TPL5010 Evaluation Module

This user's guide provides the setup instructions, configuration, and operation of the TPL5010 evaluation module (EVM). Also included are the printed-circuit board (PCB) layouts, schematic, and the bill of materials (BOM).

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LaunchPad is a trademark of Texas Instruments.
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1 Introduction

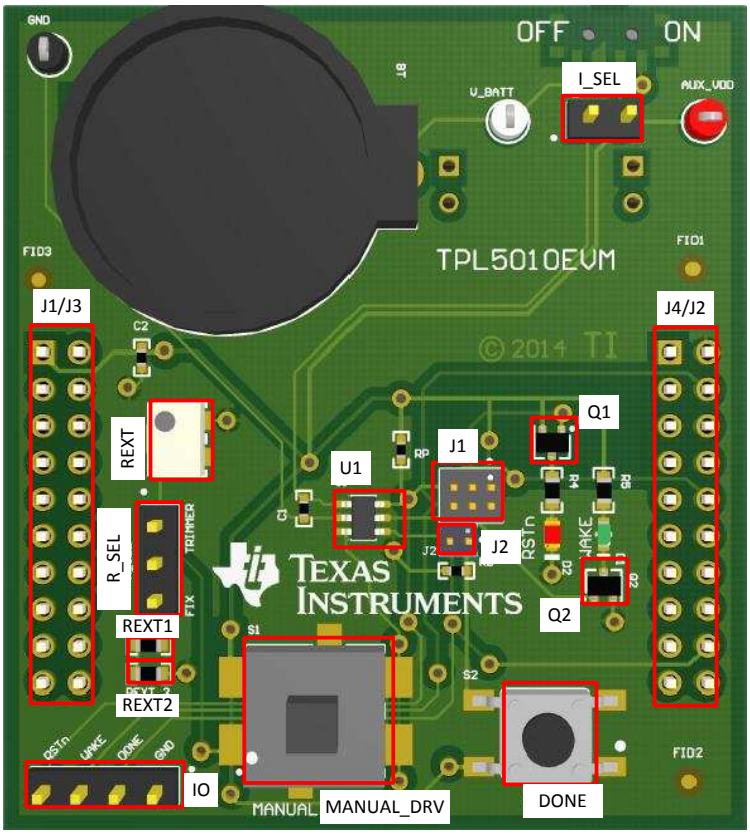


Figure 1. TPL5010EVM

TI's TPL5010EVM evaluation module (EVM) allows a designer to configure the timer intervals of the TPL5010 and measure its very low current consumption. Moreover, the TPL5010EVM is ready to be connected to the LaunchPad™ of the MSP430F5529 in order to test its watchdog and timer features. The EVM has an onboard battery holder (coin battery) to supply the TPL5010 and the microcontroller, if connected.

The EVM contains one TPL5010 (see Table 1).

Table 1. Device and Package Configurations

Device	IC	Package
U1	TPL5010DDC	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 TPL5010EVM.

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	WAKE	WAKE signal to external microcontroller
		IO.4	RSTn	RSTn signal to external microcontroller

Table 3. Jumpers Description

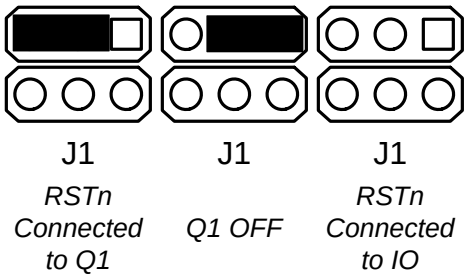
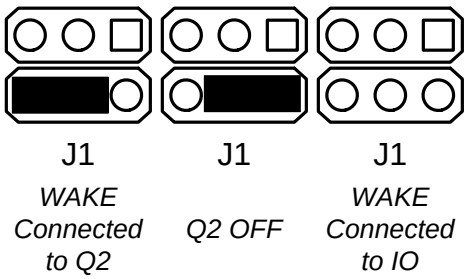
Name	Layer	Description
J1	Top	J1.5–J1.3 shorted, the RSTn pin of the TPL5010 is connected to the gate of Q1 MOSFET. J1.3–J1.1 shorted, the gate of Q1 MOSFET is connected to VDD (MOSFET OFF).  **Figure 2. J1 Jumper Setting**
		J1.6–J1.4 shorted, the WAKE pin of the TPL5010 is connected to the gate of Q2 MOSFET. J1.4–J1.2 shorted, the gate of Q2 MOSFET is connected to VDD (MOSFET OFF).  **Figure 3. J1 Jumper Setting**

Table 3. Jumpers Description (continued)

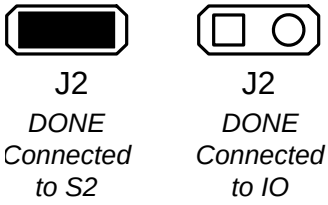
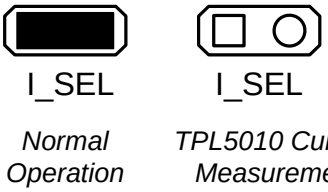
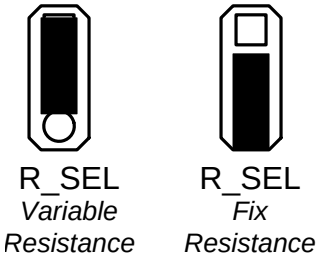
Name	Layer	Description
J2	Top	In short configuration, the DONE pin of the TPL5010 is connected to the S2 switch with a pull-down resistor.  **Figure 4. J2 Jumper Setting**
I_SEL	Top	In open configuration allows the measurement of the current consumption of the TPL5010.  **Figure 5. I_SEL Jumper Setting**
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 6. R_SEL 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 reset pulse

Table 5. Test Points Description

Name	Layer	Description
GND	Top	Test point of the ground, connect the GND of the power supplies
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
- Minimum capacity: 220 mAh
- Minimum discharge rate: N/A mA

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

2.3 TPL5010EVM Configuration

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

2.3.1 Setting the Time Interval Period

Set the Time interval period 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 (RSTn connected to Q1, WAKE connected to Q2) and J2 (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 WAKE signals can be monitored at the IO connector (pin 2 and 3, respectively).

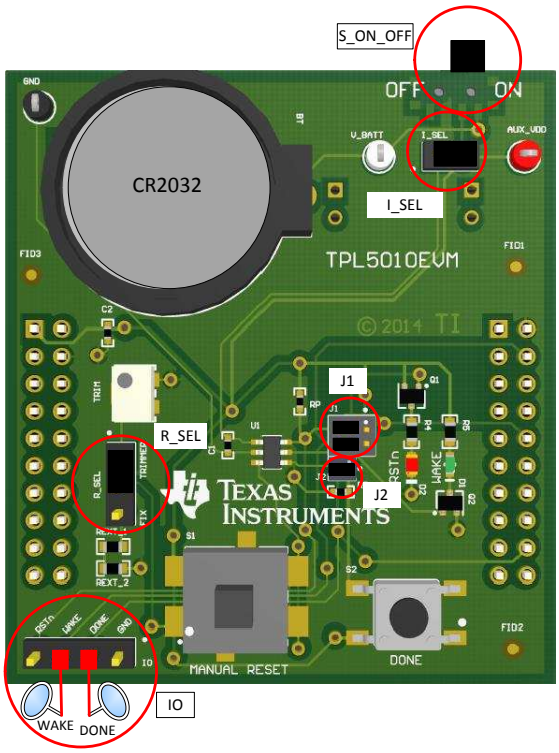


Figure 7. Jumpers Configuration – EVM Standalone Without Microcontroller

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).
- Supply the microcontroller, connecting its supply pin to the AUX_VDD test point and the ground to the GND pin of the IO header.
- 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 (RSTn connected to IO, WAKE connected to IO) and J2 (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 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.

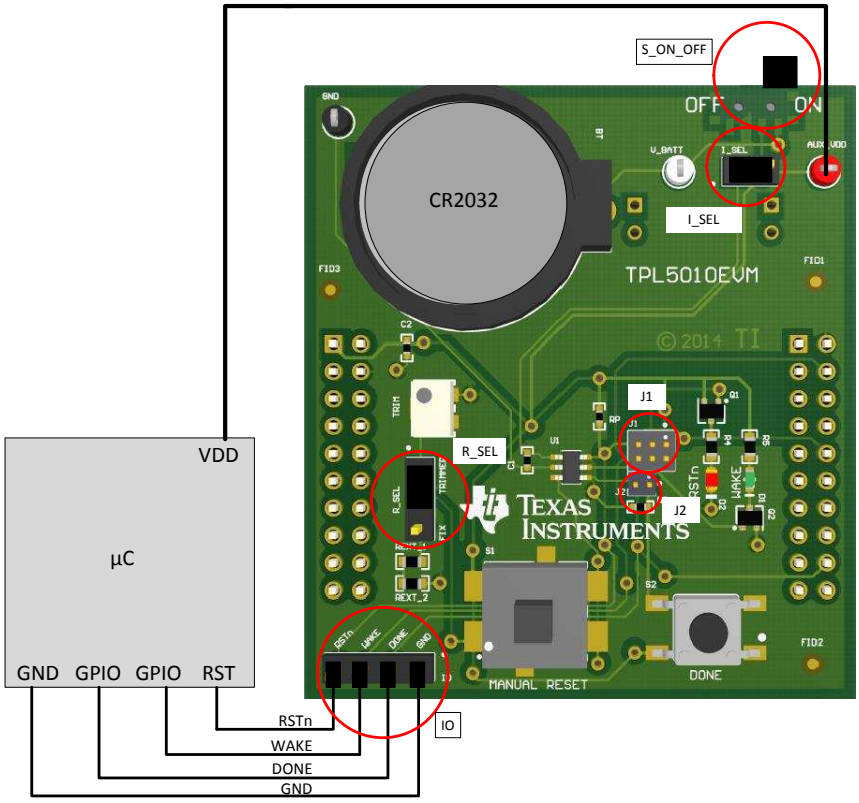


Figure 8. Jumpers Configuration – EVM With Microcontroller

2.3.4 EVM With LaunchPad

Load the code from this section into the MSP430F5529 of the LaunchPad. Refer to 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:

TPL5010EVM			MSP430 LaunchPad		
J1/J3	J1.1	VDD_µC	J1/J3	pin 1	3V3
	pin 4	GND		pin 4	GND
J4/J2	pin 2	GND	J4/J2	pin 2	GND
	pin 4	WAKE		pin 4	P2.0
	pin 10	RSTn		pin 10	RST
	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 (RSTn connected to Q1, WAKE connected to Q2) and J2 (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 ON position, or turn on the external voltage source if it is used instead of the coin cell battery.

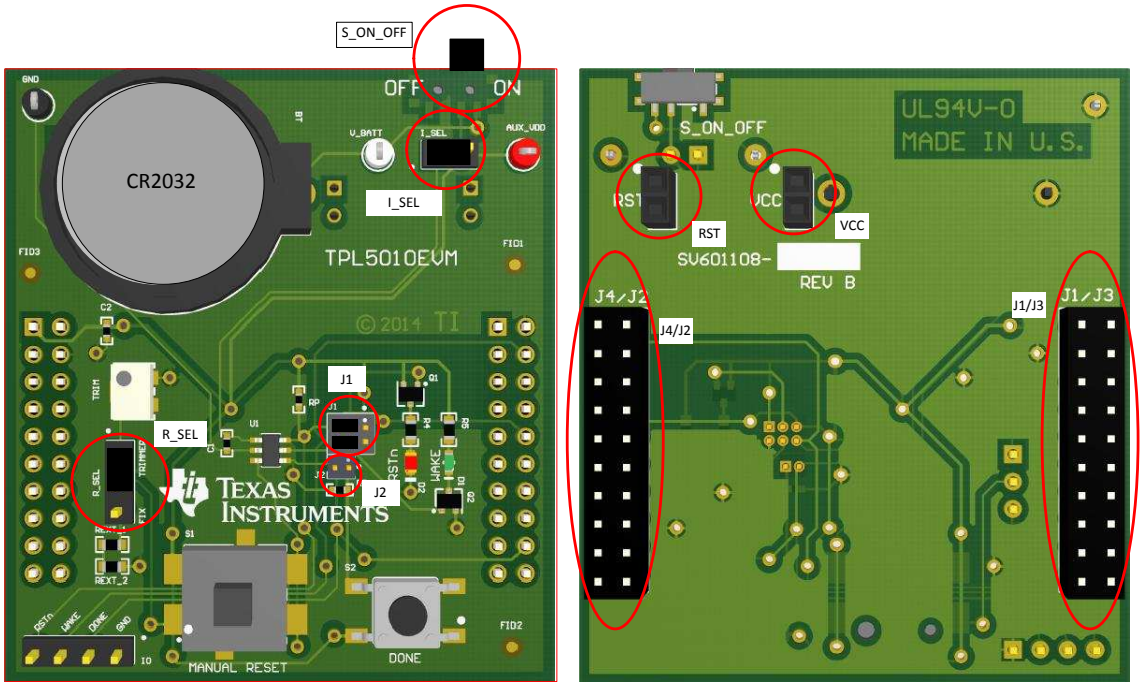


Figure 9. Jumpers Configuration – EVM With LaunchPad

Example code

Once loaded into the MSP430 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 and turned off.
- When the MSP430 receives a RSTn, the red LED is toggled 5 times, then the green LED is turned ON and OFF and the MSP430 sends a DONE signal to the TPL5010.
- When the MSP430 receives a WAKE pulse, the green LED is turned ON and OFF and the MSP430 sends a DONE signal to the TPL5010.

```
#include <msp430.h>

void main(void) {

    WDTCTL = WDTPW | WDTHOLD;       // Stop watchdog timer

    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

    P2IES &= ~BIT0;                 // P2.0 Lo/Hi edge
    P2IFG &= ~BIT0;                 // P2.0 IFG Cleared
    P2IE  |= BIT0;                  // P2.0 Interrupt Enabled

    SFRRPCR |= SYSNMIIES | SYSNMI;  // Select NMI function for the RST/NMI pin,
                                    // interrupt on falling edge
                                    // (pull-up R on RST/NMI is already enabled after PUC)
    SFRIE1 |= NMIIE;                // Set NMI pin interrupt enable

    P4OUT |= BIT7;                  // Set P4.7 GREEN LED ON
    __delay_cycles(500000);         // Set Delay
    P4OUT &= ~BIT7;                 // Set P4.7 GREEN LED OFF

    P2OUT |= BIT3;                  // Done High
    __delay_cycles(100);            // Set Delay
    P2OUT &= ~BIT3;                 // Done Low

    __bis_SR_register(LPM4_bits + GIE);     // Enter LPM4
}

// Port 2 interrupt service routine
#pragma vector=PORT2_VECTOR
__interrupt void Port_2(void)
{

    volatile unsigned int i;

    P4OUT |= BIT7;                  // GREEN LED ON
    i = 10000;                      // SW Delay
    do i--;
    while(i != 0);
    P4OUT &= ~BIT7;                 // Set P4.7 GREEN LED OFF

    P2OUT |= BIT3;                  // Done High
    __delay_cycles(100);            // Set Delay
    P2OUT &= ~BIT3;                 // Done Low

    P2IES &= ~BIT0;                 // P2.0 Lo/Hi edge
    P2IFG &= ~BIT0;                 // P2.0 IFG Cleared
    P2IE  |= BIT0;                  // P2.0 Interrupt Enabled
```

```
}

// User NMI interrupt service routine
#pragma vector=UNMI_VECTOR
__interrupt void UNMI_ISR (void)
{
    int n=0;
    // Efficiently decode the User NMI interrupt source
        switch (__even_in_range(SYSUNIV, SYSUNIV_SYSBUSIV)) {
           case SYSUNIV_NMIIFG :
           {
               for(n=0; n<10; n++) {
                    volatile unsigned int i;
                    P1OUT ^= 0x01;              // Toggle RED led
                    i = 10000;                  // SW Delay
                    do i--;
                    while(i != 0);
                }
                volatile unsigned int i;
                P4OUT |= BIT7;                  // GREEN LED ON
                i = 10000;                      // SW Delay
                do i--;
                while(i != 0);
                P4OUT &= ~BIT7;                 // Set P4.7 GREEN LED OFF

                P2OUT |= BIT3;                  // Done High
                __delay_cycles(100);            // Set Delay;
                P2OUT &= ~BIT3;                 // Done Low;


           }
               break;
           case SYSUNIV_OFIFG :
           case SYSUNIV_ACCVIFG :
           case SYSUNIV_BUSIFG :
           default :
               break;

        }

}
```

3 Operation

Once the EVM is powered ON, the TPL5010 starts working. Refer to the TPL5010 datasheet (SNAS651) for further details on the timing:

- Configure the trimmer equal to 5 kΩ to set a time interval of 1 s.
- When an RSTn pulse is generated by the TPL5010, the red LED (D2) is turned on. The green LED (D1) is turned on when a WAKE signal is generated by the TPL5010.
- If the DONE switch (S2) is pushed, a DONE pulse is sent to the TPL5010. If the DONE pulse is sent within the programmed time interval, at the next cycle the green LED (D1) is turned ON.
- When the M_RST switch (S1) is pushed, a manual reset pulse is sent to the TPL5010. For both DONE and M_RST pulses, the width of the pulse is proportional to the pressure time. While the M_RST switch is pressed the red LED turns ON.

3.1 Supply Current Measurement

3.1.1 Supply Current Measurement of the TPL5010 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 (second pin of IO header) to GND (first pin of IO header), turn OFF the Q1 and Q2 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.

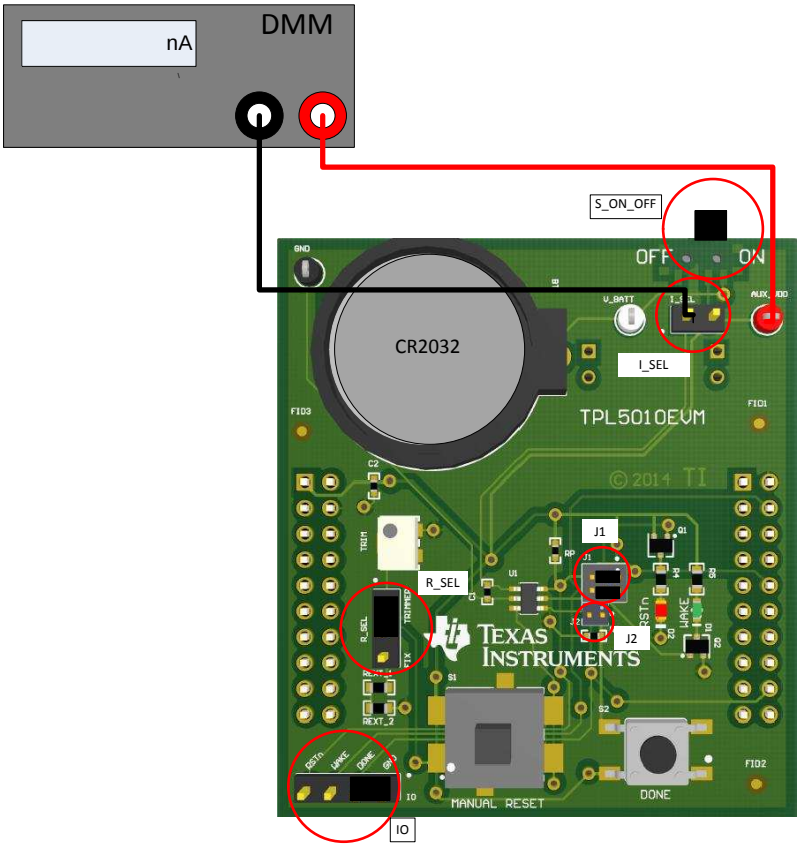


Figure 10. Current Measurement Setup – TPL5010 Only

3.1.2 Supply Current Measurement of the TPL5010 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 your 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 (second pin of IO header) to GND (first pin of IO header), turn OFF the Q1 and Q2 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_RST switch pressed while turning ON the EVM.
- Turn on the EVM (ON/OFF switch to ON position).
- Read the current consumption on the DMM.

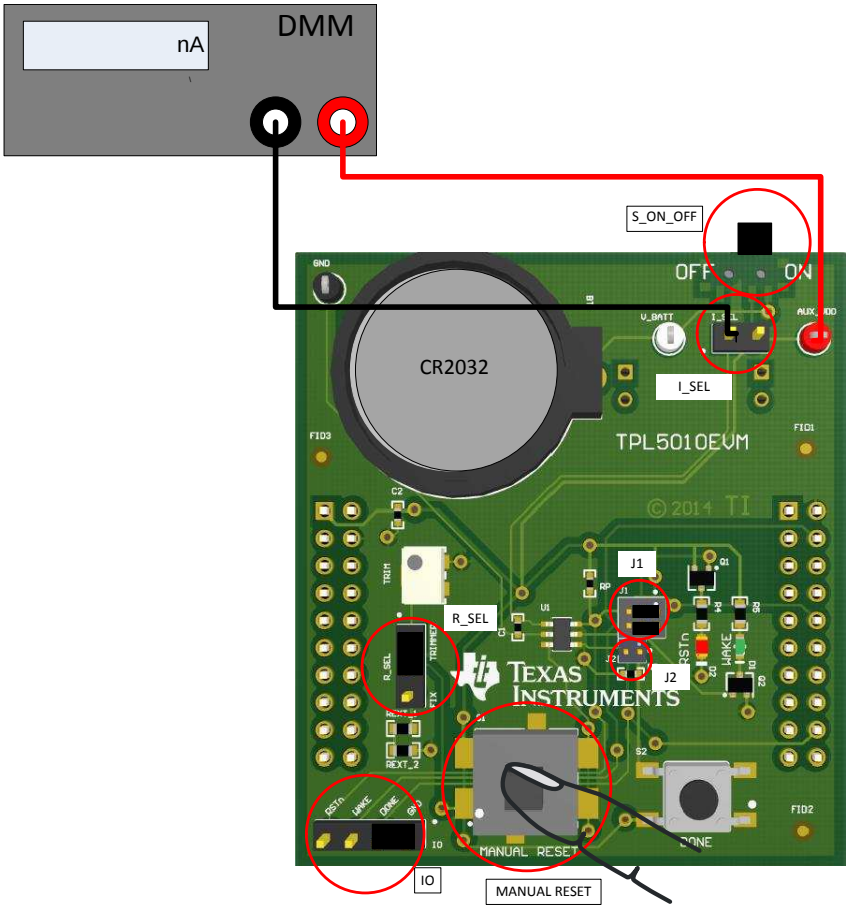


Figure 11. Current Measurement Setup – TPL5010 During the Reading of the Resistance

3.1.3 Supply Current Measurement of the TPL5010 With Microcontroller

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

- Load the code into the microcontroller.
- Connect the microcontroller to the EVM, refer to Section 2.3.3.
- Install the I_SEL jumper.
- **Do not leave digital input pins floating**; Ensure that the DONE signal is controlled by the microprocessor, turn OFF the Q1 and Q2 MOSFET (as explained in Table 3).
- Connect a digital multimeter, configured as the current meter (able to measure nA), between V_BATT test point and AUX_VDD test point.
- Leave the EVM OFF (ON/OFF switch to OFF position).
- Read the current consumption on the DMM while pressing the MANUAL_RESET switch.

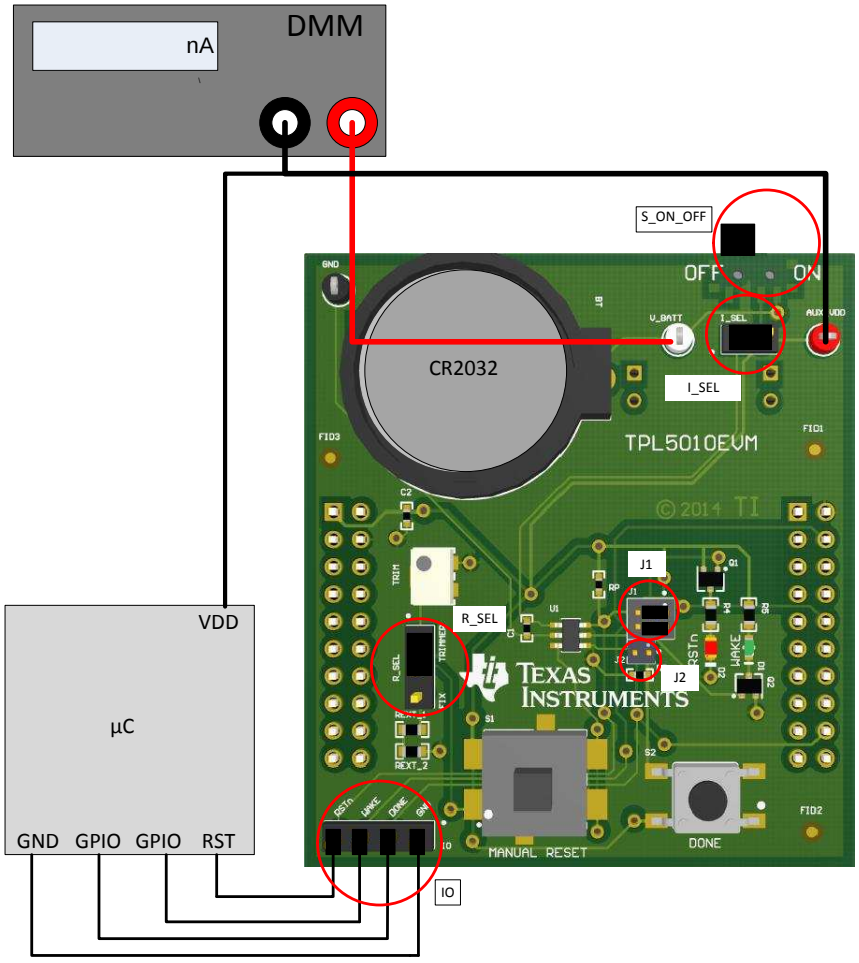


Figure 12. Current Measurement Setup – TPL5010 With Microcontroller

4 Board Layout

Figure 13 and Figure 14 illustrate the TPL5010EVM board layouts.

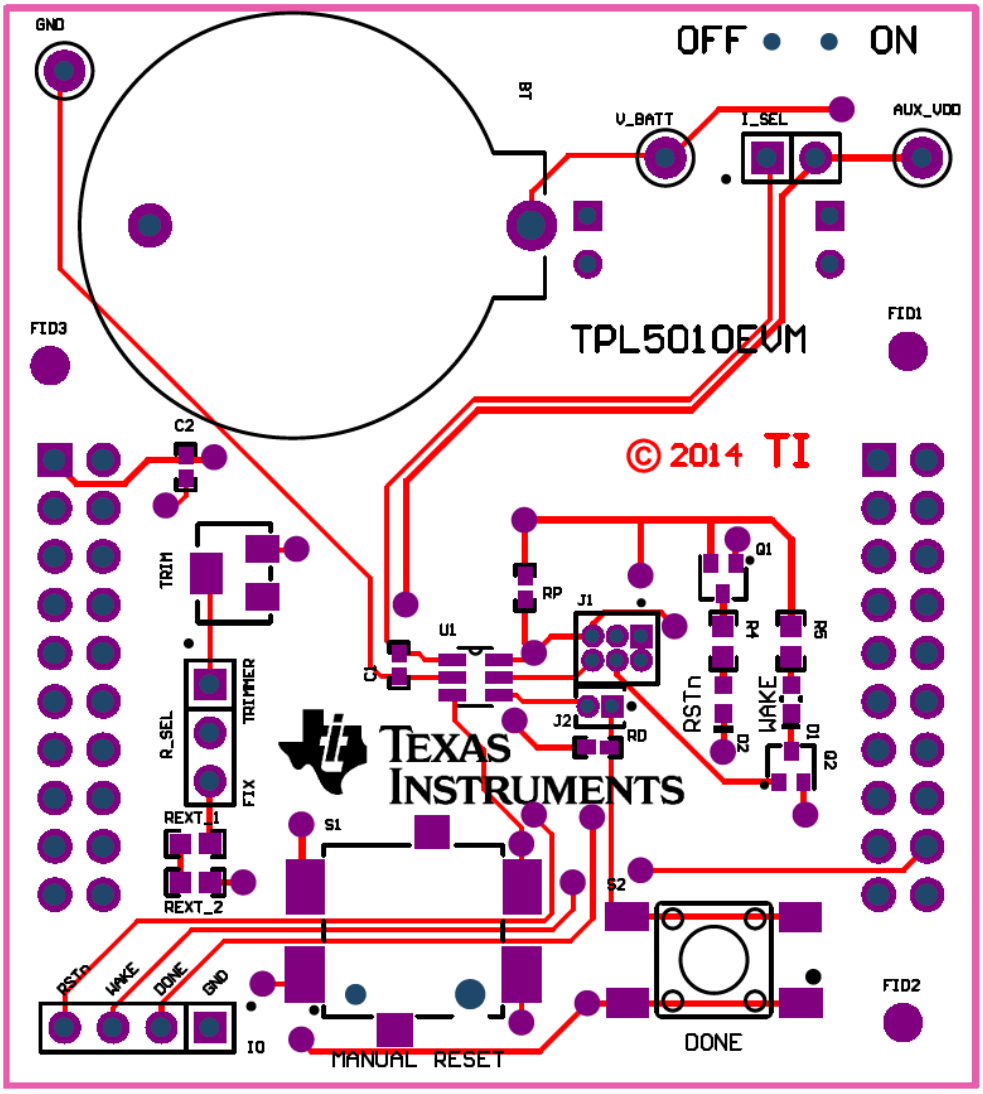


Figure 13. Top Layer

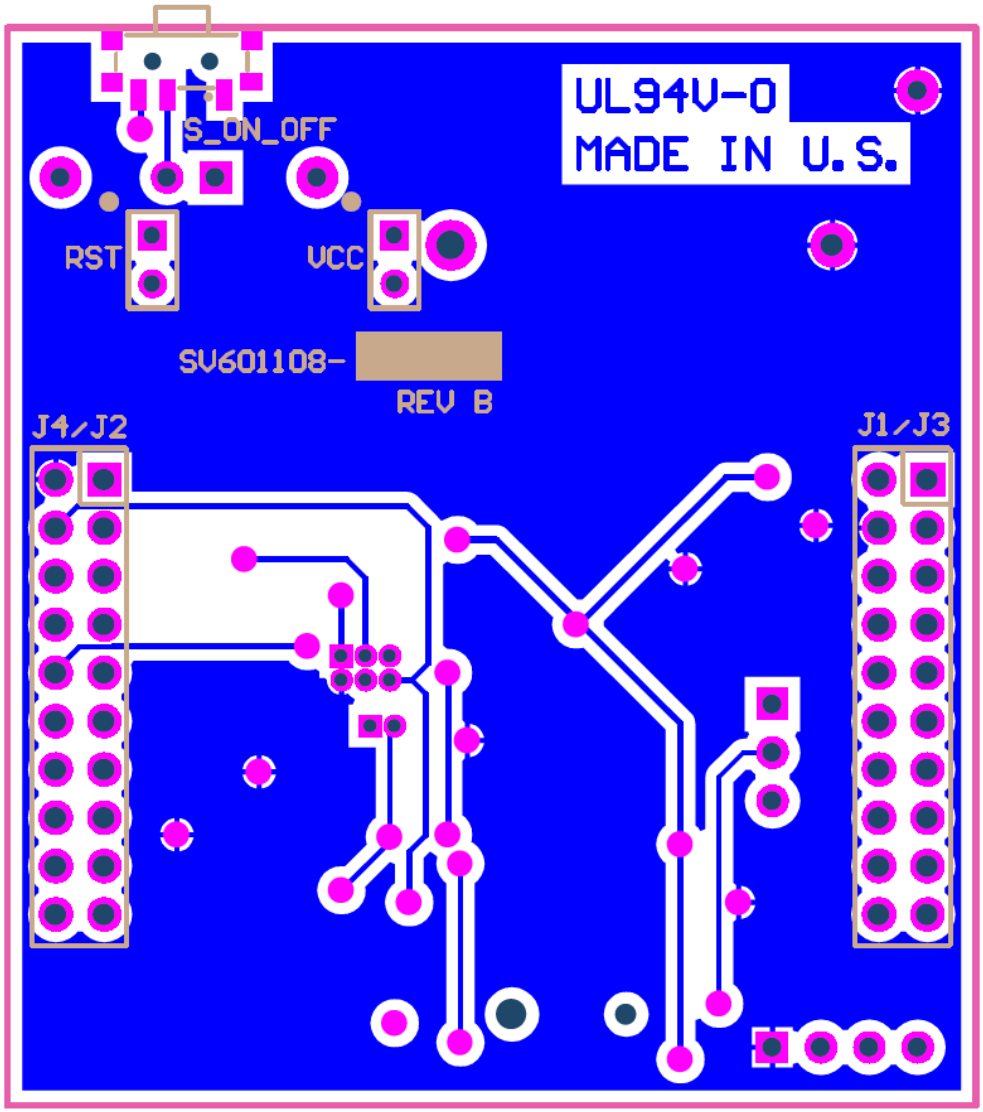


Figure 14. Bottom Layer

5 Schematic

Figure 15 illustrates the TPL5010EVM schematic.

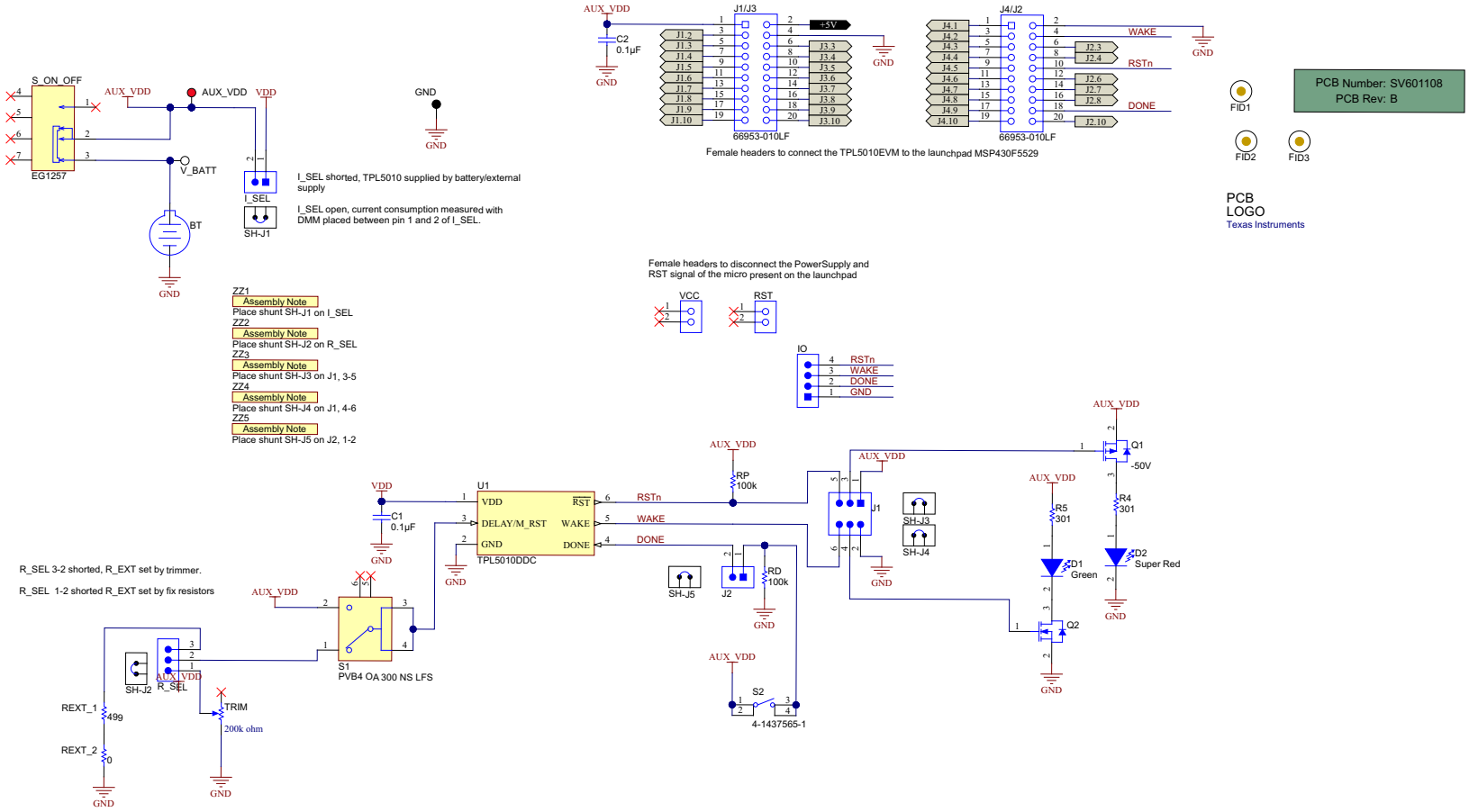


Figure 15. TPL5010EVM Schematic

6 Bill of Materials

Table 6 lists the TPL5010EVM BOM.

Table 6. TPL5010EVM 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
D2	LED, Super Red, SMD	Lumex	SML-LX0603SRW-TR	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
J2	Header, 50mil, 2x1, Gold, TH	Sullins Connector Solutions	GRPB021VWVN-RC	1
J1/J3, J4/J2	Receptacle, 100mil, 10X2, TH	FCI	66953-010LF	2
Q1	MOSFET, P-CH, -50V, -0.13A, SOT-323	Diodes Inc.	BSS84W-7-F	1
Q2	MOSFET, N-CH, 50V, 0.2A, SOT-323	Diodes Inc.	BSS138W-7-F	1
R4, R5	RES, 301 ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603301RFKEA	2
REXT_1	RES, 499 ohm, 0.1%, 0.1W, 0603	Susumu Co Ltd	RG1608P-4990-B-T5	1
REXT_2	RES, 0 ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW06030000Z0EA	1
RD, RP	RES, 100k ohm, 5%, 0.063W, 0402	Vishay-Dale	CRCW0402100KJNED	2
RST, VCC	Connector, Receptacle, 100mil, 2x1, Gold plated, TH	TE Connectivity	5-534206-1	2
R_SEL	Header, TH, 100mil, 3x1, Gold plated, 230 mil above insulator	Samtec, Inc.	TSW-103-07-G-S	1
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	Shunt, 100mil, Gold plated, Black	3M	969102-0000-DA	2
SH-J3, 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	3
S_ON_OFF	Switch, Slide, SPDT, 0.3A, SMT	E-Switch	EG1257	1
TRIM	TRIMMER, 200K, 0.25W, SMD	Bourns	3224W-1-204E	1
U1	Ultra-Low Power System Timer with Watchdog functionality and Manual Reset, DDC0006A	Texas Instruments	TPL5010DDC	1
V_BATT	Test Point, Miniature, White, TH	Keystone	5002	1

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