TEXAS INSTRUMENTS

Multipoint-Low Voltage Differential Signaling (M-LVDS) Evaluation Module

User's Guide

April 2004

High Performance Analog

SLLU039B

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EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the supply voltage range of 3 V to 3.6 V.

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

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During normal operation, some circuit components may have case temperatures greater than 125°C. The EVM is designed to operate properly with certain components above 125°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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Preface

How to Use This Manual

This document contains the following chapters:

- Chapter 1—The M-LVDS Evaluation Module
- Chapter 2—Test Setup
- Chapter 3—Bill of Materials, Board Layout, and PCB Construction
- Appendix A—Schematic

Related Documentation From Texas Instruments and Others

- *Introduction to M-LVDS* (SLLA108)
- *LVDS Designer's Notes* (SLLA014A).
- *Reducing EMI With Low Voltage Differential Signaling* (SLLA030B).
- *Interface Circuits for TIA/EIA−644 (LVDS)* (SLLA038B).
- *Transmission at 200 Mpbs in VME Card Cage Using LVDM* (SLLA088).
- *LVDS Multidrop Connections* (literature number SLLA054).
- SN65MLVD20x data sheets, *Multipoint-LVDS Line Drivers and Receivers*, (SLLS573 and SLLS558)
- *Electromagnetic Compatibility Printed Circuit Board and Electronic Module Design,* VEC workshop, Violette Engineering Corporation.

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Chapter 1

The M-LVDS Evaluation Module

This document describes the multipoint low-voltage differential-signaling (M-LVDS) evaluation module (EVM) used to aid designers in development and analysis of this new signaling technology. The Texas Instruments SN65MLVD200A, SN65MLVD201, SN65MLVD202A, SN65MLVD203, SN65MLVD204A, SN65MLVD205A, SN65MLVD206, SN65MLVD207 series are low-voltage differential line drivers and receivers complying with the M-LVDS standard (TIA/EIA−899). The EVM kit contains the assembled printed-circuit board and all of the released devices referred to in Table 1−1. Using the EVM to evaluate these devices should provide insight into the design of low-voltage differential circuits. The EVM board allows the designer to connect an input to one or both of the drivers and configure a point-to-point, multidrop, or multipoint data bus.

The EVM can be used to evaluate device parameters while acting as a guide for high-frequency board layout. The board allows for the connection of a 100-Ω controlled impedance cable of varying lengths. This provides the designer with a tool for evaluation and successful design of an end product.

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1.1 Overview

The EVM comes with all the production devices in Table 1−1. The SN65MLVD201 and SN65MLVD207 are installed on the circuit board, and can easily be replaced with the other devices supplied. The M-LVDS devices evaluated with this EVM are in the SN75ALS180 and SN75176 footprint. Use of these industry standard footprints allows the designer to easily configure the parts into a simplex or half-duplex data bus. These are all TIA/EIA−899 M-LVDS standard compliant devices. While initially intended for half-duplex or multipoint applications, M-LVDS devices are not precluded from being used in a point-to-point or multidrop configuration. In these configurations there can be a distinct advantage to the additional current drive provided by an M-LVDS driver.

The M-LVDS devices shown in Table 1−1 all include output slew-rate limited drivers, thus the need for different nominal signaling rates. The M-LVDS standard recommends the transition time not exceed 0.5 of the unit interval (UI). The definition of transition time (t_r and t_f) in M-LVDS is the 10% to 90% levels shown in Figure 1−1. Using the maximum transition time for each of the drivers and the 0.5(t_{UI}) *rule* results in the signaling rates shown in Table 1−1. This slew-rate control differentiates M-LVDS devices from LVDS (TIA/EIA−644A) compliant devices. The slower transition times available with M-LVDS help to reduce higher frequency components in the transmitted signal. This reduces EMI and allows longer stubs on the main transmission line. For this reason it is generally better to select a driver with a specified signaling rate no greater than is required in the system.

Figure 1−1. M-LVDS Unit Interval Definition

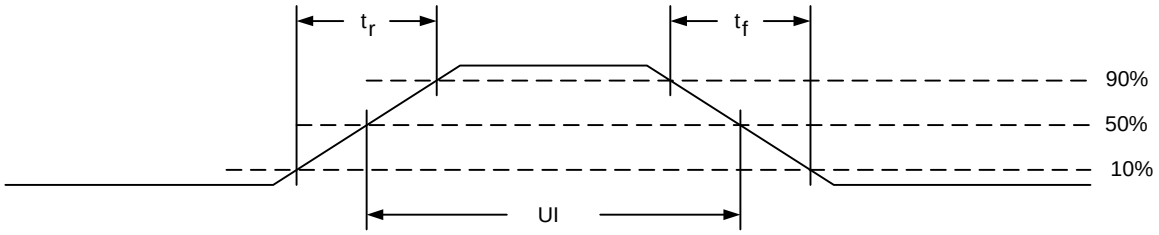


Table 1−1. M-LVDS Devices Supported by the EVM

Nominal Signaling Rate (Mbps)	Footprints	Receiver Type	Part Number	Status
100	SN75176	Type-1	SN65MLVD200AD	Production
200	SN75176	Type-1	SN65MLVD201D	Production
100	SN75ALS180	Type-1	SN65MLVD202AD	Production
200	SN75ALS180	Type-1	SN65MLVD203D	Production
100	SN75176	Type-2	SN65MLVD204AD	Production
100	SN75ALS180	Type-2	SN65MLVD205AD	Production
200	SN75176	Type-2	SN65MLVD206D	Production
200	SN75ALS180	Type-2	SN65MLVD207D	Production

The EVM has been designed with the individual driver and receiver section (SN75ALS180 footprint, U1) on one half of the board and the transceiver section (SN75176 footprint, U2) on the other half (see Figure 3−1). The EVM as delivered incorporates two 100-Ω termination resistors at each driver output, receiver input, and transceiver I/O. These allow the user to evaluate a single driver, receiver, or transceiver, while not having to deal with a transmission line or additional I/Os.

Jumpers are included to allow the two sections of the EVM to either share the same power and ground or be run off of independent supplies. Ground shifts or common-mode offsets can be introduced by the removal of these jumpers and using separate power supplies.

1.2 M-LVDS Standard TIA/EIA−899

The M-LVDS 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 TIA/EIA−644 standard defines the LVDS electrical-layer characteristics used for transmitting information in point-to-point and multidrop architectures. TIA/EIA−644 does not address data transmission for multipoint architectures, therefore the need for development of a new standard.

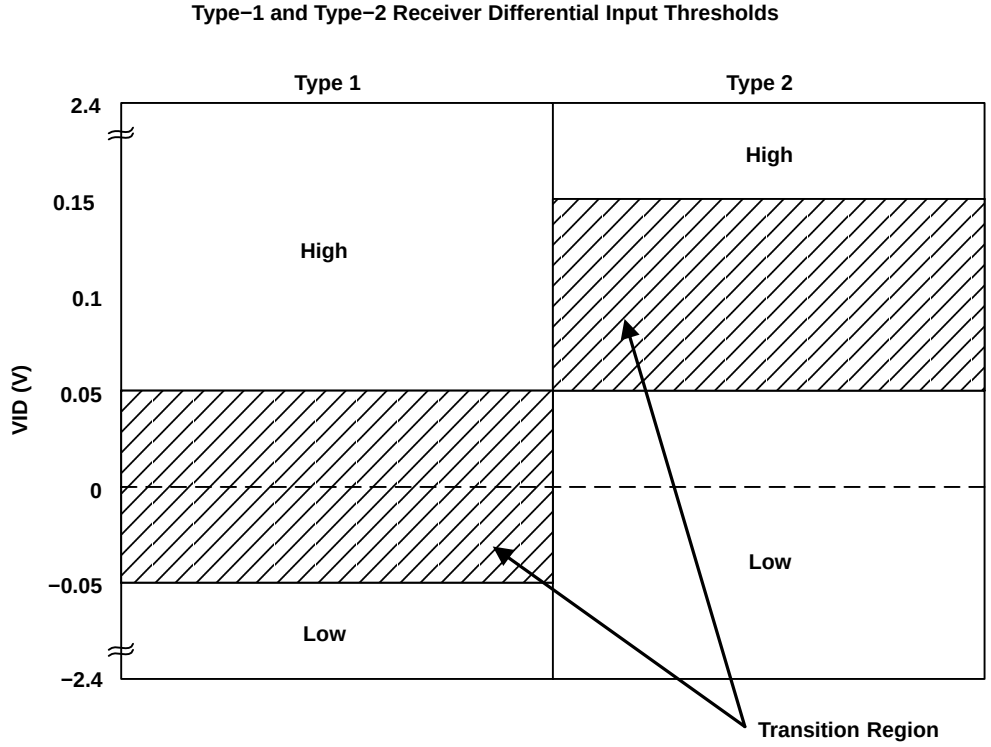
The standard, Electrical Characteristics of Multipoint-Low-Voltage Differential Signaling (M-LVDS) TIA/EIA−899, specifies low-voltage differential signaling drivers and receivers for data interchange across half-duplex or multipoint data bus structures. M-LVDS is capable of operating at signaling rates up to 500 Mbps. In other words, when the devices are used at the nominal signaling rate, the rise and fall times will be within the specified values in the standard. The M-LVDS standard defines the transition time (t_r and t_f) to be 1 ns or slower into a test load. Using this information combined with the requirement that the transition time not exceed 0.5 of the unit interval (UI), gives a minimum unit interval of 2 ns, leading to the 500 Mpbs maximum signaling rate.

The standard defines Type-1 and Type-2 receivers. Type-1 receivers include no provisions for failsafe and have their differential input voltage thresholds near zero volts. Type-2 receivers have their differential input voltage thresholds offset from zero volts to detect the absence of a voltage difference. Type-1 receivers maximize the differential noise margin and are intended for the maximum signaling rate. Type-2 receivers are intended for control signals, slower signaling rates, or where failsafe provisions are needed. The bus voltage logic state definition can be seen in Table 1−2 and Figure 1−2.

Table 1−2. Receiver Input Voltage Threshold Requirements

Receiver Type	Low	High
Type-1	$-2.4\ V \le V_{ID} \le -0.05\ V$	$0.05\ V \le V_{ID} \le 2.4\ V$
Type-2	$-2.4\ V \le V_{ID} \le 0.05\ V$	$0.15\ V \le V_{ID} \le 2.4\ V$

Figure 1−2. Expanded Graph of Receiver Differential Input Voltage Showing Transition Region



1.3 M-LVDS EVM Kit Contents

The M-LVDS EVM kit contains the following:

- M-LVDS EVM PWB with SN65MLVD201D and SN65MLVD207D installed (6424409B)
- Additional devices SN65MLVD200A, SN65MLVD202A, SN65MLVD203, SN65MLVD204A, SN65MLVD205A, SN65MLVD206
- M-LVDS EVM kit documentation (user's guide)
- SN65MLVD20x data sheets, *Multipoint-LVDS Line Driver and Receiver*, (SLLS573 and SLLS558)

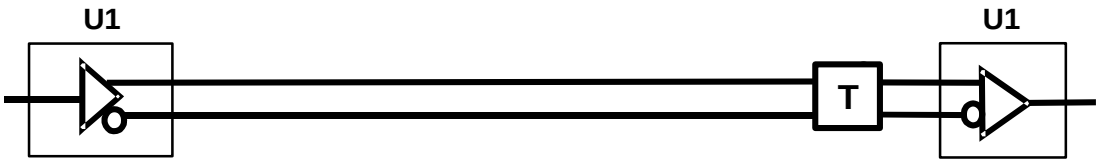
1.4 Configurations

The M-LVDS EVM board allows the user to construct various bus configurations. The two devices on the EVM allow for point-to-point simplex, parallel-terminated point-to-point simplex, and two-node multipoint operation. All of these modes of operation can be configured through onboard jumpers, external cabling, and different resistor combinations. The devices which are delivered with the EVM change output operation but, configuration of jumpers to setup the transmission type is independent of the devices installed

1.4.1 Point-to-Point

The point-to-point simplex configuration is shown in Figure 1−3. The setup schematic for this option is shown in Figure 2−1. Although this is not the intended mode of operation for M-LVDS, it works well for high noise or long 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 a doubly 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.

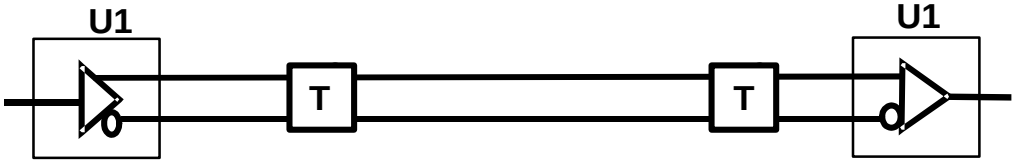
Figure 1−3. Point-to-Point Simplex Circuit



This configuration can also have a termination at the source and load (parallel terminated), thereby, keeping normal M-LVDS signal levels as shown in Figure 1−4.

The schematic for this option is shown in Figure 2−2. Due to the increased drive current, double termination can be used to improve transmission line characteristics .

Figure 1−4. Parallel Termination Simplex Circuit

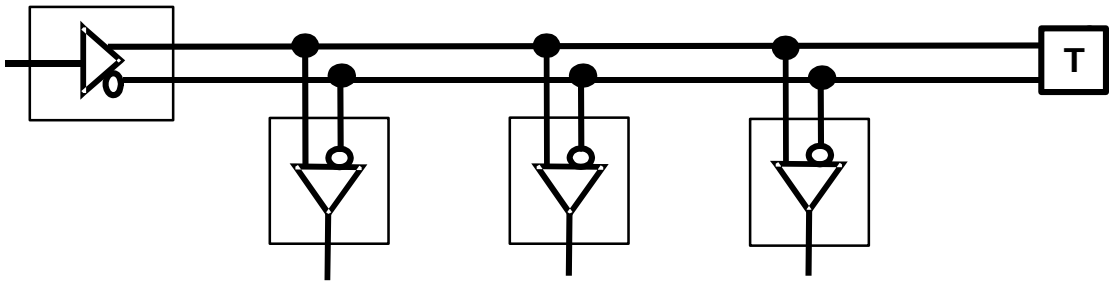


1.4.2 Multidrop

A multidrop configuration (see Figure 1−5) with two receiver nodes can be simulated with the EVM. To get additional receiver nodes on the same bus requires additional EVMs. M-LVDS controlled driver transition times and higher signal levels help to accommodate the multiple stubs and additional loads on the bus. This does not exempt good design practices, which would keep stubs short to help prevent excessive signal reflections.

A bus line termination could be placed at both ends of the transmission line, improving the signal quality by reducing return reflections to the driver. This would allow the use of standard compliant TIA/EIA 644A receivers on the bus in addition to M-LVDS receivers.

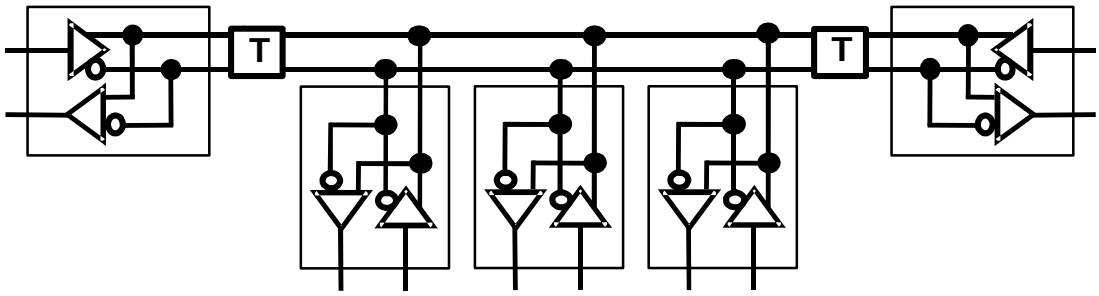
Figure 1−5. Multidrop or Distributed Simplex Circuit



1.4.3 Multipoint

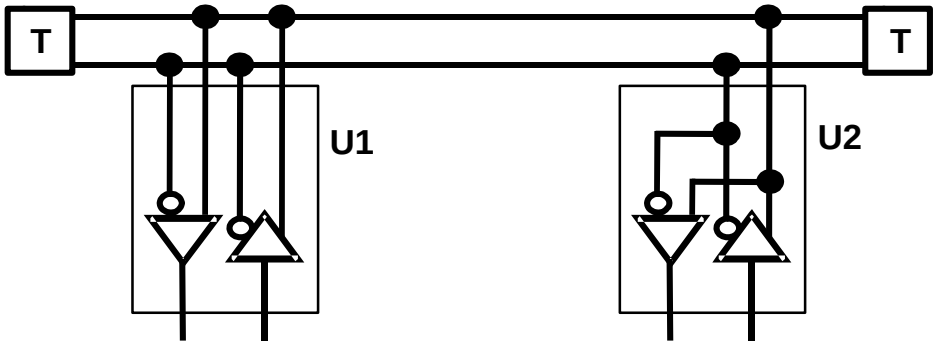
The multipoint configuration is the primary application of the M-LVDS devices and the associated standard. The M-LVDS standard allows for any combination of drivers, receivers, or transceivers up to a total of 32 on the line. Figure 1−6 shows a representation of a five-node multipoint configuration using transceivers. Increased drive current, in addition to the wider common-mode input, allows M-LVDS parts to drive multiple receivers over longer line lengths with up to 2 V of ground noise.

Figure 1−6. Five-Node Multipoint Circuit



A two-node multipoint setup (see Figure 1−7) can be configured with the EVM. Additional EVMs are needed for more nodes. The test setup and schematic for this configuration is shown in Figure 2−3.

Figure 1−7. Two-Node Multipoint Circuit



1.4.4 EVM Operation With Separate Power Supplies

The EVM has been designed with independent power planes for the two devices. The two devices can be powered with independent supplies or with a single supply. Sending and receiving data between backplanes, racks, or cabinets where separate power sources may exist can have offset ground potentials between nodes. Jumpers W7, 8, 9, and 10 tie the two separate power and ground planes together. If two separate supplies are used and jumpers W7, 8, 9, and 10 are removed, care should be taken to ensure the absolute maximum device ratings are not exceeded. Keep in mind that if jumpers W7, 8, 9, and 10 are not removed when using separate power supplies, a difference in potential between the supplies causes a current to flow between supplies and through the jumpers.

The EVM 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 1−8). This induces a ground potential difference voltage between U1 and U2. To demonstrate this capability, the following steps should be followed.

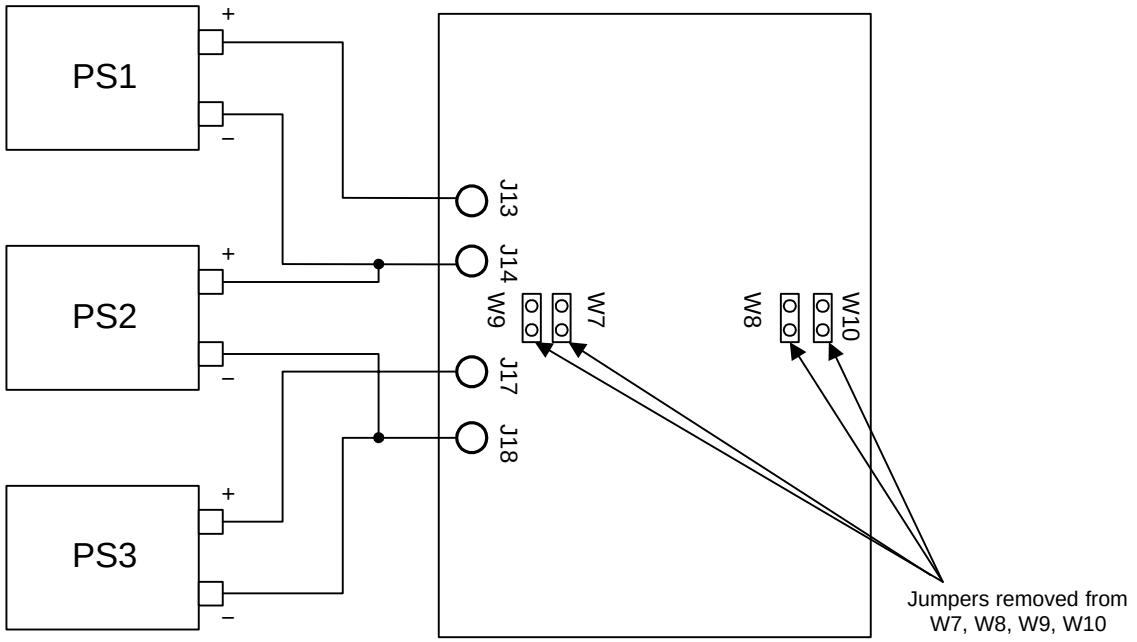
- ❏ Adjust PS1 and PS3 to the supply voltage (3.3 V) and current limit to 50 mA.
- ❏ Set PS2 to 0 V
- ❏ Induce a ground offset by varying the output of PS2.

PS2 Output

The PS2 output should not exceed ± 2 V to remain within the device ratings.

WARNING

Figure 1−8. EVM Configuration for Including a Ground Potential Difference Voltage Between Nodes



1.5 Recommended Equipment

- ❏ 3.3 Vdc at 0.5-A power supply or multiple power supplies (with both devices powered and enabled the board draws about 35 mA).
- ❏ A 100-Ω transmission medium from the driver to the receiver, (twisted-pair cable recommended, CAT5 cable for example).
- ❏ A function or pattern generator capable of supplying 3.3-V signals at the desired signaling rate.
- ❏ A multiple-channel high-bandwidth oscilloscope, preferably above the 1-GHz range
- ❏ Differential or single ended oscilloscope probes.

Chapter 2

Test Setup

This chapter describes how to setup and use the M-LVDS EVM.

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2.1 Typical Cable Test Configurations

Each of the following test configurations is a transmission line consisting of a twisted-pair cable connected on the 2-pin connectors (P1, P2, or P3). Table 2−1 shows the possible configurations.

In addition to the different transmission topologies, the EVM can also be configured to run off two or three separate power supplies, as described in the previous section. This would allow the user to induce a ground shift or offset between the two different drivers and receivers. This setup can be used with any transmission line test.

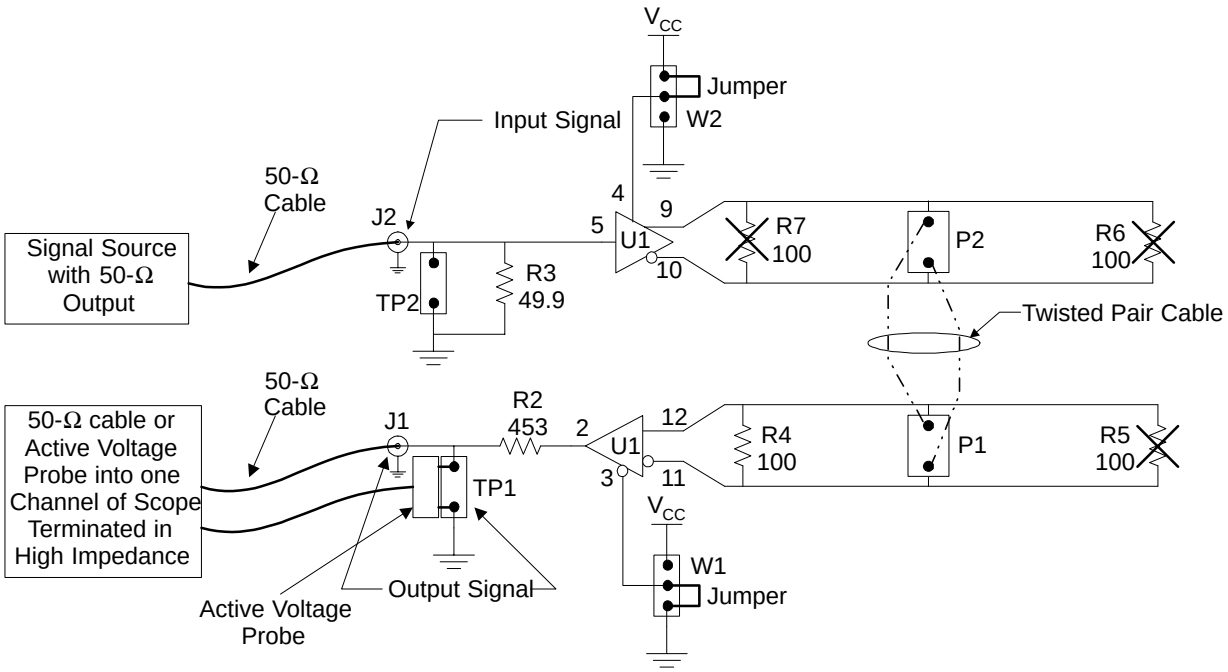
Table 2−1. EVM Configuration Options

Configuration	Jumpers In	Resistors In	Resistors Out	Diagram
Point-to-point simplex transmission	W1, 2, 7, 8, 9, 10	R4	R5, 6, 7	Figure 2−1
Point-to-point parallel terminated simplex transmission	W1, 2, 7, 8, 9, 10	R4, 7	R5, 6	Figure 2−2
Two-node multipoint transmission	W1, 2, 3, 4, 7, 8, 9, 10	R5, 16	R2, 4, 6, 7, 13 15	Figure 2−3

2.1.1 Point-to-Point Simplex Transmission

1) Connect a twisted-pair cable from P1 to P2.
2) Verify resistor R4 is installed.
3) Remove resistors R5, R6, and R7. This properly terminates the transmission line at one end.
4) Enable the driver by connecting the jumper on W2 between pin 1 and pin 2, or U1 pin 4 to V_{CC}.
5) Enable the receiver by connecting the jumper on W1 between pin 2 and pin 3, or U1 pin 3 to GND.

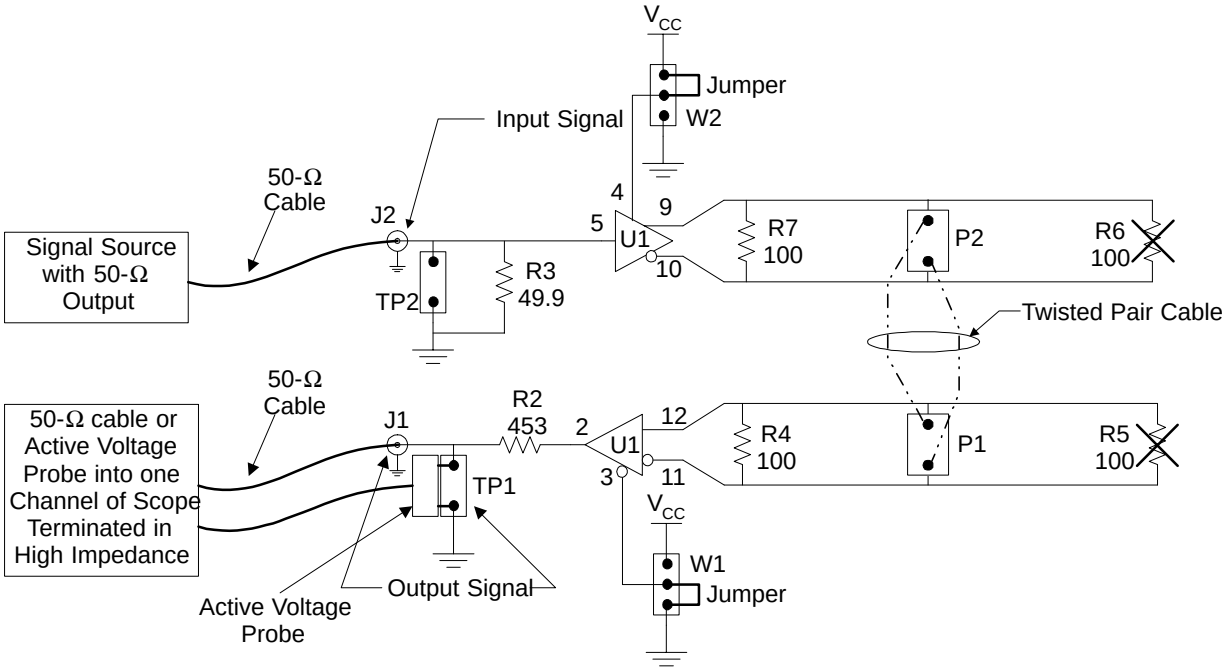
Figure 2−1. Point-to-Point Simplex Transmission



2.1.2 Point-to-Point Parallel Terminated Simplex Transmission

1) Connect a twisted-pair cable from P1 to P2.
2) Verify resistor R4 and R7 are installed.
3) Remove resistors R5 and R6. This properly terminates the transmission line at both ends.
4) Enable the driver by connecting the jumper on W2 between pin 1 and pin 2, or U1 pin 4 to V_{CC}.
5) Enable the receiver by connecting the jumper on W1 between pin 2 and pin 3, or U1 pin 3 to GND.

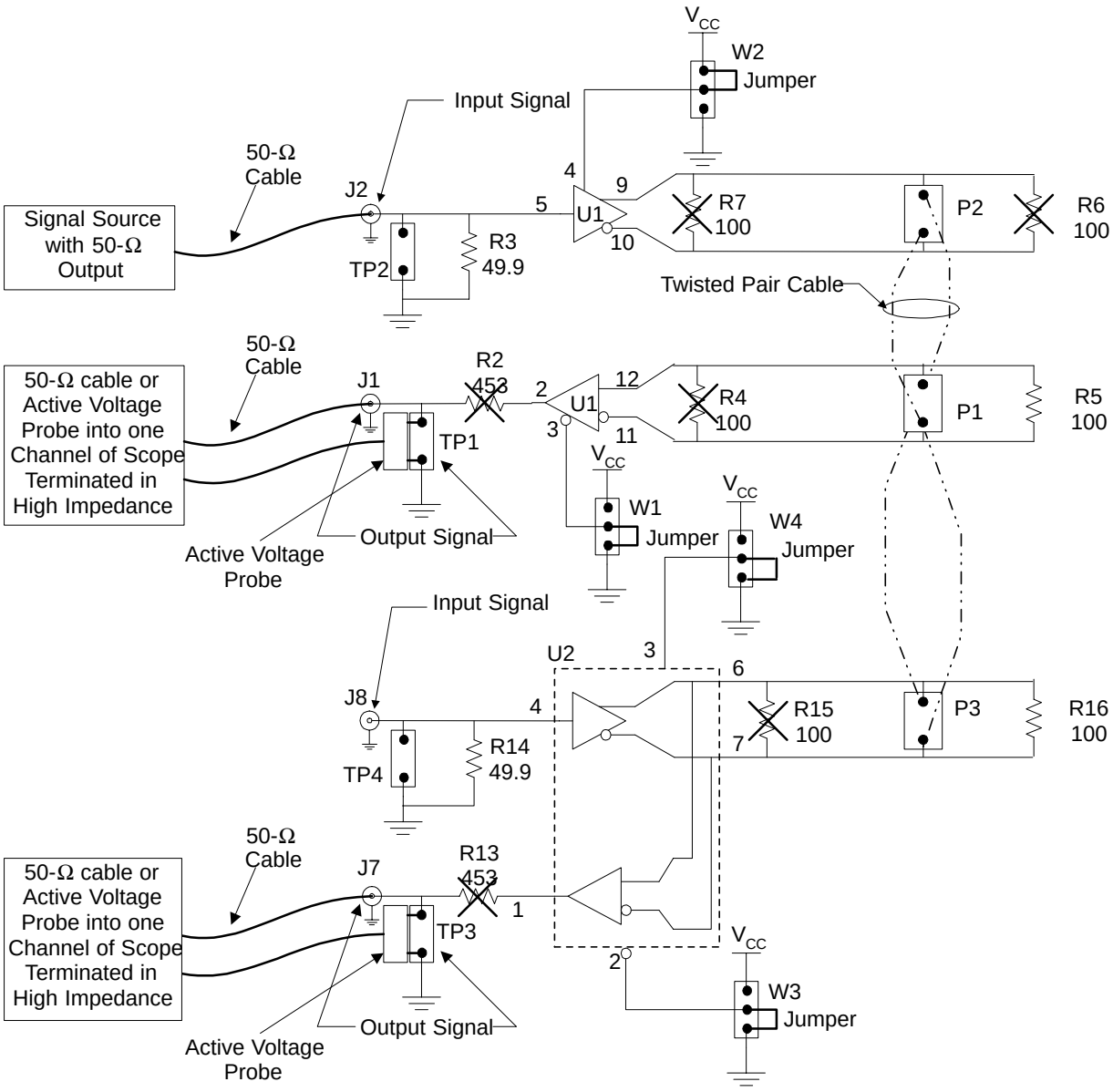
Figure 2−2. Point-to-Point Parallel Terminated Simplex Transmission



2.1.3 Two-Node Multipoint Transmission

1) Connect a twisted-pair cable between P1, P2, and P3.
2) Verify resistor R5 and R16 are installed.
3) Remove resistors R4, R6, R7, and R15. This properly terminates the transmission line at both ends.
4) Enabling the driver in a two-node multipoint configuration will be a slightly more challenging task. The user can either jumper enable a single driver and send all of the data on the bus through a single driver, or sync the driver enable to the data and send data from each driver. Enable a single driver by connecting the jumper on W4 between pin 1 and pin 2 which connects U2 pin 3 to V_{CC}, or by connecting the jumper on W2 between pin 1 and pin 2 which connects U1 pin 4 to V_{CC}.
5) Enable the receivers by connecting the jumpers on W1 and W3 between pin 2 and pin 3, or U1 pin 3 to GND and U2 pin 2 to GND.

Figure 2−3. Two-Node Multipoint Transmission



2.2 Test Results

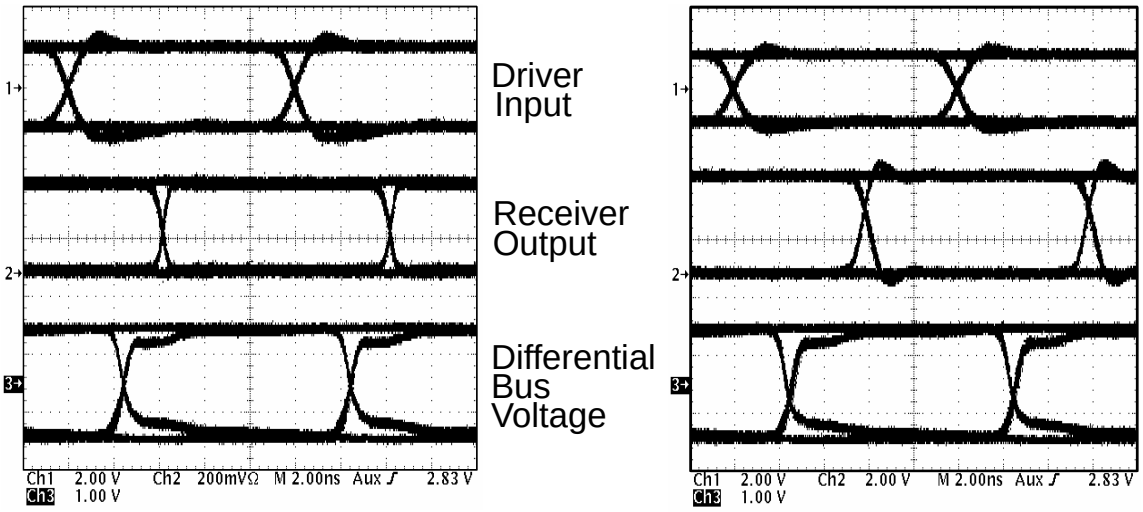
The test configurations described in Section 2.1 were used to simulate point-to-point simplex, parallel-terminated point-to-point simplex, and two-node multipoint. The test results are shown in the following figures. A Tektronix HFS9003 was used to generate input signals, and a Tektronix TDS784D was used to collect the output data.

The EVM was populated with a SN65MLVD207D and SN65MLVD201D for U1 and U2 respectively. The eye patterns were measured with the source (Tektronix HFS9003) generating $2^{15}-1$ PRBS NRZ data. In all cases, the length of the transmission line is approximately 21 inches (53 cm), and adds to the propagation delay in the device. This can be seen in the figures below as a time delay from input to output

Figure 2−4 shows the point-to-point simplex transmission eye patterns. Trace 1 is the driver input signal applied to J2. The output signal is shown below measured on both J1 (Figure 2−4 left picture), and TP1 (Figure 2−4 right picture). The receiver output in both figures shows the offset zero crossing, which is due to the Type-2 receiver incorporated into the SN65MLVD207 device. The reduced offset from a Type-1 receiver can be seen in Figure 2−6, receiver number 2 output.

Measuring the output signal on J1 with a 50-Ω cable terminated into 50-Ω at the scope will attenuate the signal due to the 453-Ω resistor in series with the receiver output. The resistor is installed as a current limit for termination into a 50-Ω load. As can be seen in the traces below the magnitude of trace 2 on the left is one-tenth of trace 2 on the right. Measuring the signal with a high-impedance probe on TP1 requires replacing R2, the 453-Ω resistor, with a short to reduce signal roll-off. Measuring the output on TP1 allows the user to see absolute signal levels out of the device.

Figure 2−4. Point-to-Point Parallel Simplex Typical Eye Pattern Data



50-Ohm Output Termination
Receiver Output Scaled 10:1

High Impedance Output Termination, R2 Shorted

The eye patterns in Figure 2−5 are parallel-terminated point-to-point simplex data where trace 1 is the input signal applied to J2, and trace 2 is the output

signal on TP1, R2 is shorted. Type-2 behavior is again observed on the SN65MLVD207 receiver output.

Trace three shows the differential voltage on the bus. Note that the bus voltages are nominal M-LVDS levels of 1.1 V_{PP} due to the lower load seen by the current driver.

Figure 2−5. Parallel Terminated Point-to-Point Parallel Simplex Typical Eye Pattern Data

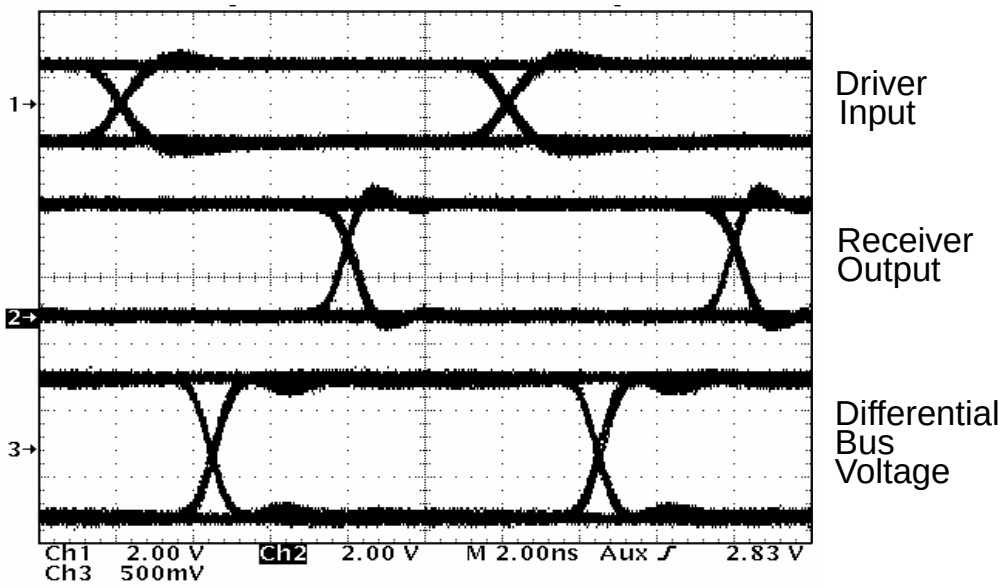
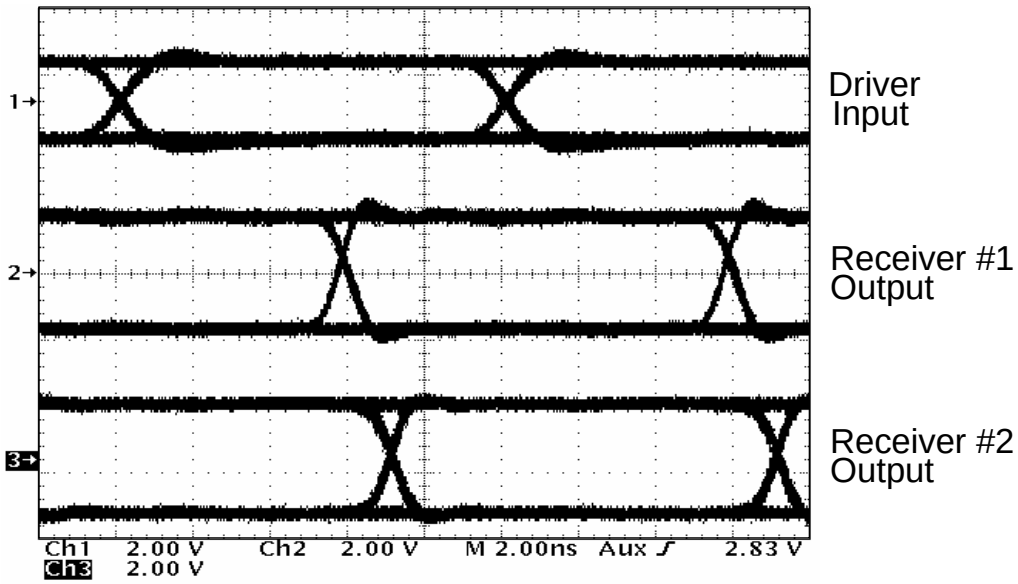


Figure 2−6 represents the two-node multipoint transmission eye patterns where trace 1 is the input signal applied to J2, and traces 2 and 3 are the output signals seen at TP1 and TP3 respectively with R2 and R13 shorted. The offset zero-crossing shows the difference between Type−2 (Receiver #1 Output) and Type−1 (Receiver #2 Output).

Figure 2−6. Two-Node Multipoint Typical Eye Pattern Data



Chapter 3

Bill of Materials, Board Layout, and PCB Construction

This chapter contains the bill of materials, board layout of the M-LVDS, and describes the printed-circuit board.

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3.1 Bill of Materials

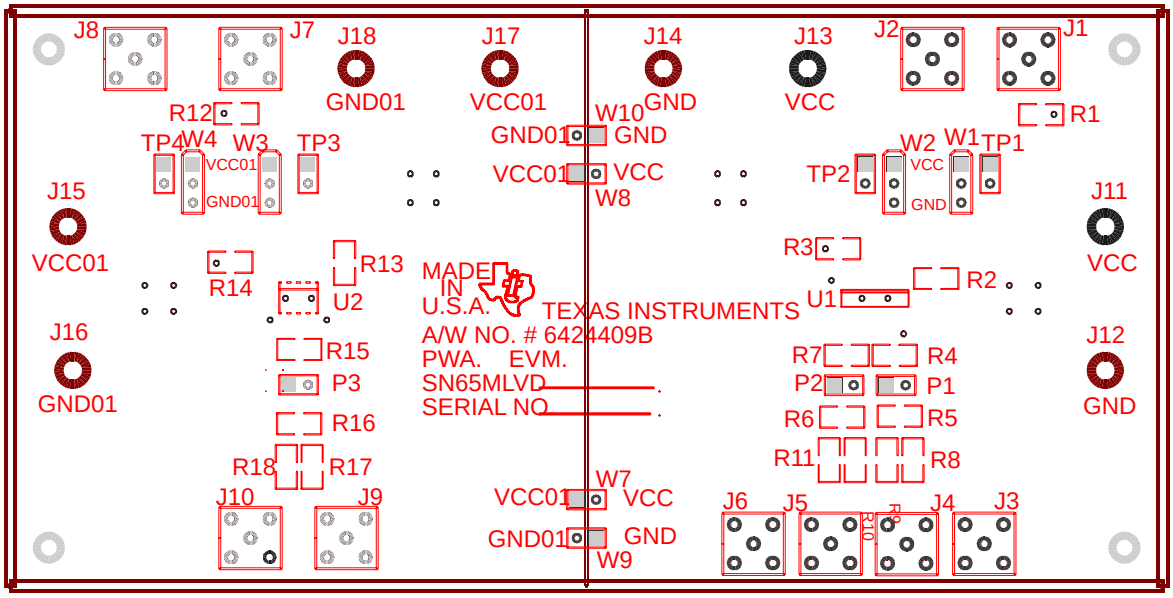
Table 3−1. M-LVDS EVM Bill of Materials

Item No.	Qty.	Reference Designation	Description	MFG	Part #	Not Installed
1	2	C1, C2	Capacitor, SMT1206, 50 V, 10%, 0.01 μF	AVX	12101C103JATMA	
2	4	C5, C6, C9, C10	Capacitor, SMT1206, 16 V, 10%, 1 μF	AVX	1206YC105KAT	
3	4	C3, C4, C7, C8	Capacitor, SMT1210, 10 V, 10%, 10 μF	AVX	1210ZG106ZAT2A	
4	2	J11, J13, J15, J17	Banana jack, red	Allied	ST−351A	J11, J15
5	2	J12, J14, J16, J18	Banana jack, black	Allied	ST−351B	J12, J16
6	4	J1 − J 10	Connector	Allied	713−4339	J3 − J6, J9, J10
7	4	TP1 − TP4	Header (make from 4−103239−0)	AMP	4−103239−0x2	
8	3	P1 − P3	Header (make from 4−103239−0)	AMP	4−103239−0x2	
9	4	W7 − W10	Header (make from 4−103239−0)	AMP	4−103239−0x2	
10	4	W1 − W4	Header (make from 4−103239−0)	AMP	4−103239−0x3	
11	1	U1	IC, SMT, 14P, High speed 50-Ω line driver/receiver	TI	†SN65MLVD202AD SN65MLVD205AD SN65MLVD203D SN65MLVD207D	
12	1	U2	IC, SMT, 8P High speed 50-Ω line driver/receiver	TI	†SN65MLVD200AD SN65MLVD204AD SN65MLVD201D SN65MLVD206D	
13	2	R1, R3, R12, R14	Resistor, SMT, 1/4 W, 1%, 49.9 Ω	Dale	CRCW121049R9F	R1, R12
14	2	R2, R13	Resistor, SMT, 1/4 W, 1%, 453 Ω	Dale	CRCW12104530F	
15	6	R8 − R11, R17, R18	Resistor, SMT, 1/4 W, 1%, 0.0 Ω	Dale	CRCW12100000F	R8 − R11, R17, R18
16	6	R4 − R7, R15, R16	Resistor, SMT, 1/4 W, 1%, 100 Ω	Dale	CRCW12101000F	
17	4		1/2” nylon, hex, standoff	Keystone	1902C	
18	4		Phillips, pan head, screw		H703−ND	
19	8		Jumper, shorting			

† Only one will be installed.

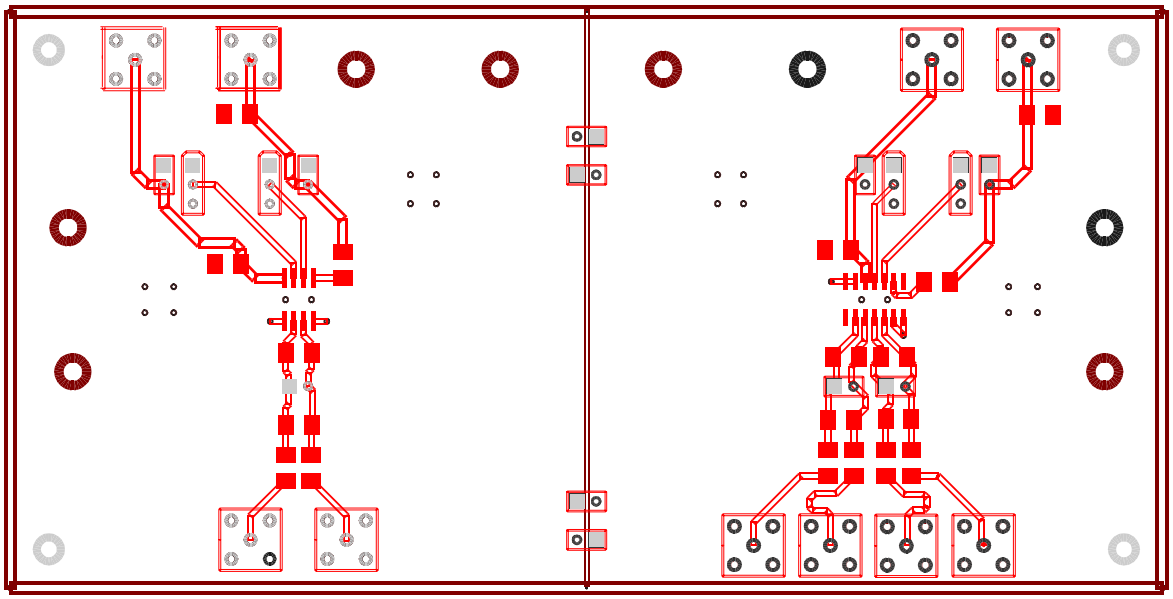
3.2 Board Layout

Figure 3−1. Assembly Drawing



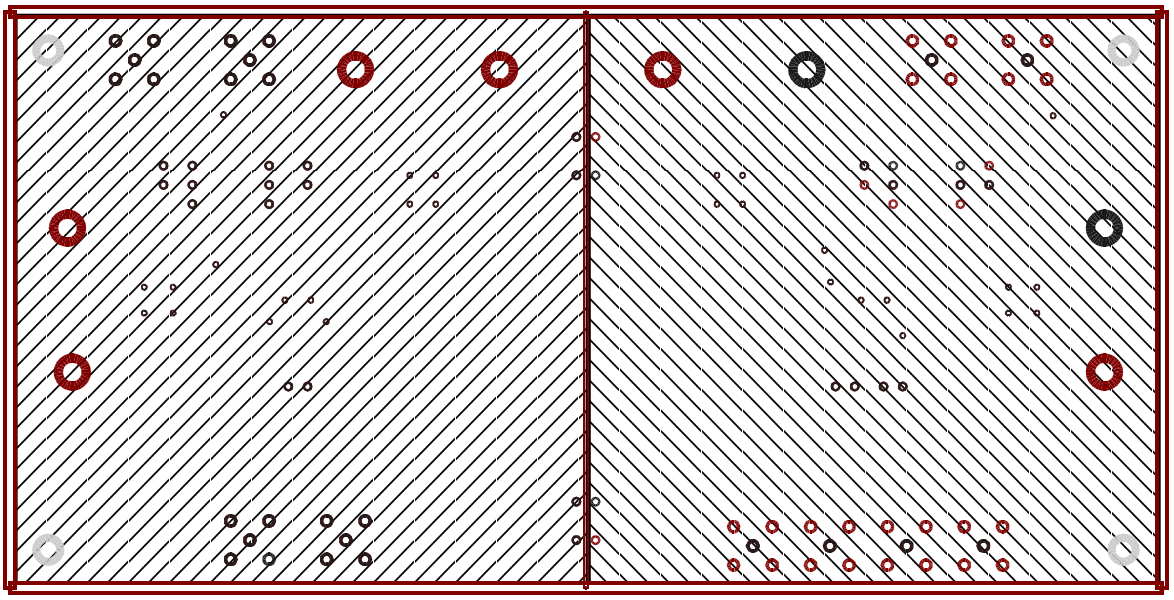
The top layer of the EVM contains the controlled impedance and matched length traces.

Figure 3−2. Top Layer



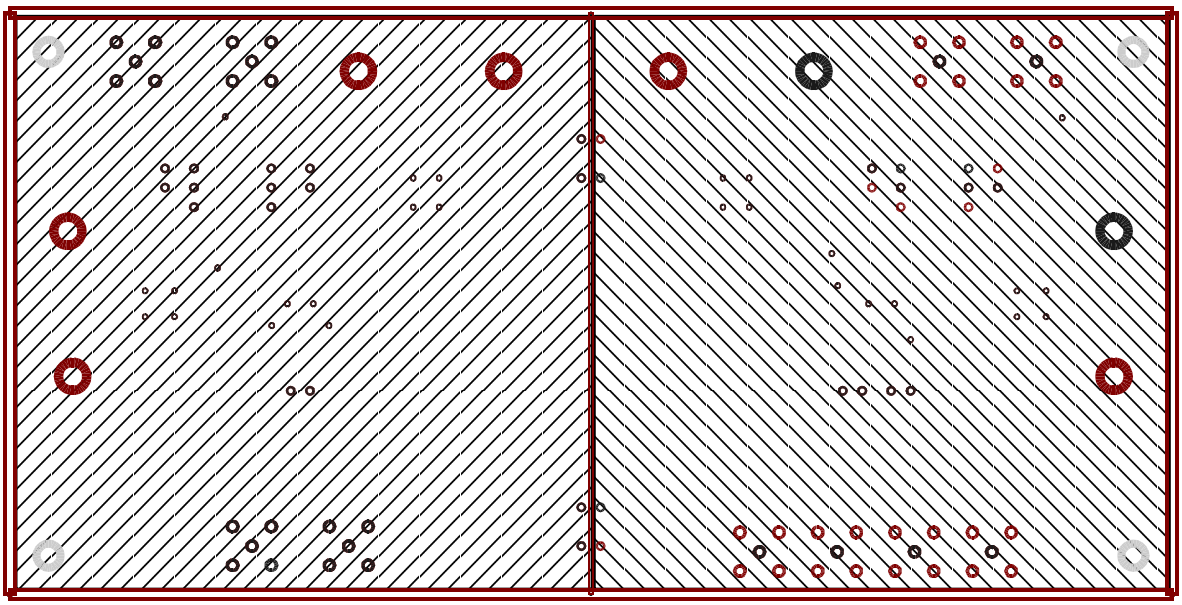
The second layer of the EVM has the separate ground planes. These are the reference planes for the controlled impedance traces on the top layer.

Figure 3−3. Second Layer



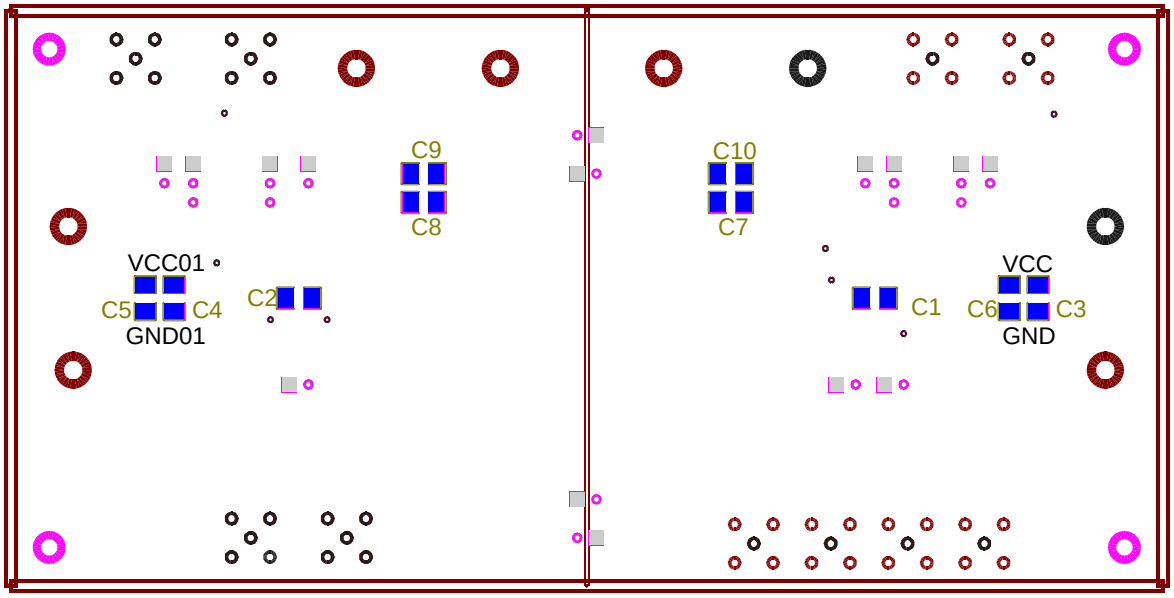
The third layer of the EVM has the power planes. These are matched to the ground planes to reduce radiated emission and crosstalk, while increasing distributed capacitance.

Figure 3−4. Third Layer



The bottom layer of the EVM contains bulk and decoupling capacitors to be placed close to the power and ground pins on the device.

Figure 3−5. Bottom Layer



3.3 PCB Construction

Information in this section was obtained from the following source:

- *Electromagnetic Compatibility Printed Circuit Board and Electronic Module Design,* VEC workshop, Violette Engineering Corporation.

Characteristic impedance is the ratio of voltage to current in a transmission line wave traveling in one direction. This characteristic impedance is the value that is matched with our termination resistors so as to reduce reflections. This reduction in reflections improves signal to noise ratio on the line and reduces EMI caused by common mode voltages and spikes.

Two typical approaches are used for controlled impedance in printed-circuit board construction, microstrip and stripline. Microstrip construction is shown in Figure 3−6. The characteristic impedance of a microstrip trace on a printed-circuit board is approximated by:

$$Z_O = \frac{60}{\sqrt{0.475\epsilon r + 0.67}} \times \ln\frac{4h}{0.67(0.8\ W + t)} \quad (1)$$

where εr is the permeability of the board material, h is the distance between the ground plane and the signal trace, W is the trace width, and t is the thickness of the trace. The differential impedance for a two microstrip traces can be approximated as follows with S being the distance between two microstrip traces:

$$Z_{DIFF} = 2 \times Z_O \times \left(1 - 0.48e^{-0.96s/h}\right) \quad (2)$$

Stripline construction is also shown in Figure 3−6, the signal lines should be centered between the ground planes. The characteristic impedance of a stripline trace in a printed-circuit board is approximated by:

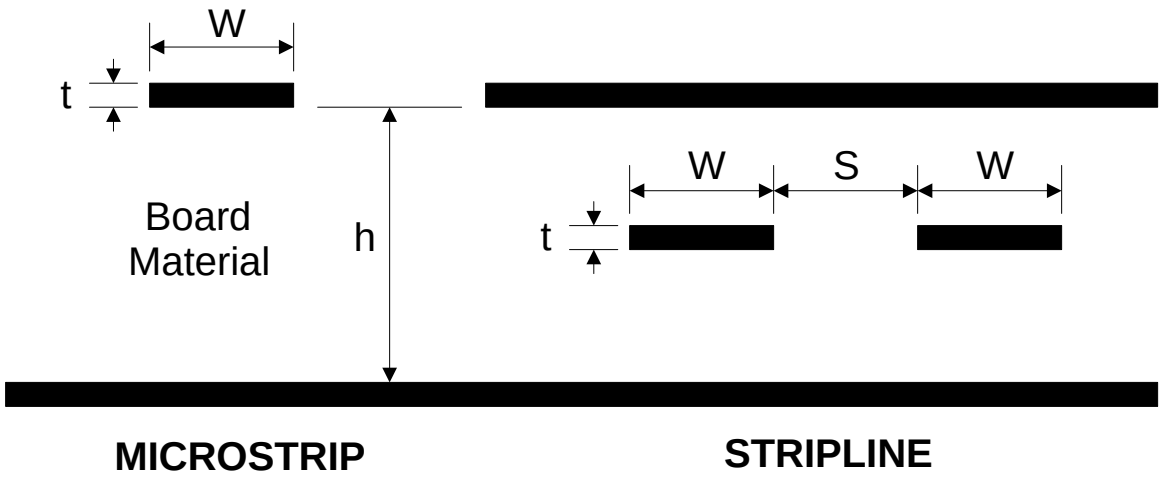
$$Z_O = \frac{60}{\sqrt{\epsilon r}} \times \ln\frac{4h}{0.67\pi(0.8\ W + t)} \quad (3)$$

where εr is the permeability of the board material, h is the distance between the ground plane and the signal trace, W is the trace width, and t is the thickness of the trace. The differential impedance for a two stripline traces can be approximated as follows with S being the distance between two stripline traces:

$$Z_{DIFF} = 2 \times Z_O \times \left(1 - 0.374e^{-2.9s/h}\right) \quad (4)$$

Note: For edge-coupled striplines, the term 0.374 may be replaced with 0.748 for lines which are closely coupled (S < 12 mils, or 0,3 mm).

Figure 3−6. Trace Configurations in Printed-Circuit Boards



Stripline construction is the preferred configuration for differential signaling. This configuration reduces radiated emissions from circuit board traces due to better control of the lines of flux. The additional ground plane also allows for better control of impedance on the traces.

It can be seen from the functions and physical construction parameters that careful consideration must be given to these parameters for a robust board design. For instance it is not uncommon for εr to vary 10% across one board, affecting skew. This is a good reason to keep differential lines close. Other factors to keep in mind when doing a printed-circuit layout for transmission lines are as follows:

1) Differences in electrical length translate into skew.

2) Careful attention to dimensions, length and spacing help to insure isolation between differential pairs.

3) Where possible use *ideal interconnects*, point-to-point with no loads or branches. This keeps the impedance more uniform from end to end and reduce reflections on the line.

4) Discontinuities on the line, vias, pads, test points will:

   - Reduce characteristic impedance
   - Increase the prop delay, and rise-time degradation
   - Increase signal transition time

5) Prioritize signals and avoid turns in critical signals. Turns can cause impedance discontinuities.

6) Within a pair of traces, the distance between the traces should be minimized to maintain common-mode rejection of the receivers. Differential transmission works best when both lines of the pair are kept as identical as possible.

Table 3−2 shows the layer stack up of the EVM with the defined trace widths for the controlled impedance etch runs using microstrip construction.

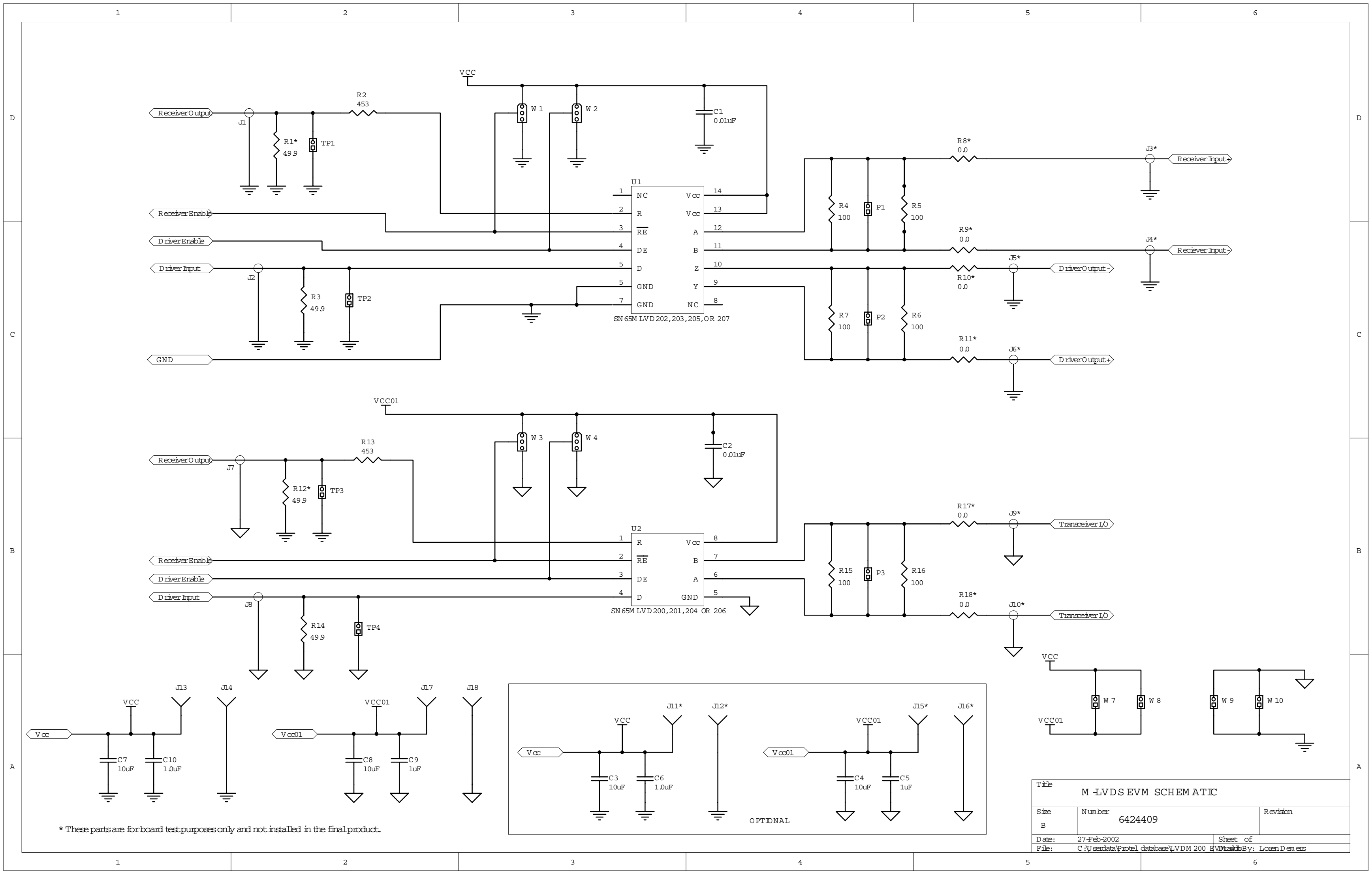
Table 3−2. EVM Layer Stack Up

Material Type: FR 406	Layer No.	Layer Type	Thickness (mils)	Copper Weight	Differential Model			Single-Ended Model	
					Line Width (mils)	Spacing (mils)	Impedance (Ω)	Line Width (mils)	Impedance (Ω)
	1	Signal	0.0006	0.5 oz (start)	0.027	0.230	100	0.0420	50
PREPREG			0.025						
	2	Plane	0.0012	1					
CORE			0.004						
	3	Plane	0.0012	1					
PREPREG			0.025						
	4	Signal	0.0006	0.5 oz (start)	0.027	0.230	100	0.0420	50

Appendix A

Schematic

This Appendix contains the EVM schematic.



VCC
W1
W2
C1
0.01uF
Receiver Output
J1
R1*
49.9
TP1
R2
453
Receiver Enable
Driver Enable
Driver Input
J2
R3
49.9
TP2
GND
U1
NC
R
RE
DE
D
GND
GND
Vcc
Vcc
A
B
Z
Y
NC
SN65MLVD202,203,205,OR 207
R8*
0.0
J3*
Receiver Input-
R4
100
P1
R5
100
R9*
0.0
J4*
Reciever Input+
R10*
0.0
J5*
Driver Output-
R7
100
P2
R6
100
R11*
0.0
J6*
Driver Output+
VCC01
W3
W4
C2
0.01uF
Receiver Output
J7
R12*
49.9
TP3
R13
453
U2
R
RE
DE
D
Vcc
B
A
GND
Receiver Enable
Driver Enable
Driver Input
J8
R14
49.9
TP4
SN65MLVD200,201,204 OR 206
R17*
0.0
J9*
Transceiver I/O
R15
100
P3
R16
100
R18*
0.0
J10*
Transceiver I/O
VCC
VCC01
W7
W8
W9
W10
Vcc
VCC
J13
J14
C7
10uF
C10
1.0uF
Vcc01
VCC01
J17
J18
C8
10uF
C9
1uF
Vcc
VCC
J11*
J12*
C3
10uF
C6
1.0uF
Vcc01
VCC01
J15*
J16*
C4
10uF
C5
1uF
OPTIONAL
* These parts are for board test purposes only and not installed in the final product.
Title
M-LVDS EVM SCHEMATIC
Size
B
Number
6424409
Revision
Date: 27-Feb-2002
Sheet of
File: C:\Userdata\Protel database\LVDM 200 EVM.ddb
Drawn By: Loren Demers

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NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

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3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

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- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

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https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

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1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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