Data Sheet | September 7, 2010 | FN6123.3

I^2C LCD Module Calibrator

The ISL45045 is specifically designed to work in notebook applications where the system's EEPROM is powered up before the rest of the devices on the I^2C bus. This enables data to be downloaded to a graphics card. The ESD protection scheme on the SDA, SCL and SCL_S pins prevent the loading of the I^2C bus during the initialization period prior to full power-up of the notebook.

The VCOM 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 VCOM buffer amplifier. The desired VCOM setting is loaded from an external source via a standard two-wire I^2C serial interface. At power-up, the part automatically comes up at the last programmed setting in an on-board 7-bit EEPROM.

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 ISL45045 is available in an 10 Ld 3mmx3mm TDFN package with a maximum thickness of 0.8mm for ultra thin LCD panel design.

Ordering Information

PART NUMBER (Note)	PART MARKING	TEMP. RANGE (°C)	PACKAGE (Pb-Free)	PKG. DWG. #
ISL45045IRZ	045Z	0 to +85	10 Ld 3x3 TDFN	L10.3x3A
ISL45045IRZ-T*	045Z	0 to +85	10 Ld 3x3 TDFN	L10.3x3A

*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

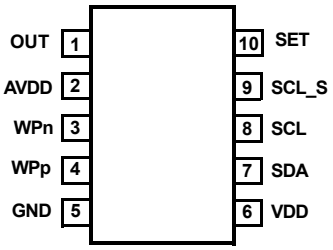
- 128-Step Adjustable Sink Current Output
- 2.25V to 3.6V Logic Supply Voltage Operating Range (2.6V Minimum Programming Voltage)
- Analog Supply Voltage Range 4.5V to 18V for VDD from 2.6V to 3.6V; 4.5V to 13V for VDD from 2.25V to 3.6V
- SDA, SCL, SCL_S pins tolerant to system power-up sequences (i.e will not alter I^2C bus state)
- I^2C Interface (Slave and Transmitter) -- Address: 1001111
- On-board 7-bit EEPROM
- Output adjustment SET Pin
- Output Guaranteed Monotonic Over-Temperature
- Thin 10 Ld 3mmx3mm DFN (0.8mm max)
- Pb-Free (RoHS Compliant)

Applications

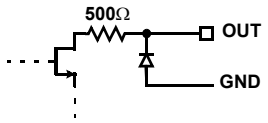
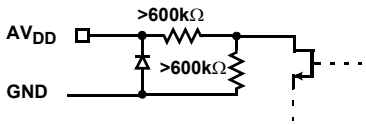
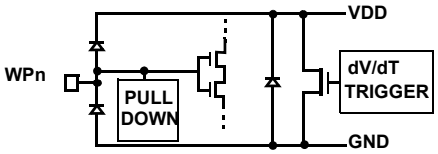
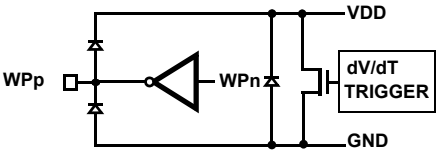
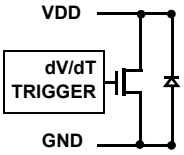
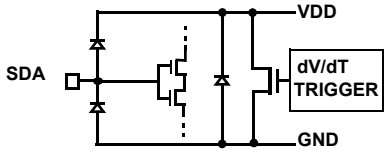
- LCD Panels

Pinout

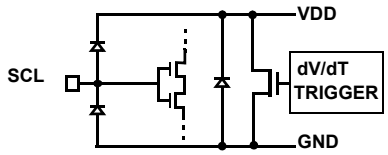
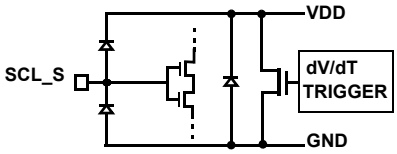
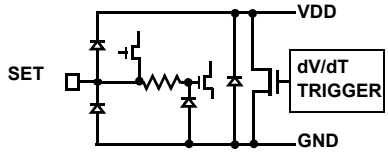
ISL45045
(10 LD TDFN)
TOP VIEW



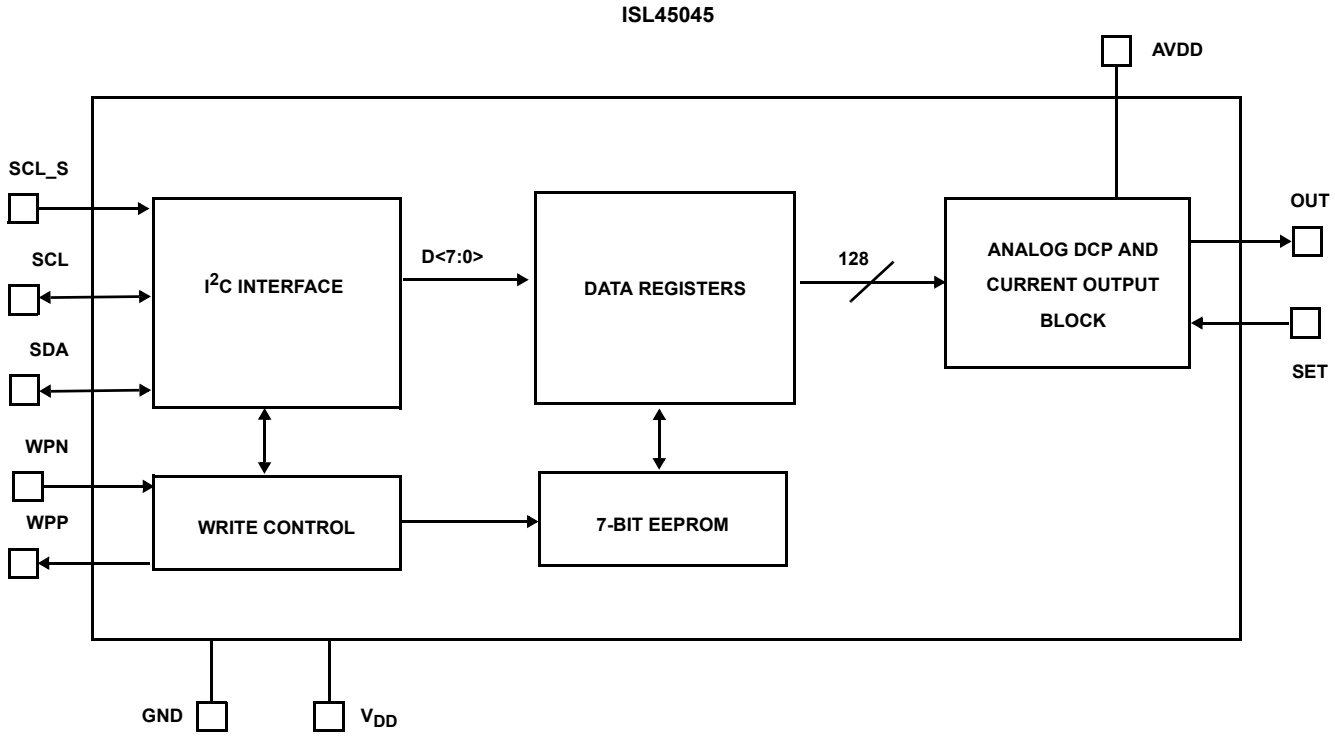
Pin Descriptions

PIN	TYPE	PULL U/D	FUNCTION	EQUIVALENT CIRCUIT
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.	
AV_{DD}	Supply		High-Voltage Analog Supply. Bypass to GND with 0.1µF Capacitor.	
WPn	Input	Pull-Down	Write Protection Active Low. CMOS Level.	
WPp	Output		Output Pin. Opposite Logic Level of WPn Pin.	
GND	Supply		Ground.	
VDD	Supply		System Power Supply Input. Bypass to GND With 0.1µF Capacitor.	
SDA	In/Out	Open Drain Output	I^2C Serial Data Input/Output.	

Pin Descriptions (Continued)

PIN	TYPE	PULL U/D	FUNCTION	EQUIVALENT CIRCUIT
SCL	In/Out	Open Drain Output	Serial Clock Input for Internal and Inter-IC Use.	
SCL_S	Input		Serial 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 (AV_{DD}/20) divided by RSET.	

Block Diagram



Absolute Maximum Ratings

V_{DD} to Ground . . . . . +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
Human Body Model 2kV

Operating Conditions

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

Thermal Information

Thermal Resistance (Typical, Note 1)	θ_{JA} (°C/W)
10 Ld TDFN Package	90

Moisture Sensitivity (see Technical Brief TB363)
All Packages . . . . . Level 1
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
Erase/Write Cycles 10,000
Data Retention . . . . . 10 years @ +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 in free air with the component mounted on a high effective thermal conductivity test board with “direct attach” features. See Tech Brief TB379.

Electrical Specifications

Test Conditions: V_{DD} = 3V, AVDD = 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	2.6	-	3.6	V
V_{DD} Supply Current	I_{DD}	(Note 4)	Full	-	-	50	µA
AVDD Supply Range	AVDD	VDD range 2.6V to 3.6V	Full	4.5	-	18	V
		VDD range 2.25V to 3.6V		4.5	-	13	V
AVDD Supply Current	IAVDD	(Note 2)	Full	-	-	25	µA
SET Voltage Resolution	SET_{VR}		Full		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, AVDD = 20V	Full	10	-	200	kΩ
		To GND, AVDD = 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, SCL_S, WPn Input Logic High	VIH		Full	0.7*VDD	-	-	V
SDA, SCL, SCL_S, WPn Input Logic Low	VIL		Full	-	-	0.3*VDD	V
SDA, SCL, SCL_S, WPn Hysteresis		(Note 3)	Full	-	0.22*VDD	-	V

Electrical Specifications Test Conditions: V_{DD} = 3V, AVDD = 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
WPn IL	IL_{WPN}		Full	15	25	35	µA
SDA, SCL Output Logic High	VOH_S	@ 3mA	Full	0.4	-	-	V
SDA, SCL Output Logic Low	VOL_S	@ 3mA	Full	-	-	0.4	V
WPp Output Logic High	VOH_{WPP}	@ 3mA	Full	VDD - 0.4	-	-	V
WPp Output Logic Low	VOL_{WPP}	@ 3mA	Full	0.4	-	-	V
WPp Delay	t_{DWPP}		Full	-	-	100	ns
SCL_S to SCL On Resistance			Full	-	-	75	Ω
Delay From SCL_S to SCL	t_S		Full	-	-	60	ns
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, SCL_S	C_S	WPn = 0	Full	-	-	10	pF
		WPn = 1		-	-	22	pF
Write Cycle Time	t_W		Full	-	-	100	ms

NOTES:

2. Tested at AVDD = 18V.
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 R_{SET} = 24.9kΩ. The maximum suggested SET Current should be 120µA.
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.

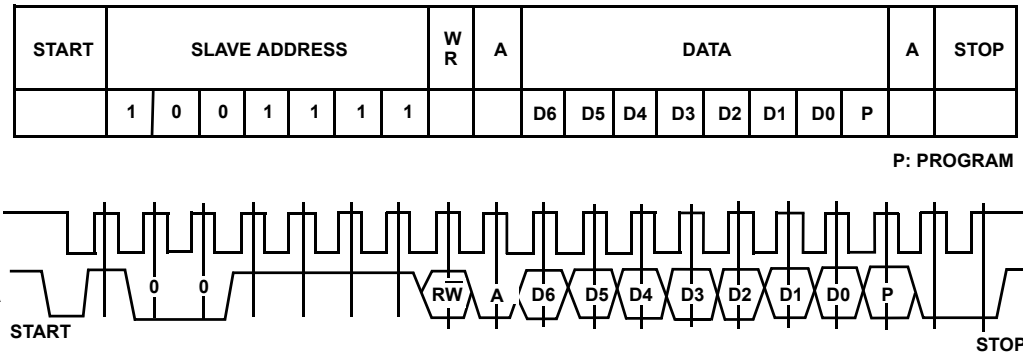
Truth Tables

TABLE 1. DVR WRITE PROTECTION TRUTH TABLE

INPUT			OUTPUT		
WPn	**SCL_S**	**SCL**	**WPp**	**REGISTER**	**EEPROM**
LOW	UNUSED	INPUT	HIGH	Write Protect	Write Protect
HIGH	CONNECTED TO SCL	CONNECTED TO SCL_S	LOW	Writeable	Writeable
HIGH to LOW	DISCONECTS FROM SCL	DISCONECTS FROM SCL_S	LOW to HIGH	EEPROM is Read into Register	EEPROM is Read into Register
FLOAT (Pull-Down Resistor Included)	UNUSED	INPUT	HIGH	Write Protect	Write Protect

NOTE: When the device is not write-protected SCL_S and SCL signals should not be driven at the same time. When SCL_S signal is “Unused” should be left floating.

I^2C Bus Format



When Read Operation, don’t care P.
P = 1: Register Writing
P = 0: EEPROM Writing (Program)

Application Information

This device provides the ability to reduce the flicker of an LCD panel by adjustment of the VCOM 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.

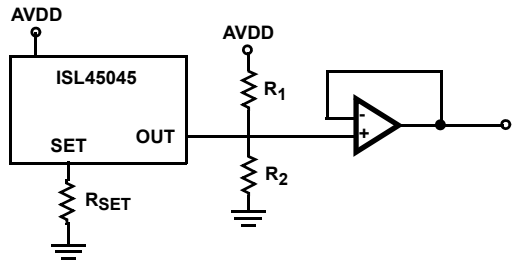


FIGURE 1. OUTPUT CONNECTION CIRCUIT EXAMPLE

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

Adjustable Sink Current Output

The device provides an output sink current which lowers the voltage on the external voltage divider. Equations 1 and 2 control the output. See Figure 1.

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

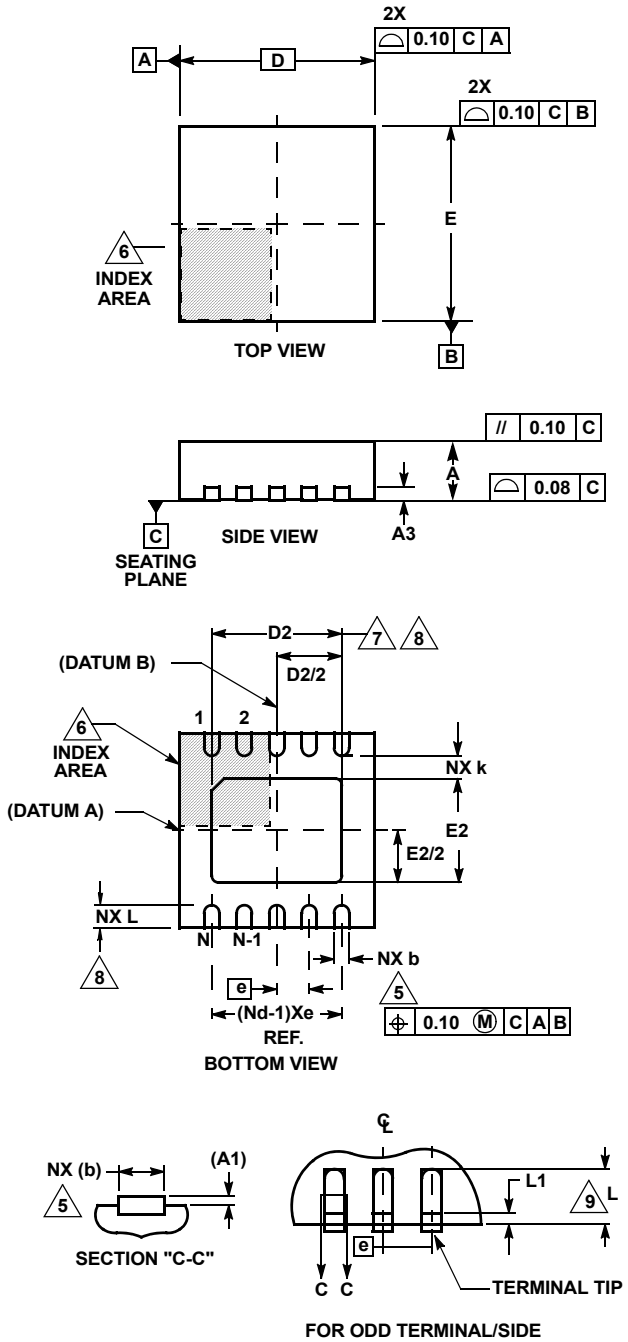
$$V_{OUT} = \left(\frac{R2}{R1+R2}\right) VAVDD\left(1 - \frac{Setting}{128} X \frac{R1}{20(R_{SET})}\right) \quad \text{(EQ. 2)}$$

Note: Where (Setting) is indicated, must be an integer between 1 and 128.

Ramp-up of the VDD Power Supply

It is required that the ramp-up from 10% VDD to 90% VDD 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.

Thin Dual Flat No-Lead Plastic Package (TDFN)



L10.3x3A

10 LEAD THIN DUAL FLAT NO-LEAD PLASTIC PACKAGE

SYMBOL	MILLIMETERS			NOTES
	MIN	NOMINAL	MAX	
A	0.70	0.75	0.80	-
A1	-	-	0.05	-
A3		0.20 REF		-
b	0.20	0.25	0.30	5, 8
D	2.95	3.0	3.05	-
D2	2.25	2.30	2.35	7, 8
E	2.95	3.0	3.05	-
E2	1.45	1.50	1.55	7, 8
e		0.50 BSC		-
k	0.25	-	-	-
L	0.25	0.30	0.35	8
N		10		2
Nd		5		3

Rev. 3 3/06

NOTES:

1. Dimensioning and tolerancing conform to ASME Y14.5-1994.
2. N is the number of terminals.
3. Nd refers to the number of terminals on D.
4. All dimensions are in millimeters. Angles are in degrees.
5. Dimension b applies to the metallized terminal and is measured between 0.15mm and 0.30mm from the terminal tip.
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. Dimensions D2 and E2 are for the exposed pads which provide improved electrical and thermal performance.
8. Nominal dimensions are provided to assist with PCB Land Pattern Design efforts, see Intersil Technical Brief TB389.
9. Compliant to JEDEC MO-229-WEED-3 except for D2 dimensions.