

DS91M040 125 MHz Quad M-LVDS Transceiver

Check for Samples: [DS91M040](#)

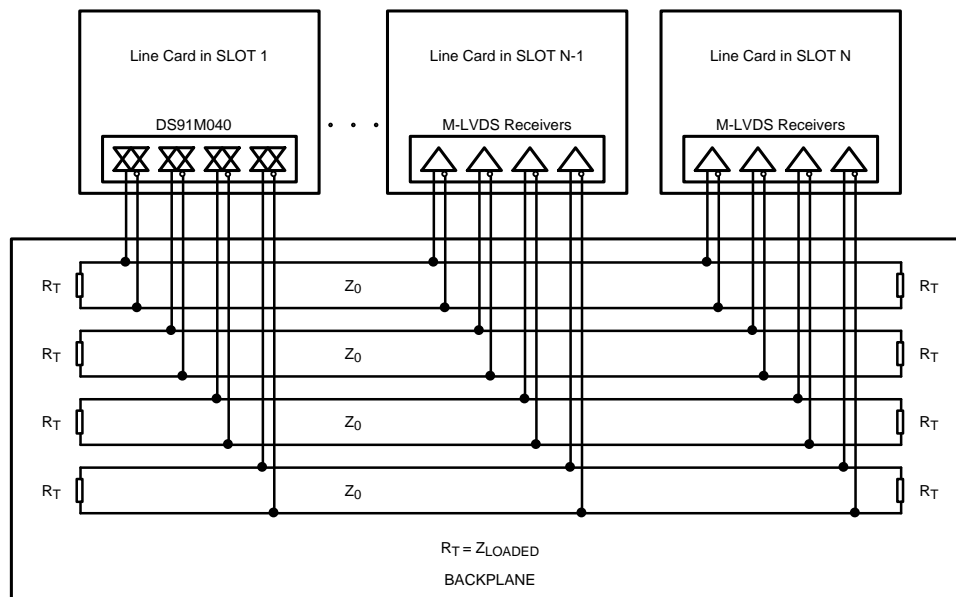
FEATURES

- DC - 125 MHz / 250 Mbps Low Jitter, Low Skew, Low Power Operation
- Wide Input Common Mode Voltage Range Allows up to $\pm 1V$ of GND Noise
- Conforms to TIA/EIA-899 M-LVDS Standard
- Pin Selectable M-LVDS Receiver Type (1 or 2)
- Controlled Transition Times (2.0 ns typ) Minimize Reflections
- 8 kV ESD on M-LVDS I/O pins protects adjoining components
- Flow-Through Pinout Simplifies PCB Layout
- Small 5 mm x 5 mm WQFN-32 Space Saving Package

APPLICATIONS

- Multidrop / Multipoint Clock and Data Distribution
- High-Speed, Low Power, Short-Reach Alternative to TIA/EIA-485/422
- Clock Distribution in AdvancedTCA (ATCA) and MicroTCA (μ TCA, uTCA) Backplanes

System Diagram



DESCRIPTION

The DS91M040 is a quad M-LVDS transceiver designed for driving / receiving clock or data signals to / from up to four multipoint networks.

M-LVDS (Multipoint LVDS) is a new family of bus interface devices based on LVDS technology specifically designed for multipoint and multidrop cable and backplane applications. It differs from standard LVDS in providing increased drive current to handle double terminations that are required in multipoint applications. Controlled transition times minimize reflections that are common in multipoint configurations due to unterminated stubs. M-LVDS devices also have a very large input common mode voltage range for additional noise margin in heavily loaded and noisy backplane environments.

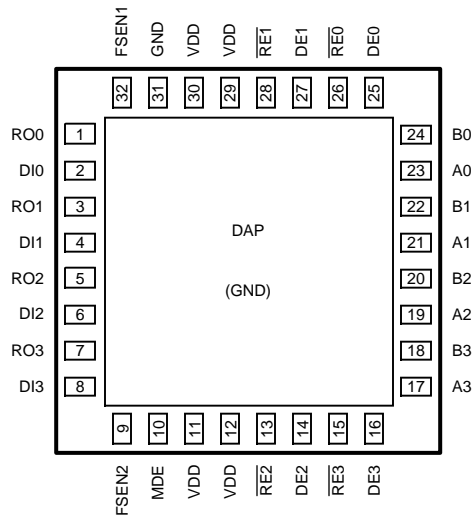
A single DS91M040 channel is a half-duplex transceiver that accepts LVTTTL/LVCMOS signals at the driver inputs and converts them to differential M-LVDS signal levels. The receiver inputs accept low voltage differential signals (LVDS, BLVDS, M-LVDS, LVPECL and CML) and convert them to 3V LVCMOS signals. The DS91M040 supports both M-LVDS type 1 and type 2 receiver inputs.



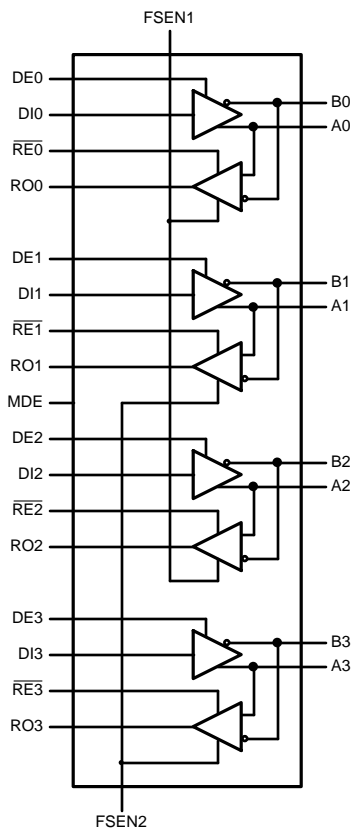
Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

All trademarks are the property of their respective owners.

Connection Diagram



Logic Diagram



PIN DESCRIPTIONS

Number	Name	I/O, Type	Description
1, 3, 5, 7	RO	O, LVCMOS	Receiver output pin.
26, 28, 13, 15	\overline{RE}	I, LVCMOS	Receiver enable pin: When \overline{RE} is high, the receiver is disabled. When \overline{RE} is low, the receiver is enabled. There is a 300 k Ω pullup resistor on this pin.
25, 27, 14, 16	DE	I, LVCMOS	Driver enable pin: When DE is low, the driver is disabled. When DE is high, the driver is enabled. There is a 300 k Ω pulldown resistor on this pin.
2, 4, 6, 8	DI	I, LVCMOS	Driver input pin.
31, DAP	GND	Power	Ground pin and pad.
17, 19, 21, 23	A	I/O, M-LVDS	Non-inverting driver output pin/Non-inverting receiver input pin
18, 20, 22, 24	B	I/O, M-LVDS	Inverting driver output pin/Inverting receiver input pin
11, 12, 29, 30	V _{DD}	Power	Power supply pin, +3.3V \pm 0.3V
32	FSEN1	I, LVCMOS	Failsafe enable pin with a 300 k Ω pullup resistor. This pin enables Type 2 receiver on inputs 0 and 2. FSEN1 = L --> Type 1 receiver inputs FSEN1 = H --> Type 2 receiver inputs
9	FSEN2	I, LVCMOS	Failsafe enable pin with a 300 k Ω pullup resistor. This pin enables Type 2 receiver on inputs 1 and 3. FSEN2 = L --> Type 1 receiver inputs FSEN2 = H --> Type 2 receiver inputs
10	MDE	I, LVCMOS	Master enable pin. When MDE is H, the device is powered up. When MDE is L, the device overrides all other control and powers down.

M-LVDS Receiver Types

The EIA/TIA-899 M-LVDS standard specifies two different types of receiver input stages. A type 1 receiver has a conventional threshold that is centered at the midpoint of the input amplitude, $V_{ID}/2$. A type 2 receiver has a built in offset that is 100mV greater than $V_{ID}/2$. The type 2 receiver offset acts as a failsafe circuit where open or short circuits at the input will always result in the output stage being driven to a low logic state.

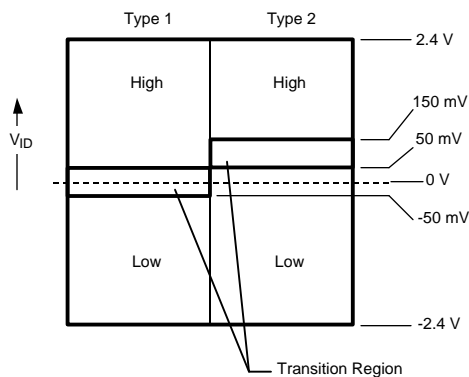


Figure 1. M-LVDS Receiver Input Thresholds



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Absolute Maximum Ratings⁽¹⁾⁽²⁾

Power Supply Voltage		-0.3V to +4V
LVC MOS Input Voltage		-0.3V to ($V_{DD} + 0.3V$)
LVC MOS Output Voltage		-0.3V to ($V_{DD} + 0.3V$)
M-LVDS I/O Voltage		-1.9V to +5.5V
M-LVDS Output Short Circuit Current Duration		Continuous
Junction Temperature		+140°C
Storage Temperature Range		-65°C to +150°C
Lead Temperature Range Soldering (4 sec.)		+260°C
Maximum Package Power Dissipation @ +25°C	RTV Package	3.91W
	Derate RTV Package	34 mW/°C above +25°C
Package Thermal Resistance (4-Layer, 2 oz. Cu, JEDEC)	θ_{JA}	+29.4°C/W
	θ_{JC}	+2.8°C/W
ESD Susceptibility	HBM ⁽³⁾	≥8 kV
	MM ⁽⁴⁾	≥250V
	CDM ⁽⁵⁾	≥1250V

- (1) "Absolute Maximum Ratings" indicate limits beyond which damage to the device may occur, including inoperability and degradation of device reliability and/or performance. Functional operation of the device and/or non-degradation at the Absolute Maximum Ratings or other conditions beyond those indicated in the Recommended Operating Conditions is not implied. The Recommended Operating Conditions indicate conditions at which the device is functional and the device should not be operated beyond such conditions.
- (2) If Military/Aerospace specified devices are required, please contact the TI Sales Office/ Distributors for availability and specifications.
- (3) Human Body Model, applicable std. JESD22-A114C
- (4) Machine Model, applicable std. JESD22-A115-A
- (5) Field Induced Charge Device Model, applicable std. JESD22-C101-C

Recommended Operating Conditions

	Min	Typ	Max	Units
Supply Voltage, V_{DD}	3.0	3.3	3.6	V
Voltage at Any Bus Terminal (Separate or Common-Mode)	-1.4		+3.8	V
Differential Input Voltage V_{ID}			2.4	V
LV TTL Input Voltage High V_{IH}	2.0		V_{DD}	V
LV TTL Input Voltage Low V_{IL}	0		0.8	V
Operating Free Air Temperature T_A	-40	+25	+85	°C

DC Electrical Characteristics⁽¹⁾⁽²⁾⁽³⁾⁽⁴⁾

Over recommended operating supply and temperature ranges unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Units	
M-LVDS Driver							
$ V_{AB} $	Differential output voltage magnitude	$R_L = 50\Omega, C_L = 5\text{ pF}$	480		650	mV	
ΔV_{AB}	Change in differential output voltage magnitude between logic states	Figure 2 Figure 4	-50	0	+50	mV	
$V_{OS(SS)}$	Steady-state common-mode output voltage	$R_L = 50\Omega, C_L = 5\text{ pF}$	0.3	1.6	2.1	V	
$ \Delta V_{OS(SS)} $	Change in steady-state common-mode output voltage between logic states	Figure 2 Figure 3	0		+50	mV	
$V_{A(OC)}$	Maximum steady-state open-circuit output voltage	Figure 5	0		2.4	V	
$V_{B(OC)}$	Maximum steady-state open-circuit output voltage		0		2.4	V	
$V_{P(H)}$	Voltage overshoot, low-to-high level output ⁽⁵⁾	$R_L = 50\Omega, C_L = 5\text{ pF}, C_D = 0.5\text{ pF}$			$1.2V_{SS}$	V	
$V_{P(L)}$	Voltage overshoot, high-to-low level output ⁽⁵⁾	Figure 7 Figure 8	-0.2V _{SS}			V	
I_{IH}	High-level input current (LVTTTL inputs)	$V_{IH} = 3.6\text{V}$	-15		15	μA	
I_{IL}	Low-level input current (LVTTTL inputs)	$V_{IL} = 0.0\text{V}$	-15		15	μA	
V_{CL}	Input Clamp Voltage (LVTTTL inputs)	$I_{IN} = -18\text{ mA}$	-1.5			V	
I_{OS}	Differential short-circuit output current ⁽⁶⁾	Figure 6	-43		43	mA	
M-LVDS Receiver							
V_{IT+}	Positive-going differential input voltage threshold	See Truth Tables	Type 1		16	50	mV
			Type 2		100	150	mV
V_{IT-}	Negative-going differential input voltage threshold	See Truth Tables	Type 1	-50	20		mV
			Type 2	50	94		mV
V_{OH}	High-level output voltage (LVTTTL output)	$I_{OH} = -8\text{ mA}$	2.4	2.7		V	
V_{OL}	Low-level output voltage (LVTTTL output)	$I_{OL} = 8\text{ mA}$		0.28	0.4	V	
I_{OZ}	TRI-STATE output current	$V_O = 0\text{V}$ or 3.6V	-10		10	μA	
I_{OSR}	Short-circuit receiver output current (LVTTTL output)	$V_O = 0\text{V}$		-50	-90	mA	

- (1) The Electrical Characteristics tables list ensured specifications under the listed Recommended Operating Conditions except as otherwise modified or specified by the Electrical Characteristics Conditions and/or Notes. Typical specifications are estimations only and are not ensured.
- (2) Current into device pins is defined as positive. Current out of device pins is defined as negative. All voltages are referenced to ground except V_{OD} and ΔV_{OD} .
- (3) Typical values represent most likely parametric norms for $V_{DD} = +3.3\text{V}$ and $T_A = +25^\circ\text{C}$, and at the Recommended Operation Conditions at the time of product characterization and are not specified.
- (4) C_L includes fixture capacitance and C_D includes probe capacitance.
- (5) Specification is ensured by characterization and is not tested in production.
- (6) Output short circuit current (I_{OS}) is specified as magnitude only, minus sign indicates direction only.

DC Electrical Characteristics⁽¹⁾⁽²⁾⁽³⁾⁽⁴⁾ (continued)

Over recommended operating supply and temperature ranges unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
M-LVDS Bus (Input and Output) Pins						
I_A	Transceiver input/output current	$V_A = 3.8V, V_B = 1.2V$			32	μA
		$V_A = 0V$ or $2.4V, V_B = 1.2V$	-20		+20	μA
		$V_A = -1.4V, V_B = 1.2V$	-32			μA
I_B	Transceiver input/output current	$V_B = 3.8V, V_A = 1.2V$			32	μA
		$V_B = 0V$ or $2.4V, V_A = 1.2V$	-20		+20	μA
		$V_B = -1.4V, V_A = 1.2V$	-32			μA
I_{AB}	Transceiver input/output differential current ($I_A - I_B$)	$V_A = V_B, -1.4V \leq V \leq 3.8V$	-4		+4	μA
$I_{A(OFF)}$	Transceiver input/output power-off current	$V_A = 3.8V, V_B = 1.2V,$ $DE = 0V$ $0V \leq V_{DD} \leq 1.5V$			32	μA
		$V_A = 0V$ or $2.4V, V_B = 1.2V,$ $DE = 0V$ $0V \leq V_{DD} \leq 1.5V$	-20		+20	μA
		$V_A = -1.4V, V_B = 1.2V,$ $DE = 0V$ $0V \leq V_{DD} \leq 1.5V$	-32			μA
$I_{B(OFF)}$	Transceiver input/output power-off current	$V_B = 3.8V, V_A = 1.2V,$ $DE = 0V$ $0V \leq V_{DD} \leq 1.5V$			32	μA
		$V_B = 0V$ or $2.4V, V_A = 1.2V,$ $DE = 0V$ $0V \leq V_{DD} \leq 1.5V$	-20		+20	μA
		$V_B = -1.4V, V_A = 1.2V,$ $DE = 0V$ $0V \leq V_{DD} \leq 1.5V$	-32			μA
$I_{AB(OFF)}$	Transceiver input/output power-off differential current ($I_{A(OFF)} - I_{B(OFF)}$)	$V_A = V_B, -1.4V \leq V \leq 3.8V,$ $DE = 0V$ $0V \leq V_{DD} \leq 1.5V$	-4		+4	μA
C_A	Transceiver input/output capacitance	$V_{DD} = OPEN$		7.8		pF
C_B	Transceiver input/output capacitance			7.8		pF
C_{AB}	Transceiver input/output differential capacitance			3		pF
$C_{A/B}$	Transceiver input/output capacitance balance (C_A/C_B)			1		
SUPPLY CURRENT (V_{CC})						
I_{CCD}	Driver Supply Current	$R_L = 50\Omega, DE = H, \overline{RE} = H$		67	75	mA
I_{CCZ}	TRI-STATE Supply Current	$DE = L, \overline{RE} = H$		22	26	mA
I_{CCR}	Receiver Supply Current	$DE = L, \overline{RE} = L$		32	38	mA
I_{CCPD}	Power Down Supply Current	$MDE = L$		3	5	mA

Switching Characteristics⁽¹⁾⁽²⁾⁽³⁾

Over recommended operating supply and temperature ranges unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
DRIVER AC SPECIFICATIONS						
t_{PLH}	Differential Propagation Delay Low to High	$R_L = 50\Omega$, $C_L = 5\text{ pF}$,	1.5	3.3	5.5	ns
t_{PHL}	Differential Propagation Delay High to Low	$C_D = 0.5\text{ pF}$	1.5	3.3	5.5	ns
t_{SKD1}	Pulse Skew ⁽⁴⁾⁽⁵⁾	Figure 7 Figure 8		30	125	ps
t_{SKD2}	Channel-to-Channel Skew ⁽⁴⁾⁽⁶⁾			100	200	ps
t_{SKD3}	Part-to-Part Skew ⁽⁴⁾⁽⁷⁾			0.8	1.6	ns
t_{SKD4}	Part-to-Part Skew ⁽⁴⁾⁽⁸⁾				4	ns
t_{TLH}	Rise Time ⁽⁴⁾		1.2	2.0	3.0	ns
t_{THL}	Fall Time ⁽⁴⁾		1.2	2.0	3.0	ns
t_{PZH}	Enable Time (Z to Active High)	$R_L = 50\Omega$, $C_L = 5\text{ pF}$,		7.5	11.5	ns
t_{PZL}	Enable Time (Z to Active Low)	$C_D = 0.5\text{ pF}$		8.0	11.5	ns
t_{PLZ}	Disable Time (Active Low to Z)	Figure 9 Figure 10		7.0	11.5	ns
t_{PHZ}	Disable Time (Active High to Z)			7.0	11.5	ns
RECEIVER AC SPECIFICATIONS						
t_{PLH}	Propagation Delay Low to High	$C_L = 15\text{ pF}$	1.5	3.0	4.5	ns
t_{PHL}	Propagation Delay High to Low	Figure 11 Figure 12 Figure 13	1.5	3.1	4.5	ns
t_{SKD1A}	Pulse Skew (Receiver Type 1) ⁽⁴⁾⁽⁵⁾			55	325	ps
t_{SKD1B}	Pulse Skew (Receiver Type 2) ⁽⁴⁾⁽⁵⁾			475	800	ps
t_{SKD2}	Channel-to-Channel Skew ⁽⁴⁾⁽⁶⁾			60	300	ps
t_{SKD3}	Part-to-Part Skew ⁽⁴⁾⁽⁷⁾			0.6	1.2	ns
t_{SKD4}	Part-to-Part Skew ⁽⁸⁾				3	ns
t_{TLH}	Rise Time ⁽⁴⁾		0.3	1.1	1.6	ns
t_{THL}	Fall Time ⁽⁴⁾		0.3	0.65	1.6	ns
t_{PZH}	Enable Time (Z to Active High)	$R_L = 500\Omega$, $C_L = 15\text{ pF}$		3	5.5	ns
t_{PZL}	Enable Time (Z to Active Low)	Figure 14 Figure 15		3	5.5	ns
t_{PLZ}	Disable Time (Active Low to Z)			3.5	5.5	ns
t_{PHZ}	Disable Time (Active High to Z)			3.5	5.5	ns
GENERIC AC SPECIFICATIONS						
t_{WKUP}	Wake Up Time ⁽⁴⁾ (Master Device Enable (MDE) time)				500	ms
f_{MAX}	Maximum Operating Frequency ⁽⁴⁾		125			MHz

- (1) The Electrical Characteristics tables list ensured specifications under the listed Recommended Operating Conditions except as otherwise modified or specified by the Electrical Characteristics Conditions and/or Notes. Typical specifications are estimations only and are not ensured.
- (2) Typical values represent most likely parametric norms for $V_{DD} = +3.3\text{V}$ and $T_A = +25^\circ\text{C}$, and at the Recommended Operation Conditions at the time of product characterization and are not specified.
- (3) C_L includes fixture capacitance and C_D includes probe capacitance.
- (4) Specification is ensured by characterization and is not tested in production.
- (5) t_{SKD1} , $|t_{PLHD} - t_{PHLD}|$, Pulse Skew, is the magnitude difference in differential propagation delay time between the positive going edge and the negative going edge of the same channel.
- (6) t_{SKD2} , Channel-to-Channel Skew, is the difference in propagation delay (t_{PLHD} or t_{PHLD}) among all output channels.
- (7) t_{SKD3} , Part-to-Part Skew, is defined as the difference between the minimum and maximum differential propagation delays. This specification applies to devices at the same V_{DD} and within 5°C of each other within the operating temperature range.
- (8) t_{SKD4} , Part-to-Part Skew, is the differential channel-to-channel skew of any event between devices. This specification applies to devices over recommended operating temperature and voltage ranges, and across process distribution. t_{SKD4} is defined as $|\text{Max} - \text{Min}|$ differential propagation delay.

Test Circuits and Waveforms

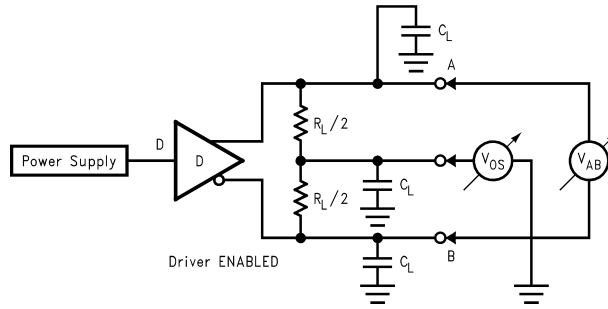


Figure 2. Differential Driver Test Circuit

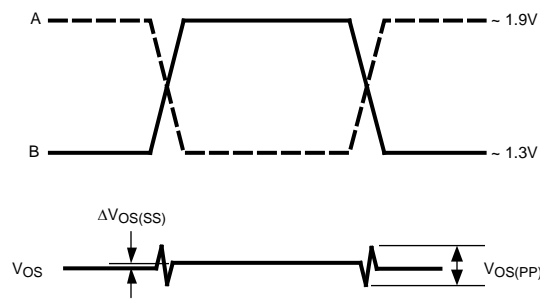


Figure 3. Differential Driver Waveforms

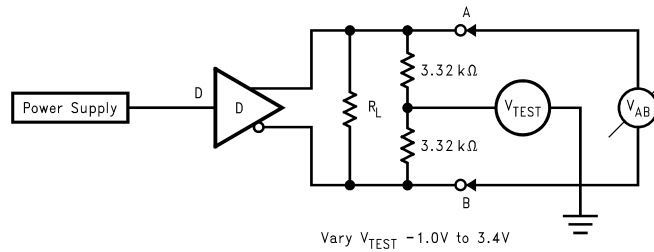


Figure 4. Differential Driver Full Load Test Circuit

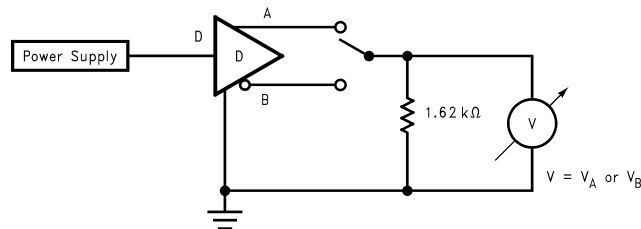


Figure 5. Differential Driver DC Open Test Circuit

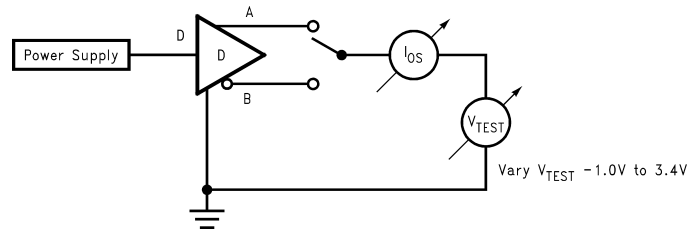


Figure 6. Differential Driver Short-Circuit Test Circuit

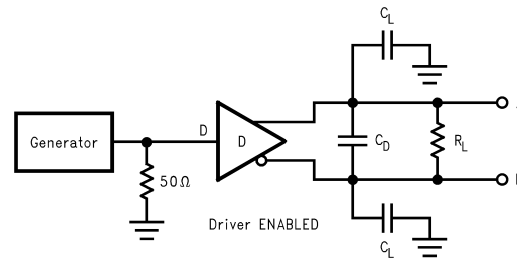


Figure 7. Driver Propagation Delay and Transition Time Test Circuit

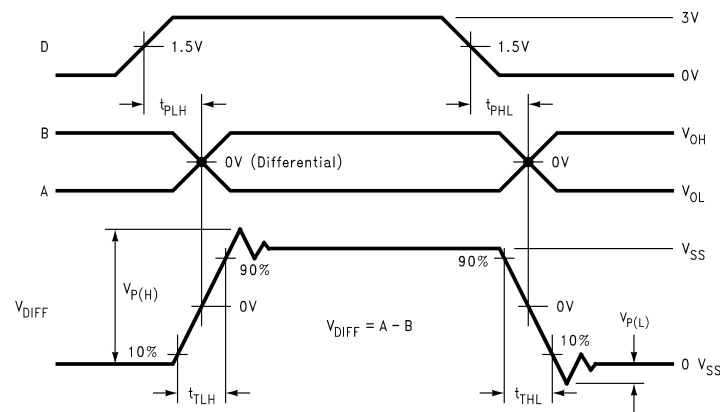


Figure 8. Driver Propagation Delays and Transition Time Waveforms

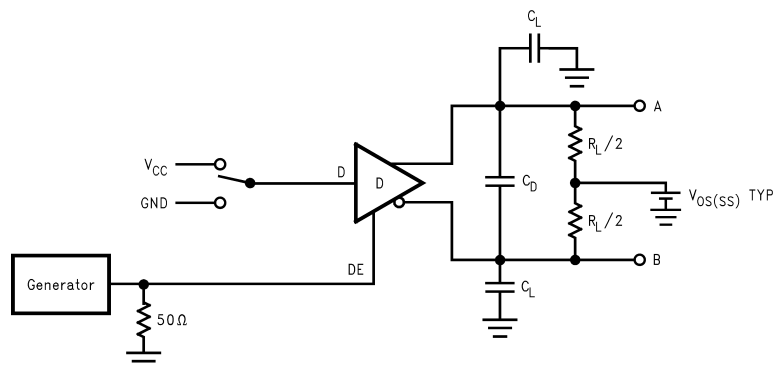


Figure 9. Driver TRI-STATE Delay Test Circuit

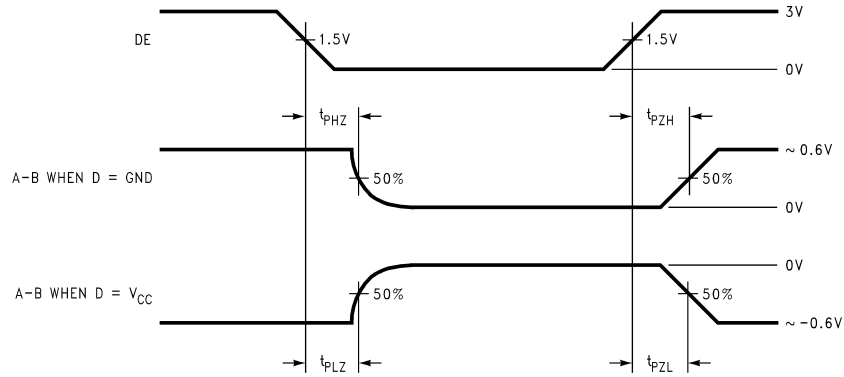


Figure 10. Driver TRI-STATE Delay Waveforms

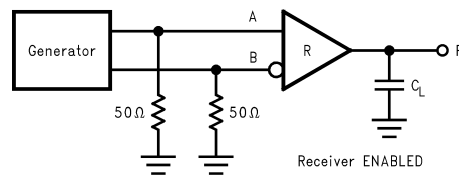


Figure 11. Receiver Propagation Delay and Transition Time Test Circuit

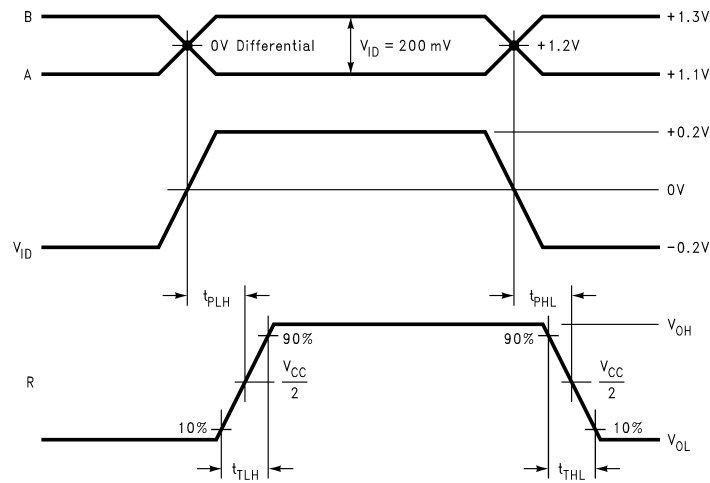


Figure 12. Type 1 Receiver Propagation Delay and Transition Time Waveforms

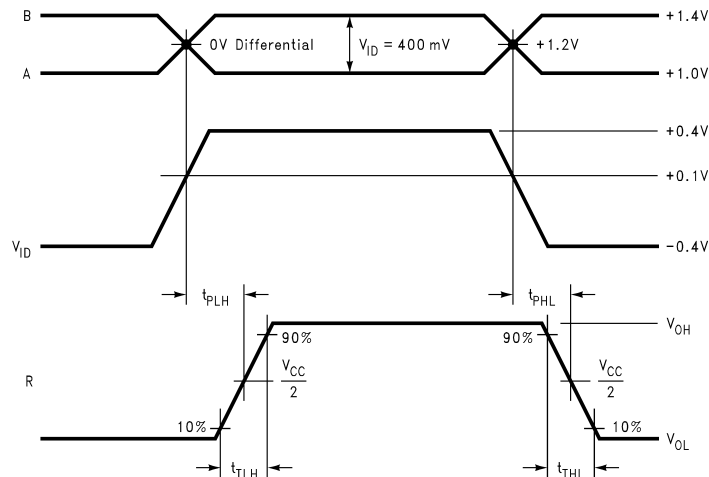


Figure 13. Type 2 Receiver Propagation Delay and Transition Time Waveforms

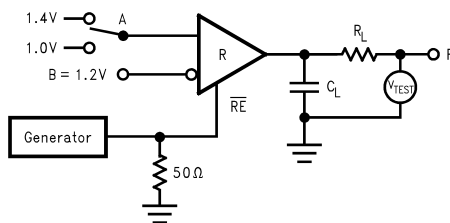


Figure 14. Receiver TRI-STATE Delay Test Circuit

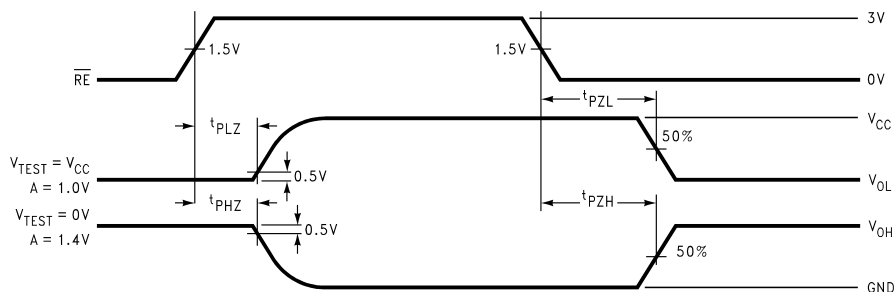


Figure 15. Receiver TRI-STATE Delay Waveforms

TRUTH TABLES

DS91M040 Transmitting⁽¹⁾

Inputs			Outputs	
RE	DE	DI	B	A
X	H	H	L	H
X	H	L	H	L
X	L	X	Z	Z

(1) X — Don't care condition
Z — High impedance state

DS91M040 as Type 1 Receiving⁽¹⁾

Inputs				Output
FSEN	\overline{RE}	DE	A – B	RO
L	L	X	$\geq +0.05V$	H
L	L	X	$\leq -0.05V$	L
L	L	X	$-0.05V \leq A-B \leq +0.05V$	Undefined
L	H	X	X	Z

- (1) X — Don't care condition
Z — High impedance state

DS91M040 as Type 2 Receiving⁽¹⁾

Inputs				Output
FSEN	\overline{RE}	DE	A – B	RO
H	L	X	$\geq +0.15V$	H
H	L	X	$\leq +0.05V$	L
H	L	X	$+0.05V \leq A-B \leq +0.15V$	Undefined
H	H	X	X	Z

- (1) X — Don't care condition
Z — High impedance state

DS91M040 Type 1 Receiver Input Threshold Test Voltages⁽¹⁾

Applied Voltages		Resulting Differential Input Voltage	Resulting Common-Mode Input Voltage	Receiver Output
V_{IA}	V_{IB}	V_{ID}	V_{ICM}	R
2.400V	0.000V	2.400V	1.200V	H
0.000V	2.400V	-2.400V	1.200V	L
3.800V	3.750V	0.050V	3.775V	H
3.750V	3.800V	-0.050V	3.775V	L
-1.350V	-1.400V	0.050V	-1.375V	H
-1.400V	-1.350V	-0.050V	-1.375V	L

- (1) H — High Level
L — Low Level

Output state assumes that the receiver is enabled ($\overline{RE} = L$)

DS91M040 Type 2 Receiver Input Threshold Test Voltages⁽¹⁾

Applied Voltages		Resulting Differential Input Voltage	Resulting Common-Mode Input Voltage	Receiver Output
V_{IA}	V_{IB}	V_{ID}	V_{IC}	R
2.400V	0.000V	2.400V	1.200V	H
0.000V	2.400V	-2.400V	1.200V	L
3.800V	3.650V	0.150V	3.725V	H
3.800V	3.750V	0.050V	3.775V	L
-1.250V	-1.400V	0.150V	-1.325V	H
-1.350V	-1.400V	0.050V	-1.375V	L

- (1) H — High Level
L — Low Level

Output state assumes that the receiver is enabled ($\overline{RE} = L$)

Typical Performance Characteristics

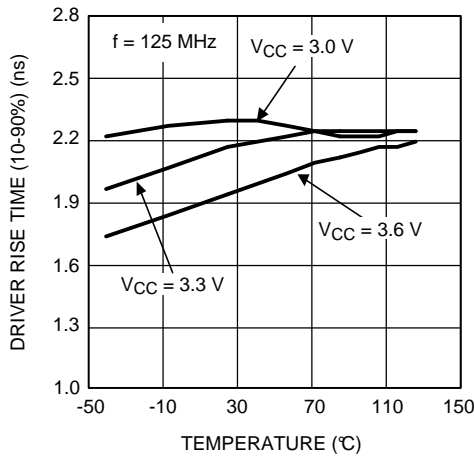


Figure 16. Driver Rise Time as a Function of Temperature

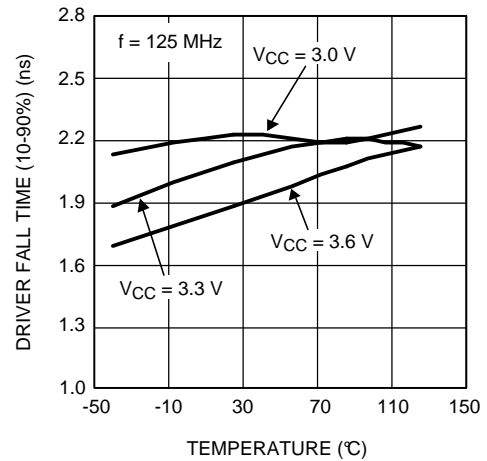


Figure 17. Driver Fall Time as a Function of Temperature

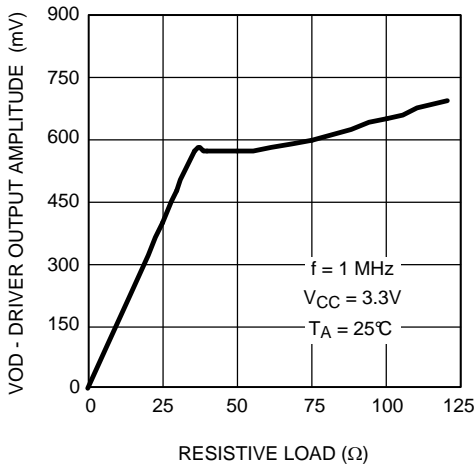


Figure 18. Driver Output Signal Amplitude as a Function of Resistive Load

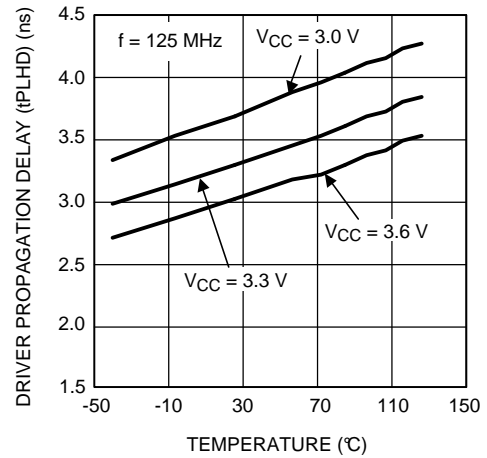


Figure 19. Driver Propagation Delay (tPLHD) as a Function of Temperature

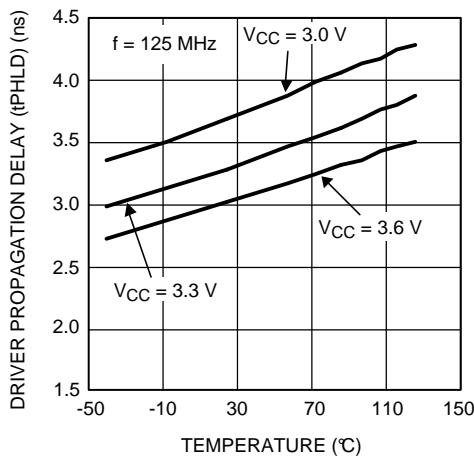


Figure 20. Driver Propagation Delay (tPHLD) as a Function of Temperature

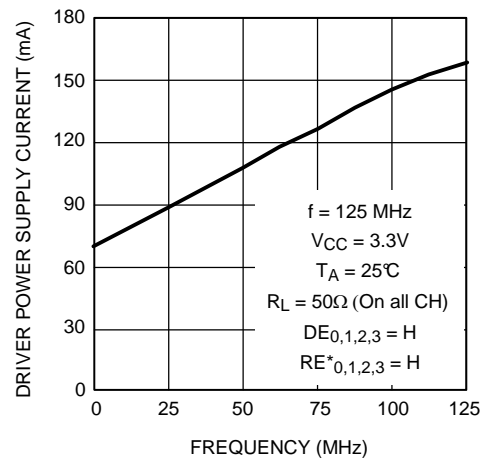


Figure 21. Driver Power Supply Current as a Function of Frequency

Typical Performance Characteristics (continued)

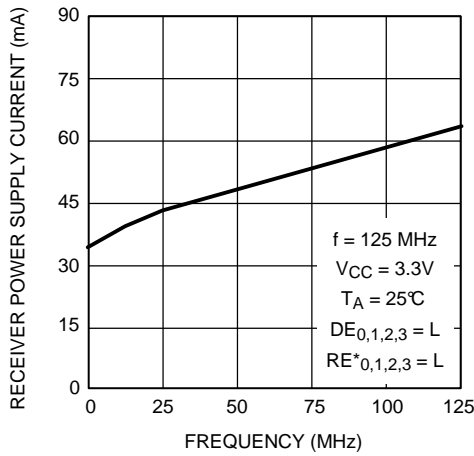


Figure 22. Receiver Power Supply Current as a Function of Frequency

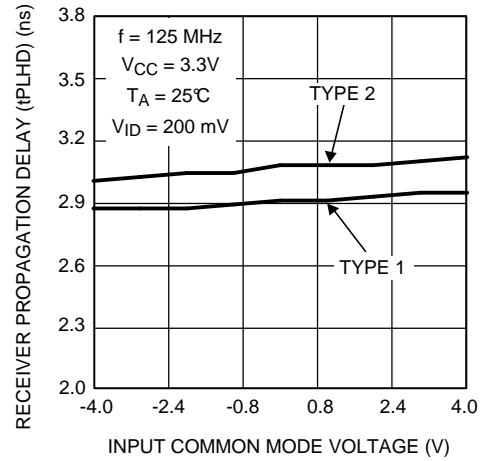


Figure 23. Receiver Propagation Delay (tPLHD) as a Function of Input Common Mode Voltage

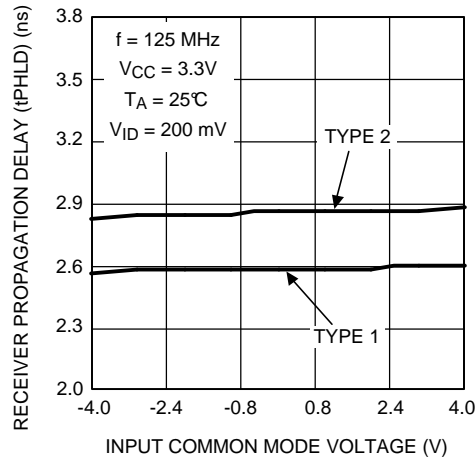


Figure 24. Receiver Propagation Delay (tPHLD) as a Function of Input Common Mode Voltage

REVISION HISTORY

Changes from Revision L (April 2013) to Revision M	Page
• Changed layout of National Data Sheet to TI format	14

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
DS91M040TSQ/NOPB	ACTIVE	WQFN	RTV	32	1000	Green (RoHS & no Sb/Br)	CU SN	Level-3-260C-168 HR	-40 to 85	M040TS	Samples
DS91M040TSQE/NOPB	ACTIVE	WQFN	RTV	32	250	Green (RoHS & no Sb/Br)	CU SN	Level-3-260C-168 HR	-40 to 85	M040TS	Samples
DS91M040TSQX/NOPB	ACTIVE	WQFN	RTV	32	4500	Green (RoHS & no Sb/Br)	CU SN	Level-3-260C-168 HR	-40 to 85	M040TS	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*All dimensions are nominal

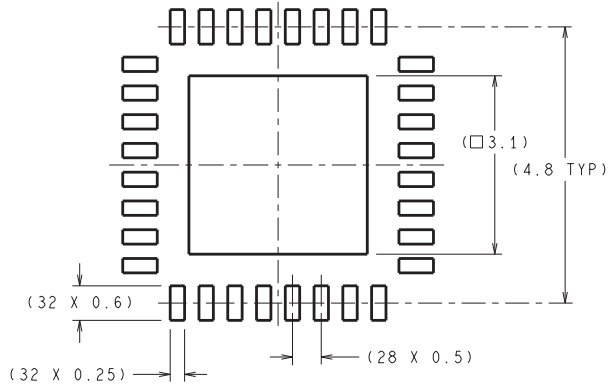
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
DS91M040TSQ/NOPB	WQFN	RTV	32	1000	178.0	12.4	5.3	5.3	1.3	8.0	12.0	Q1
DS91M040TSQE/NOPB	WQFN	RTV	32	250	178.0	12.4	5.3	5.3	1.3	8.0	12.0	Q1
DS91M040TSQX/NOPB	WQFN	RTV	32	4500	330.0	12.4	5.3	5.3	1.3	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DS91M040TSQ/NOPB	WQFN	RTV	32	1000	210.0	185.0	35.0
DS91M040TSQE/NOPB	WQFN	RTV	32	250	210.0	185.0	35.0
DS91M040TSQX/NOPB	WQFN	RTV	32	4500	367.0	367.0	35.0

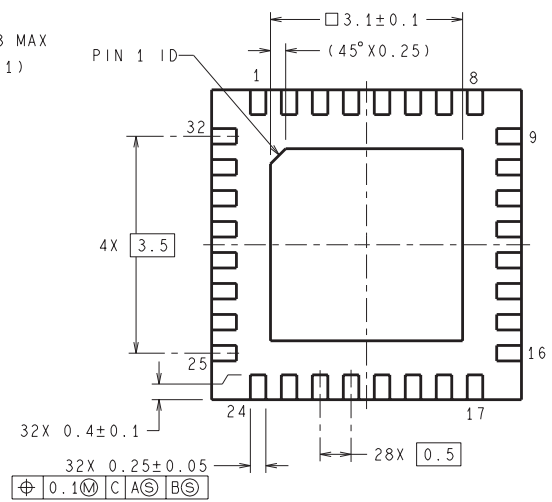
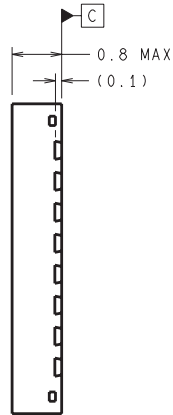
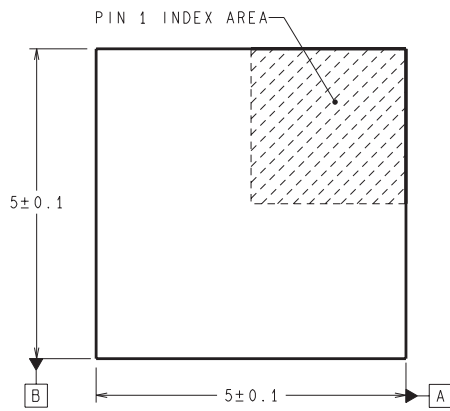
RTV0032A



DIMENSIONS ARE IN MILLIMETERS
DIMENSIONS IN () FOR REFERENCE ONLY



RECOMMENDED LAND PATTERN



SQA32A (Rev B)

IMPORTANT NOTICE

Texas Instruments Incorporated (TI) reserves the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete.

TI's published terms of sale for semiconductor products (<http://www.ti.com/sc/docs/stdterms.htm>) apply to the sale of packaged integrated circuit products that TI has qualified and released to market. Additional terms may apply to the use or sale of other types of TI products and services.

Reproduction of significant portions of TI information in TI data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such reproduced documentation. Information of third parties may be subject to additional restrictions. Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyers and others who are developing systems that incorporate TI products (collectively, "Designers") understand and agree that Designers remain responsible for using their independent analysis, evaluation and judgment in designing their applications and that Designers have full and exclusive responsibility to assure the safety of Designers' applications and compliance of their applications (and of all TI products used in or for Designers' applications) with all applicable regulations, laws and other applicable requirements. Designer represents that, with respect to their applications, Designer has all the necessary expertise to create and implement safeguards that (1) anticipate dangerous consequences of failures, (2) monitor failures and their consequences, and (3) lessen the likelihood of failures that might cause harm and take appropriate actions. Designer agrees that prior to using or distributing any applications that include TI products, Designer will thoroughly test such applications and the functionality of such TI products as used in such applications.

TI's provision of technical, application or other design advice, quality characterization, reliability data or other services or information, including, but not limited to, reference designs and materials relating to evaluation modules, (collectively, "TI Resources") are intended to assist designers who are developing applications that incorporate TI products; by downloading, accessing or using TI Resources in any way, Designer (individually or, if Designer is acting on behalf of a company, Designer's company) agrees to use any particular TI Resource solely for this purpose and subject to the terms of this Notice.

TI's provision of TI Resources does not expand or otherwise alter TI's applicable published warranties or warranty disclaimers for TI products, and no additional obligations or liabilities arise from TI providing such TI Resources. TI reserves the right to make corrections, enhancements, improvements and other changes to its TI Resources. TI has not conducted any testing other than that specifically described in the published documentation for a particular TI Resource.

Designer is authorized to use, copy and modify any individual TI Resource only in connection with the development of applications that include the TI product(s) identified in such TI Resource. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT, AND NO LICENSE TO ANY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT OF TI OR ANY THIRD PARTY IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information regarding or referencing third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of TI Resources may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

TI RESOURCES ARE PROVIDED "AS IS" AND WITH ALL FAULTS. TI DISCLAIMS ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, REGARDING RESOURCES OR USE THEREOF, INCLUDING BUT NOT LIMITED TO ACCURACY OR COMPLETENESS, TITLE, ANY EPIDEMIC FAILURE WARRANTY AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS. TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY DESIGNER AGAINST ANY CLAIM, INCLUDING BUT NOT LIMITED TO ANY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON ANY COMBINATION OF PRODUCTS EVEN IF DESCRIBED IN TI RESOURCES OR OTHERWISE. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, DIRECT, SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF TI RESOURCES OR USE THEREOF, AND REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

Unless TI has explicitly designated an individual product as meeting the requirements of a particular industry standard (e.g., ISO/TS 16949 and ISO 26262), TI is not responsible for any failure to meet such industry standard requirements.

Where TI specifically promotes products as facilitating functional safety or as compliant with industry functional safety standards, such products are intended to help enable customers to design and create their own applications that meet applicable functional safety standards and requirements. Using products in an application does not by itself establish any safety features in the application. Designers must ensure compliance with safety-related requirements and standards applicable to their applications. Designer may not use any TI products in life-critical medical equipment unless authorized officers of the parties have executed a special contract specifically governing such use. Life-critical medical equipment is medical equipment where failure of such equipment would cause serious bodily injury or death (e.g., life support, pacemakers, defibrillators, heart pumps, neurostimulators, and implantables). Such equipment includes, without limitation, all medical devices identified by the U.S. Food and Drug Administration as Class III devices and equivalent classifications outside the U.S.

TI may expressly designate certain products as completing a particular qualification (e.g., Q100, Military Grade, or Enhanced Product). Designers agree that it has the necessary expertise to select the product with the appropriate qualification designation for their applications and that proper product selection is at Designers' own risk. Designers are solely responsible for compliance with all legal and regulatory requirements in connection with such selection.

Designer will fully indemnify TI and its representatives against any damages, costs, losses, and/or liabilities arising out of Designer's non-compliance with the terms and provisions of this Notice.