213FA	SFH 213 FA	OSRAM	PHOTODIODE 5MM 900NM

Table 4. OPT3101EVM Bill of Materials (continued)

Item	Quantity	Reference	Value	PCB Footprint	Part Number	Manufacturer	Description
12	2	J17,J19	TMS-107-01-L-S	SAMTEC_TMS-107-01-L-S	TMS-107-01-L-S	Samtech	.050" (1.27MM) MICRO HEADER
13	1	J20	ZX62R-B-5P(30)	te_1981568_cus	ZX62R-B-5P(30)	Hirose Electric Co Ltd	CONN RCPT MICRO USB B R/A SMD
14	7	L1,L2,L3,L4,L5,L6,L7	MMZ1005S182ET000	FB0402H0_55	MMZ1005S182ET000	TDK CORPORATION	FB,1.8 KOhms@100MHz,20 0mA,1.5Ohms DC ,G,SMD0402
15	1	R1	604 Ω	RC0402	RC0402FR-07604RL	yageo	RES SMD 604 OHM 5% 1/16W 0402
16	2	R2,R3	330 Ω	RC0402	RC0402JR-07330RL	yageo	RES SMD 330 OHM 5% 1/16W 0402
17	2	R4,R18	47 kΩ	RC0402	RC0402FR-0747KL	yageo	RES SMD 47K OHM 1% 1/16W 0402
18	1	R5	100 Ω	RC0402	RC0402FR-07100RL	yageo	RES SMD 100 OHM 1% 1/16W 0402
19	1	R6	1.5 kΩ	RC0402	RC0402FR-071K5L	yageo	RES SMD 1.5K OHM 1% 1/16W 0402
20	1	R7	1 MΩ	RC0402	RC0402FR-071ML	yageo	RES SMD 1M OHM 1% 1/16W 0402
21	2	R9,R10	27 Ω	RC0402	RC0402JR-0727RL	YAGEO	RES SMD 27 OHM 5% 1/16W 0402
22	4	R11,R12,R13,R14	2.2 kΩ	RC0402	RC0402FR-072K2L	YAGEO	RES SMD 2.2K OHM 1% 1/16W 0402
23	3	R15,R16,R17	0 Ω	RC0402	RC0402JR-070RL	YAGEO	RES SMD 0.0OHM JUMPER 1/16W 0402
24	1	SW1	PTS830GM140 SMTR LFS	sw_pts830	PTS830GM140 SMTR LFS	C&K	SWITCH TACTILE SPST-NO 0.05A 12V
25	1	U3	CSTCR4M00G15L99	MURATA_CSTCR_G 15L	CSTCR4M00G15L99	Murata	CER RES 4.0000MHZ 39PF SMD
26	1	U4	CLVBA-FKA-CAEDH8BBB7A363CT-ND	LED_CLVBA-FKA-CAEDH8BBB7A363	CLVBA-FKA-CAEDH8BBB7A363CT-ND	CREE	LED RGB DIFFUSED 4PLCC SMD
27	1	U5	MSP430F5503IRGZ	qfn50p700x700x80-49n_a	MSP430F5503IRGZ	Texas Instruments	IC MCU 16BIT 32KB FLASH 48VQFN
28	1	U6	TPD2E001DRLR	SOT553	TPD2E001DRLR	Texas Instruments	TVS DIODE 5.5VWM 100VC SOT5
29	1	U7	OPT3101-QFN28	QFN50P400X500X10 0_EPA-29N	OPT3101RHFR	Texas Instruments	OPT3101

Table 4. OPT3101EVM Bill of Materials (continued)

Item	Quantity	Reference	Value	PCB Footprint	Part Number	Manufacturer	Description
30	1	U12	TMP102AIDRLR	SOT563	TMP102AIDRLR	Texas Instruments	Temperature Sensor Digital, Local -40°C ~ 125°C 11 b SOT-563
31	1	U14	TPS73633DBVR	SOT-23-5H1_45	TPS73633DBVR	Texas Instruments	IC,Regulator,TPS736 33DBVR,400mA,ADJ, 1%,G,SOT23-5,SMD
32	1	H17	DC11		DC11	Any	PCB
33	4	H19,H20,H21,H22	M3 Screw		NMS-308	Essentra Components	MACHINE SCREW PAN PHILLIPS M3
34	4	H23,H24,H25,H26	10mm Stand		25510	Keystone Electronics	HEX SPACER M3 PLASTIC 10MM
35	1	H27	NPB02SVAN-RC		NPB02SVAN-RC	Sullins Connector Solutions	Jumper Shunt
36	2	U28,U29	Isolation Rings		KR-CT374	Smith Tool & Mfg	Alloy 122 Copper Tubing .3125" OD (5/16 inch) x .032" W cut to 0.374+/-0.004 ENIG Coated -- Pre-Ordered
37	2	U30,U31	LED Holder Clip		Bivar C-174	Bivar	LED HOLDER PNL CLIP 5MM BK NYL

8 Appendix

8.1 Running Scripts and Collecting Data

8.1.1 Hidden IDE Window

The Latte program runs a number of python scripts in the background to capture and display data from the EVM. These scripts allow for initialization of the device including loading calibration data from the EVM flash memory, launching a live view window with measurement plot and readings, and additional functionality such as reading from the flash and selecting a specific LED current for the device to use. For advance users or users looking for more flexibility when using the OPT3101EVM these python scripts are available in an integrated development environment (IDE) window that is minimized when TI-Latte is launched. The IDE window allows advanced users to customize the existing scripts or write new scripts

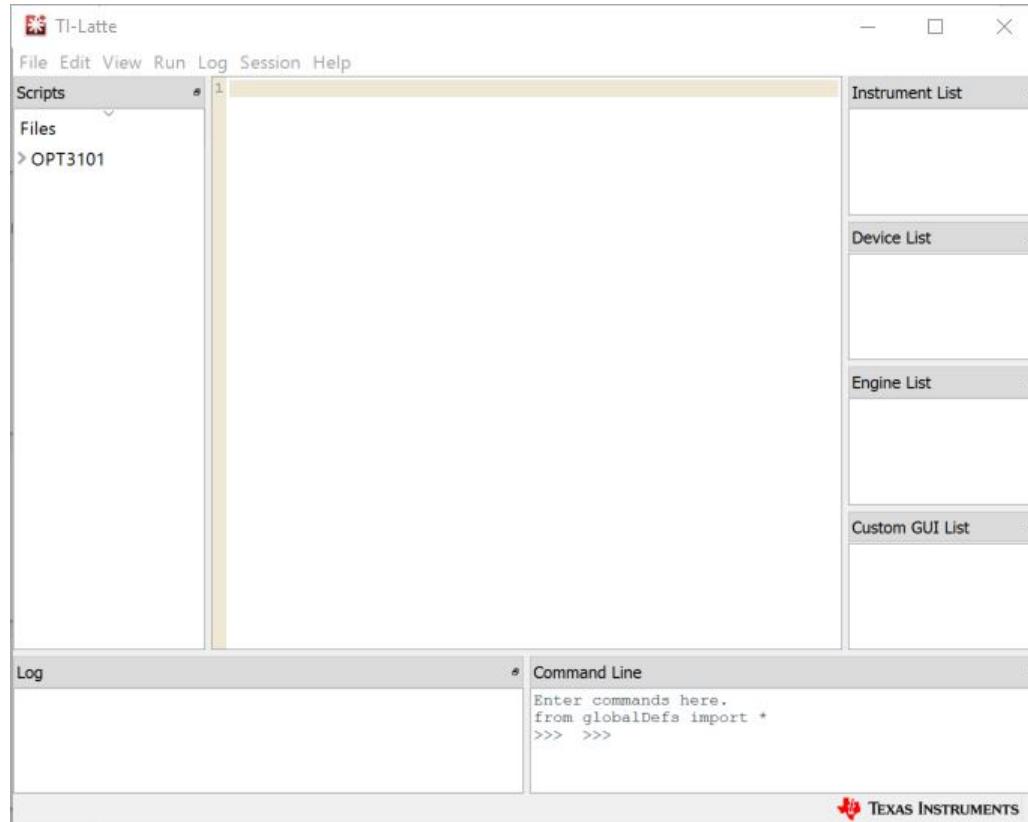


Figure 23. IDE Window

Figure 23 shows the scripts window.

Customization of the 01-variableSetup.py scripts allows for initialization parameters of the device to be changed. Latte also provides functionality to write custom Python scripts for testing and evaluation purposes with the OPT3101. The example scripts provided can be used as a reference to write custom scripts.

The default script install location is:

C:\Users\<user name>\Documents\Texas Instruments\Latte\projects\opt3101

8.1.2 Initialization

The EVM is initialized by running the devInit.py script in Latte. This runs the variablesSetup.py, Initialization.py, and loadRegistersFromFlash.py scripts in addition to creating the objects for interfacing with the device (dev), the device registers (regProg), and the capture infrastructure of the MSP430 on the EVM (capDev), which allows for higher speed data transfer over a dedicated data COM port. Running the devInit.py script will automatically run the launchGUI.py script after completing initialization steps. This will display the graphical window for controlling the EVM and visualizing data.

8.1.3 Calibration

The OPT3101 device has a number of calibration features to increase the device's performance that are loaded when running devInit.py. The EVM is calibrated for internal crosstalk, illumination crosstalk, phase offset, crosstalk over temperature, phase offset over temperature, and ambient correction. For more details on these calibration features see [OPT3101 ToF based Long Range Proximity and Distance Sensor AFE](#) and the [OPT3101 Distance Sensor System Calibration](#). The EVM calibration values are stored onboard the flash of the MSP430. The calibration values are loaded from the flash into the OPT3101 using the loadRegistersFromFlash.py script in Latte.

8.1.4 Running the Scripts

After launching Latte, expand the OPT3101 directory on the left hand side of the window under Files by clicking the triangle to the left of the directory name. This displays the calibData, drivers, and OPT3101EVMrevE3_Demo folders. Further expanding the OPT3101EVMrevE3_Demo folder will display all the example scripts as shown in [Figure 24](#).

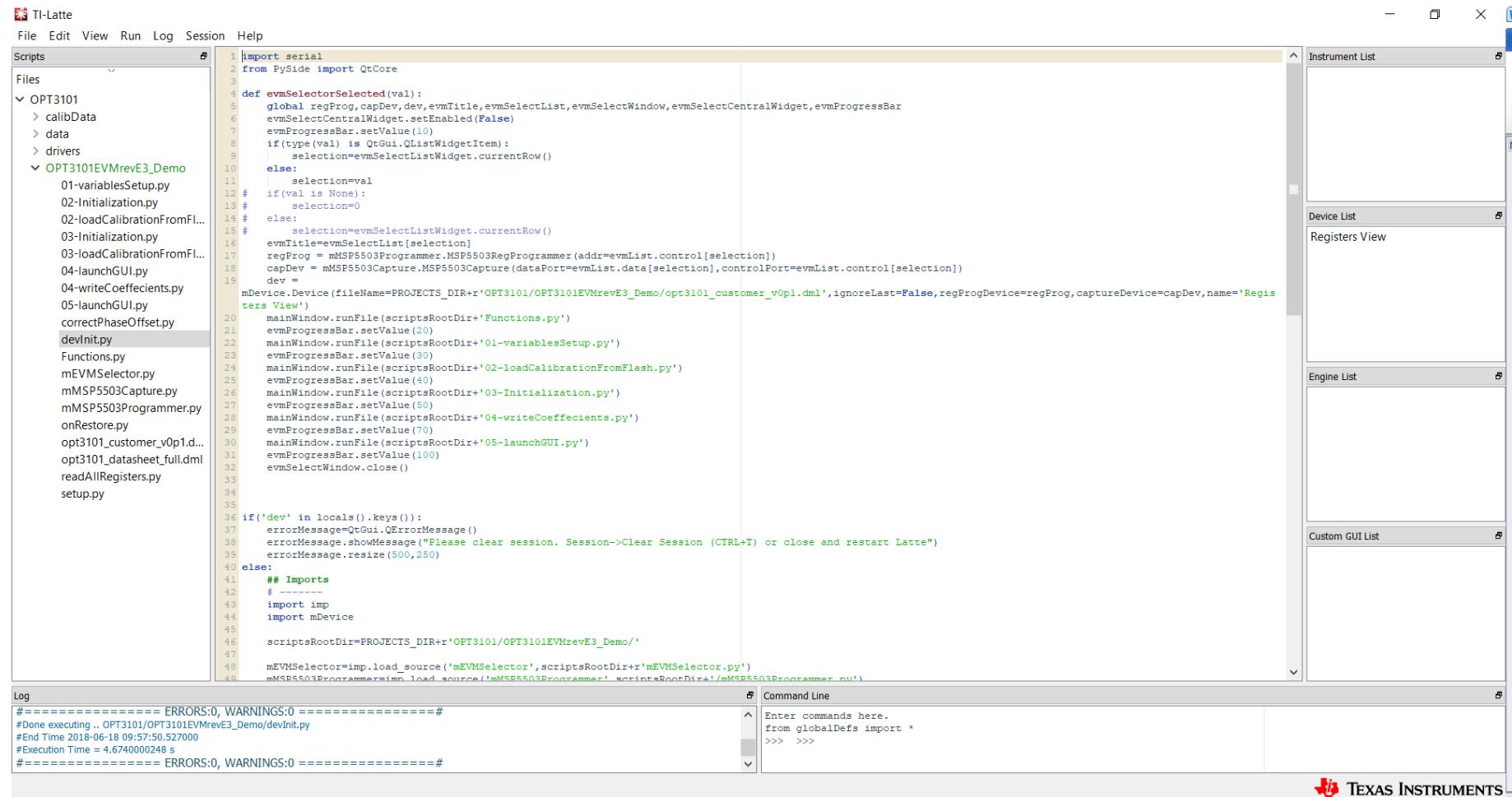
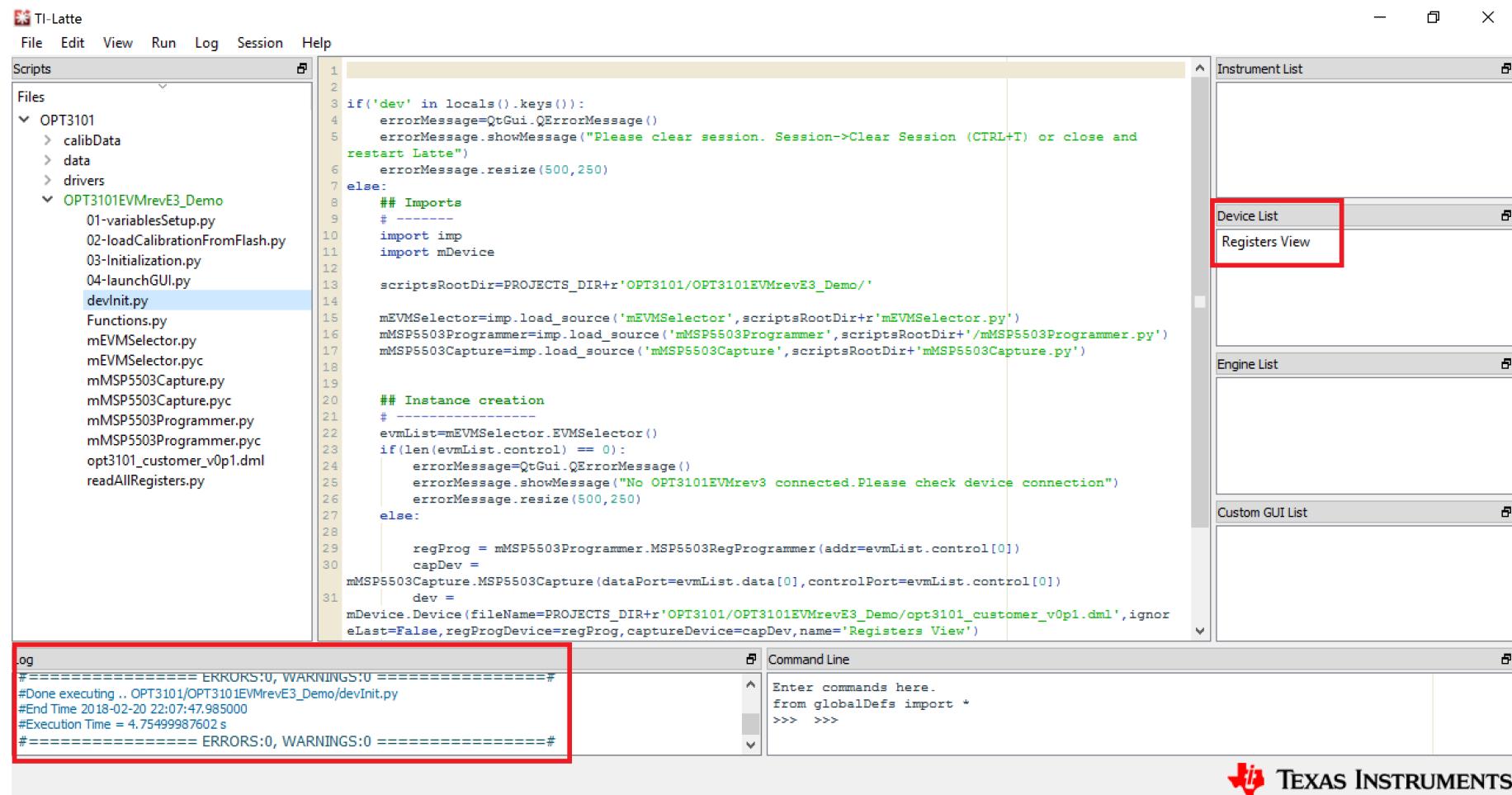


Figure 24. Demo Scripts in Latte Software

8.1.4.1 Device Initialization: devInit.py

Open the devInit.py script by clicking on the corresponding file in the OPT3101EVMrevE3_Demo folder on the left side of the screen. This displays the contents of the script on the center of the window. With devInit.py still selected in TI-Latte, click Run>Buffer from the top menu bar of TI-Latte (or press F5) to run the script. Once completed, the live view GUI is opened in a new window. More details on the live view GUI are given in the following section. Additional info is also displayed in the log window in the lower left-hand corner of the main window. [Figure 25](#) shows the register view and log output added to the main window.



```

1
2
3 if('dev' in locals().keys()):
4     errorMessage=QtGui.QErrorMessage()
5     errorMessage.showMessage("Please clear session. Session->Clear Session (CTRL+T) or close and
restart Latte")
6     errorMessage.resize(500,250)
7 else:
8     ## Imports
9     # -----
10    import imp
11    import mDevice
12
13 scriptsRootDir=PROJECTS_DIR+r'OPT3101/OPT3101EVMrevE3_Demo/'
14
15 mEVMSelctor=imp.load_source('mEVMSelctor',scriptsRootDir+r'mEVMSelctor.py')
16 mMSP5503Programmer=imp.load_source('mMSP5503Programmer',scriptsRootDir+r'mMSP5503Programmer.py')
17 mMSP5503Capture=imp.load_source('mMSP5503Capture',scriptsRootDir+r'mMSP5503Capture.py')
18
19 ## Instance creation
20 # -----
21 evmList=mEVMSelctor.EVMSelctor()
22 if(len(evmList.control) == 0):
23     errorMessage=QtGui.QErrorMessage()
24     errorMessage.showMessage("No OPT3101EVMrev3 connected. Please check device connection")
25     errorMessage.resize(500,250)
26 else:
27
28     regProg = mMSP5503Programmer.MSP5503RegProgrammer(addr=evmList.control[0])
29     capDev =
30     mMSP5503Capture.MSP5503Capture(dataPort=evmList.data[0],controlPort=evmList.control[0])
31     dev =
32     mDevice.Device(fileName=PROJECTS_DIR+r'OPT3101/OPT3101EVMrevE3_Demo/opt3101_customer_v0p1.dml',ignor
eLast=False,regProgDevice=regProg,captureDevice=capDev,name='Registers View')

.log
=====
#=====ERRORS:0, WARNINGS:0 =====#
#Done executing .. OPT3101/OPT3101EVMrevE3_Demo/devInit.py
#End Time 2018-02-20 22:07:47.985000
#Execution Time = 4.75499987602 s
#=====ERRORS:0, WARNINGS:0 =====#

```

Figure 25. After Running devInit.py

8.2 Capture GUI: *launchGUI.py*

A liveview GUI window is launched when running the devInit.py script. This allows data from the OPT3101 to be viewed on a graph in real time. The GUI is created in the launchGUI.py example script. When running devInit.py, the launchGUI.py script is automatically run. However, if the GUI window is closed it can be re-launched by directly running the launchGUI.py script. To do this, select the launchGUI.py script and click Run>Buffer or press F5. [Figure 15](#) shows the live GUI plot

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- 3 *Regulatory Notices:*

- 3.1 *United States*

- 3.1.1 *Notice applicable to EVMs not FCC-Approved:*

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

- 3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

3.3 Japan

3.3.1 Notice for EVMs delivered in Japan: Please see http://www.tij.co.jp/lsts/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。 http://www.tij.co.jp/lsts/ti_ja/general/eStore/notice_01.page

3.3.2 Notice for Users of EVMs Considered "Radio Frequency Products" in Japan: EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsts/ti_ja/general/eStore/notice_02.page
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3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 EVM Use Restrictions and Warnings:

- 4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
- 4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
- 4.3 Safety-Related Warnings and Restrictions:
 - 4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.
 - 4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.
- 4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

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