ISO1176EVM

This document describes the ISO1176 Evaluation Module (EVM). It will allow designers to develop and analyze data transmission systems using the ISO1176 Isolated Profibus Transceiver from Texas Instruments.

The EVM can be used to evaluate device parameters while acting as a guide for board layout. The board allows the connection of a 50-Ω coaxial cable (via an SMA connector) to connect to instrumentation, or to 54-Ω controlled impedance cable of varying lengths (via a female header or Quietzone® connector). This provides the designer with a tool for evaluation and successful design of an end product.

1 Overview

This EVM allows evaluation of the ISO1176 ProfiBus Transceiver. The EVM comes with a single transceiver installed on the circuit board (U1), but because it has been designed into the industry standard *176* footprint for 16-pin devices, other *176-* footprint devices may be evaluated as well. Take care with regard to the isolated power and ground, as this is an *isolating* device. Power and ground for the *Data/Control* side of the device (pins D, R, DE, $\overline{RE}$) can be completely isolated from power and ground for the *Bus* side of the device (pins A, B, ISODE). While initially intended for half-duplex or multipoint applications, ProfiBus devices can also be used in point-to-point or multidrop configurations.

The ISO1176 meets or exceeds the requirements of EN50170 and TIA/EIA RS-485 while providing 4000 V of isolation between the *Data/Control* and *Bus* sides of the device. Additional features contribute to making the ISO1176 an excellent choice for use in industrial and factory environments:

- Receiver hysteresis
- Low bus capacitance
- Failsafe receiver for bus open, short, or idle conditions while transmitting at rates up to 25 Mbps

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CAUTION

Note that although the device provides galvanic isolation of up to 4000 V, this EVM cannot be used for isolation voltage testing. It is designed for the examination of device operating parameters only and will be damaged if high voltage (>5.5 V) is applied anywhere in the circuit.

The data sheet for the ISO1176 is available at: SLLS897. A pin out of the device and functional block diagram are shown below in Figure 1.
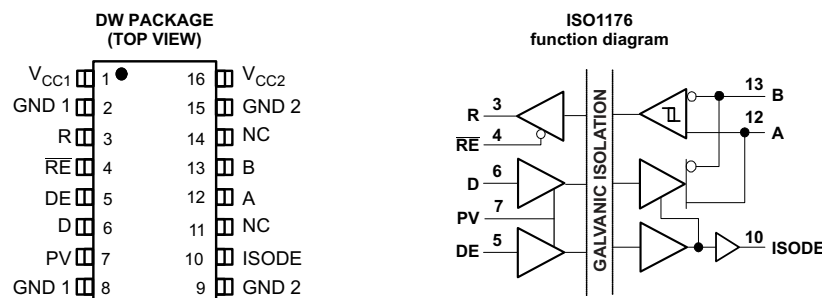
Figure 1. ISO1176 Device Pin Out and Block Diagram

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1.1 *Profibus/RS-485*

The TIA/EIA-485 (a.k.a. RS-485) standard was created in response to a demand from the data communications community for a general-purpose high-speed balanced interface standard for multipoint applications. The standard, *Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems*. specifies differential signaling drivers and receivers for data interchange across half-duplex or multipoint data bus structures. Although TIA/EIA-485 specifies requirements for drivers and receivers operating at a signaling rate up to 10 Mbps, the standard also states that devices meeting the electrical characteristics of the standard;

> …."need not operate over the entire data signaling rate range specified nor be limited to 10 Mbps. They may be specified to operate at data rates to satisfy specific applications. The upper bound is application dependent and beyond the scope of this standard. Maximum signaling rate is typically limited by the following: ratio of signal transition time to the unit interval, maximum allowable stub length, and the bandwidth of the interconnecting media."

Profibus (Process Field Bus), developed subsequently, made several improvements on the electrical (physical) layer including an increase in the receiver noise margin, to allow the bus to be used in extremely noisy EMI-rich environments. This was accomplished by increasing the minimum differential voltage on the bus. The ISO1176 has been designed specifically for these types of environments.

1.2 *ISO1176 EVM Kit Contents*

- ISO1176 EVM circuit board with ISO1176DW installed – (6493171)
- Additional devices – (check website for availability of additional devices '176' footprint)
- ISO1176 EVM User's Guide
- ISO1176 Datasheet

The ISO1176 is shown in Figure 2.

Figure 2. The ISO1176EVM

1.3 Configurations

The ISO1176 EVM board allows the user to evaluate performance of the ISO1176 device, or to connect easily to an existing Profibus or RS-485 bus to evaluate system performance in an existing system. Also, multiple EVMs can be obtained to allow the user to construct various bus configurations. With just two EVMs, the user may evaluate performance of a point-to-point simplex, parallel-terminated point-to-point simplex, and two-node multipoint operation. When using multiple EVMs, all of these modes of operation can be configured through on-board jumpers, external cabling and the R9 and R10 bus termination resistors.

1.3.1 Point-to-Point

The point-to-point configuration is shown in Figure 3. This configuration requires two EVMs, and although this is not the intended mode of operation for Profibus/RS-485 devices, it is used for high noise or longer (higher loss) transmission lines. Due to the increased drive current, a single 100-Ω termination resistor on the EVM will result in a differential bus voltage (V_{OD}) twice as large as the normally-terminated line. This practice is acceptable as long as the combination of input voltage and common-mode voltage does not exceed absolute maximum ratings of the line circuits.

This configuration is shown in Figure 3. It consists of a single driver on the left, and a single receiver on the right. Note that the termination resistors (R9 and R10) have been removed from the driver EVM.

This configuration shows the receiver disabled on the driver (JUMP2 connected to V_{CC}) EVM and the driver disabled on the receiver EVM (JMP4 tied to GND1). Note that with only a single termination, the differential bus voltage will be higher than normal.

Figure 3. Point-to-Point Simplex Circuit

This configuration can also have a termination at the source and load (parallel-terminated as shown in Figure 4) thereby, keeping nominal Profibus/RS-485 signal levels.
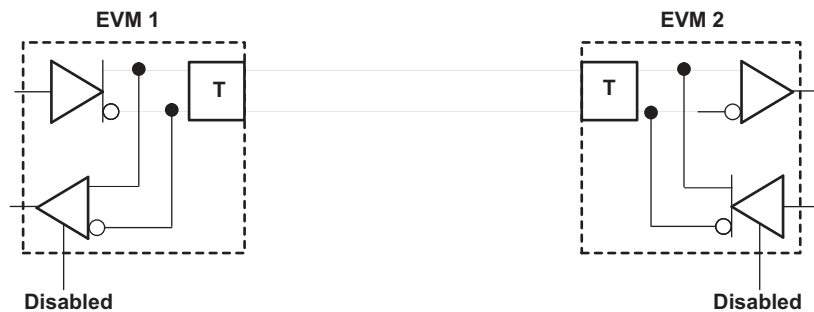
**Figure 4. Parallel Terminated Simplex Circuit**

1.3.2 Multipoint

The multipoint configuration is the primary application of Profibus/RS-485, The RS-485 standard allows for any combination of drivers, receivers, or transceivers up to a total of 32 Unit Loads on the line. The ISO1176 device allow the total number of nodes to be increased because ISO1176 represents just 1/5 of a "unit load". This allows up to 160 nodes to be connected onto a single bus. Figure 4 shows a representation of a five-node multipoint configuration using five ISO1176 transceivers. Increased drive current in addition to the wide common-mode input allows the ISO1176 Profibus transceiver to drive multiple receivers over longer line lengths. Notice that the termination resistors (R9 and R10) are only installed on the EVMs at each end of the bus.
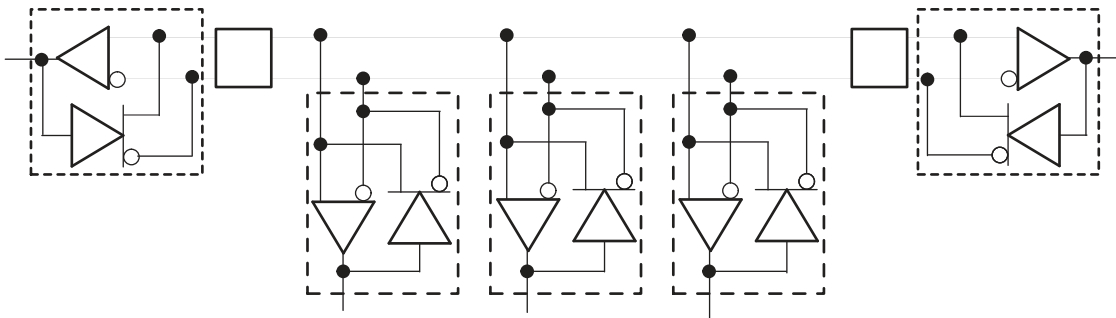
Figure 5. A Five-Node Multipoint Circuit

Notice that the bus configuration shown in Figure 4 can be redrawn as shown in Figure 6. Additional EVMs can be obtained and connected to the bus, but the termination resistors on those EVMs must be removed so that the bus is terminated only at each end.
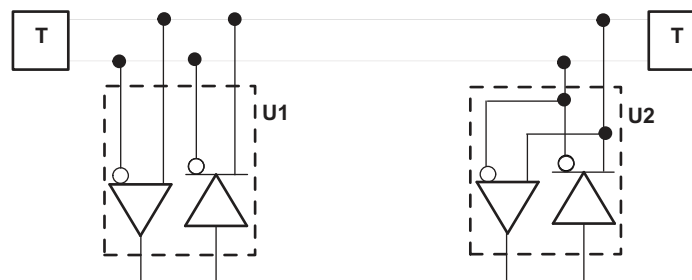
Figure 6. Two-Node Multipoint Circuit

1.4 *Operation Over Extended Common Mode Voltage Range*

One of the features of the ISO1176 device is its operation over an extremely wide common-mode voltage range. This can be evaluated using two EVMs, each powered from a separate independent power supply. This extended common mode range is important because communications between equipment located hundreds of meters apart usually means there is a voltage offset between the grounds of each node. The EVMs can be configured with three power supplies with isolated outputs in such a way as to input a fixed offset between the grounds (see Figure 7). This will induce a ground-potential difference voltage (VGPD) between EVM#1 and EVM#2. The following procedure demonstrates this capability:

1. Adjust PS1 and PS2 to the supply voltage (+5.0 V) and current-limit to 200 mA.
2. Set PS3 to 0 V.
3. Induce a ground offset by varying the output of PS3.

CAUTION

PS3 output must not exceed 12 V to –7 V to remain within the device ratings.
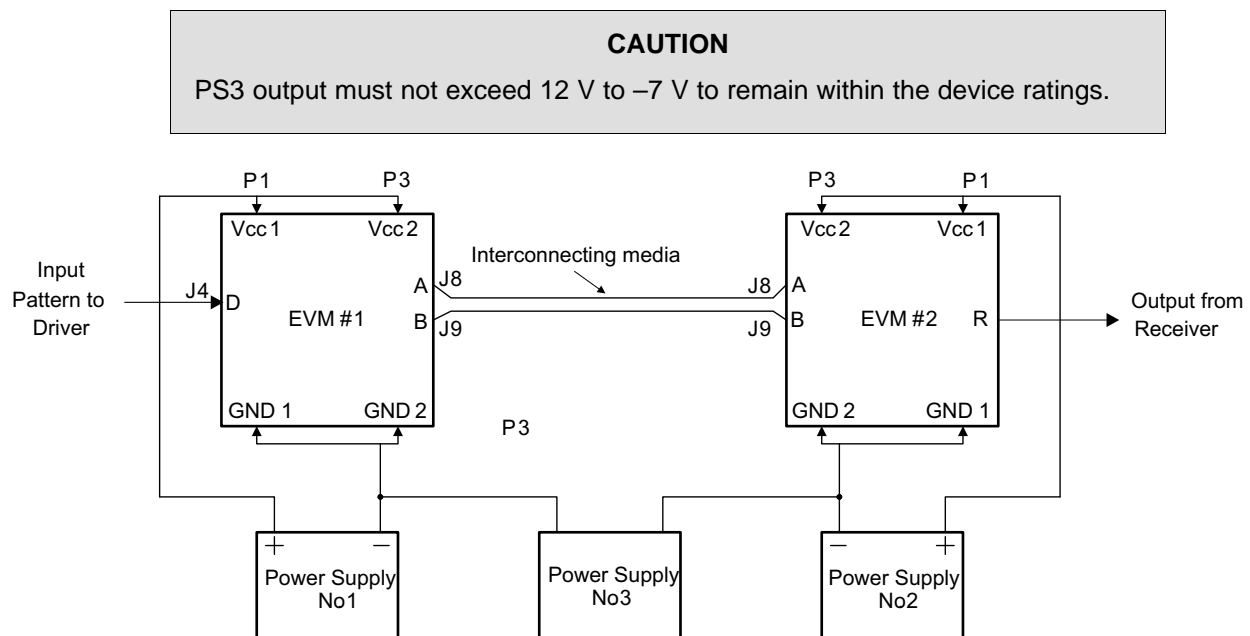
Figure 7. EVM Configuration for Inducing a Ground Potential Difference Voltage Between Nodes

2 Recommended Equipment

- Power supply, 5.0 Vdc at 0.5 A
- Pattern generator capable of supplying single-ended signals at the desired signaling rate
- Multiple-channel high-bandwidth oscilloscope, preferably above the 100 MHz range
- Differential and single ended oscilloscope probes

When using two or more EVMs, a 100-Ω transmission medium between transceivers (twisted-pair cable recommended, CAT5 cable for example) may be used using JMP8 and JMP9 between EVMs. Coaxial cable may be used by connecting SMA J8 to SMA J8 and SMA J9 to SMA J9 together. This will result in the topology shown in Figure 2.

2.1 *EVM Configurations*

The schematic for the ISO1176EVM is shown in Figure 8.
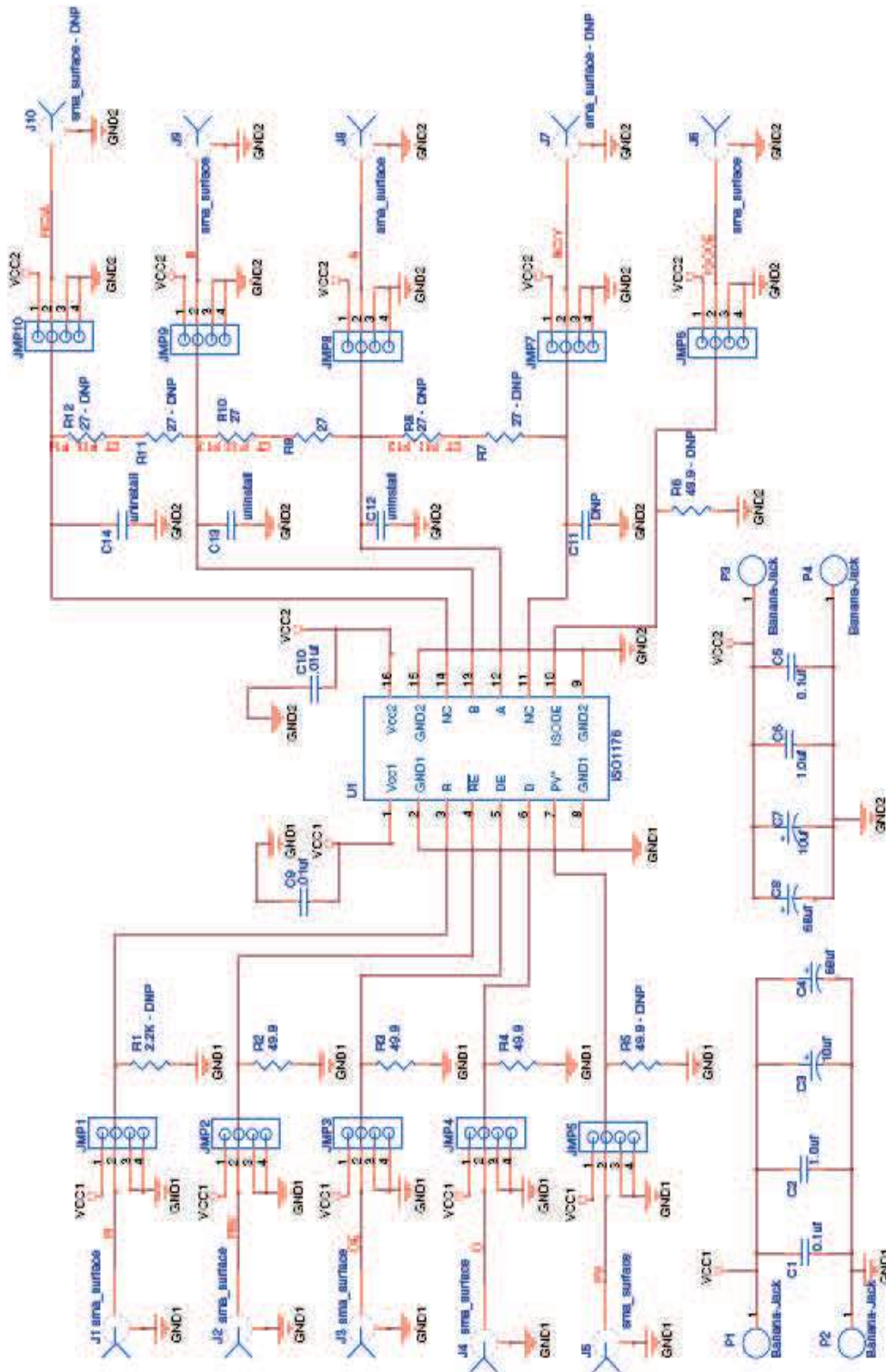
Figure 8. ISO1176EVM Schematic

Table 1 contains a list of the onboard jumpers and their function, as well as the input and output loading installed on the board.

Table 1. EVM Configuration Options

JUMPER FUNCTION	CONFIGURATION	I/O LOAD
DATA/CONTROL SIDE JUMPERS		
JMP1 – Receiver Output JMP2 – Receiver Enable JMP3 – Driver Enable JMP4 – Driver Input JMP5 – Power Valid		R1– Uninstalled R2 – 50 Ω[1] R3 – 50 Ω[1] R4 – 50 Ω[1] R5 – Uninstalled
BUS SIDE JUMPERS		
JMP6 – ISODE		R6 – Uninstalled
JMP7 – N/C	Reserved For Future Use Reserved For Future Use	C11– Uninstalled R7,R8 – Uninstalled
JMP8 – A Output		C12 – Uninstalled R7,R8 – Uninstalled R9, R10 27 Ω
JMP9 – B Output		C13 – Uninstalled R9, R10 – 27 Ω R11, R12 Uninstalled
JMP10 – N/C	Reserved For Future Use	C14 – Uninstalled R11, R12 – Uninstalled
DEVICE OPERATION Driver	JMP2 – Hi (Disable Receiver) JMP4 – Hi (Enable Driver)	
Receiver	JMP2 – Lo (Enable Receiver) JMP4 – Lo (Disable Driver)	

[1]   These resistors are provided as impedance matching terminations to be used when driving these Signals with 50-Ω source impedance test/measurement equipment. When not driving these signals with a 50Ω source, the components should be removed

2.2   Bill of Materials

The items used in the ISO1176EVM are listed in Table 2.

Table 2. ISO1176EVM Bill of Material

Item	Qty	Ref Designator	MFR P/N	Footprint	Description
1	2	C1, C5	12061C104JAT2A	cc1206	X7RCap1206_0.1 μF
2	2	C2, C6	C1206C105Z3VACTU	cc1206	Y5VCap1206 1.0 μF
3	2	C3, C7	293D106X0035D2TE3	cc7343	Tantalum, 35V, 10 μF
4	2	C4, C8	TAJE686K025R	cc7343	Tantalum, 25V_68 μF
5	2	C9, C10	08051C103JAT2A	cc0805	X7R, 100V, 0.01 μF
6	4	C11 - C14		cc0603	cc0603 Uninstalled
7	7	J1 - J5, J7, J8, J9	141-0701-201	conn, jack, pcb, vert	sma_surface
8	10	JMP1–JMP10	4-103239-0x4	jmp4	4 pin berg_0
9	4	P1–P4	3267	Bjack	Banana-Jack
10	3	R2, R3, R4	CRCW120649R9FKEA	r1206	Res1206_49_9 Ω
11	2	R9, R10	RR1220Q-270-D	r0805	Res0805_27R0 Ω
12	1	U1	ISO1176DW	SOIC16-DW_TI	ISO100_0

2.3   PCB Layout and Construction

The ISO1176EVM Printed Circuit Board (PCB) is a four (4) layer board. The top and bottom layers (1 and 4) contain signal routing. The remaining layers (2 and 3) are power and ground planes. These are split planes to keep the V_{CC1}/GND1 separate from V_{CC2}/GND2. The I/O traces are designed to have a characteristic impedance of 50Ω.
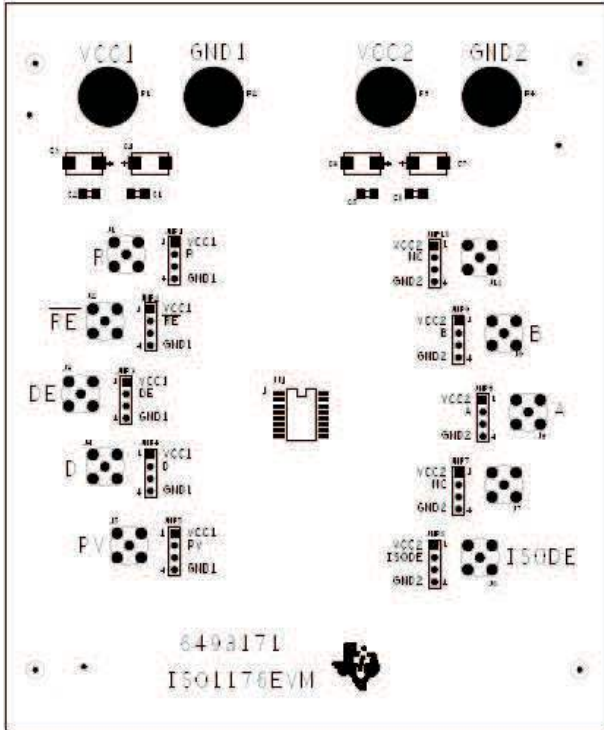
Figure 9. PWB Top Layer
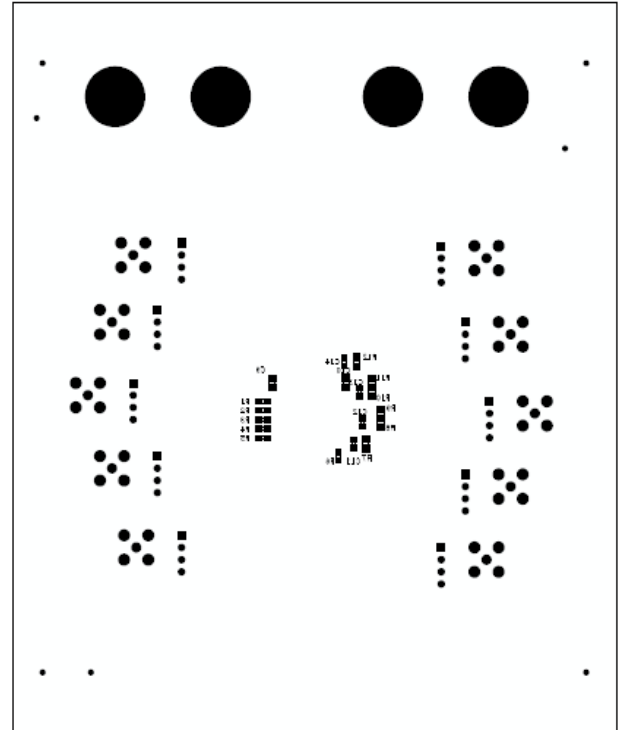
Figure 10. PWB Bottom Layer
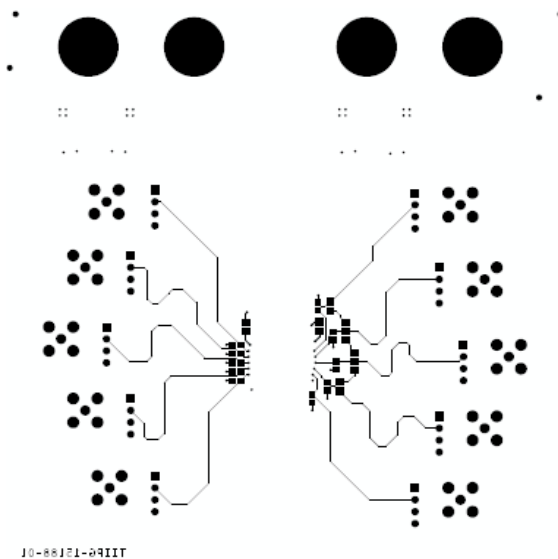
Figure 11. Signal Traces On Bottom Layer
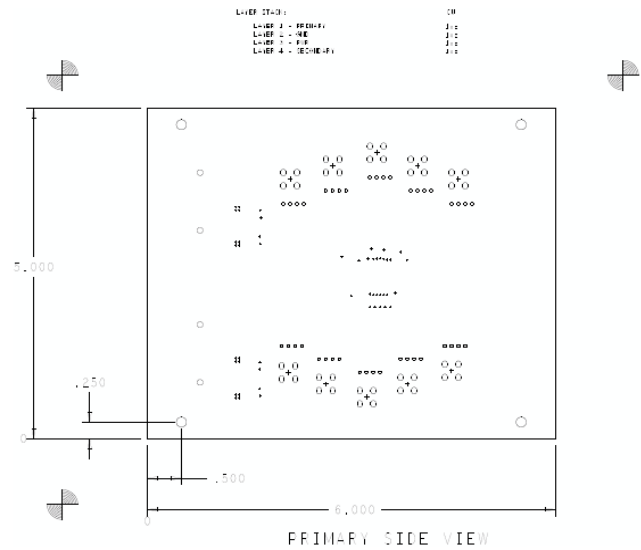
Figure 12. EVM Mechanical Layout

EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage and the output voltage ranges as specified in the table below.

Input Range, V_S	−0.5 V to 7 V
Input Range, V_I	−0.5 V to 7 V NOT TO EXCEED VS+ or VS-
Output Range, V_O	−9 V to 14 V NOT TO EXCEED VS+ or VS-

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.

EVM WARNINGS AND RESTRICTIONS (continued)

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 170°C. The EVM is designed to operate properly with certain components above 170°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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