TPL5000EVM User's Guide

1 Introduction

The Texas Instruments TPL5000EVM evaluation module (EVM) allows a designer to configure the delay timers of the TPL5000 and measure its very low current consumption. Moreover, the TPL5000EVM is ready to be connected to the Launchpads of MSP430, Stellaris and C2000, in order to test its watchdog, timer cycling, and power cycling features.

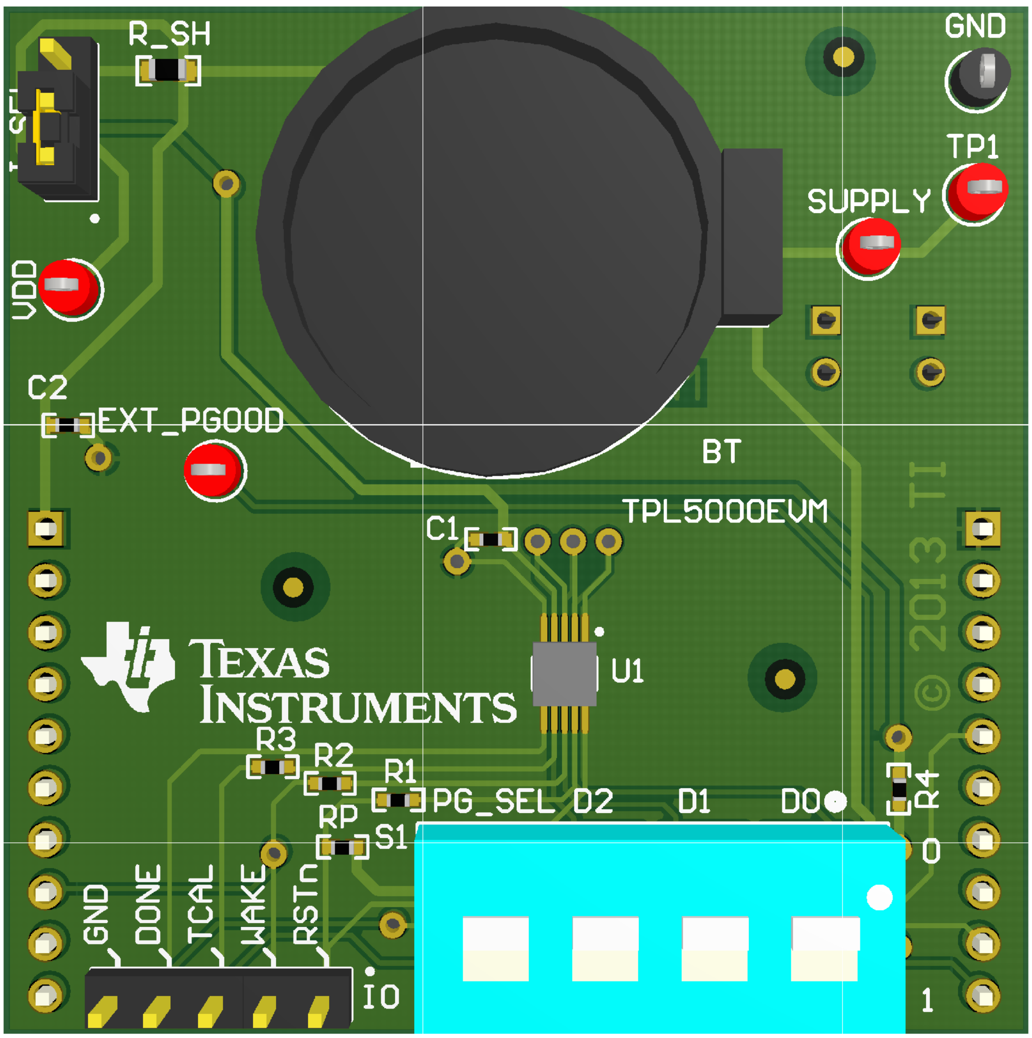

Figure 1. The LMP91010 Evaluation Board

2 Setup

This section describes how to properly connect, set up and use the TPL5000EVM.

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2.1 INPUT/OUTPUT CONNECTORS AND JUMPER DESCRIPTION

I_SEL	selects the current consumption measurement method: Open, current consumption measured with DMM connected between TP1 and VDD test points. 3-2 shorted, current consumption = Voltage drop on R_SH divided by R_SH 1-2 R_SH bypass
IO	5-pin header connector to bring out RSTn, WAKE, TCAL, DONE and GND signals.
S1	4 SPDT positions to set the D0, D1, D2 logic values and the source of the PGOOD signal (refer to Table 1)

Table 1. S1 Description

Description	Slider position	Value
PG_SEL	Top	0
	Bottom	1 or External PGOOD
D2	Top	0
	Bottom	1
D1	Top	0
	Bottom	1
D0	Top	0
	Bottom	1

In case the PGOOD is provided by an external power supply, set PG_SEL=1, Remove the REPG resistor and connect a power supply to the EXT_PGOOD test point.

VCC	2- pin female connector to plug the TPL5000EVM into MSP430 launchpad.
RST	2- pin female connector to plug the TPL5000EVM into MSP430 launchpad.
J1_10	10-pin female connector to plug the TPL5000EVM into MSP430 launchpad.
J11_20	10-pin female connector to plug the TPL5000EVM into MSP430 launchpad.
SUPPLY	test point to connect external supply voltage in alternative to the coin cell battery.
VDD	test point to monitor VDD pin of TPL5000.
TP1	test point to monitor the external supply voltage or coin cell battery voltage.
EXT_PGOOD	test point to connect external voltage supply for PGOOD signal.
GND	test point of the ground, connect here the GND of the power supplies.
BT	coin cell 2032 battery holder.

2.2 EVALUATION BOARD CONFIGURATION

The evaluation board can work standalone or plugged into the MSP430 launchpad; the following steps apply to both usages:

- Set the desired delay, configuring S1 (from position 2 to 4).
- Set the POWER GOOD source, configuring S1 (position 1). If you set the external source, connect the voltage source between the EXT_PGOOD and GND test points; do not turn on this voltage source. Refer to the data sheet regarding the allowable voltage range. This can be found on the MSP430 LaunchPad Wiki (MSP430 LaunchPad (MSP-EXP430G2) Wiki)
- Configure I_SEL as explained in Section 2.1.
- Plug the evaluation board in to the launchpad according to Table 2.

2.2.1 EVM Plugged into MSP430 Launchpad

- Load the code present in Section 5 of this User's Guide, into the MSP430 of the launchpad. Refer to the MSP430 launchpad documentation (MSP430 LaunchPad (MSP-EXP430G2) Wiki) for more details.
- Remove the jumpers VCC and RST of J3 header of the launchpad.

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- Set the desired delay, configuring S1 (from position 2 to 4).
- Set the POWER GOOD source configuring S1 (position 1), if you set external source connect the voltage source between the EXT_PGOOD and GND test points; do not turn on this voltage source. Refer to the data sheet regarding the allowable voltage range. This can be found on the MSP430 LaunchPad Wiki (MSP430 LaunchPad (MSP-EXP430G2) Wiki).
- Configure I_SEL as explained in Section 2.1.
- Plug the evaluation board into the launchpad according to Table 2.

Table 2. TPL5000EVM to Launchpad Connection

TPL5000EVM	MSP430 Launchpad
J1_10	J1
J11_20	J2
VCC	VCC of J3
RST	RST of J3

- Insert a 2032 coin cell battery in the battery holder (BT), or alternatively connect a voltage source between the SUPPLY and GND test points. **DO NOT CONNECT THE COIN CELL BATTERY AND THE VOLTAGE SOURCE TO SUPPLY THE EVALUATION BOARD AT SAME TIME**.
- Power on the voltage sources connected to the EVM.

2.2.1.1 SOFTWARE OF THE MSP430

Once loaded into the MSP430 of the launchpad, the code in Section 5 of this User's Guide performs the following features:

- At power on, the red LED present on the Launchpad is turned ON.
- As soon as the MSP430 receives a RESET signal from the TPL5000, the red LED blinks.
- As soon as the MSP430 receives a WAKE signal from the TPL5000, the green LED blinks.
- The S2 button of the Launchpad acts as a toggle button; the first push of the button does not allow the MSP430 to send the DONE signal to the TPL5000, a second push of the button allows the MSP430 to send the DONE signal.

2.2.2 EVM Standalone

- Connect your micro controller to the IO header, in order to manage the I/O signal of the DUT.
- Insert a 2032 coin cell battery in the battery holder (BT), or alternatively connect a voltage source between the **SUPPLY and GND test points. DO NOT CONNECT THE COIN CELL BATTERY AND THE VOLTAGE SOURCE TO SUPPLY THE EVALUATION BOARD AT SAME TIME**.
- Power on the voltage sources connected to the EVM.
- DO NOT LEAVE DONE PIN (4th pin of IO header) FLOATING. If supervisor feature is not needed, connect DONE pin to GND.

3 Supply Current Measurement

The TPL5000EVM offers 2 ways to measure the current consumption of the DUT. First, disconnect the TPL5000 from the launchpad or your micro controller, in order to not load the digital output pins of the DUT.

3.1 DIRECT MEASUREMENT

- Leave the I_SEL 3-pin header open.
- DO NOT LEAVE DIGITAL INPUT PINS FLOATING; for instance:
  - Short the DONE pin (4th pin of IO header) to GND
  - Set PGOOD =1 (see Table 1)
- Connect a Digital Multi Meter, configured as the current meter (able to measure nA), between TP1 and

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VDD test points.

- Read the current consumption on the DMM.

3.2 *INDIRECT MEASUREMENT*

- Short pin 2 and 3 of I_SEL.
- DO NOT LEAVE DIGITAL INPUT PINS FLOATING; for instance:
  - Short the DONE pin (4th pin of IO header) to GND
  - Set PGOOD =1 (see Table 1)
- Connect a Digital Multi Meter, configured as a voltage meter, between TP1 and VDD test points.
- Read the voltage drop on the R_SH on the DMM.
- The current consumption is simply the voltage drop on R_SH, divided by 1Mohm.

4 Bill of Materials (BOM)

Table 3. Bill of Material TPL5000EVM

DESIGNATOR	DESCRIPTION	PART NUMBER	MANUFACTURER	QUANTITY
BT	HOLDER COINCELL 2032 RETAINRCLIP	BS-7	Memory Protection Devices	1
C1, C2	CAP CER 0.1UF 6.3V 10% X5R 0402	C1005X5R0J104K050BA	TDK	2
EXT_PGOOD, SUPPLY, TP1, VDD	TEST POINT PC MINI .040	5000	Keystone	4
GND	TEST POINT PC MINI .040	5001	Keystone	1
IO	CONN HEADER 5POS .100	TSW-105-07-G-S	Samtec, Inc.	1
I_SEL	CONN HEADER 3POS .100	TSW-103-07-G-S	Samtec, Inc.	1
J1_10, J11_20	Connector, Receptacle, 100mil, 10x1, Gold plated, TH	SSW-110-01-G-S	Samtec, Inc.	2
R1, R2, R3	RES 1.0K OHM 1/16W 5% 0402 SMD	CRCW04021K00JNED	Vishay-Dale	3
R4	RES 49.9K OHM 1/16W 1% 0402 SMD	CRCW040249K9FKED	Vishay-Dale	1
REPG	RES 0.0 OHM 1/16W JUMP 0402 SMD	CRCW04020000Z0ED	Vishay-Dale	1
RP	RES 100K OHM 1/16W 5% 0402 SMD	CRCW0402100KJNED	Vishay-Dale	1
RST, VCC	CONN RECEPT 2POS .100 VERT DUAL	5-534206-1	TE Connectivity	2
R_SH	RES 1.00M OHM 1/10W 1% 0603 SMD	CRCW06031M00FKEA	Vishay-Dale	1
S1	SWITCH SPDT GOLD	206-124	CTS Electrocomponents	1
SH-J1	SHUNT JUMPER .1	969102-0000-DA	3M	1
U1	Nano Power Programmable Timer and Supervisor	TPL5000DGS	Texas Instruments	1

5 Source Code of MSP430 Present in the Launchpad

```
#include  <msp430g2553.h>

volatile unsigned int DONE=1;

void main(void)
{
  WDTCTL = WDTPW + WDTHOLD + WDTNMI + WDTNMIES;  // WDT off NMI hi/lo
```


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```
  P1DIR |= BIT0;                              // Set P1.0 to output direction RED LED
  P1DIR |= BIT6;                              // Set P1.6 to output direction GREEN LED
  P1DIR &= ~BIT3;                              // Set P1.3 S2 button to input
  P2DIR &= ~BIT0;                              // Set P2.0 (WAKE) to input
  P2DIR |= BIT4;                              // Set P2.4 (Done) to output direction

  P1OUT |= BIT0;                              // RED LED ON
  __delay_cycles(25000);                      // delay 25ms
  P1OUT &= ~BIT0;                             // Clear P1.0 RED LED Off

  //BUTTON S2 configuration
  P1REN |= BIT3;                              // Pull-up resistor enabled
  P1IE  |= BIT3;                              // P1.3 interrupt enabled
  P1IES |= BIT3;                              // P1.3 Hi/Lo edge
  P1IFG &= ~BIT3;                             // P1.3 IFG cleared

  // WAKE signal
  P2IE  |= BIT0;                              // P2.0 interrupt enabled
  P2IES &= ~BIT0;                             // P2.0 Lo/Hi edge
  P2IFG &= ~BIT0;                             // P2.0 IFG cleared

  // DONE signal
  P2OUT |= BIT4;                              // Done High
  __delay_cycles(100);                          // delay 100u
  P2OUT &= ~BIT4;                              // Done Low

  IE1 |= NMIIE;                                  // Enable NMI

  _BIS_SR(LPM4_bits + GIE);                     // Enter LPM4 with Interrupt enabled
}

#pragma vector=NMI_VECTOR
__interrupt void nmi_ (void)
{
  P1OUT |= BIT0;                          // P1.0 Red Led On
  __delay_cycles(200000);                  // delay 200ms
  P1OUT &= ~BIT0;                          // P1.0 Red Led Off

  if (DONE==1)
    {
      P2OUT |= BIT4;                      // Done On
      __delay_cycles(100);                  // delay 100us
      P2OUT &= ~BIT4;                      // Done Off
    }
  IFG1 &= ~NMIIFG;                        // Re-clear NMI flag in case bounce
  IE1 |= NMIIE;                           // Enable NMI
}

// Port 2 interrupt service routine
#pragma vector=PORT2_VECTOR
__interrupt void Port_2(void)
{
    P1OUT |= BIT6;                        // P1.6 Red Green On
    __delay_cycles(200000);                  // delay 200ms
    P1OUT &= ~BIT6;                          // P1.6 Red Green Off

  if (DONE==1)
  {
      P2OUT |= BIT4;                      // Done On
      __delay_cycles(100);                  // delay 100us
      P2OUT &= ~BIT4;                      // Done Off
  }
  P2IES &= ~BIT0;                         // P1.4 Lo/Hi edge
  P2IFG &= ~BIT0;                         // P1.4 IFG cleared
}
```


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```
// Port 1 interrupt service routine
#pragma vector=PORT1_VECTOR
__interrupt void Port_1(void)
{
    if (DONE == 1)                                  // enabled/disabled and viceverasa DONE signal
          {
                DONE = 0;
          }
  else
  {
          DONE = 1;
  }
  P1IFG &= ~BIT3;                                    // P1.3 IFG cleared
  P1IES |= BIT3;                                     // P1.3 Hi/Lo edge
}
```


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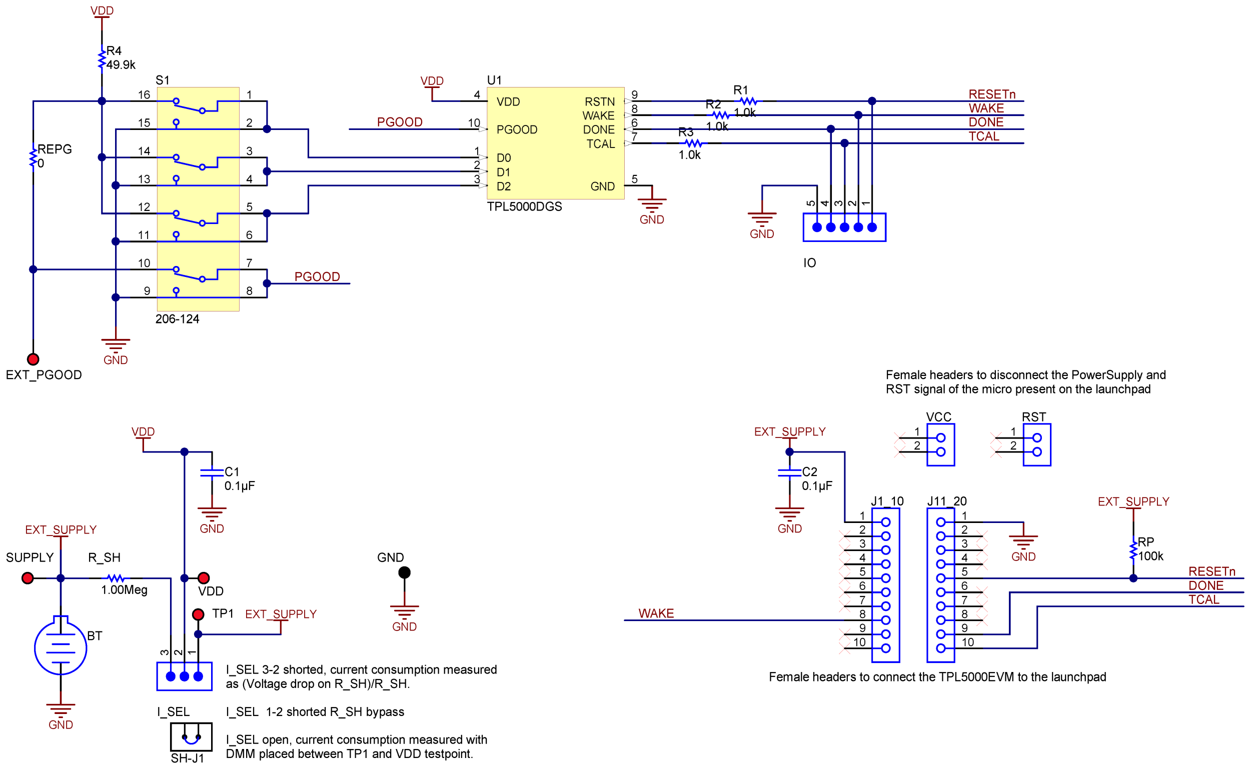
Appendix A Schematic



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Appendix B Layout

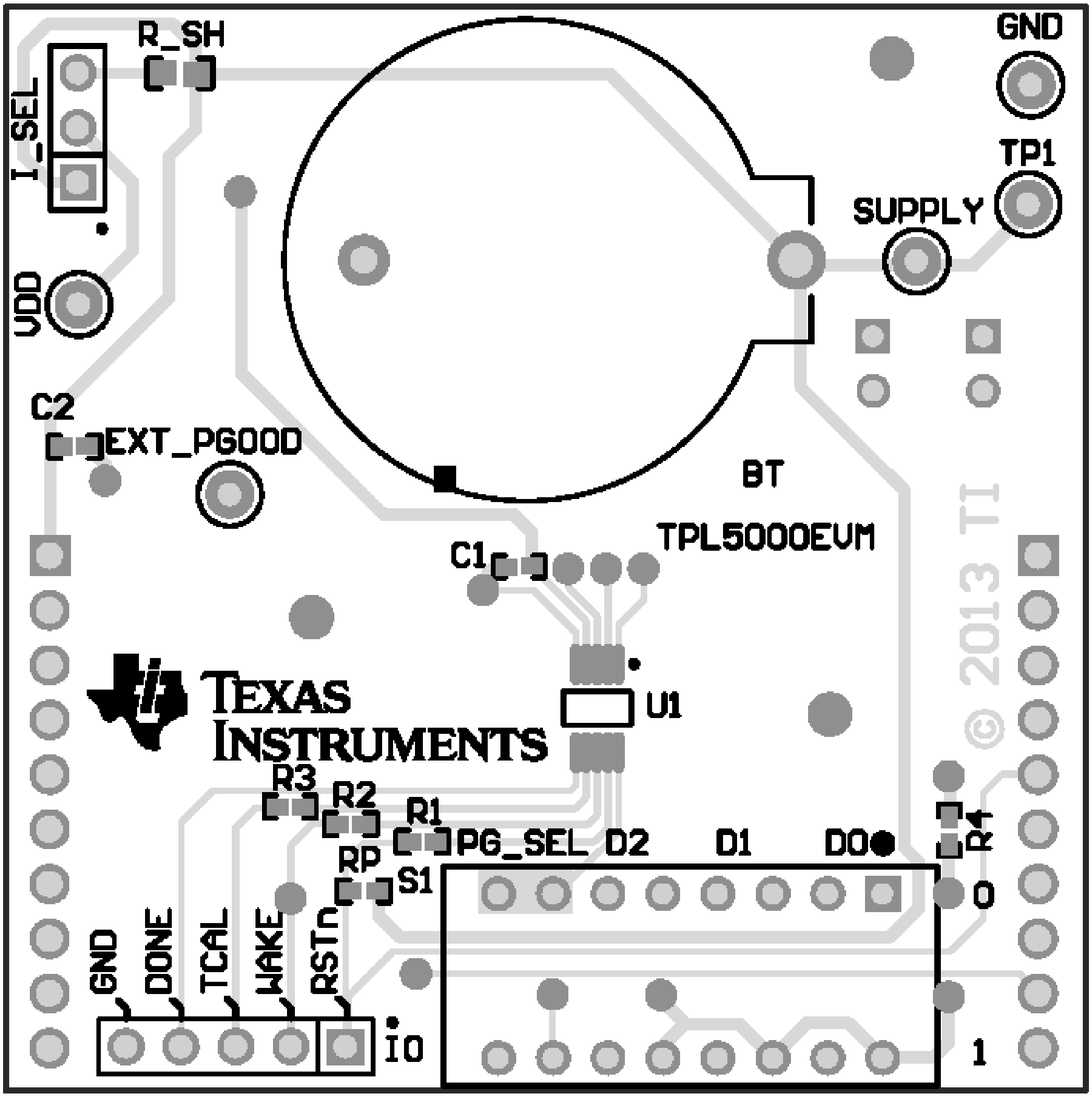

Figure 2. Layout Top Layer Silkscreen

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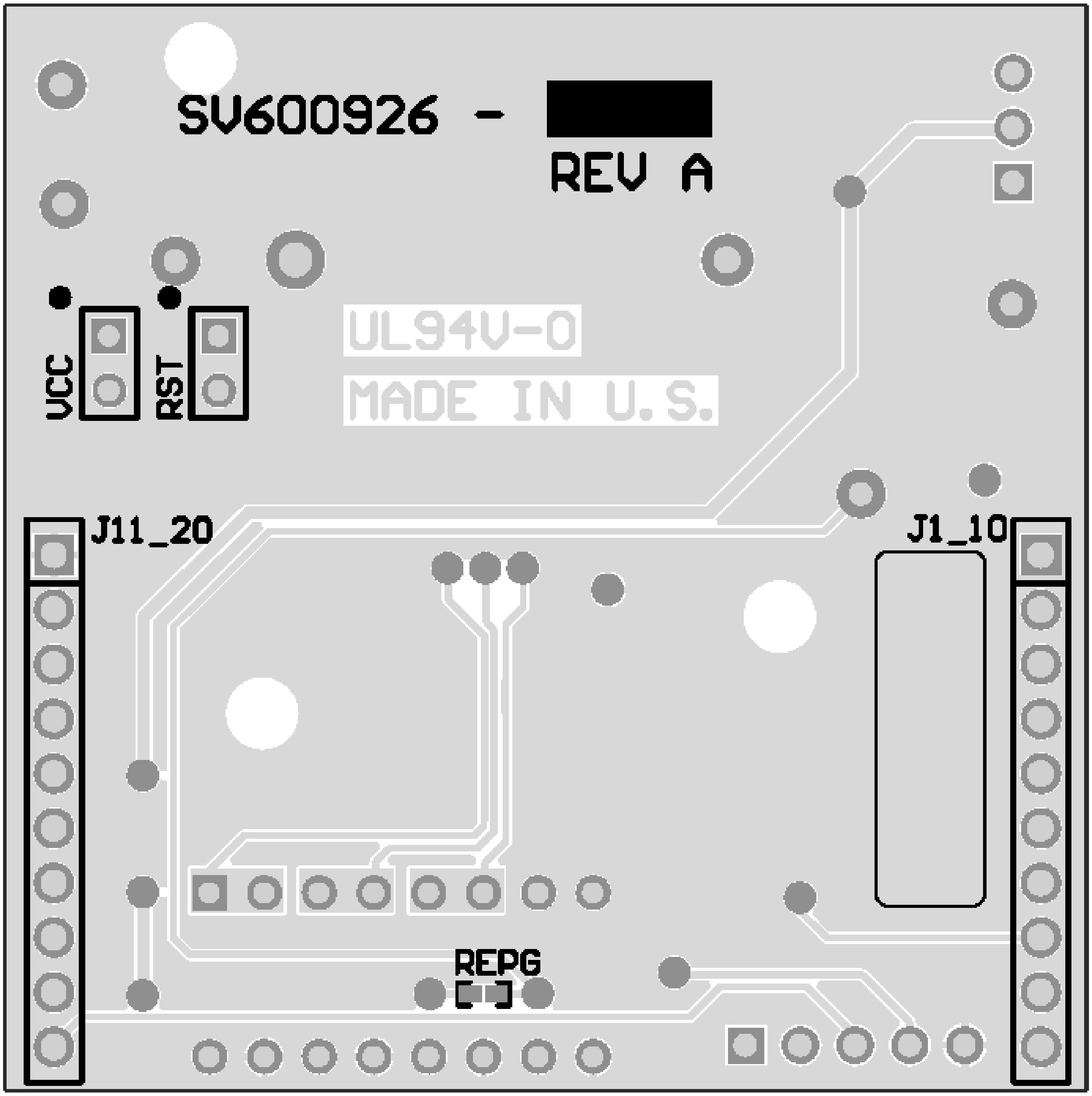

Figure 3. Layout Bottom Layer Silkscreen

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