

Evaluation Module for TPS386000 and TPS386040

This User's Guide describes the evaluation modules (EVM) for the TPS386000 (TPS386000EVM) and TPS386040 (TPS386040 EVM). The EVM contains evaluation and reference circuitry for the TPS386000 and TPS386040. TPS386000 and TPS386040 are quad supervisors with reset and sequence capabilities.

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1 Description

The TPS386000/40EVM provides the capabilities needed for supervising and sequencing four power supplies including one negative power supply. The EVM also provides an I2C interface for use with the TI USB-GPIO adapter.

The TPS386000/40 interfaces with the TPS65055 providing a sequenced power on and supervised setup to demonstrate a typical application as shown in Figure 1.

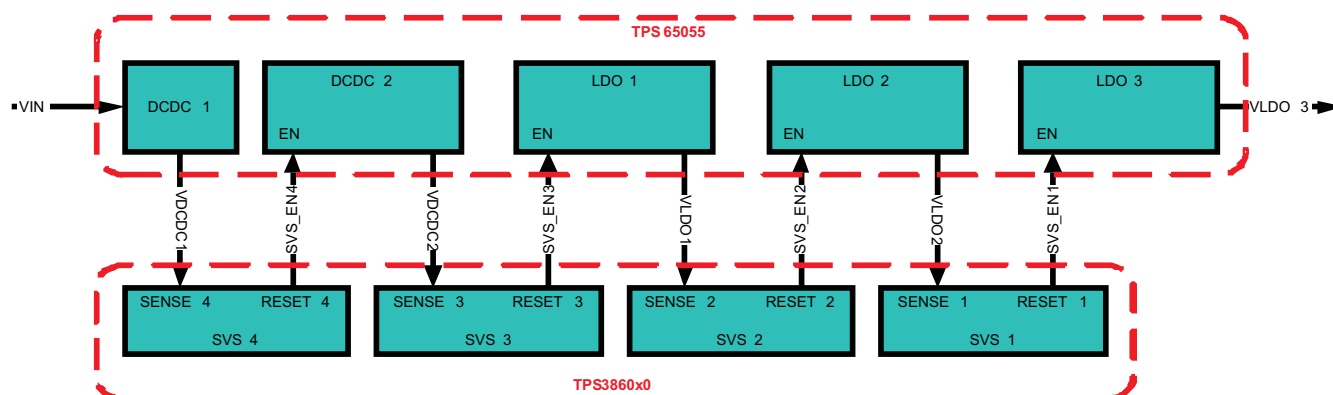


Figure 1. Typical TPS386000/40EVM Power-on Sequence

The TPS386000/40EVM can also be configured to sequence and supervise an external power supply system including one negative power supply.

1.1 Features

- General features
 - On board local power supply used to demonstrate the sequencing and supervision capabilities of the TPS3860x0.
 - Single 5V EVM supply input
 - 4 rail on EVM and external sequencing
 - 4 analog supervisors including one negative supervisor
 - USB interface for communication with on board TPS65055 power management unit.
- Orderable options
 - TPS386000EVM 4 channel supervisor/sequencer with open drain RESET outputs
 - TPS386040EVM 4 channel supervisor/sequencer with push-pull RESET outputs

2 Schematic

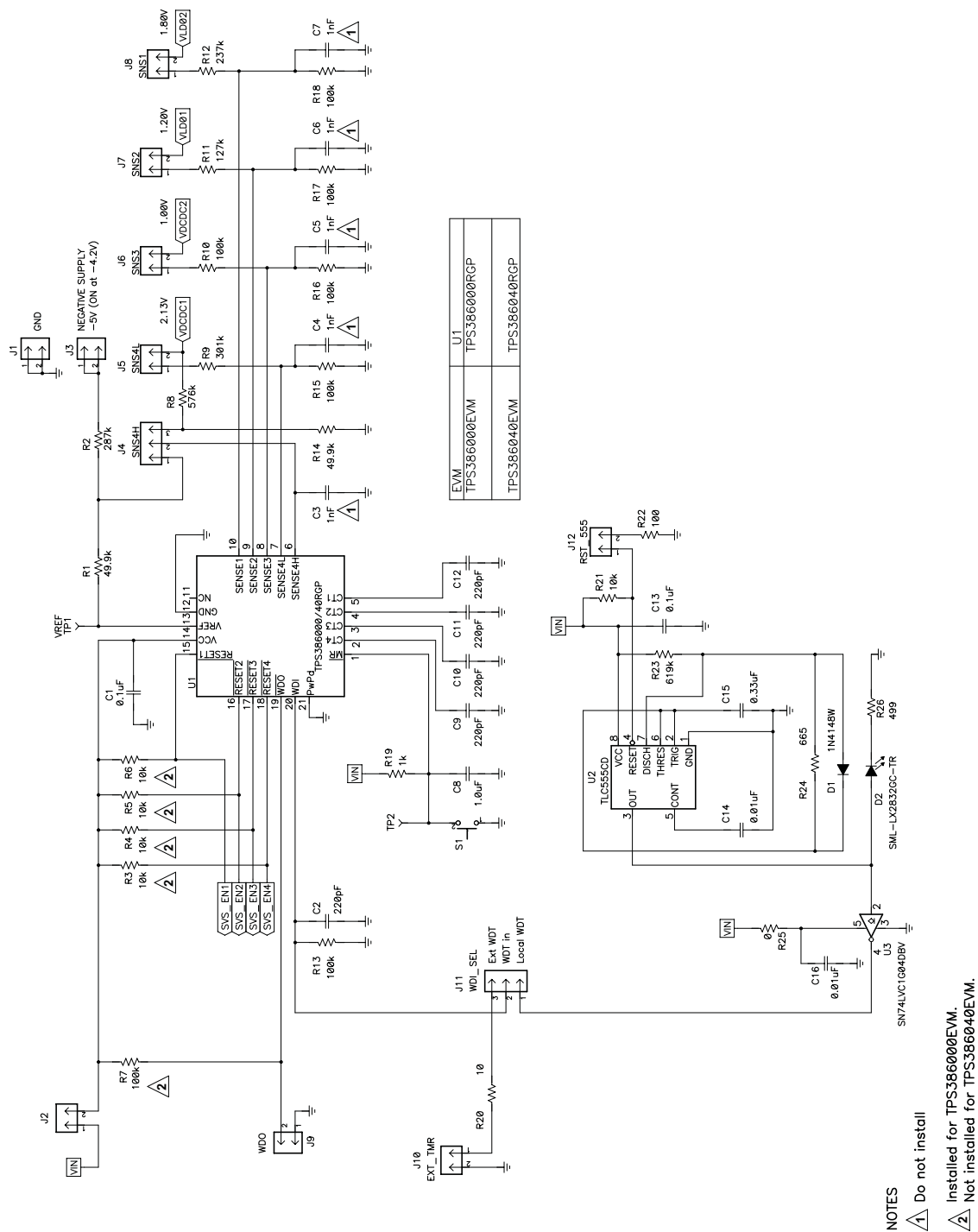


Figure 2. TPS386000/40 EVM Schematic (TPS386000/40)



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3.1 EVM On-Board Jumper Default Installation

As ordered, the EVM should have 18 jumpers installed in the following locations.

Table 1. EVM Default Jumper Installation

Shunt Reference Designator	Shunt Pin Position
J2, J5-J8, J11, J20, J22, J24, J28, J31, J34, JP2, JP5	Between pins 1 and 2
J4, JP1, JP3, JP4	Between pins 2 and 3

3.2 EVM Test Points, Indicators and Switches

Table 2. EVM Test Points, Indicators and Switches

TP/LED/SW	Label	Description
S1	MR	Master reset input switch for TPS3860x0. Use this switch to reset the WDO pin and force local resequence.
D2 (GRN)	LWDT ON	Indicates when the local watch dog timer is operational.
TP1 (RED)	VREF	TPS3860x0 VREF output nominally 1.2V
TP2 (RED)	MR	TPS3860x0 MR (master reset) input.
TP3 (RED)	SCLK	Serial clock input to TPS65055 from USB-GPIO adapter.
TP4 (RED)	SDAT	Serial data input-output to TPS65055 from USB-GPIO adapter.

3.3 EVM Input/Output Connectors and Test Jumpers

Table 3. EVM Input/Output Connectors

Connector	Description
J14	EVM 5V input voltage (VIN). Use with GND at J16 and with JP1 set to the VIN position.
J16	EVM input GND used with J14 (VIN).
J3	Negative supply input used with J3 (GND). Set J4 shunt to the NEGVDC SNS4H position to monitor negative supplies using SENSE4H.
J1	GND input used with J3 (NEGVDC).
J13	TPS65055 DCDC1 output voltage (VDCDC1) which is nominally 2.1VDC.
J15	GND output used with J13 (VDCDC1).
J17	TPS65055 DCDC2 output voltage (VDCDC2) which is nominally 1.0VDC.
J18	GND output used with J17 (VDCDC2).
J19	TPS65055 LDO1 output voltage (VLDO1) which is nominally 1.2VDC.
J21	GND output used with J19 (VLDO1).
J23	TPS65055 LDO2 output voltage (VLDO2) which is nominally 1.8VDC.
J25	GND output used with J23 (VLDO2).
J27	TPS65055 LDO3 output voltage (VLDO3) which is nominally 2.8VDC.
J29	GND output used with J27 (VLDO3).
J30	TPS65055 LDO4 output voltage (VLDO4) which is nominally 1.3VDC.
J32	GND output used with J30 (VLDO4).
J33	Used with the USB-GPIO adapter for communication with the TPS65055 using the TPS65055 GUI. The USB-GPIO adapter can also provide 3.3V to the EVM (derived from the PC on which the GUI is operating) when JP1 is in the 3.3V position.
J12	Local watch dog timer reset (RST LWDT). Use this when J11 is set to the LWDT position when testing the watch dog timer function. When a shunt is installed on J12 the local watch dog timer will reset causing the TPS3860x0 WDO signal to go low after timeout.
J10	External watch dog timer input terminal. Use this input when J11 is set to the EXT WDT position.
J9	TPS3860x0 WDO pin output.

Table 4. EVM Jumpers

Jumper	Description
JP1	EVM input voltage select jumper. Install shunt between pins 2 and 3 (5V) for normal external 5V power supply input from J14 and J16. Install shunt between pins 1 and 2 (3.3V) when using the USB-GPIO adapter to communicate with the TPS65055 through J33. USB power from the USB-GPIO adapter is nominally 3.3VDC.
J2	VIN source for TPS3860x0. Install shunt for normal operation.
J22	VIN source for TPS65055 LDO1, LDO2, LDO3, LDO4. Install shunt for normal operation.
J11	Watch Dog Input Select. Place shunt in the LWDT position for the local watch dog timer and place the shunt in the EXT WDT position for the external watch dog timer source via J10.
J31	RESET1 output from TPS3860x0. Install shunt between pins 1 and 2 (RESET1) for local LDO3 enable (EN_LDO3) or remove shunt and connect RESET1 to external power supply enable for system operation. Install shunt between pins 2 and 3 to always enable LDO3.
J28	RESET2 output from TPS3860x0. Install shunt between pins 1 and 2 (RESET2) for local LDO2 enable (EN_LDO2) or remove shunt and connect RESET2 to external power supply enable for system operation. Install shunt between pins 2 and 3 to always enable LDO2.
J24	RESET3 output from TPS3860x0. Install shunt between pins 1 and 2 (RESET3) for local LDO1 enable (EN_LDO1) or remove shunt and connect RESET3 to external power supply enable for system operation. Install shunt between pins 2 and 3 to always enable LDO1.
J20	RESET4 output from TPS3860x0. Install shunt between pins 1 and 2 (RESET4) for local DCDC2 enable (EN_DCDC2) or remove shunt and connect RESET4 to external power supply enable for system operation. Install shunt between pins 2 and 3 to always enable DCDC2.
J8	SENSE1 input to TPS650x0 derived from TPS65055 LDO2. Install shunt for normal local operation or remove shunt and connect SNS1 to external supply output for system operation.
J7	SENSE2 input to TPS650x0 derived from TPS65055 LDO1. Install shunt for normal local operation or remove shunt and connect SNS2 to external supply output for system operation.
J6	SENSE3 input to TPS650x0 derived from TPS65055 DCDC2. Install shunt for normal local operation or remove shunt and connect SNS3 to external supply output for system operation.
J5	SENSE4L input to TPS650x0 derived from TPS65055 DCDC1. Install shunt for normal local operation or remove shunt and connect SNS4 to external supply output for system operation.
J4	SENSE4H input to TPS650x0 derived from TPS65055 DCDC1. Install shunt between pins 2 and 3 (VDCDC1 SNS4H) for normal local operation or install shunt between pins 1 and 2 (NEGVDC SNS4H) to monitor negative external power supply using J3 and J1.
J34	Enable input for local TPS65055 LDO4. Install shunt for normal operation.
JP2	TPS65055 DCDC1 enable. Install shunt between pins 1 and 2 (HIGH) to enable DCDC1 and between pins 2 and 3 (GND) to disable DCDC1.
JP5	Used to select TPS65055 DCDC2 output voltage. Refer to the TPS65055 datasheet for more detail.
JP4	Used with JP3 to select TPS65055 LDO1-LDO4 output voltage. Refer to the TPS65055 datasheet for more detail.
JP3	Used with JP4 to select TPS65055 LDO1-LDO4 output voltage. Refer to the TPS65055 datasheet for more detail.
J26	TPS65055 control signal input. Refer to TPS65055 datasheet for control signal explanation.

4 Description

The following paragraphs describe the functionality and operation of the TPS386000/40 EVM.

4.1 General Usage

4.1.1 Input Power

The 5VDC EVM input power is provided through J14/J16 terminals. Ensure that the correct polarity is provided and that this input voltage does not exceed 6.0VDC. The normal operating current for the TPS386000/40EVM will be less than 50mA when there is no load on the TPS65055 outputs. 3.3VDC EVM input power can also be furnished at the J33 (I2C) connector through the USB-GPIO adapter when using the TPS65055 GUI. In this case, 5VDC EVM input power is not required.

4.1.2 I2C Interface

An I2C interface to the TPS65055 is provided at J33. The TPS65055 internal registers and output voltages can be modified using a GUI.

4.2 On EVM Supervisor/Sequencer

The TPS386000/40 and TPS65055 are configured to provide a power-on sequence as shown in [Figure 1](#). When power is applied to the EVM, VDCDC1 rises to approximately 2.1VDC causing RESET4 to enable DCDC2. VDCDC2 rises to approximately 1.0VDC causing RESET3 to enable LDO1. VLDO1 rises to approximately 1.2VDC causing RESET2 to enable LDO2. VLDO2 rises to approximately 1.8VDC causing RESET1 to enable LDO3. VLDO3 then rises to approximately 2.8V and the sequence is complete.

4.2.1 Local Voltage Rails

The TPS65055 provides DC outputs from 2 switching (DCDC1 and DCDC2) and 4 linear power supplies (LDO1-LDO4) for sequencing and monitoring. The nominal output voltages are listed in [Table 5](#).

Table 5. Local Rail Nominal Output Voltages

Local Rail	VDCDC1	VDCDC2	VLDO1	VLDO2	VLDO3	VLDO4
Nominal Voltage	2.1V	1.0V	1.2V	1.8V	2.8V	1.3V

4.2.2 Supervisor Inputs

The TPS386000/40 supervisor inputs (SENSE1L, SENSE2L, SENSE3L, SENSE4L, and SENSE4H) can be used to monitor onboard or off board voltages. Jumpers are used to select the analog source. The default EVM configuration monitors the onboard voltage rails as described above. The SENSE1L-SENSE4L inputs are programmed with a resistor divider which turns on at approximately 75% of the rail nominal output voltage. The SENSE4H input is set below the 400mV threshold by default when using the onboard power supplies.

The supervisor inputs can also be used to monitor an external power supply source by removing the associated jumper shunt and connecting the jumper pin to the external source. The SENSE input trip points can be adjusted by changing the resistor dividers using the following equations:

$$V_{ITN} = 400 \text{ mV}$$

$$R_{SU} = R_{SL} \times \left(\frac{VCC_target}{V_{ITN}} \right) - 1, VCC_target = V_{ITN} \times \left(\frac{R_{SU}}{R_{SL}} + 1 \right)$$

Example for EVM SENSE1 input from LDO2

$$VCC_target = 1.35 \text{ V}, R_{SL} = 100 \text{ k}\Omega$$

$$R_{SU} = 100 \text{ k}\Omega \times \left(\frac{1.35\text{V}}{0.4\text{V}} - 1 \right) = 237.5 \text{ k}\Omega \text{ (choose 237 k}\Omega\text{)}$$

$$VCC_target = 0.4 \text{ V} \times \left(\frac{237\text{k}\Omega}{100\text{k}\Omega} + 1 \right) = 1.348 \text{ V}$$

Additionally, the SENSE4H input can be used along with V_{REF} to monitor negative voltages applied at J3/J1. J4 jumper must also be installed to the NEGVDG SNS4H position when monitoring negative voltages. The onboard resistors have been chosen so that SENSE4H trips with approximately -4.2V at J3/J1 for a -5VDC nominal power supply. The SENSE4H input trip points can be adjusted by changing the resistor dividers using the following equations:

$$V_{REF} = 1.2 \text{ V}, V_{ITP} = 400 \text{ mV}$$

$$R_{S42L} = R_{S42H} \times \frac{V_{ITP} - VCC42_target}{V_{REF} - V_{ITP}}$$

$$VCC42_target = V_{ITP} - \frac{R_{S42L}}{R_{S42H}} \times (V_{REF} - V_{ITP})$$

Example for EVM SENSE4H input from NEGVDG

$$VCC42_target = -4.2 \text{ V}, R_{S42H} = 49.9 \text{ k}\Omega$$

$$R_{S42L} = 49.9 \text{ k}\Omega \times \left[\frac{0.4 \text{ V} - (-4.2) \text{ V}}{1.2 \text{ V} - 0.4 \text{ V}} \right] = 286.9 \text{ k}\Omega \text{ (choose 287 k}\Omega\text{)}$$

$$VCC42_target = 0.4\text{V} - \frac{287 \text{ k}\Omega}{49.9 \text{ k}\Omega} \times (1.2\text{V} - 0.4\text{V}) = 4.201 \text{ V}$$

The EVM includes a PCB footprint for a small filter capacitor on each of the SENSE inputs for use with noisy external sources.

4.2.3 RESET Outputs

The TPS386000/40 RESET outputs are used on the EVM to enable the associated power supplies. The TPS386000 has open drain outputs and are pulled up by R3-R6 pullup resistors by default on the TPS386000EVM. The TPS386040 has push-pull outputs and R3-R6 are not installed on the TPS386040EVM.

Jumpers allow the RESET pins to be connected to an external power supply enable for use with a user system.

4.2.4 Timing Delay on CT Pins

Delay from SENSE input to output RESET can be adjusted with the value at the CT1-CT4 pins. Use the following equations to adjust the delay from the nominal 1.3mS EVM value.

$$V_{CT} = 1.24V, I_{CT} = 300 \text{ nA}, T_{DELAY} = 1.4 \text{ ms}$$

$$C_{CT} = \frac{I_{CT}}{V_{CT}} \times (T_{DELAY} - 0.5 \text{ ms})$$

Example for EVM CT pins with a desired $T_{DELAY} = 1.4 \text{ ms}$

$$C_{CT} = \frac{300 \text{ nA}}{1.24 \text{ V}} \times (1.4 \text{ ms} - 0.5 \text{ ms}) = 218 \text{ pF (choose } C_{CT} = 220 \text{ pF)}$$

$$T_{DELAY} = 220 \text{ pF} \times \frac{1.24 \text{ V}}{300 \text{ nA}} + 0.5 \text{ ms} = 1.41 \text{ ms}$$

4.3 Watch Dog Timer Function

The TPS386000/40 contains a watch dog timer (WDT) and the EVM contains a local WDT (LWDT) as well as a provision for an external WDT connection. LWDT provides a pulse approximately every 140ms to the TPS386000/40 WDI pin when configured by J11. LED D2 indicates when the LWDT is active.

The TPS386000/40 WDT function can be tested in the LWDT mode by holding LWDT in reset by placing a shunt on J12 (RST LWDT). When a shunt is installed on J12, the WDO output on J9 will go to logic low after approximately 600ms. WDO can be reset to logic high by pressing the S1 push-button switch to reset the TPS386000/40.

A system WDT can also be provided externally through J10 when J11 is set to the EXT WDT position.

5 Test Setup

Figure 4 shows a typical test setup for TPS386000/40EVM.

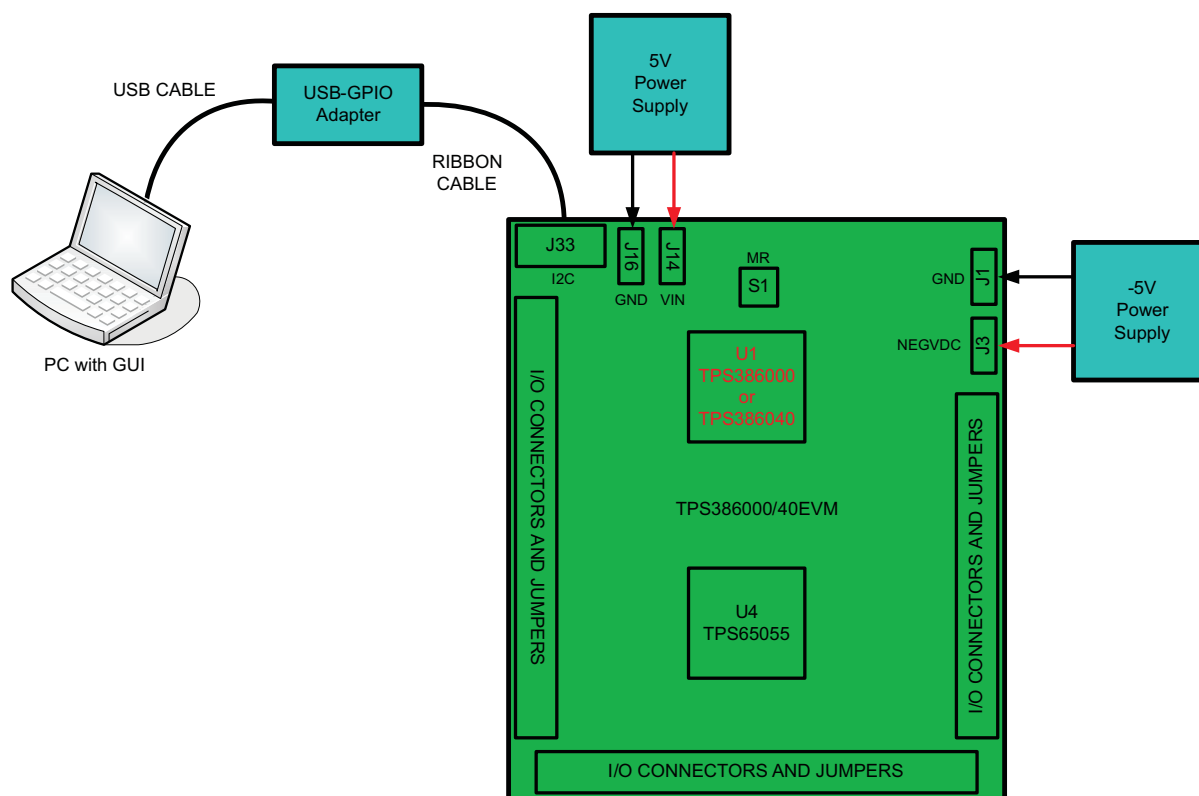


Figure 4. Typical TPS386000/40EVM Test Setup

6 TPS65055 EVM GUI

6.1 TPS65055 EVM GUI Installation

The TPS65055 EVM Software provides a software interface for the TPS65055 EVM boards. Use this software to change the TPS65055 IC registers via the USB Interface Adapter. Navigate to the following link to download the software:

<http://focus.ti.com/docs/toolsw/folders/print/tps65055evm-sw.html>

6.1.1 Software Requirements

- Microsoft Windows 2000 or Newer Operating System
- Microsoft .Net Framework 2.0
- NOTE: It is advised to install this component independently. This EVM software will attempt to install it if it's not already installed, but it might require a restart of your system.
- Microsoft Internet Explorer 6
- This is required for receiving automatic updates to the EVM software.

6.1.2

- Personal Computer with USB port
- USB Interface Adapter

7 7 EVM Assembly Drawings and Layout Guidelines

7.1 PCB Drawings

The following figures show component placement and layout.

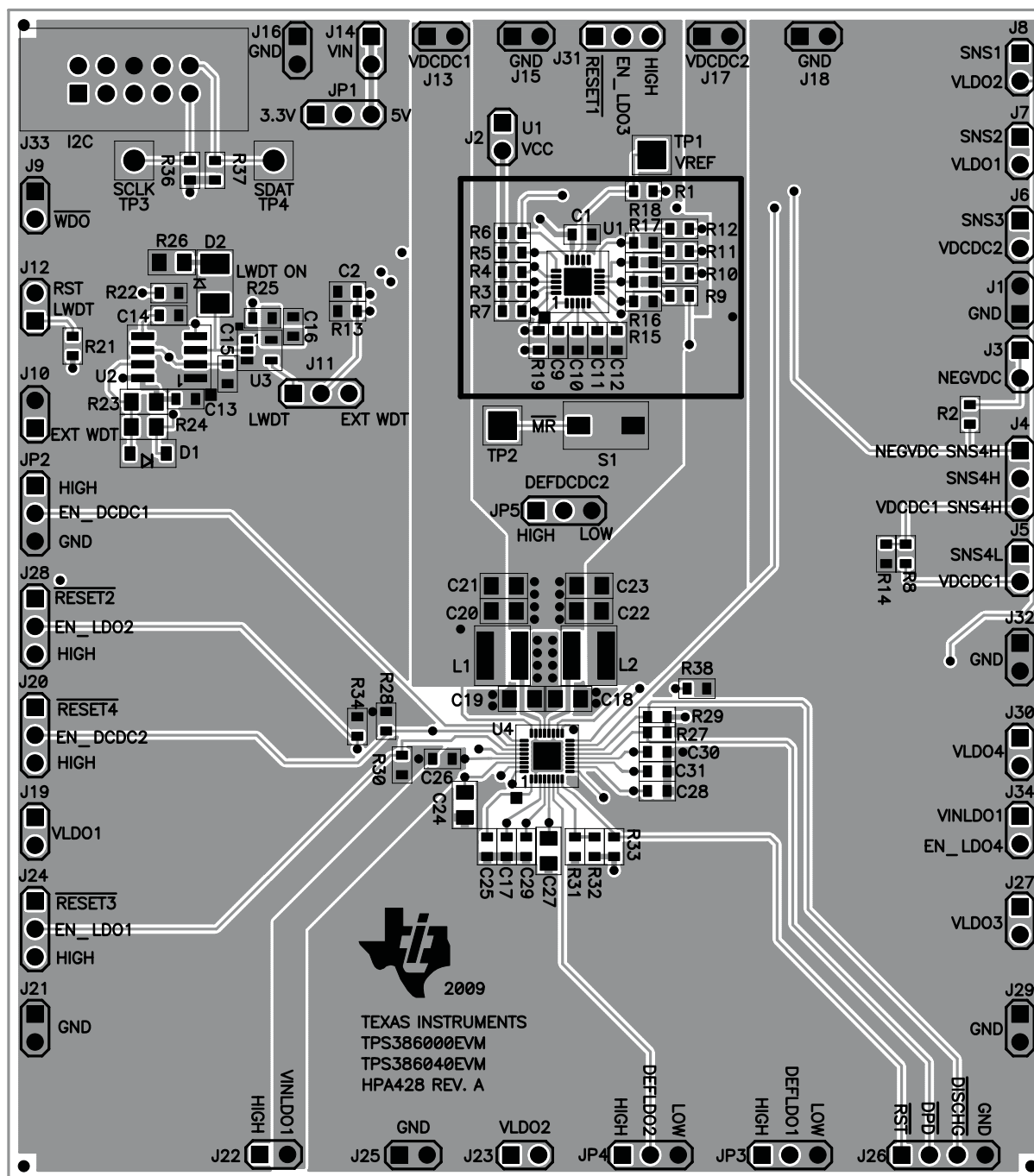


Figure 5. Top Side Layout/Routing

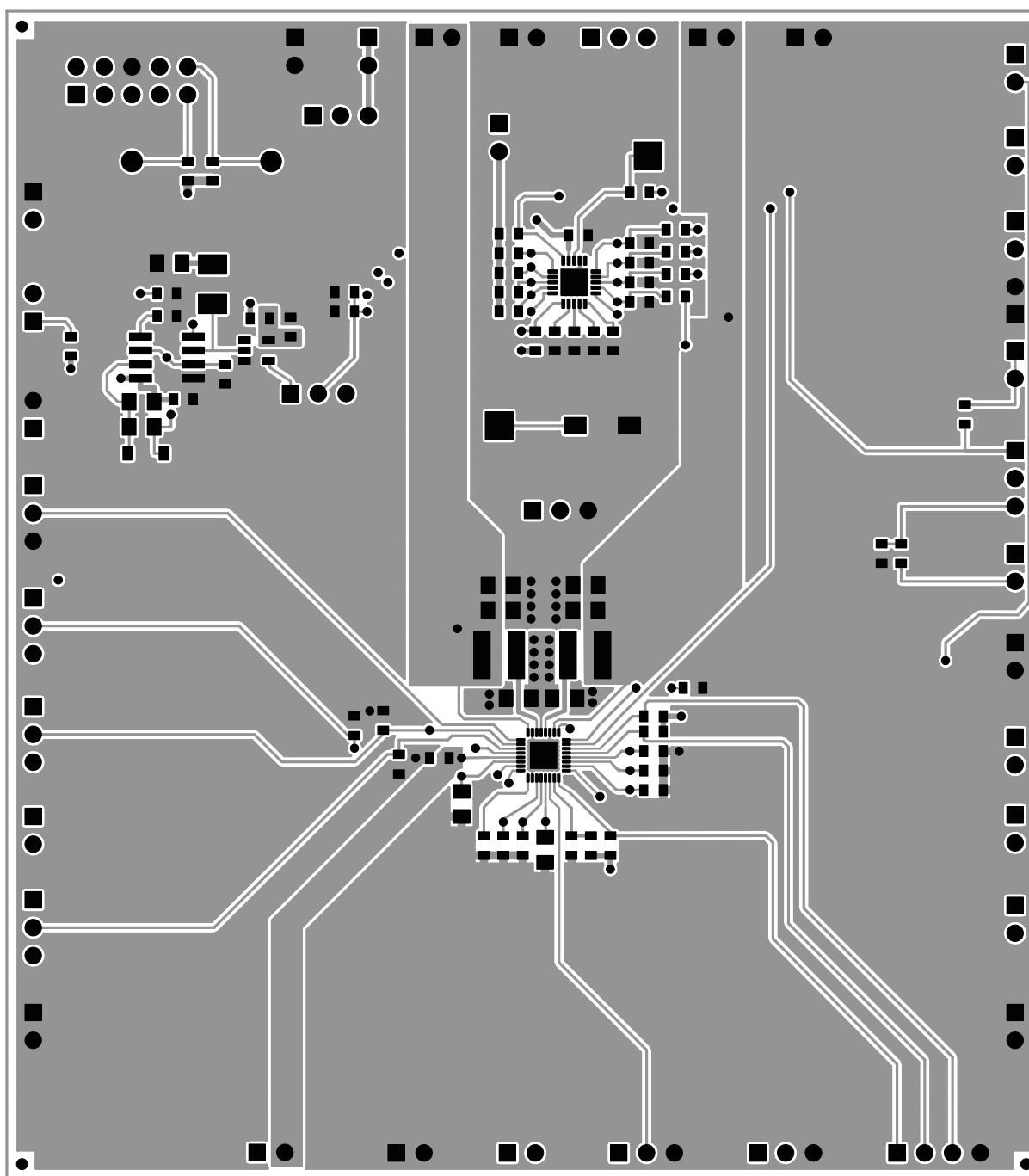


Figure 6. Top Side Layout/Routing

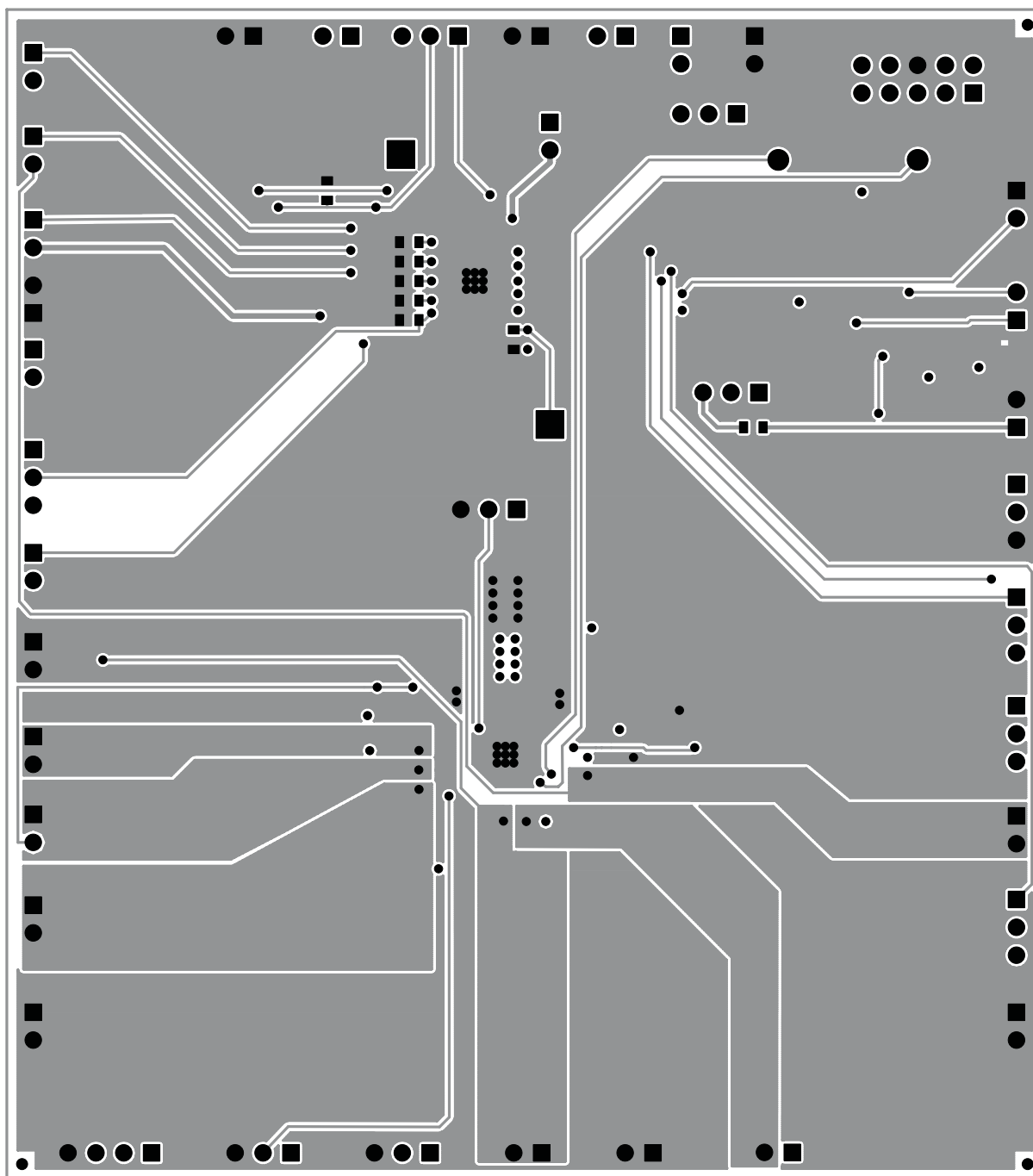


Figure 7. Top Side Layout/Routing

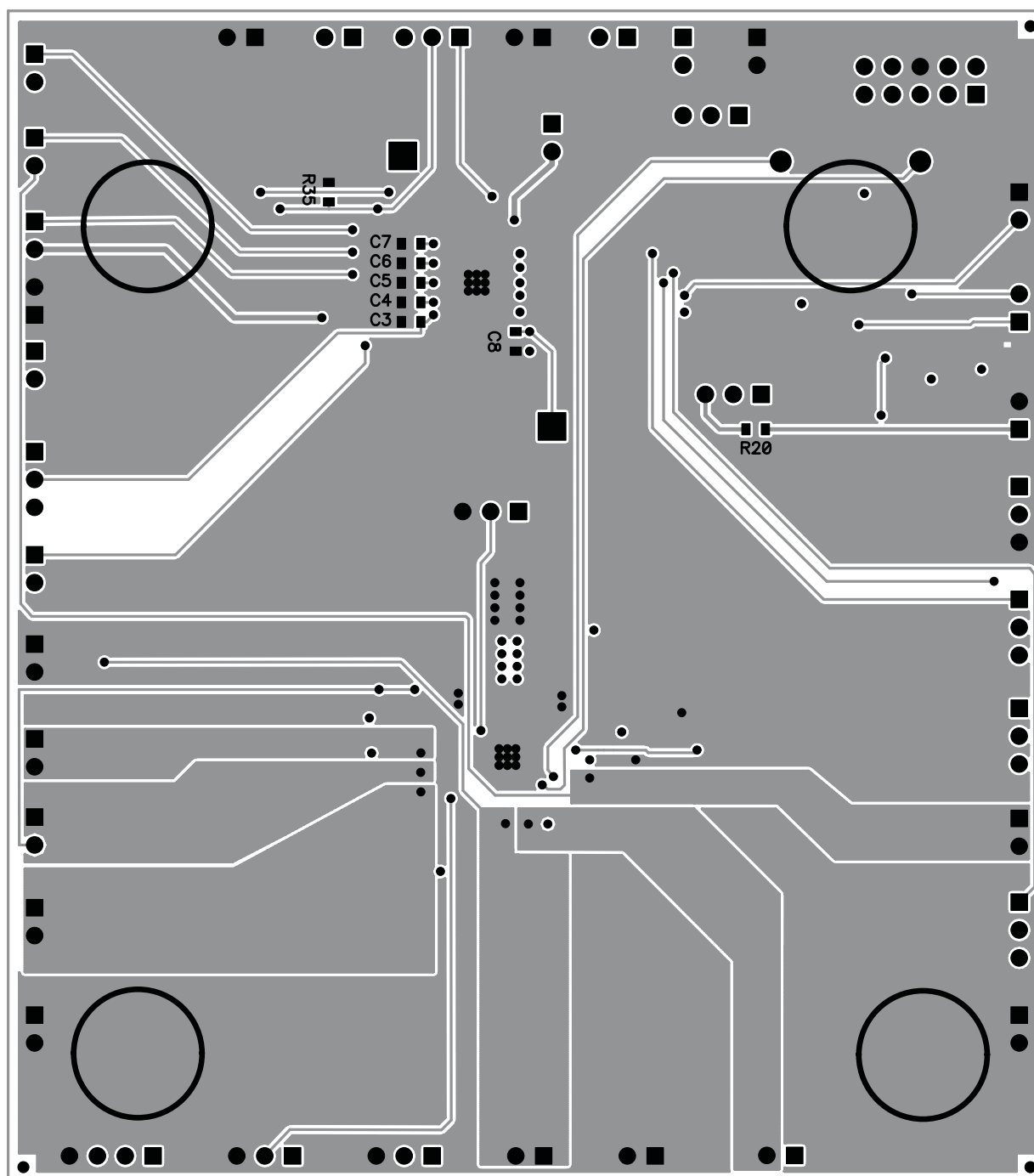


Figure 8. Bottom Side Placement/Routing

7.2 Layouts Guidelines

Thermal pad

The thermal pad provides a thermal and mechanical interface between the device and the printed circuit board (PCB). Connect the exposed thermal pad of the PCB to the device VSS pins and provide at least a 3 x 3 pattern of PCB vias to connect the thermal pad and GND pin to the circuit ground on other PCB layers.

Supply voltage decoupling

Provide power supply pin bypass to the device as follows:

- 0.1 μ F, X7R ceramic at pin 15 (VCC)
- 1nF, X7R ceramic at pins 6-10 (SENSE1, SENSE2, SENSE3, SENSE4L, SENSE4H) while not absolutely required can provide noise filtering in noisy power supply systems.

8 Bill of Materials

Table 6. TPS386000/40EVM Bill of Materials

EVM COUNT		RefDes	Value	Description	Size	Part Number	MFR
TPS386040	TPS386000						
3	3	C1, C13, C25	0.1 μ F	Capacitor, Ceramic, X7R, 16V, 10%	0603	Std	Std
2	2	C14, C16	0.01 μ F	Capacitor, Ceramic, X7R, 16V, 10%	0603	Std	Std
1	1	C15	0.33 μ F	Capacitor, Ceramic, X7R, 16V, 10%	0603	Std	Std
6	6	C18, C19, C20, C21, C22, C23	10 μ F	Capacitor, Ceramic, 10V, X5R, 10%	0805	GRM21BR61A106KE19L	Murata
5	5	C2, C9, C10, C11, C12	220 pF	Capacitor, Ceramic, COG, 50V, 5%	0603	Std	Std
2	2	C24, C27	4.7 μ F	Capacitor, Ceramic, 10V, X5R, 10%	0805	GRM219R61A475KE19D	Murata
5	5	C26, C28, C29, C30, C31	2.2 μ F	Capacitor, Ceramic, 10V, X5R, 10%	0603	GRM188R61A225KE34D	Murata
0	0	C3, C4, C5, C6, C7	1 nF	Capacitor, Ceramic, X7R, 16V, 10%	0603	Std	Std
2	2	C8, C17	1.0 μ F	Capacitor, Ceramic, 25V, X5R, 10%	0603	GRM188R61E105KA12D	Murata
1	1	D1	1N4148W	Diode, Signal, 300-mA, 75-V, 350-mW	SOD-123	1N4148W	Diodes
1	1	D2	SML-LX2832GC-TR	Diode. LED, Green, 2.1-V, 25-mcd, SM	1210	SML-LX2832GC-TR	Lumex
26	26	J1, J2, J3, J5, J6, J7, J8, J9, J10, J12, J13, J14, J15, J16, J17, J18, J19, J21, J22, J23, J25, J27, J29, J30, J32, J34	PEC02SAAN	Header, Male 2-pin, 100mil spacing,	0.100 inch \times 2	PEC02SAAN	Sullins
1	1	J26	PEC04SAAN	Header, Male 4-pin, 100mil spacing,	0.100 inch \times 4	PEC04SAAN	Sullins
1	1	J33	N2510-6002-RB	Connector, Male Straight 2x5 pin, 100mil spacing, 4 Wall	0.338 \times 0.788 inch	N2510-6002-RB	3M
6	6	J4, J11, J20, J24, J28, J31	PEC03SAAN	Header, Male 3-pin, 100mil spacing,	0.100 inch \times 3	PEC03SAAN	Sullins
5	5	JP1, JP2, JP3, JP4, JP5	PEC03SAAN	Header, 3-pin, 100mil spacing	0.100 inch \times 3	PEC03SAAN	Sullins
2	2	L1, L2	2.2 μ H	Inductor, SMT, 2.5A, 70milliohm	0.153 \times 0.153 inch	LPS4018-222ML	Coilcraft
2	2	R1, R14	49.9k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R11	127k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R12	237k	Resistor, Chip, 1/16W, 1%	0603	Std	Std

Table 6. TPS386000/40EVM Bill of Materials (continued)

EVM COUNT		RefDes	Value	Description	Size	Part Number	MFR
TPS386040	TPS386000						
1	1	R19	1k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R2	287k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R20	10	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R22	100	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R23	619k	Resistor, Chip, 1/16W, 1%	0805	Std	Std
1	1	R24	665	Resistor, Chip, 1/16W, 1%	0805	Std	Std
1	1	R25	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R26	499	Resistor, Chip, 1/16W, 1%	0805	Std	Std
0	4	R3, R4, R5, R6	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R21	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R32	357k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	2	R36, R37	4.75k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
15	15	R10, R13, R15, R16, R17, R18, R27, R28, R29, R30, R31, R33, R34, R35, R38	100k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	1	R7	100k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R8	576k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R9	301k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	S1	EVQ-PJA04Q	Switch, 1P1T, PB Momentary, 50-mA	0.24 × 0.14 inch	EVQ-PJA04Q	Panasonic
2	2	TP3, TP4	5000	Test Point, Red, Thru Hole Color Keyed	0.100 × 0.100 inch	5000	Keystone
2	2	TP1, TP2	5005	Test Point, Red, Thru Hole Compact Style	0.125 × 0.125 inch	5005	Keystone
0	1	U1	TPS386000RGP	IC, Quad Supply Voltage Supervisors, Open Drain RESET		TPS386000RGP	TI
1	0	U1	TPS386040RGP	IC, Quad Supply Voltage Supervisors, Push-Pull RESET		TPS386040RGP	TI
1	1	U2	TLC555CD	IC, Timer, Low-Power CMOS	SO8	TLC555CD	TI
1	1	U3	SN74LVC1G04DBV	IC, Single Inverter	SOT23-5	SN74LVC1G04DBV	TI
1	1	U4	TPS65055RSM	IC, 2.25MHz, Two Step Down DC to DC Converters with PWM and PFM features, 4 LDOs		TPS65055RSM	TI
18	18	–		Shunt, Black	100-mil	929950-00	3M

Table 6. TPS386000/40EVM Bill of Materials (continued)

EVM COUNT		RefDes	Value	Description	Size	Part Number	MFR
TPS386040	TPS386000						
4	4		SJ-5003	BUMPON HEMISPHERE .44X.20 BLACK		SJ-5003	3M
1	1	–		PCB, 4.2 In x 3.7 In x 0.062 In		HPA428	Any

EVALUATION BOARD/KIT IMPORTANT NOTICE

Texas Instruments (TI) provides the enclosed product(s) under the following conditions:

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EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 0 V to 7 V and the output voltage range of 0 V to 7 V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's 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, some circuit components may have case temperatures greater than +85°C. The EVM is designed to operate properly with certain components above +85°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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