Microsemi
INTEGRATED PRODUCTS

PanelMatch™ **LXM1644-12-61**

12V Quad 6W CCFL Programmable Inverter Module

PRELIMINARY DATASHEET

DESCRIPTION

The LXM1644-12-61 is a Quad 6W Output Direct Drive™ CCFL (Cold Cathode Fluorescent Lamp) Inverter Module specifically designed for driving LCD backlight lamps. It is ideal for driving typical 12.1" to 18.1" TFT panels.

The modules are available with a dimming input that permits brightness control from either a DC voltage source or a PWM signal or external Potentiometer. The maximum output current is externally programmable over a range of 10 to 16mA in 1mA steps to allow the inverter to properly match to a wide array of LCD panel lamp current specifications.

LXM1644 modules unlike the LXM1643 series does not provide wide range 'burst' mode dimming, rather dimming is provided by amplitude control of the output current waveform, this limits the potential dim range to typically less than 5:1.

For applications not requiring wide range dimming, amplitude control results in lower ripple on the input supply and reduced potential transient noise generation. Many STN type panels are particularly well suited for current amplitude dimming.

The modules convert DC voltage from the system battery or AC adapter directly to high frequency, high-voltage waves required to ignite and operate CCFL lamps.

The LXM1644-12-61 inverter is intended for panel assemblies where lamp pairs share close proximity with one another and a common return (low side) wire.

Other benefits of this new topology are stable fixed-frequency operation, secondary-side strike-voltage regulation and both open/shorted lamp protection with fault timeout.

IMPORTANT: For the most current data and a panel to inverter cross reference, consult *MICROSEMI*'s website: **http://www.microsemi.com**

KEY FEATURES

- Externally Programmable Maximum Output Current
- Easy to Use Brightness Control
- Analog Current Amplitude Dimming Method
- Output Open/Short-Circuit Protection and Timeout
- Fixed Frequency Operation
- Rated From -20 to 70°C
- UL 60950 E175910

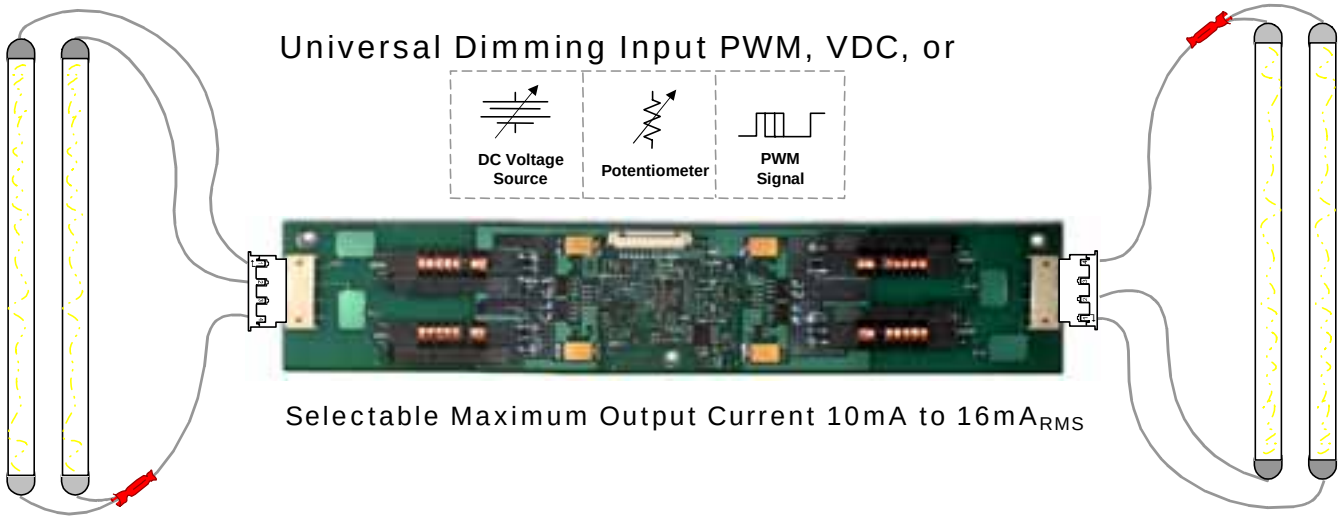
APPLICATIONS

- High Brightness Displays
- Desktop Displays
- Industrial Display Controls

BENEFITS

- Compact, Low Profile Design
- Programmable output current allows inverter to mate with a wide variety of LCD panel's specifications

PRODUCT HIGHLIGHT



PACKAGE ORDER INFO

ART NUMBER	OUTPUT CONNECTORS	INVERTER MATES DIRECTLY TO PANEL CONNECTORS
LXM1644-12-61	Two JST SM04(4.0)B-BHS-1-TB or Yeon Ho 20015WR-07A00	JST BHR-04VS-1

Rev. 0.5b, 2004-11-03

Microsemi
Integrated Products
11861 Western Avenue, Garden Grove, CA. 92841, 714-898-8121, Fax: 714-893-2570

ABSOLUTE MAXIMUM RATINGS (NOTE 1)

Input Signal Voltage (V_{IN1}) ..... -0.3V to 15V
Input Power 30W
Output Voltage, no load ..... Internally Limited to 2000V_{RMS}
Output Current (each output) ..... 9.5mA_{RMS} (Internally Limited)
Output Power (each output) 6.0W

Input Signal Voltage ($\overline{SLEEP}$ Input) ..... -0.3V to V_{IN1}
Input Signal Voltage (BRITE) ..... -0.3V to 5.5V
Ambient Operating Temperature, zero airflow ..... -20°C to 70°C
Operating Relative Humidity, non-condensing ..... ≤90%
Storage Temperature Range ..... -40°C to 85°C

Note 1: Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of specified terminal.

RECOMMENDED OPERATING CONDITIONS (R.C.)

This module has been designed to operate over a wide range of input and output conditions. However, best efficiency and performance will be obtained if the module is operated under the condition listed in the 'R.C.' column. Min. and Max. columns indicate values beyond which the inverter, although operational, will not function optimally.

Parameter	Symbol	Recommended Operating Conditions			Units
		Min	R.C.	Max	
Input Supply Voltage Range (Fully Regulated Lamp Current)	V_{IN1}	10.8	12	13.2	V
Input Supply Voltage Range (Functional)		10.2	12	13.8	
Output Power (each lamp)	P_O		5.0	6.0*	W
Linear BRITE Control Input Voltage Range[1]	V_{BRT_ADJ}	0.65 to 0.9		2.0	V
Lamp Operating Voltage	V_{LAMP}	530	625	720	V_{RMS}
Lamp Current (Each pair, Full Brightness)	I_{OLAMP}	10		16	mA_{RMS}
Operating Ambient Temperature Range	T_A	-20		70	°C

*Total output power must not exceed 12W per lamp pair. Higher voltage lamps may require the maximum output current to be set lower 16mA

[1] The minimum $V_{BRT\ ADJ}$ voltage depends on the panel characteristics, depending on the panel it can vary from 0.65V to 0.9V

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, the following specifications apply over the recommended operating condition and ambient temperature of 25°C except where otherwise noted.

Parameter	Symbol	Test Conditions	LXM1644-12-61			Units
			Min	Typ	Max	
OUTPUT PIN CHARACTERISTICS						
Full Bright Lamp Current (two lamps)	$I_{L(MAX)}$	$V_{BRT\_ADJ} \geq 2.0V_{DC}$, $\overline{SLEEP} \geq 2.0V$, $V_{IN1} = 12V_{DC}$ I_{SET1} = Ground, I_{SET2} = Ground	9	10	11	mA_{RMS}
Full Bright Lamp Current (two lamps)	$I_{L(MAX)}$	$V_{BRT\_ADJ} \geq 2.0V_{DC}$, $\overline{SLEEP} \geq 2.0V$, $V_{IN1} = 12V_{DC}$ I_{SET1} = Ground, I_{SET2} = Open	10.8	12	13	mA_{RMS}
Full Bright Lamp Current (two lamps)	$I_{L(MAX)}$	$V_{BRT\_ADJ} \geq 2.0V_{DC}$, $\overline{SLEEP} \geq 2.0V$, $V_{IN1} = 12V_{DC}$ I_{SET1} = Open, I_{SET2} = Ground	12.8	14	15	mA_{RMS}
Full Bright Lamp Current (two lamps)	$I_{L(MAX)}$	$V_{BRT\_ADJ} \geq 2.0V_{DC}$, $\overline{SLEEP} \geq 2.0V$, $V_{IN1} = 12V_{DC}$ I_{SET1} = Open, I_{SET2} = Open	14.7	16	17	mA_{RMS}
Output Current pair of Lamps to pair of Lamps Deviation	$I_{LL\%DEV}$	$V_{BRT\_ADJ} \geq 2.0V_{DC}$, $\overline{SLEEP} \geq 2.0V$, $V_{IN1} = 12V_{DC}$ I_{SET1} = Open, I_{SET2} = Open		3	10	%
Min. Average Lamp Current (each output)	$I_{L(MIN)}$	$V_{BRT\_ADJ} \leq 0.5V_{DC}$, $\overline{SLEEP} \geq 2.0V$, $V_{IN1} = 12V_{DC}$ $I_{SET1} = I_{SET2}$ = Ground		5.5[2]		mA_{RMS}
Lamp Start Voltage	V_{LS}	-20°C < T_A < 70°C, $V_{IN1} > 10.8V_{DC}$	1500	1650		V_{RMS}
Operating Frequency	f_O	$V_{BRT\_ADJ} = 2.5V_{DC}$, $\overline{SLEEP} \geq 2.0V$, $V_{IN1} = 12V$	69	72	75	kHz

[2] The inverter is capable of a lower output current than may be recommended by the panel manufacturer. It is the user's responsibility to set the minimum brightness (BRITE) input at or above the panel specification for minimum current.

Microsemi
Integrated Products
11861 Western Avenue, Garden Grove, CA. 92841, 714-898-8121, Fax: 714-893-2570

ELECTRICAL CHARACTERISTICS (CONTINUED)

Unless otherwise specified, the following specifications apply over the recommended operating condition and ambient temperature of 25°C except where otherwise noted.

Parameter	Symbol	Test Conditions	LXM1644-12-61 Min	LXM1644-12-61 Typ	LXM1644-12-61 Max	Units
BRITE INPUT						
Input Current	I_{BRT}	V_{BRT_ADJ} = 0V_{DC}		-300		μA_{DC}
		V_{BRT_ADJ} = 3V_{DC}		50		μA_{DC}
Minimum Input for Max. Lamp Current	V_{BRT_ADJ}	$I_{O(LAMP)}$ = Maximum Lamp Current		2.0	2.05	V_{DC}
Minimum Input for Min. Lamp Current	V_{BRT_ADJ}	$I_{O(LAMP)}$ = Minimum Lamp Current	0.65*			V_{DC}
SLEEP INPUT						
RUN Mode	$V_{\overline{SLEEP}}$		2.0		V_{IN1}	V_{DC}
SLEEP Mode	$V_{\overline{SLEEP}}$		-0.3		0.8	V_{DC}
$SET_{1,2}$ INPUT						
$SET_{1,2}$ Low Threshold	V_L				0.4	V
Input Current	I_{SET}	$V_{SET} \leq 0.4V$		-300		µA
POWER CHARACTERISTICS						
Sleep Current	$I_{IN(MIN)}$	V_{IN1} = 12V_{DC}, $\overline{SLEEP} \leq 0.8V$	0.0	10	30	μA_{DC}
Run Current	I_{RUN}	V_{IN1} = 12V_{DC}, $\overline{SLEEP} \geq 2.0V$, I_{SET1} = Open, I_{SET2} = Ground, V_{LAMP} = 625V_{RMS}		1750		mA_{DC}
Efficiency	η	V_{IN1} = 12V_{DC}, $\overline{SLEEP} \geq 2.0V$, I_{SET1} = Open, I_{SET2} = Ground, V_{LAMP} = 625V_{RMS}		85		%

* The Inverter is capable of a lower output current than may be recommended by the panel manufacturer. It is the user's responsibility to set the minimum brightness (BRITE) input at or above the panel specification for minimum current. This is likely greater than the 0.65V minimum input.

FUNCTIONAL PIN DESCRIPTION

CONN	PIN	DESCRIPTION
CN1 (Molex 53261-1290) Mates with 51021-1200 housing, 50079-8100 pins. Mates with LX9508 input cable assembly		
CN1-1,2,3	V_{IN1}	Main Input Power Supply (10.8V $\leq V_{IN1} \leq$ 13.2V)
CN1-4,5,6	GND	Power Supply Return
CN1-7	AGND	Analog Signal Ground
CN1-8	NC	No Connect
CN1-9	$\overline{SLEEP}$	ON/OFF Control. (0V < $\overline{SLEEP}$ < 0.8 = OFF, $\overline{SLEEP}$ >= 2.0V = ON
CN1-10	BRITE	Brightness Control (0.65V to 2.0V). 2.0V_{DC} gives maximum lamp current.
CN1-11	SET_1	SET_1 MSB Connecting this pin to ground decreases the output current (see Table 1)
CN1-12	SET_2	SET_2 LSB Connecting this pin to ground decreases the output current (see Table 1)
CN2, CN3 (JST SM04(4.0)B-BHS-1-TB or Yeon Ho 20015WR-07A00)		
CN2,3-1	V_{HI1}	High voltage connection to high Side of lamp. Connect to lamp terminal with shortest lead length. **DO NOT** connect to Ground.
CN2,3-2	V_{HI2}	High voltage connection to high Side of lamp. Connect to lamp terminal with shortest lead length. **DO NOT** connect to Ground.
CN2,3-3	NC	Open Pin
CN2,3-4	V_{LO}	Connection to low side of lamps. Connect to lamp terminal with longer lead length. **DO NOT** connect to Ground

Microsemi
Integrated Products
11861 Western Avenue, Garden Grove, CA. 92841, 714-898-8121, Fax: 714-893-2570

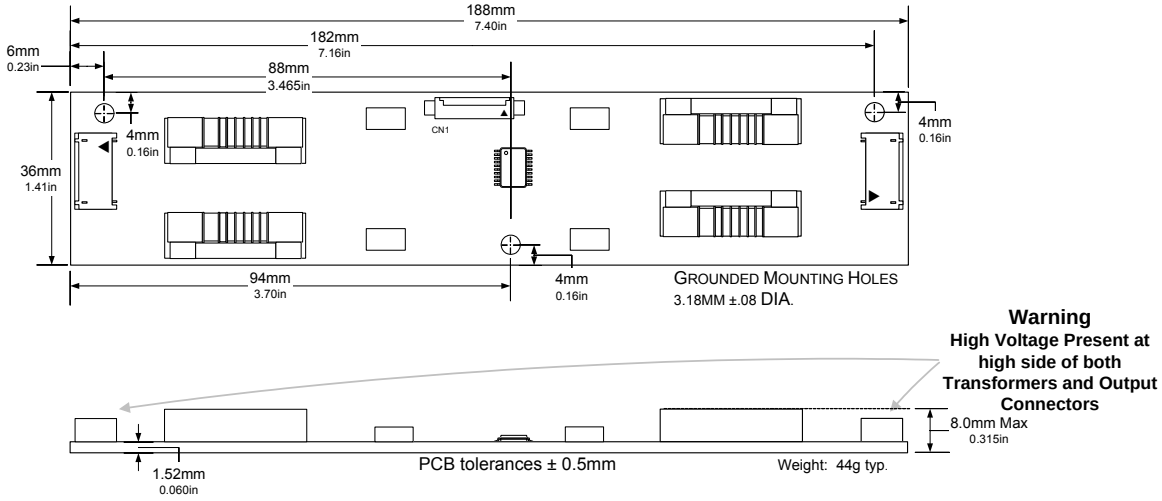
TABLE 1

OUTPUT CURRENT SETTINGS (TWO LAMPS)

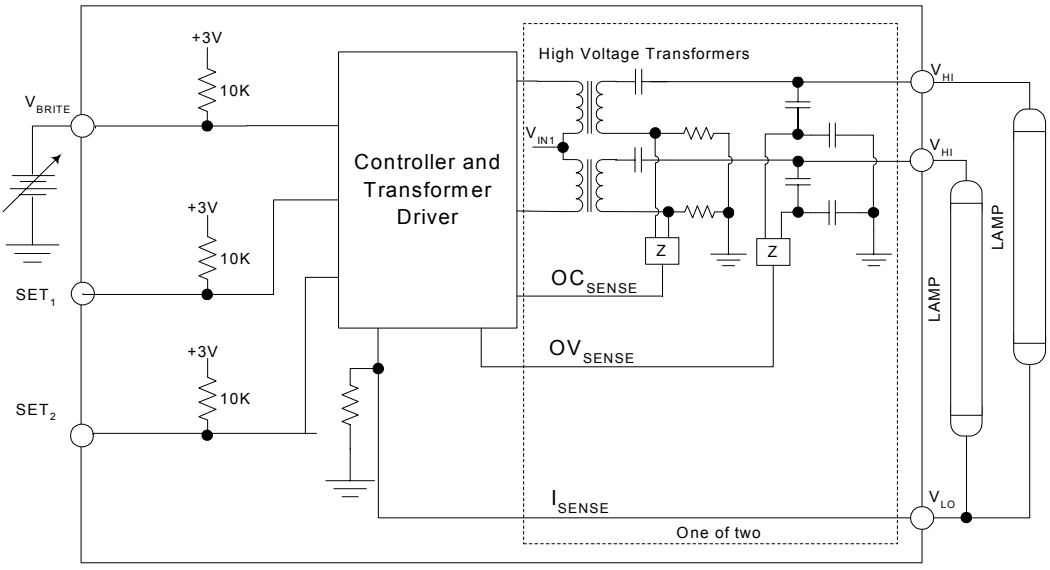
SET_1 (Pin 11)	SET_2 (Pin 12)	Nominal Output Current
Open*	Open*	16.0mA
Open*	Ground	14.0mA
Ground	Open*	12.0mA
Ground	Ground	10.0mA

* If driven by a logic signal it should be open collector or open drain only, not a voltage source.

PHYSICAL DIMENSIONS



SIMPLIFIED BLOCK DIAGRAM



Microsemi
Integrated Products
11861 Western Avenue, Garden Grove, CA. 92841, 714-898-8121, Fax: 714-893-2570

TYPICAL APPLICATION

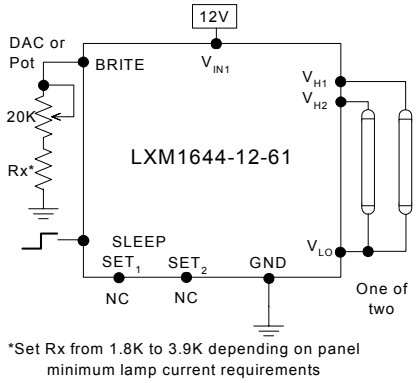


Figure 1 – Brightness Control
(Output current set to maximum)

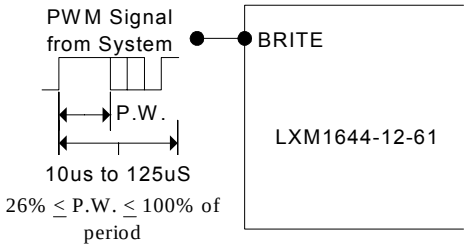
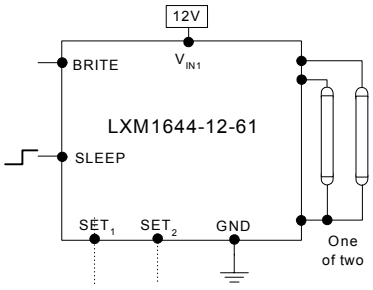


Figure 1A – PWM Brightness Control



L	L	10.0mA$_{RMS}$
L	H	12.0mA$_{RMS}$
H	L	14.0mA$_{RMS}$
H	H	16.0mA$_{RMS}$

L=GND; H=Open

Figure 2 – Max Output Current (Two Lamps)
(SET_1 and SET_2 Inputs)

- The brightness control may be a voltage output DAC or other voltage source, a digital pot or 20K manual pot. The inverter contains an internal 10K pull-up to 3V to bias the pot, add a 1.8K to 3.9K resistor to set the lower threshold voltage. A 3.3V Logic Level PWM signal from a micro-controller may also be used as shown in Figure 1A.
- If you need to turn the inverter ON/OFF remotely, connect to TTL logic signal to the $\overline{\text{SLEEP}}$ input.
- Connect V_{HI} to high voltage wire from the lamp. Connect V_{LO} to the low voltage wire (wire with thinner insulation). Never connect V_{LO} to circuit ground as this will defeat lamp current regulation. If both lamp wires have heavy high voltage insulation, connect the longest wire to V_{LO}. This wire is typically white.
- Use the SET_1 and SET_2 (see Figure 2) inputs to select the desired maximum output current. Using these two pins in combination allows the inverter to match a wide variety of panels from different manufactures. Generally the best lamp lifetime correlates with driving the CCFL at the manufactures nominal current setting. However the SET_1 and SET_2 inputs allow the user the flexibility to adjust the current to the maximum allowable output current to increase panel brightness at the expense of some reduced lamp life.
- Although the SET pins are designed such that just leaving them open or grounding them is all that is needed to set the output current, they can also be actively set. Using a open collector or open drain logic signal will allow you to reduce the lamp current for situations where greater dim range is required, as an example in nighttime situations. In conjunction with a light sensor or other timer the panel could be set to higher brightness (maximum output current) for daytime illumination and lower brightness (minimum or typical output current) at nighttime. Since the dim ratio is a factor of both the burst duty cycle and the peak output current, using this technique the effective dim ratio can be increased greater than the burst duty cycle alone. Conversely the SET inputs could be used to overdrive the lamp temporarily to facilitate faster lamp warm up at initial lamp turn on. Of course any possible degradation on lamp life from such practices is the users responsibility since not all lamps are designed to be overdriven.
- The inverter has a built in fault timeout function. If the output return is open (lamp disconnected or broken) or shorted the inverter will attempt to strike the lamp for several seconds. After about a second without success the inverter will shutdown. In order to restart the inverter it is necessary to toggle the sleep input or cycle the V_{IN1} input supply. In the timeout shutdown mode input drain current will be about 8mA.

Microsemi
Integrated Products
11861 Western Avenue, Garden Grove, CA. 92841, 714-898-8121, Fax: 714-893-2570

NOTES