TPL5110 Evaluation Module

This user's guide provides the setup instructions, configuration, and operation of the TPL5110 evaluation module (EVM). Also included are the printed-circuit board (PCB) layouts, schematic, and the bill of materials (BOM).

Contents

List of Figures

List of Tables

1 Introduction

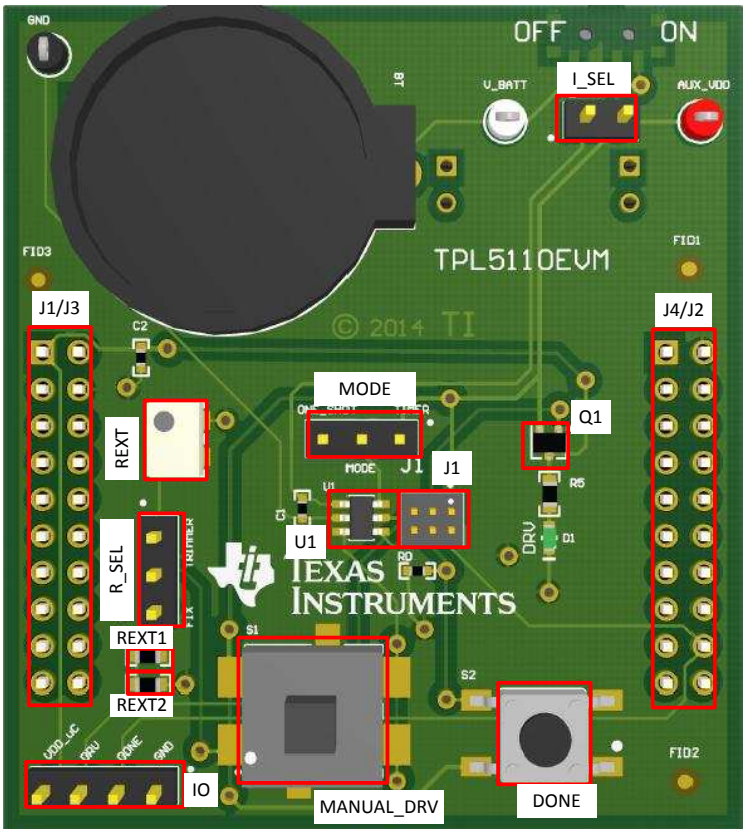


Figure 1. TPL5110EVM

TI's TPL5110EVM evaluation module (EVM) allows a designer to configure the timer intervals of the TPL5110 and measure its very low current consumption. Moreover, the TPL5110EVM is ready to be connected to the LaunchPad™ of the MSP430F5529 in order to test its power gating and timer features. The EVM has an onboard battery holder (coin battery) to supply the TPL5110 and the microcontroller, if connected.

The EVM contains one TPL5110 converter (see Table 1).

Table 1. Device and Package Configurations

Device	IC	Package
U1	TPL5110DDC	SOT23-6

2 Setup

Section 2.1 describes the jumpers and connectors on the EVM and Section 2.3 describes how to properly connect, set up, and use the TPL5110EVM.

See Figure 1 for locations of the top layer jumpers and switches.

2.1 Jumpers and Connectors

Table 2 through Table 5 list the input/output connectors description, jumpers description, switches and selectors description, and the test points description.

Table 2. Input/Output Connectors Description

Name	Layer	Description		
J1/J3	Bottom	2 × 10 pin receptacle to plug the TPL5010EVM into the MSP430F5529 LaunchPad		
J4/J2	Bottom	2 × 10 pin receptacle to plug the TPL5010EVM into the MSP430F5529 LaunchPad		
RST	Bottom	2-pin receptacle to plug the TPL5010EVM into the MSP430F5529 LaunchPad		
VCC	Bottom	2-pin receptacle to plug the TPL5010EVM into the MSP430F5529 LaunchPad		
IO	Top	4-pin header connector to bring out RSTn, WAKE, DONE, and GND signals		
		IO.1	GND	Ground
		IO.2	DONE	DONE signal from external microcontroller
		IO.3	DRV	DRV signal to control external MOSFET
		IO.4	VDD_uC	Power gated supply voltage to external microcontroller

Table 3. Jumpers Description

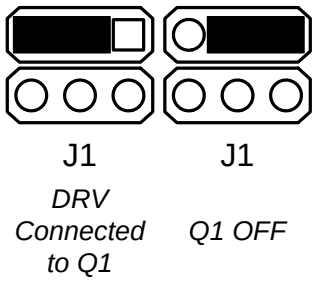
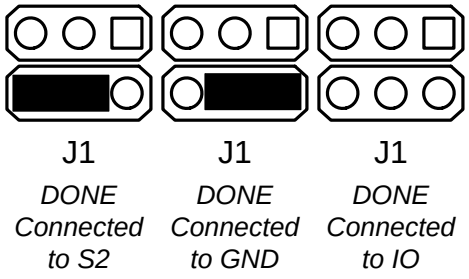
Name	Layer	Description
J1	Top	J1.5–J1.3 shorted, the DRV pin of the TPL5110 is connected to the gate of Q1 MOSFET. J1.3–J1.1 shorted, the gate of Q1 MOSFET is connected to VDD (MOSFET OFF).  **Figure 2. J1 Jumper Setting**
		J1.6–J1.4 shorted, the DONE pin of the TPL5110 is connected to the S2 switch with pull-down resistor. J1.4–J1.2 shorted, the DONE pin of the TPL5110 is connected to GND.  **Figure 3. J1 Jumper Setting**

Table 3. Jumpers Description (continued)

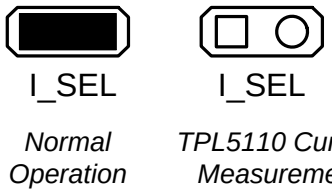
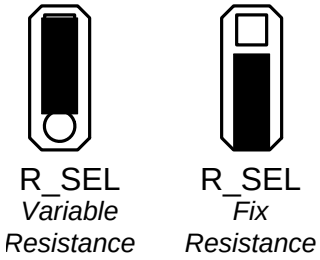
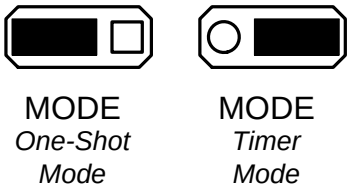
Name	Layer	Description
I_SEL	Top	In open configuration, allows the measurement of the current consumption of the TPL5110.  **Figure 4. I_SEL Jumper Setting**
R_SEL	Top	Pin1-2 in short configuration, the variable resistance is used to set the timer interval. Pin2-3 in short configuration, the fix resistance is used to set the timer interval.  **Figure 5. R_SEL Jumper Setting**
MODE	Top	Pin1-2 in short configuration, TPL5110 in timer mode. Pin2-3 in short configuration, TPL5110 in one-shot mode.  **Figure 6. MODE Jumper Setting**

Table 4. Switches and Selectors Description

Name	Layer	Description
S_ON_OFF	Bottom	In ON position turns ON the EVM, in OFF position turns OFF the EVM
S1	Top	When pushed, the SPST switch generates a DONE pulse
S2	Top	When pushed, the SPDT ON/Momentary switch generates a manual MOSFET drive pulse

Table 5. Test Points Description

Name	Layer	Description
GND	Top	Test point of the ground, connect the GND of the power supplies here
V_BATT	Top	Test point to monitor battery voltage
AUX_VDD	Top	Test point to connect external supply voltage in alternative to the coin cell battery

2.2 Battery Requirements

In case the EVM is battery powered, the battery must meet the following requirements:

- Battery type: CR2032 UL-certified battery
- Voltage: 3 V
- Min capacity: 220 mAh
- Min discharge rate: N/A mA

NOTE: Only insert DURACELL® 2032 lithium battery type CR2032, or equivalent.

2.3 TPL5110EVM Configuration

The evaluation board can work standalone or plugged into the MSP430F5529 LaunchPad.

2.3.1 Setting the DRV Pulse Interval

Set the DRV pulse interval by tuning the variable resistance (the trimmer can generate resistances in the range between 1 kΩ and 200 kΩ).

To tune the value of the resistance:

1. Connect a DMM between pin 1 of R_SEL and GND.
2. Turn the screw on the top of the trimmer until you reach the desired value.
3. Disconnect the DMM at the end of the operation.

Alternatively, set the DRV pulse interval with the fix resistances (R_EXT1 = 500 Ω, R_EXT2 = 0 Ω). If required, replace the resistances with customized ones.

See Figure 1 for locations of the resistances REXT1 and REXT2

2.3.2 EVM Standalone Without Microcontroller

The following settings are provided to use the EVM standalone, without a microcontroller:

- Put the S_ON_OFF selector in the OFF position.
- Set the mode of operation through the MODE header (see Table 3).
- Insert a CR2032 coin cell battery in the battery holder (BT), alternatively, connect a voltage source between the AUX_VDD and GND test points.
- Configure jumper J1 (DRV connected to Q1, DONE connected to S2), as explained in Table 3.

NOTE: Do not connect the coin cell battery and the voltage source to supply the evaluation board at same time.

- Put the S_ON_OFF selector in the ON position, or turn on the external voltage source if it is used instead of the coin cell battery.

The DONE and DRV signals can be monitored at the IO connector (pin 2 and 3, respectively).

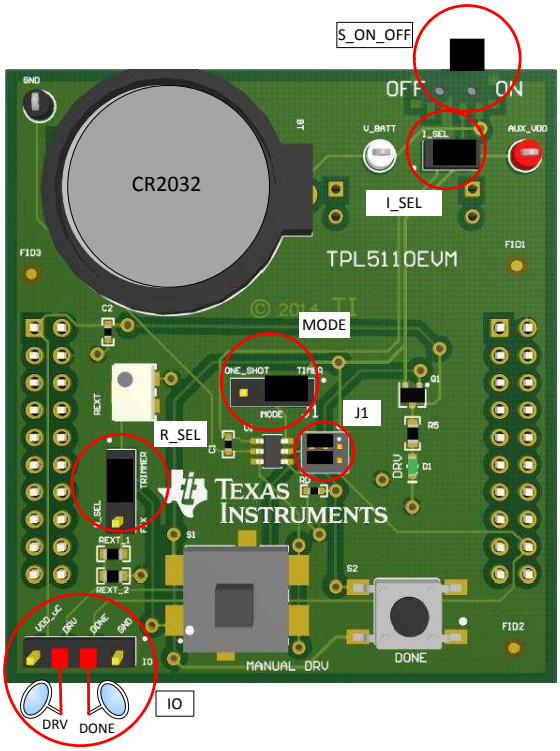


Figure 7. Jumpers Configuration – EVM Standalone Without Microcontroller

2.3.3 EVM With Microcontroller

The following settings are provided to use the EVM with a microcontroller:

- Put the S_ON_OFF selector in the OFF position.
- Set the mode of operation through the MODE header (see Table 3).
- Connect the microcontroller to the IO header, in order to manage the I/O signal of the design under test (DUT).
- Insert a CR2032 coin cell battery in the battery holder (BT), alternatively, connect a voltage source between the V_BATT and GND test points.
- Configure jumper J1 (DRV connected to Q1, DONE connected to IO), as explained in Table 3.

NOTE: Do not connect the coin cell battery and the voltage source to supply the evaluation board at the same time.

Do not use the switch S2 (DONE), in this configuration the DONE switch is connected to a digital output pin of the microcontroller.

- Put the S_ON_OFF selector in the ON position, or turn on the external voltage source if it is used instead of the coin cell battery.

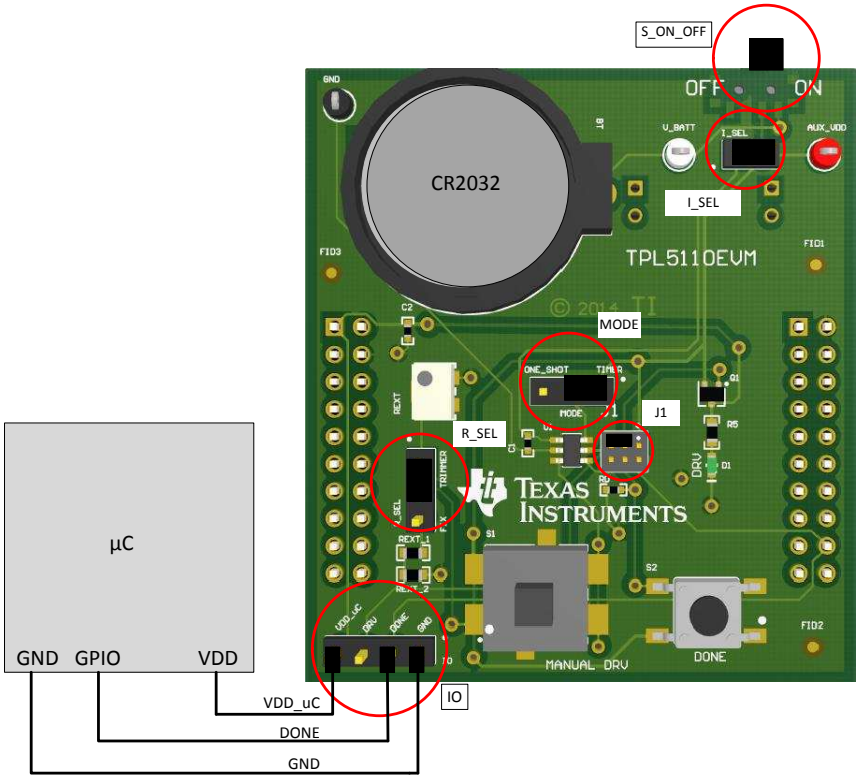


Figure 8. Jumpers Configuration – EVM With Microcontroller

2.3.4 EVM With LaunchPad

Load the code from this section into the MSP430F5529 of the LaunchPad. Refer to the MSP430 LaunchPad (MSP-EXP430F5529) Wiki) for more details.

- Put the S_ON_OFF selector in the OFF position.
- Set the mode of operation through the MODE header (see Table 3).
- Remove jumpers VCC and RST of the LaunchPad.
- Plug the EVM into the LaunchPad (MSP430F5529) according to the following table:

TPL5110EVM			MSP430 LaunchPad		
J1/J3	J1.1	AUX_VDD	J1/J3	pin 1	3V3
	pin 4	GND		pin 4	GND
J4/J2	pin 2	GND	J4/J2	pin 2	GND
	pin 18	DONE		pin 18	P2.3
VCC			3V3		
RST			SBW RST		

- Insert a CR2032 coin cell battery in the battery holder (BT), alternatively, connect a voltage source between the AUX_VDD and GND test points.
- Configure the jumper J1 (DRV connected to Q1, DONE connected to IO), as explained in Table 3.

NOTE: Do not connect the coin cell battery and the voltage source to supply the evaluation board at the same time.

Do not use the switch S2 (DONE), in this configuration the DONE switch is connected to a digital output pin of the microcontroller.

- Put the S_ON_OFF selector in the ON position, or turn on the external voltage source if it is used instead of the coin cell battery.

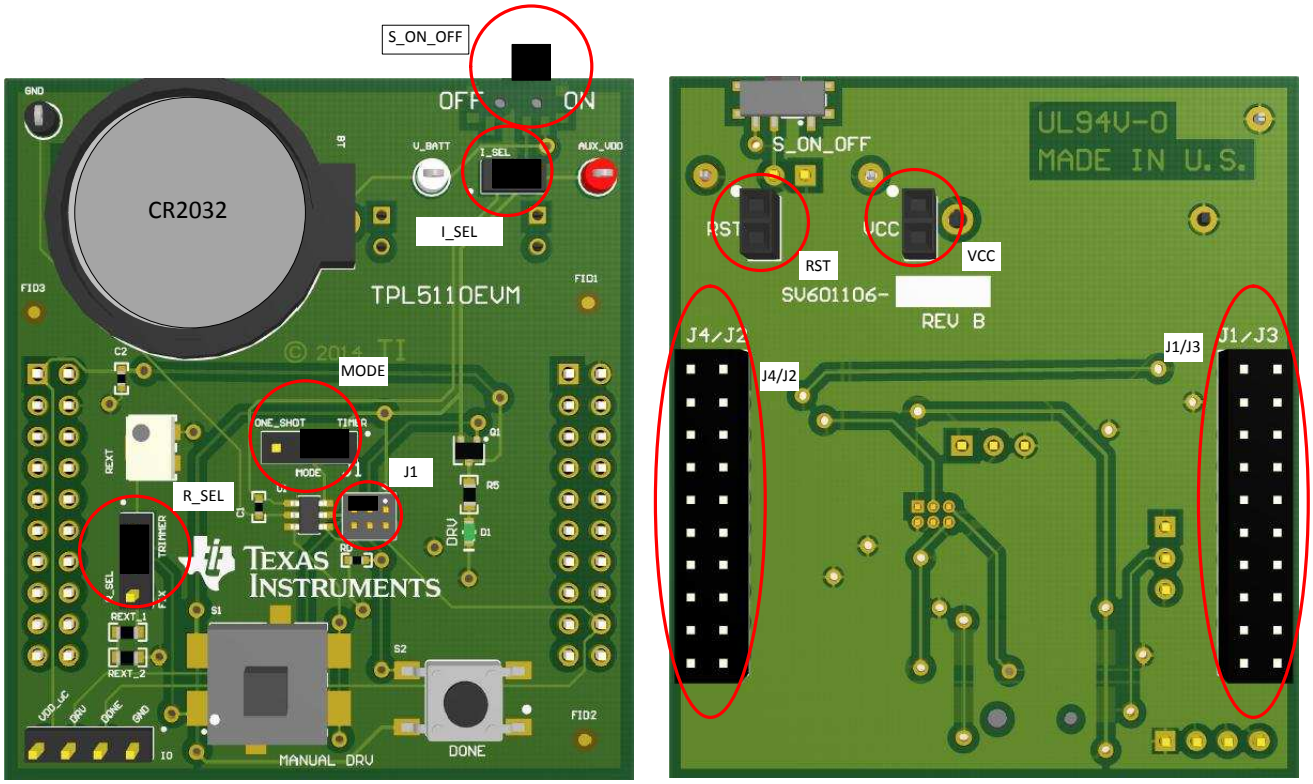


Figure 9. Jumpers Configuration – EVM With LaunchPad

Example code

Once loaded into the MSP430F5529 of the LaunchPad, the code presented in this section performs the following features:

- At power on, the green LED present on the LaunchPad is turned on.
- The red LED present on the LaunchPad is turned on.
- Next, both green and red LEDs are turned off.
- The MSP430 sends the DONE signal to the TPL5110.

Before launching the code, set a timer interval > 5 s (Trimmer > 8.85 kΩ)

```
#include <msp430.h>

int main(void)
{

    WDTCTL = WDTPW+WDTHOLD;            // Stop watchdog timer
    __delay_cycles(50000);             // Set Delay;

    P1DIR |= BIT0;                 // Set P1.0 to output direction
    P2DIR |= BIT3;                 // Set P2.3 to output direction
    P4DIR |= BIT7;                 // Set P4.7 to output direction

    P1OUT &= ~BIT0;                // Set P1.0 RED LED OFF
    P2OUT &= ~BIT3;                // Set P2.3 DONE Low
    P4OUT &= ~BIT7;                // Set P4.7 GREEN LED OFF

    while (1)
    {
   __delay_cycles(10000);               // Set Delay;
       P4OUT |= BIT7;                         // Set P4.7 GREEN LED ON
       __delay_cycles(1000000);         // Set Delay;
       P1OUT |= BIT0;                         // Set P1.0 RED LED ON
       __delay_cycles(500000);             // Set Delay;
       P1OUT &= ~BIT0;                        // Set P1.0 RED LED OFF
       P4OUT &= ~BIT7;                        // Set P4.7 GREEN LED OFF
       __delay_cycles(100000);             // Set Delay;
       P2OUT |= BIT3;                         // Done High
       __delay_cycles(1000);               // Set Delay;
       P2OUT &= ~BIT3;                        // Set P2.3 DONE Low
     }
}
```

3 Operation

Once the EVM is powered ON, the TPL5110 starts working. Refer to the TPL5110 datasheet (SNAS650) for further details on the timing.

For instance, configure the trimmer equal to 5 kΩ to set a time interval of 1 s.

The TPL5110 has 2 modes of operation: Timer mode and One-Shot mode:

Timer Mode

In timer mode, the TPL5110 works in cycling mode.

When a DRV signal is asserted by the TPL5110, the green LED (D1) is turned on. If the DONE switch (S2) is pushed, a DONE pulse is sent to the TPL5110 (refer to Section 2.1 for jumper configurations), the MOSFET connected to DRV is turned off, and this event is indicated by the green LED turning off. When the programmed timer interval elapses, the MOSFET is turned on again.

When the MANUAL_DRV switch (S1) is pushed, a manual MOSFET drive pulse is sent to the TPL5110. The width of the manual MOSFET drive pulse is proportional to the pressure time.

One-Shot Mode

In this mode of operation, the TPL5110 turns on the MOSFET at the power on and when a manual drive pulse is sent.

Once the EVM is powered ON, the TPL5110 asserts the DRV signal which turns on the MOSFET, the green LED (D1) is turned on. If the DONE switch (S2) is pushed, a DONE pulse is sent to the TPL5110, the MOSFET is turned off, this event is indicated by the green LED turning off. At this point only a manual drive pulse that can be sent pushing the MANUAL_DRV switch (S1) can trigger another cycle. This mode of operation is useful to implement the auto-power off of battery-powered devices

3.1 Supply Current Measurement

3.1.1 Supply Current Measurement of the TPL5110 Only

First, turn off the EVM (ON/OFF switch to OFF position), then disconnect the EVM from the LaunchPad or microcontroller, in order to not load the digital output pins of the DUT.

- Leave the I_SEL jumper open.
- **Do not leave digital input pins floating**; Short the DONE pin to GND and turn OFF the Q1 MOSFET (as explained in Table 3).
- Connect a digital multimeter, configured as the current meter (able to measure nA), between AUX_VDD and pin 1 of I_SEL.
- Turn on the EVM (ON/OFF switch to ON position).
- Read the current consumption on the DMM.

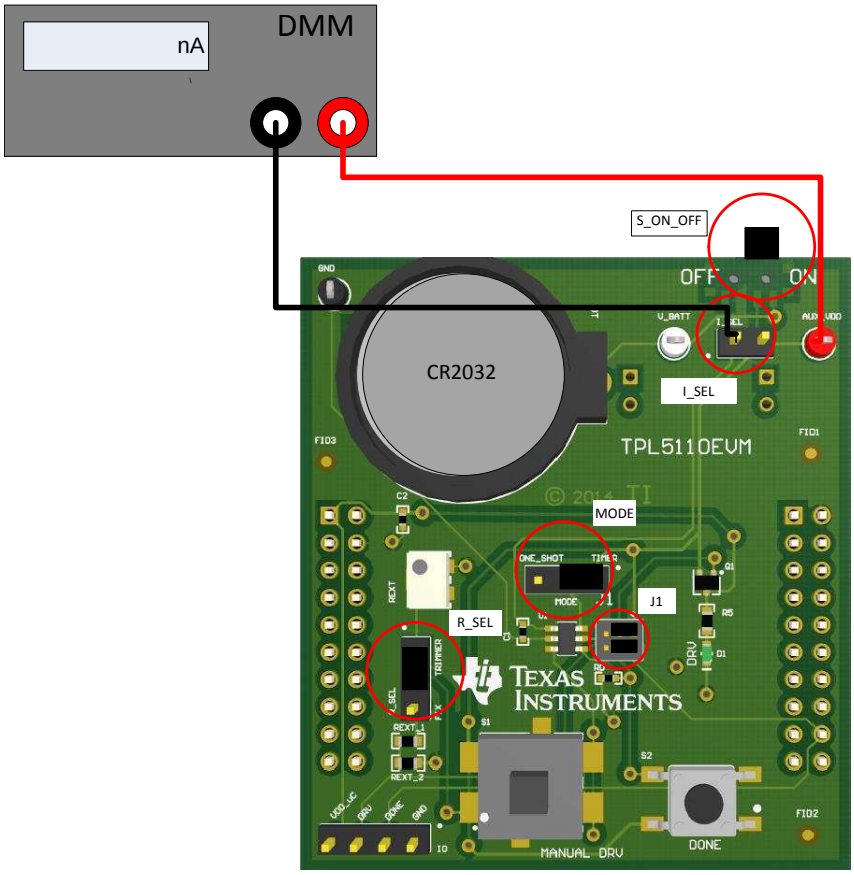


Figure 10. Current Measurement Setup – TPL5110 only

3.1.2 Supply Current Measurement of the TPL5110 During the Reading of the Resistance

First, turn off the EVM (ON/OFF switch to OFF position), then disconnect the EVM from the LaunchPad or microcontroller, in order to not load the digital output pins of the DUT.

- Leave the I_SEL jumper open.
- **Do not leave digital input pins floating**; Short the DONE pin to GND and turn OFF the Q1 MOSFET (as explained in Table 3).
- Connect a digital multimeter, configured as the current meter (able to measure nA), between AUX_VDD and pin 1 of I_SEL.
- Keep the MANUAL_DRV switch pressed while turning ON the EVM.
- Turn on the EVM (ON/OFF switch to ON position).
- Read the current consumption on the DMM while pressing the MANUAL_DRV switch.

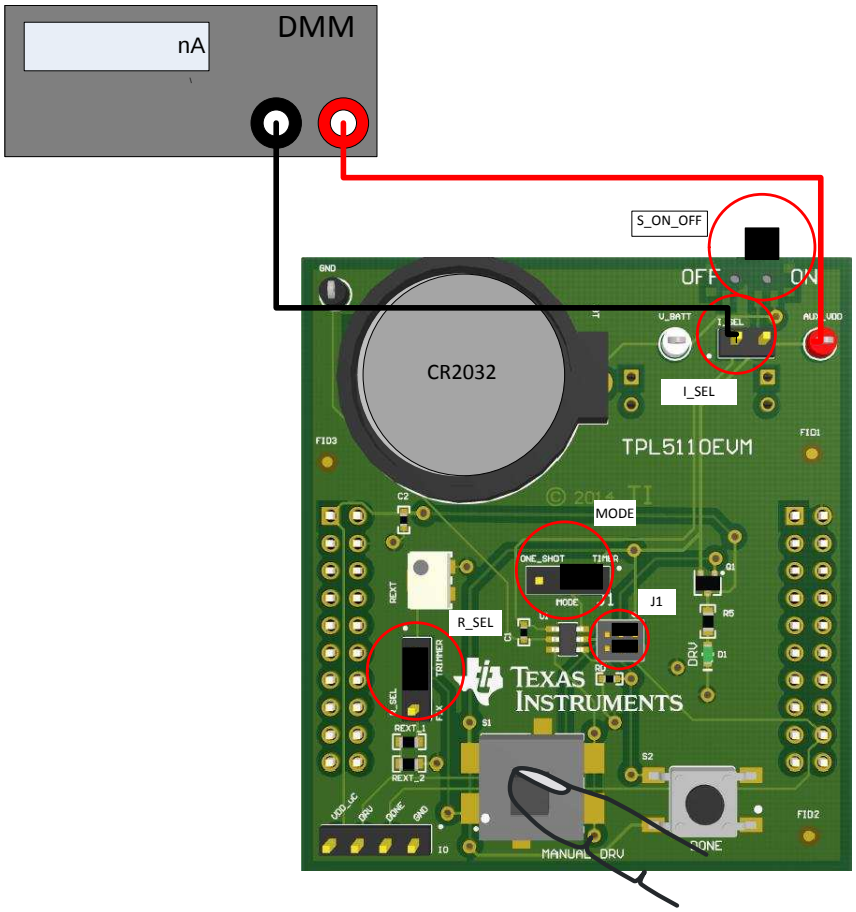


Figure 11. Current Measurement Setup – TPL5110 During the Reading of the Resistance

3.1.3 Supply the Current Measurement of the TPL5110 with Microcontroller

First, turn off the EVM (ON/OFF switch to OFF position):

- Install the I_SEL jumper.
- **Do not leave digital input pins floating**; make sure that the µC is driving the DONE pin.
- Connect a digital multimeter, configured as the current meter (able to measure nA), between the V_BATT test point and AUX_VDD test point.
- Read the current consumption on the DMM.

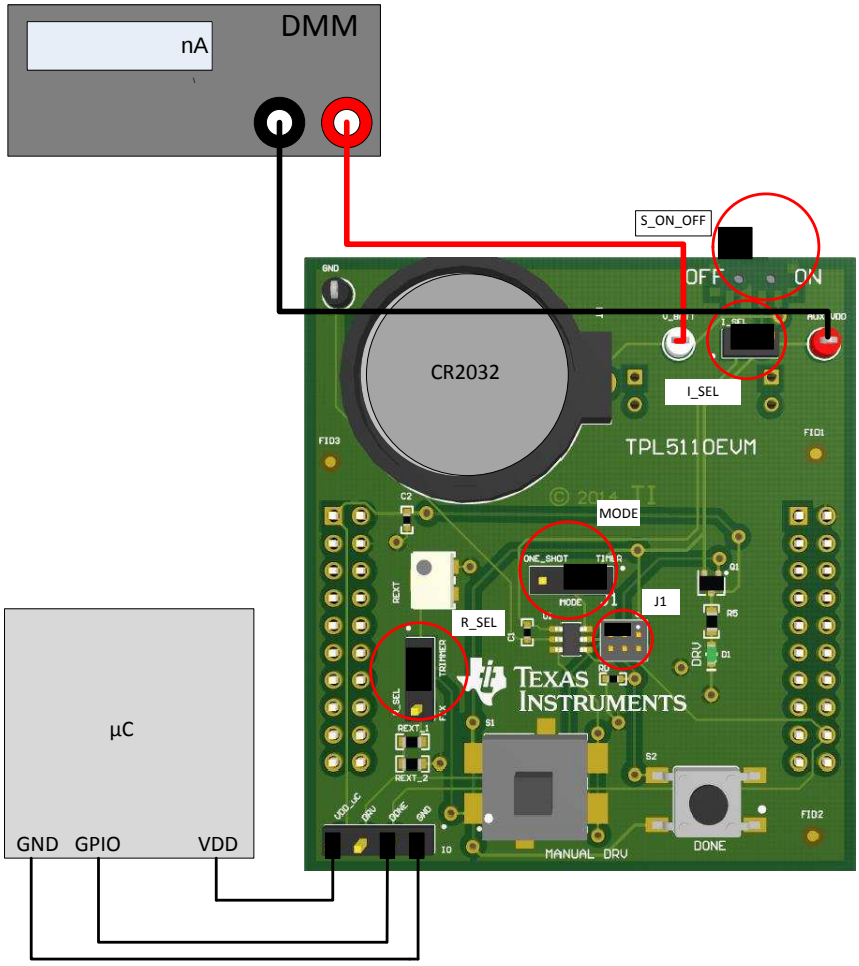


Figure 12. Current Measurement Setup – TPL5110 With Microcontroller

4 Board Layout

Figure 13 and Figure 14 illustrate the TPL5110EVM board layouts.

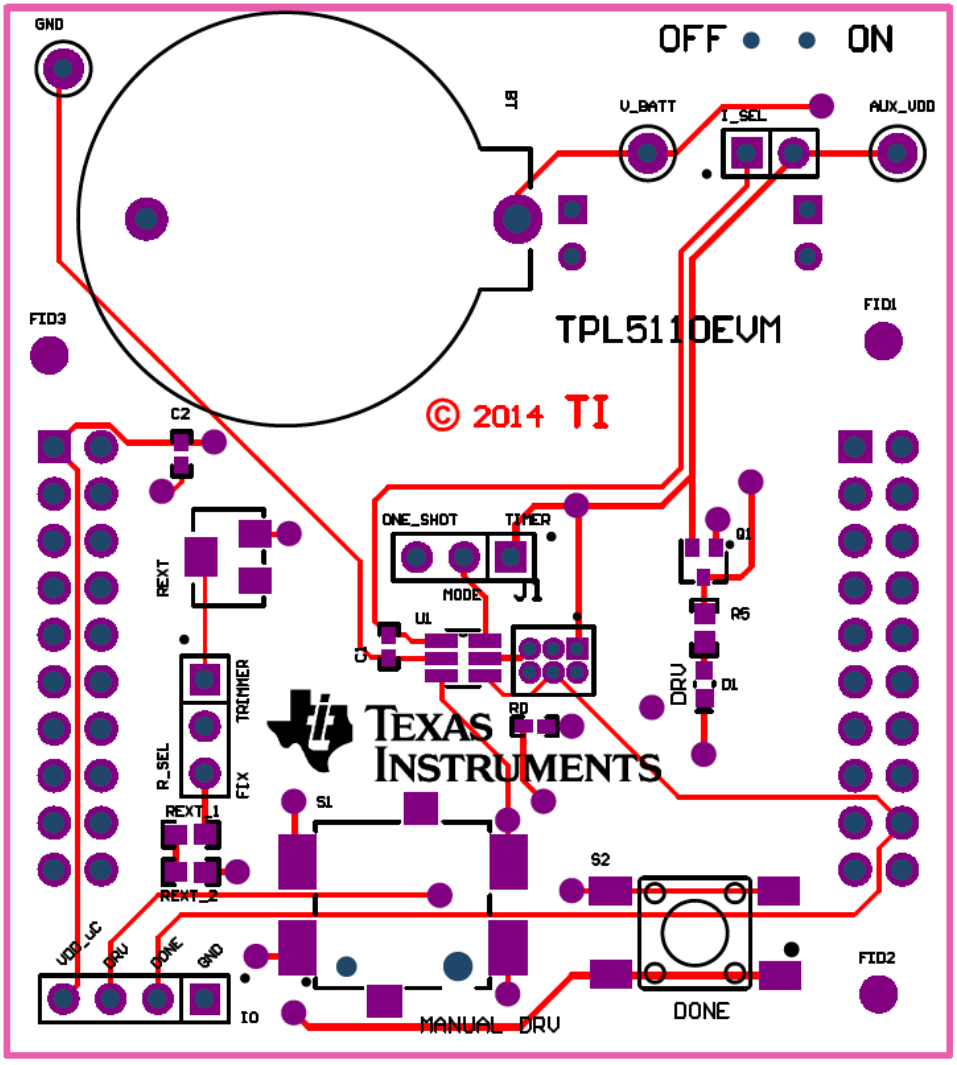


Figure 13. Top Layer

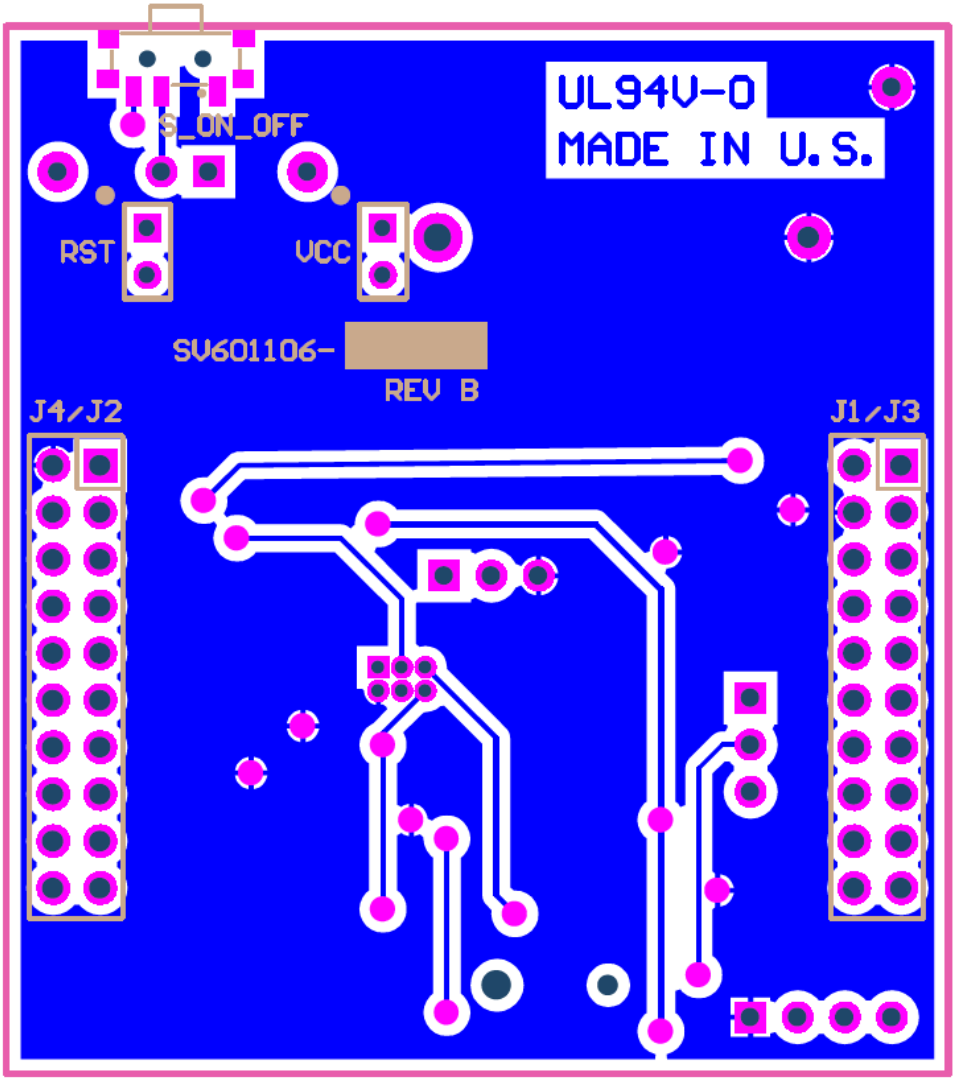


Figure 14. Bottom Layer

5 Schematic

Figure 15 illustrates the TPL5110EVM schematic.

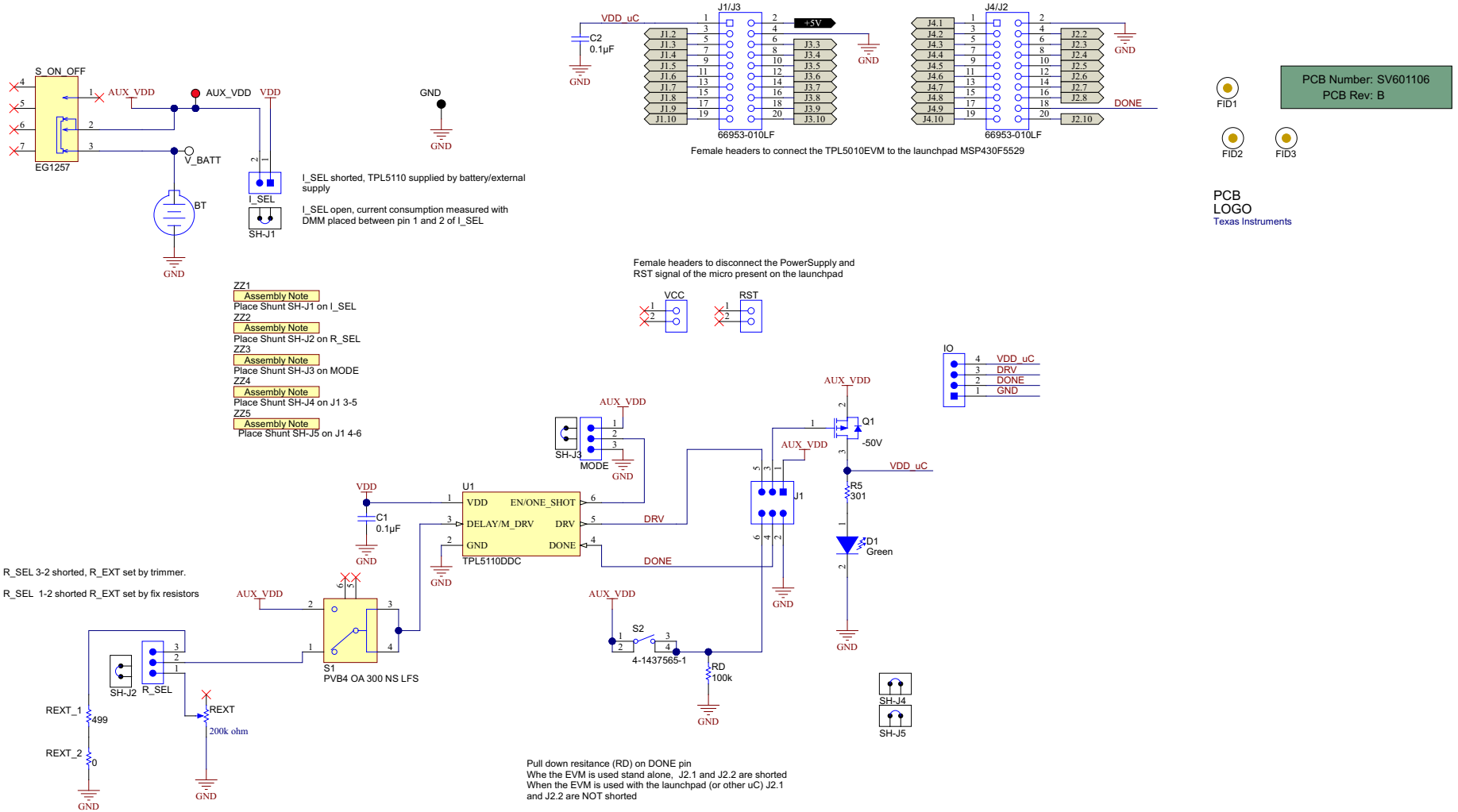


Figure 15. TPL5110EVM Schematic

6 Bill of Materials

Table 6 lists the TPL5110EVM BOM.

Table 6. TPL5110EVM Bill of Materials

Designator	Description	Manufacturer	Part Number	Quantity
AUX_VDD	Test Point, TH, Miniature, Red	Keystone	5000	1
BT	Battery Holder, CR2032, Retainer clip, TH	Memory Protection Devices	BS-7	1
C1, C2	CAP, CERM, 0.1uF, 6.3V, +/-10%, X5R, 0402	TDK	C1005X5R0J104K	2
D1	LED, Green, SMD	Osram	LG L29K-G2J1-24-Z	1
GND	Test Point, TH, Miniature, Black	Keystone	5001	1
IO	Header, 100mil, 4x1, Gold, TH	Samtec	TSW-104-07-G-S	1
I_SEL	Header, TH, 100mil, 2x1, Gold plated, 230 mil above insulator	Samtec	TSW-102-07-G-S	1
J1	Header, 50mil, 3x2, Gold, TH	Sullins Connector Solutions	GRPB032VWVN-RC	1
J1/J3, J4/J2	Receptacle, 100mil, 10X2, TH	FCI	66953-010LF	2
MODE, R_SEL	Header, TH, 100mil, 3x1, Gold plated, 230 mil above insulator	Samtec, Inc.	TSW-103-07-G-S	2
Q1	MOSFET, P-CH, -50V, -0.13A, SOT-323	Diodes Inc.	BSS84W-7-F	1
REXT_2	RES, 0 ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW06030000Z0EA	1
REXT	TRIMMER, 200K, 0.25W, SMD	Bourns	3224W-1-204E	1
REXT_1	RES, 499 ohm, 0.1%, 0.1W, 0603	Susumu Co Ltd	RG1608P-4990-B-T5	1
R5	RES, 301 ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603301RFKEA	1
RST, VCC	Connector, Receptacle, 100mil, 2x1, Gold plated, TH	TE Connectivity	5-534206-1	2
S1	Switch, Pushbutton, SPDT, 0.1A 14V	C&K Components	PVB4 OA 300 NS LFS	1
S2	Switch, Tactile, SPST-NO, 0.05A, 12V, SMT	TE Connectivity	4-1437565-1	1
SH-J1, SH-J2, SH-J3	Shunt, 100mil, Gold plated, Black	3M	969102-0000-DA	3
SH-J4, SH-J5	Mini Shunt, Closed Top, 650 V AC, -45 to 85°C, Pitch 1.27 mm, Height 3 mm, RoHS	Sullins Connector Solutions	NPB02SVAN-RC	2
S_ON_OFF	Switch, Slide, SPDT, 0.3A, SMT	E-Switch	EG1257	1
U1	Ultra-Low Power System Timer with MOS driver and manual MSFET power ON, DDC0006A	Texas Instruments	TPL5110DDC	1
V_BATT	Test Point, Miniature, White, TH	Keystone	5002	1

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