TFT-LCD I^2C Programmable VCOM Calibrator

The V_{COM} voltage of an LCD panel needs to be adjusted to remove flicker. This part provides a digital interface to control the sink-current output that attaches to an external voltage divider. The increase in output sink current lowers the voltage on the external divider, which is applied to an external V_{COM} buffer amplifier. The desired V_{COM} setting is loaded from an external source via a standard 2-wire I^2C serial interface. At power up, the part automatically comes up at the last programmed EEPROM setting.

An external resistor attaches to the SET pin and sets the full-scale sink current that determines the lowest voltage of the external voltage divider.

The ISL45041 is available in an 8 Ld 3mmx3mm TDFN package with a maximum thickness of 0.8mm for ultra thin LCD panel design.

An evaluation kit complete with software to control the DCP from a computer is available. Reference Application Note AN1275 and “Ordering Information”.

Ordering Information

PART NUMBER (Note)	PART MARKING	TEMP. RANGE (°C)	PACKAGE (Pb-Free)	PKG. DWG. #
ISL45041IRZ	041Z	0 to +85	8 Ld 3x3 TDFN	L8.3X3A
ISL45041IRZ-T*	041Z	0 to +85	8 Ld 3x3 TDFN Tape and Reel	L8.3X3A
ISL45041EVAL1Z	Evaluation Board			

*Please refer to TB347 for details on reel specifications.

NOTE: These Intersil Pb-free plastic packaged products employ special Pb-free material sets, molding compounds/die attach materials, and 100% matte tin plate plus anneal (e3 termination finish, which is RoHS compliant and compatible with both SnPb and Pb-free soldering operations). Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.

Features

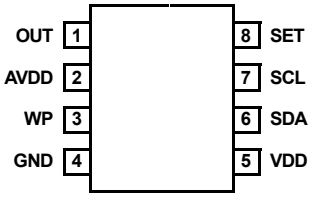
- 128-Step Adjustable Sink Current Output
- 2.25V to 3.6V Logic Supply Voltage Operating Range (2.25V Minimum Programming Voltage)
- Analog Supply Voltage Range 4.5V to 18V for VDD from 2.6V to 3.6V; 4.5V to 13V for VDD from 2.25V to 2.6V
- I^2C Interface (Slave and Transmitter) - Address: 1001111
- On-Board 7-Bit EEPROM
- Output Adjustment SET Pin
- Output Guaranteed Monotonic Over-Temperature
- Thin 8 Ld 3mmx3mm DFN (0.8mm max)
- Pb-free (RoHS compliant)

Applications

- LCD Panels

Pinout

ISL45041
(8 LD TDFN)
TOP VIEW



CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
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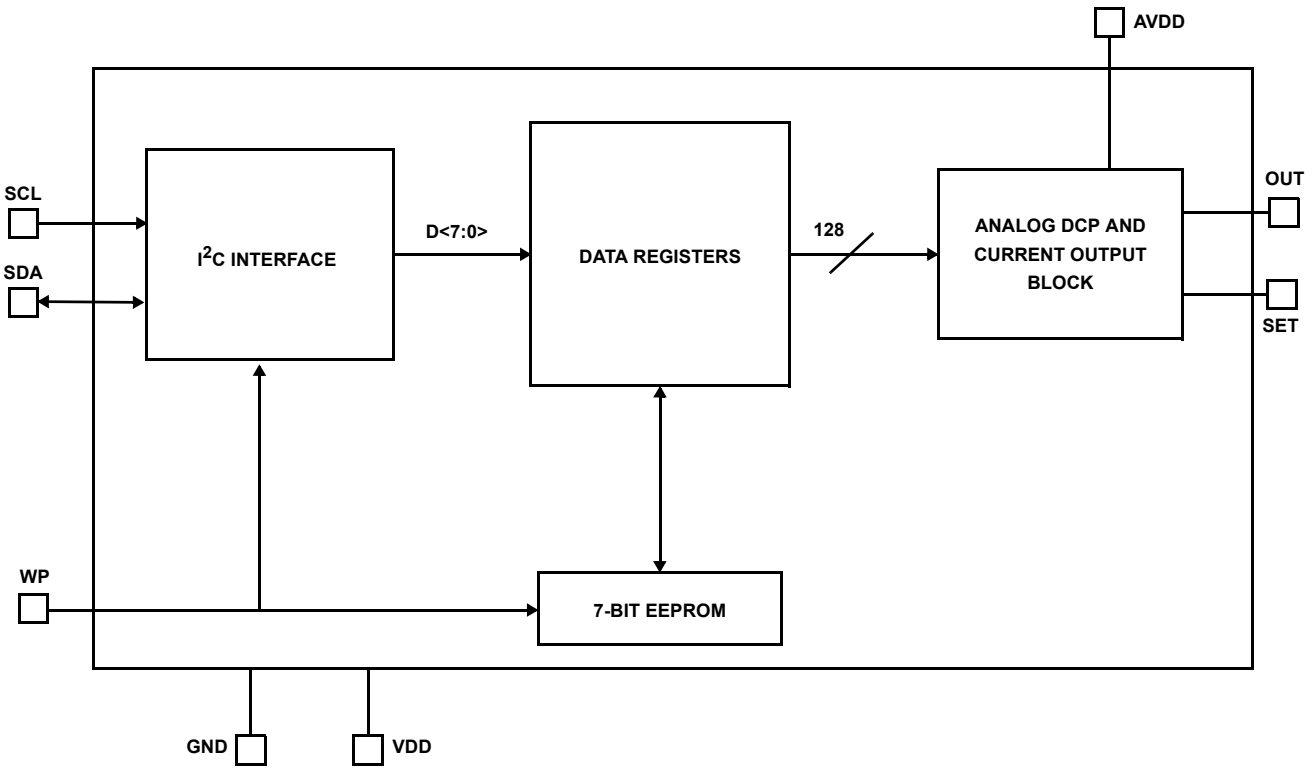
Pin Descriptions

PIN	TYPE	PULL U/D	FUNCTION
OUT	Output		Adjustable Sink Current Output Pin. The current sinks into the OUT pin is equal to the DAC setting times the maximum adjustable sink current divided by 128. See SET pin function description for the maximum adjustable sink current setting.
AVDD	Supply		High-Voltage Analog Supply. Bypass to GND with 0.1µF capacitor.
WP	Input	Pull-Down	Write Protect. Active Low. To enable programming, connect to 0.7*VDD supply or greater. The WP pin is designed for static control. It has an internal pull-down 150k resistor. To avoid possibly over-writing the EEPROM contents, no frequency above 1Hz should be applied to this input. Care should be taken to avoid any glitches on the input. When removing or applying mechanical jumpers, always ensure the VDD power is off. A high to low transition on the WP pin results in the register contents being loaded with EEPROM data.
GND	Supply		Ground connection.
VDD	Supply		System power supply input. Bypass to GND with 0.1µF capacitor.
SDA	In/Out		I^2C Serial Data Input and Output.
SCL	Input		I^2C Clock Input
SET	Analog		Maximum Sink Current Adjustment Point. Connect a resistor from SET to GND to set the maximum adjustable sink current of the OUT pin. The maximum adjustable sink current is equal to (AVDD/20) divided by RSET.

Block Diagram



Absolute Maximum Ratings

V_{DD} to GND . . . . . +4V
Input Voltages to GND
SET . . . . . -0.3V to +4V
AVDD . . . . . -0.3V to +20V
Output Voltages to GND
OUT . . . . . -0.3V to +20V
ESD Rating
HBM for Device 2kV
HBM for Input Pins (SCL, SDA) 4kV

Thermal Information

Thermal Resistance (Typical, Note 1)	θ_{JA} (°C/W)
8 Ld TDFN Package	170

Moisture Sensitivity (see Technical Brief TB363)
All Packages . . . . . Level 2
Maximum Junction Temperature (Plastic Package) . . . . . +150°C
Maximum Storage Temperature Range . . . . . -65°C to +150°C
Pb-free reflow profile . . . . . see link below
http://www.intersil.com/pbfree/Pb-FreeReflow.asp

Operating Conditions

Temperature Range . . . . . 0°C to +85°C

CAUTION: Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions may adversely impact product reliability and result in failures not covered by warranty.

NOTE:

1. θ_{JA} is measured with the component mounted on a high effective thermal conductivity test board in free air. See Tech Brief TB379 for details.

Electrical Specifications

Test Conditions: V_{DD} = 3V, AV_{DD} = 10V, OUT = 5V, R_{SET} = 24.9kΩ; Unless Otherwise Specified. Typicals are at T_A = +25°C

PARAMETER	SYMBOL	TEST CONDITIONS	TEMP (°C)	MIN (Note 7)	TYP	MAX (Note 7)	UNITS
DC CHARACTERISTICS							
V_{DD} Supply Range - Operating	V_{DD}		Full	2.25	-	3.6	V
V_{DD} Supply Range - EEPROM Programming	V_{DD}		Full	2.25	-	3.6	V
V_{DD} Supply Current	I_{DD}	(Note 4)	Full	-	-	50	µA
AVDD Supply Range	AVDD	V_{DD} Range 2.6V to 3.6V	Full	4.5	-	18	V
		V_{DD} Range 2.25V to 2.6V	Full	4.5	-	13	V
AVDD Supply Current	IAVDD	(Note 2)	Full	-	-	25	µA
SET Voltage Resolution	SET_{VR}		Full	7	7	7	Bits
SET Differential Nonlinearity	SET_{DN}	Monotonic Over-Temperature	Full	-	-	±1	LSB
SET Zero-Scale Error	SET_{ZSE}		Full	-	-	±2	LSB
SET Full-Scale Error	SET_{FSE}		Full	-	-	±8	LSB
SET Current	ISET	Through R_{SET} (Note 5)	Full	-	20	-	µA
SET External Resistance	SET_{ER}	To GND, AV_{DD} = 20V	Full	10	-	200	kΩ
		To GND, AV_{DD} = 4.5V	Full	2.25	-	45	kΩ
AVDD to SET Voltage Attenuation	AVDD to SET	(Note 3)	Full	-	1:20	-	V/V
OUT Settling Time	OUT_{ST}	to ±0.5 LSB Error Band (Note 3)	Full	-	8	-	µs
OUT Voltage Range	V_{OUT}		Full	VSET + 0.5V	-	13	V
SET Voltage Drift	SET_{VD}	(Note 3)	25 to 55	-	<10	-	mV
SDA, SCL, WP Input Logic High	VIH		Full	0.7*VDD	-	-	V
SDA, SCL, WP Input Logic Low	VIL		Full	-	-	0.3*VDD	V
SDA, SCL, WP Hysteresis		(Note 3)	Full	-	0.22*VDD	-	V
WP Input Current	IL_{WPN}		Full	15	25	35	µA
SDA, SCL Logic High	VOH_S	@ 3mA	Full	0.4	-	-	V
SDA, SCL Logic Low	VOL_S	@ 3mA	Full	-	-	0.4	V

Electrical Specifications Test Conditions: V_{DD} = 3V, AV_{DD} = 10V, OUT = 5V, R_{SET} = 24.9kΩ; Unless Otherwise Specified. Typicals are at T_A = +25°C **(Continued)**

PARAMETER	SYMBOL	TEST CONDITIONS	TEMP (°C)	MIN (Note 7)	TYP	MAX (Note 7)	UNITS
I^2C							
SCL Clock Frequency	F_{SCL}		Full	0	-	400	kHz
I^2C Clock High Time	t_{SCH}		Full	0.6	-	-	µs
I^2C Clock Low Time	t_{SCL}		Full	1.3	-	-	µs
I^2C Spike Rejection Filter Pulse Width	t_{DSP}		Full	0	-	50	ns
I^2C Data Set-up Time	t_{SDS}		Full	100	-	-	ns
I^2C Data Hold Time	t_{SDH}		Full	0	-	900	ns
I^2C SDA, SCL Input Rise Time	t_{ICR}	Dependent on Load (Note 6)	Full	-	20 + 0.1*Cb	1000	ns
I^2C SDA, SCL Input Fall Time	t_{ICF}	(Note 6)	Full	-	20 + 0.1*Cb	300	ns
I^2C Bus Free Time Between Stop and Start	t_{BUF}		Full	1.3	-	-	µs
I^2C Repeated Start Condition Set-up	t_{STS}		Full	0.6	-	-	µs
I^2C Repeated Start Condition Hold	t_{STH}		Full	0.6	-	-	µs
I^2C Stop Condition Set-up	t_{SPS}		Full	0.6	-	-	µs
I^2C Bus Capacitive Load	Cb		Full	-	-	400	pF
Capacitance on SDA	C_{SDA}		Full	-	-	10	pF
Capacitance on SCL	C_S	WP = 0	Full	-	-	10	pF
		WP = 1		-	-	22	pF
Write Cycle Time	t_W		Full	-	-	100	ms

NOTES:

2. Tested at AV_{DD} = 20V.
3. Simulated and Determined via Design and NOT Directly Tested.
4. Simulated Maximum Current Draw when Programming EEPROM is 23mA, should be considered when designing Power Supply.
5. A Typical Current of 20µA is Calculated using the AVDD = 10V and RSET = 24.9kΩ. Reference “RSET Resistor” on page 5.
6. Simulated and Designed According to I^2C Specifications.
7. Parameters with MIN and/or MAX limits are 100% tested at +25°C, unless otherwise specified. Temperature limits established by characterization and are not production tested.

Application Information

This device provides the ability to reduce the flicker of an LCD panel by adjustment of the V_{COM} voltage during production test and alignment. A 128-step resolution is provided under digital control, which adjusts the sink current of the output. The output is connected to an external voltage divider, so that the device will have the capability to reduce the voltage on the output by increasing the output sink current.

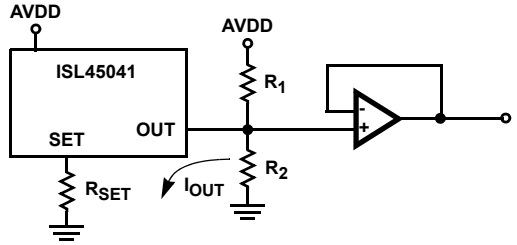


FIGURE 1. OUTPUT CONNECTION CIRCUIT EXAMPLE

The adjustment of the output is provided by the 2-wire I^2C serial interface.

Expected Output Voltage

The ISL45041 provides an output sink current, which lowers the voltage on the external voltage divider (VCOM output voltage). Equation 1 and Equation 2 can be used to calculate the output current (I_{OUT}) and output voltage (V_{OUT}) values.

$$I_{OUT} = \frac{Setting}{128} x \frac{AV_{DD}}{20(R_{SET})} \quad \text{(EQ. 1)}$$

$$V_{OUT} = \left(\frac{R_2}{R_1 + R_2}\right) AV_{DD}\left(1 - \frac{Setting}{128} x \frac{R_1}{20(R_{SET})}\right) \quad \text{(EQ. 2)}$$

NOTE: Where setting is an integer between 1 and 128.

Table 1 gives the calculated value of V_{OUT} for the evaluation board using the on-board resistors values of: R_{SET} = 24.9k, R_1 = 200k, R_2 = 243k, and AV_{DD} = 10V.

TABLE 1.

SETTING VALUE	V_{OUT}
1	5.468
10	5.313
20	5.141
30	4.969
40	4.797
50	4.625

TABLE 1. (Continued)

SETTING VALUE	V_{OUT}
60	4.453
70	4.281
80	4.109
90	3.936
100	3.764
110	3.592
128	3.282

R_{SET} Resistor

The external R_{SET} resistor sets the full-scale sink current that determines the lowest voltage of the external voltage divider R_1 and R_2 (Figure 1). The voltage difference between the OUT pin and SET pin (Figure 2) has to be greater than 1.75V. This will keep the output MOS transistor in the saturation region. Expected current settings and 7-Bit accuracy occurs when the output MOS transistor is operating in the saturation region. Figure 2 shows the internal connection for the output MOS transistor. The value of the AV_{DD} supply sets the voltage at the source of the output transistor. This voltage is equal to (Setting/128) x (AV_{DD}/20). The I_{SET} current is therefore equal to (Setting/128) x (AV_{DD}/20 x R_{SET}). The value of the Drain voltage is found using Equation 2. The values of R_1 and R_2 (Equation 2) should be determined (setting equal to 128) so the minimum value of V_{OUT} is greater than 1.75V + AV_{DD}/20.

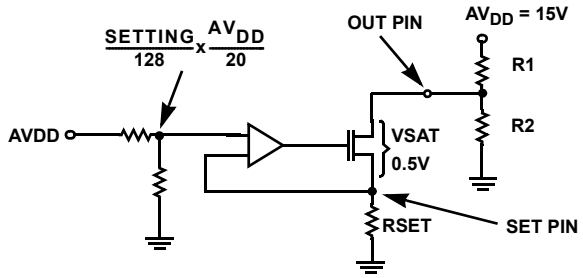


FIGURE 2. OUTPUT CONNECTION CIRCUIT EXAMPLE

Ramp-Up of the VDD Power Supply

It is required that the ramp-up from 10% VDD to 90% VDD level be achieved in less than or equal to 10ms to assure that the EEPROM and Power-on-reset circuits are synchronized and the correct value is read from the EEPROM Memory.

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Intersil Corporation's quality certifications can be viewed at www.intersil.com/design/quality

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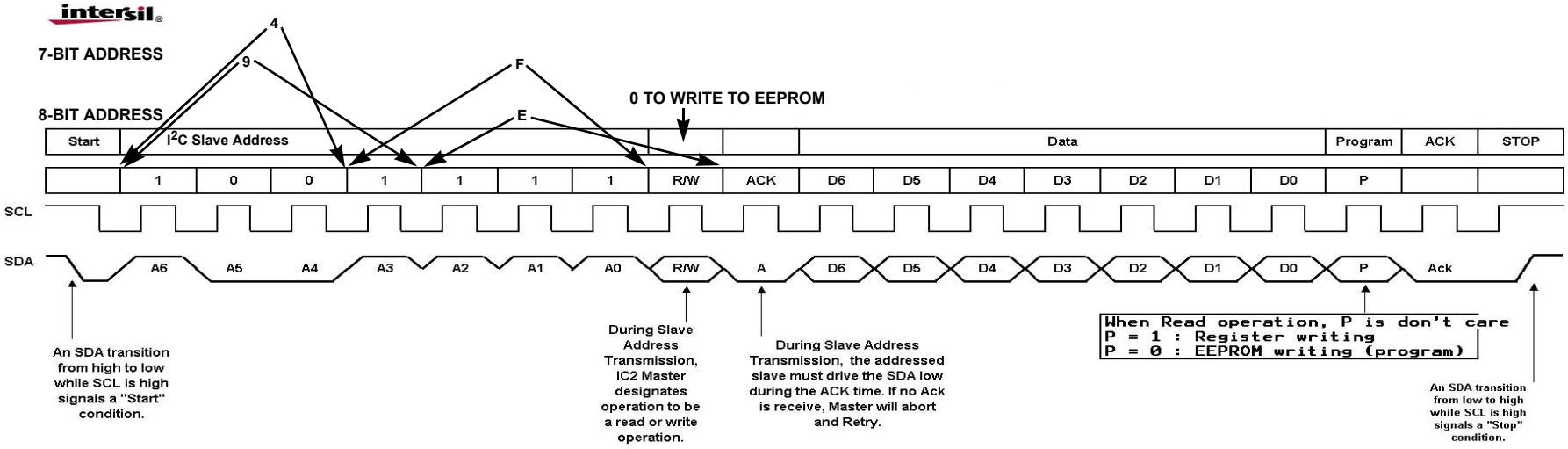
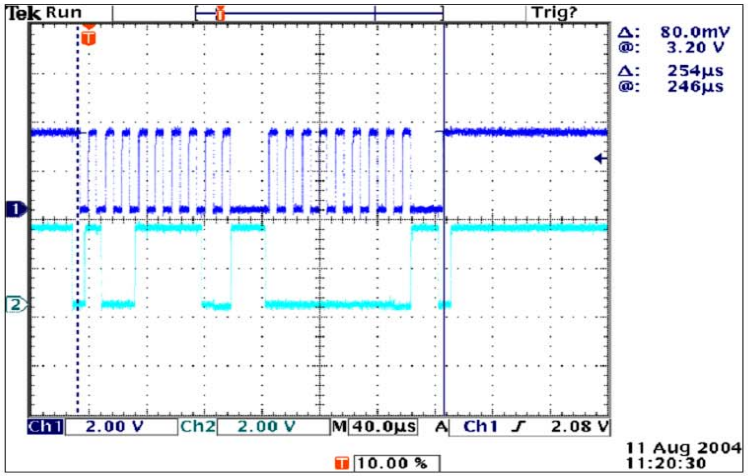
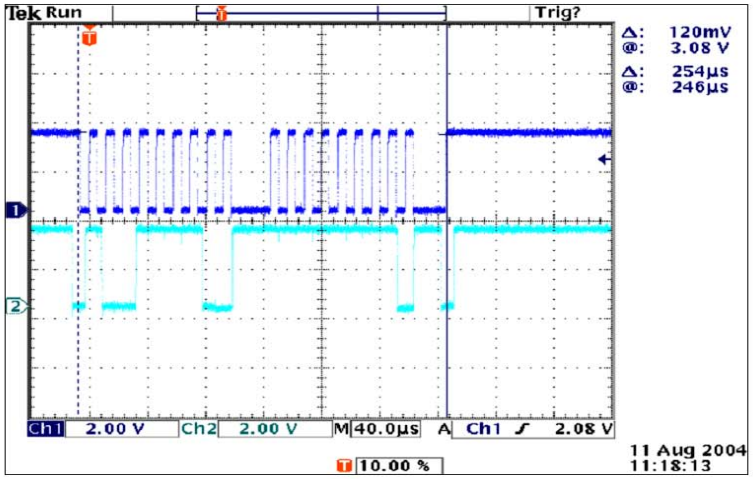
I^2C Timing Diagram

Figure 3 shows the I^2C timing diagram and expected scope photos of SCL and SDA when writing all zeros or all ones.





Writing data = 00 to slave 4F (9E)



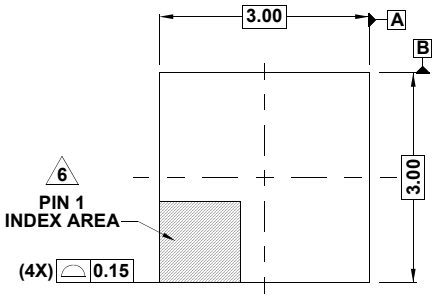
Writing data = FF to slave 4F (9E)

FIGURE 3. ISL45041 I^2C TIMING DIAGRAM

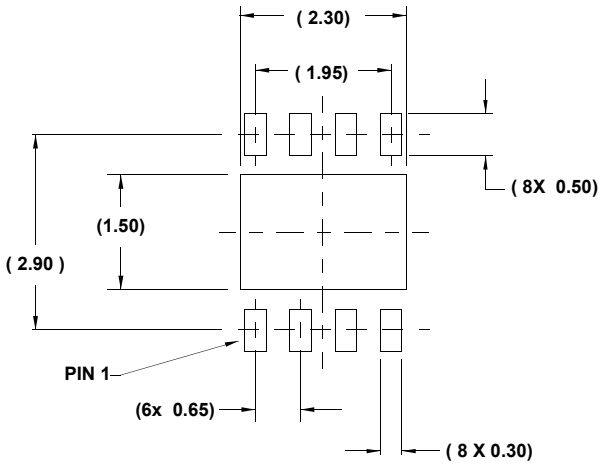
Package Outline Drawing

L8.3x3A

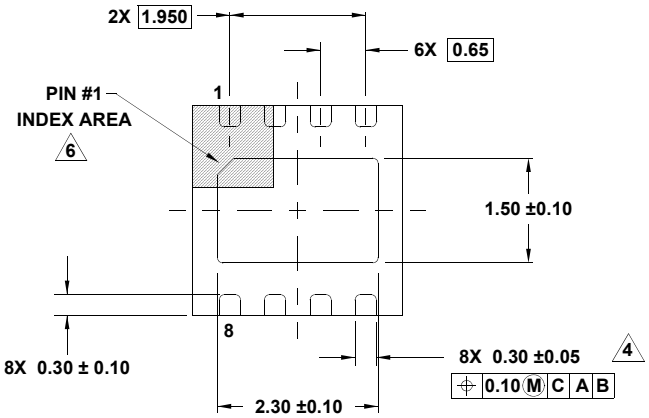
8 LEAD THIN DUAL FLAT NO-LEAD PLASTIC PACKAGE
Rev 4, 2/10



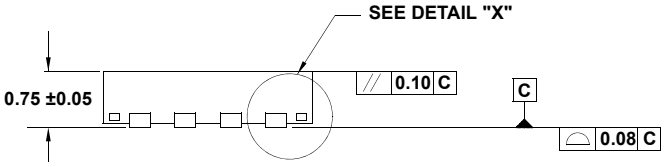
TOP VIEW



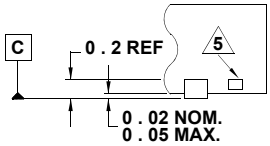
TYPICAL RECOMMENDED LAND PATTERN



BOTTOM VIEW



SIDE VIEW



DETAIL "X"

NOTES:

1. Dimensions are in millimeters.
   Dimensions in ( ) for Reference Only.
2. Dimensioning and tolerancing conform to ASME Y14.5m-1994.
3. Unless otherwise specified, tolerance : Decimal ± 0.05
4. Dimension applies to the metallized terminal and is measured between 0.15mm and 0.20mm from the terminal tip.
5. Tiebar shown (if present) is a non-functional feature.
6. The configuration of the pin #1 identifier is optional, but must be located within the zone indicated. The pin #1 identifier may be either a mold or mark feature.
7. Compliant to JEDEC MO-229 WEEC-2 except for the foot length.