

**DESCRIPTION**

The LXMG1626-12-46 is a Dual 6W Output Direct Drive™ CCFL (Cold Cathode Fluorescent Lamp) Inverter Module specifically designed to be compatible with variety of LCD panels that have both lamps on one side of the panel and use a single common lamp return wire.

LXMG1626 modules provide the designer with a vastly superior display brightness range. This brightness range is achievable with virtually any LCD display.

The modules are available with a dimming input that permits brightness control from either, a DC voltage source, a PWM signal or external potentiometer.

The maximum output current is externally programmable (through the input connector) at either 10mA or 12mA (5mA or 6mA per lamp). This allows the inverter to match the panel's lamp current specifications, or it can be used to purposely drive the lamps at a lower or higher current to decrease or increase nominal brightness. The inverter also has a dedicated FAULT pin that indicates an open/shorted lamp condition.

In addition when only one of the two lamps in the LCD fails open, the second lamp will continue to operate with a FAULT signal toggling to indicate the failed condition.

RangeMAX Digital Dimming Technique provides flicker-free brightness control in any wide range typically (100:1+) dimming application.

The resultant "burst drive" that energizes the lamp is designed specifically to ensure that no premature lamp degradation occurs, while allowing significant power savings at lower dim levels.

The design utilizes Microsemi's highly integrated LX1691B backlight controller to convert DC voltage from the system battery or AC adapter directly to high frequency, high-voltage waves required to ignite and operate CCFL lamps.

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.

**KEY FEATURES**

- Externally Programmable Maximum Output Current
- Easy to Use Brightness Control
- RangeMAX Wide Range Dimming
- Output Open & Short-Circuit Protection and Automatic Strike-Voltage Regulation and Timeout
- Continued Operation with Single Open Lamp failure
- Fixed Frequency Operation
- Fault Output Signal
- Rated From -30°C to 80°C
- RoHS Compliant
- UL60950 E175910

**APPLICATIONS**

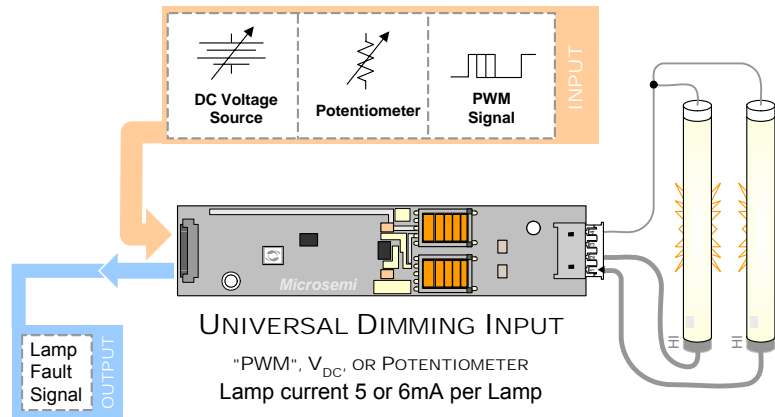
- Dual lamp LCD's Requiring a Shared Common Lamp Return
- Mates to a Single JST BHR-04 VS-1 Lamp Connector
- Industrial Display Controls

**BENEFITS**

- Smooth, Flicker Free 1%-100% Full-Range Brightness Control
- Programmable Output Current Allows Inverter To Mate With a Wide Variety of LCD Panel's Specifications
- Output Open Circuit Voltage Regulation Minimizes Corona Discharge For High Reliability

**IMPORTANT:** For the most current data, consult MICROSEMI's website: <http://www.microsemi.com>

Protected By U.S. Patents: 5,923,129; 5,930,121; 6,198,234; Patents Pending

**PRODUCT HIGHLIGHT**

**PACKAGE ORDER INFO**

PART NUMBER	OUTPUT CONNECTOR	INVERTER MATES DIRECTLY TO PANEL CONNECTORS
LXMG1626-12-46	JST SM04(4.0)B-BHS-1-TB(LF)(SN) or Yeon Ho 20015WR-07A00	JST BHR-04VS-1

**ABSOLUTE MAXIMUM RATINGS (NOTE 1)**

Input Signal Voltage ( $V_{IN1}$ ).....	-0.3V to 15V
Input Power .....	8W
Output Voltage, no load .....	Internally Limited to 1500V <sub>RMS</sub>
Output Current (per lamp) .....	6.6mA <sub>RMS</sub> (Internally Limited)
Output Power .....	6W
Input Signal Voltage ( SLEEP Input).....	-0.3V to 13.2V
Input Signal Voltage (BRITE) .....	-0.3V to 5.5V
Ambient Operating Temperature, zero airflow.....	-30°C to 80°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	13.6	
Output Power	$P_O$		4.5	5.5	W
Linear BRITE Control Input Voltage Range	$V_{BRT\_ADJ}$	0		2.0	V
Lamp Operating Voltage	$V_{LAMP}$	320	370	420	V <sub>RMS</sub> <sup>1</sup>
Lamp Current (Full Brightness, per lamp)	$I_{OLAMP}$	5.0		6.0	mA <sub>RMS</sub> <sup>2</sup>
Operating Ambient Temperature Range	$T_A$	-30		80	°C

<sup>1</sup> Based on single lamp voltage measurement.

<sup>2</sup> At input voltages below 12V the inverter may not be able to output the full 6mA<sub>RMS</sub> per lamp in all configurations.

**ELECTRICAL CHARACTERISTICS**

Unless otherwise specified, the following specifications apply over the recommended operating condition and ambient temperature of 0°C to 60°C except where otherwise noted.

Parameter	Symbol	Test Conditions	LXMG1626-12-46			Units
			Min	Typ	Max	
<b>OUTPUT PIN CHARACTERISTICS</b>						
Full Bright Lamp Current (two lamps)	$I_{L(MAX)}$	$V_{BRT\_ADJ} \geq 2.0V_{DC}$ , $\overline{SLEEP} \geq 2.0V$ , $V_{IN1} = 12V_{DC}$ $I_{SET} = \text{Ground}$	9	10	11	mA <sub>RMS</sub>
Full Bright Lamp Current (two lamps)	$I_{L(MAX)}$	$V_{BRT\_ADJ} \geq 2.0V_{DC}$ , $\overline{SLEEP} \geq 2.0V$ , $V_{IN1} = 12V_{DC}$ $I_{SET} = \text{Open}$	11	12	13	mA <sub>RMS</sub>
Output Current Lamp to Lamp Deviation	$I_{LL\%DEV}$	$V_{BRT\_ADJ} \geq 2.0V_{DC}$ , $\overline{SLEEP} \geq 2.0V$ , $V_{IN1} = 12V_{DC}$ $I_{SET} = \text{Open}$		5		%
Min. Average Lamp Current	$I_{L(MIN)}$	$V_{BRT\_ADJ} = 0V_{DC}$ , $\overline{SLEEP} \geq 2.0V$ , $V_{IN1} = 12V_{DC}$ $I_{SET} = \text{Ground}$ ; $I_{OUT} = I_{MAX} * \text{SQRT of \% duty cycle}$		1.6		mA <sub>RMS</sub>
Lamp Start Voltage	$V_{LS}$	$V_{IN1} \geq 10.8V_{DC}$	1250	1400		V <sub>RMS</sub>
Operating Frequency	$f_O$	$V_{BRT\_ADJ} \geq 2.0V_{DC}$ , $\overline{SLEEP} \geq 2.0V$ , $V_{IN1} = 12V$	55.2	57.6	60	kHz
Burst Frequency	$f_{BURST}$	Output Burst Frequency	215	225	235	Hz
FAULT Output Voltage High	FAULT <sub>VH</sub>	FAULT = -10uA	3	3.5		V
FAULT Output Voltage Low	FAULT <sub>VL</sub>	FAULT = 10uA		0.3	0.8	V

**ELECTRICAL CHARACTERISTICS (CONTINUED)**

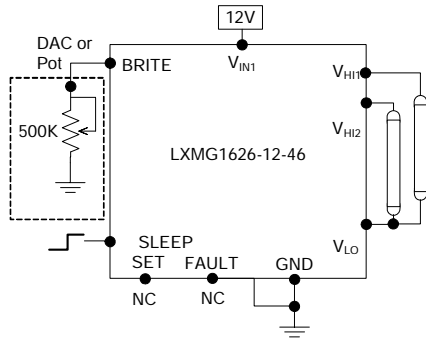
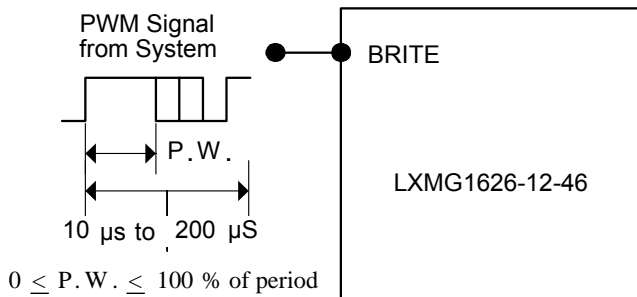
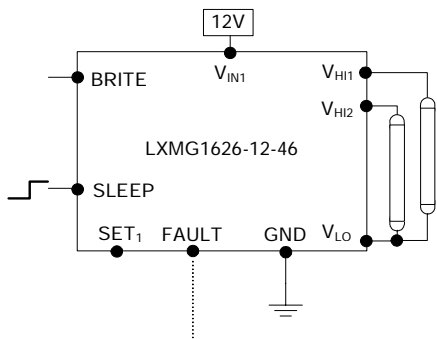
Unless otherwise specified, the following specifications apply over the recommended operating condition and ambient temperature of 25°C except where otherwise noted.

Parameter	Symbol	Test Conditions	LXMG1626-12-46			Units
			Min	Typ	Max	
<b>BRITE INPUT</b>						
Input Current	$I_{BRT}$	$V_{BRT\_ADJ} = 0V_{DC}$		-13		$\mu A_{DC}$
		$V_{BRT\_ADJ} = 3V_{DC}$		1		$\mu A_{DC}$
Minimum Input for Max. Lamp Current	$V_{BRT\_ADJ}$	$I_{O(LAMP)} = \text{Maximum Lamp Current}$		2.0	2.05	$V_{DC}$
Maximum Input for Min. Lamp Current	$V_{BRT\_ADJ}$	$I_{O(LAMP)} = \text{Minimum Lamp Current}$	0			$V_{DC}$
<b>SLEEP INPUT</b>						
RUN Mode	$V_{SLEEP}$		2.1		$V_{IN1}$	$V_{DC}$
SLEEP Mode	$V_{SLEEP}$		-0.3		0.8	$V_{DC}$
<b>SET INPUT</b>						
SET Low Threshold	$V_L$				0.4	V
Input Current	$I_{SET}$	$V_{SET} \leq 0.4V$		-500		$\mu A$
<b>POWER CHARACTERISTICS</b>						
Sleep Current	$I_{IN(MIN)}$	$V_{IN1} = 12V_{DC}, \overline{SLEEP} \leq 0.8V$	0.0	12	50	$\mu A_{DC}$
Run Current	$I_{IN(RUN)}$	$V_{IN1} = 12V_{DC}, \overline{SLEEP} \geq 2.0V, I_{SET} = \text{Ground}$ $V_{LAMP} = 370V_{RMS}$		360		$mA_{DC}$
Efficiency	$\eta$	$V_{IN1} = 12V_{DC}, \overline{SLEEP} \geq 2.0V, I_{SET} = \text{Ground}$ $V_{LAMP} = 370V_{RMS}$		85		%

**FUNCTIONAL PIN DESCRIPTION**

CONN	PIN	DESCRIPTION
<b>CN1 (Molex 53261-0871) Mates with 51021-0800 housing, 50079-8100 pins. Mates with LX9501G input cable assembly</b>		
CN1-1	$V_{IN1}$	Main Input Power Supply ( $10.8V \leq V_{IN1} \leq 13.2V$ )
CN1-2		
CN1-3	GND	Power Supply Return
CN1-4		
CN1-5	$\overline{SLEEP}$	ON/OFF Control. ( $0V < \overline{SLEEP} < 0.8 = \text{OFF}, \overline{SLEEP} \geq 2.1V = \text{ON}$ )
CN1-6	BRITE	Brightness Control ( $0V$ to $2.0V_{DC}$ ). $2.0V_{DC}$ gives maximum lamp current.
CN1-7	SET	SET Connecting this pin to ground decreases the output current (see Table 1)
CN1-8	FAULT	High Impedance Output that indicates lamp status, high indicates fault (see figure 2 on page 5)
<b>CN2 for LXMG1626-12-46 (JST SM03(4.0)B-BHS-1-TB(LF)(SN) or Yeon Ho 20015WR-07A00 )</b>		
CN2-1	$V_{HI1}$	High voltage connection to high side of lamp. Connect to lamp terminal with shortest lead length. <b>DO NOT</b> connect to ground.
CN2-2	$V_{HI2}$	High voltage connection to high side of lamp. Connect to lamp terminal with shortest lead length. <b>DO NOT</b> connect to ground.
CN2-3	NC	No Connect
CN2-4	$V_{LO}$	Connection to low side of lamp. Connect to lamp terminal with longer lead length. <b>DO NOT</b> connect to ground



**TYPICAL APPLICATION**

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

**Figure 1A – PWM Brightness Control**


Lamp(s) Status	FAULT	Inverter Operation
Normal Operation	Low	Normal full lamp current
One Lamp Open	High	Normal @ ~½ lamp current*
Both Lamps Open	High	Shutdown
One Lamp High Side Short to Ground	High	Normal @ ~½ lamp current*
Both Lamps High Side Short to Ground	High	Shutdown

**Figure 2 – FAULT Output Operation**

\* Under some conditions the second lamp will also shutdown, this is especially true if the inverter draws an arc going open or when shorted.

- The brightness control may be a voltage output DAC or other voltage source, a digital pot or 500K manual pot. The inverter contains an internal 215K pull-up to 3V to bias the pot. 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 SLEEP input.
- Connect  $V_{HI1}$  and  $V_{HI2}$  to high voltage wires from the lamps. Connect  $V_{LO}$  to the low voltage wire lamp return (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 input to program the desired maximum output current. Generally the best lamp lifetime correlates with driving the CCFL at the manufactures nominal current setting.
- Typically the SET pin is permanently wired to ground or intentionally left open. However it can also be actively driven, using an open collector or open drain logic signal. This will allow dynamic adjustment of 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 dimming ratio is a factor of both the burst duty cycle and the peak output current, by using this technique the effective dim ratio can be increased greater than what the burst duty cycle alone could provide. Conversely, the SET input could be used to overdrive the lamp current temporarily to facilitate faster lamp warm up at initial lamp turn on. Of course, any possible degradation of lamp life from such practices is the user's responsibility since not all lamps are designed to be under or overdriven.
- Input connector (CN1-8) FAULT signal which is normally low will toggle high to indicate that an output fault condition has occurred as summarized in the table to the left figure 2. FAULT will toggle high if one or both lamps are open or short circuited. If only one lamp opens, or its high side shorts to ground then the other lamp should continue to operate with the FAULT signal going high. If both lamps open and/or both lamps are shorted the FAULT will toggle high if it is not already high and the inverter output will shutdown. Also if either low side connection of the lamps is shorted to ground, or the lamps are shorted high side to low side, FAULT will go high and the inverter will shutdown. In order to restart the inverter after a fault it is necessary to toggle the SLEEP input or cycle the  $V_{IN1}$  input supply. In fault induced shutdown mode the inverter will draw about 15mA from  $V_{IN1}$  supply.



PanelMatch™

LXMG1626-12-46

12V Dual 6W CCFL Programmable Inverter Module

PRODUCTION DATASHEET

NOTES

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