

LXMG1623-12-4x

12V Dual 4W CCFL Programmable Inverter Module

#### **PRODUCTION DATASHEET**

#### **DESCRIPTION**

The LXMG1623-12-4x is a Dual 4W Output Direct Drive<sup>TM</sup> CCFL (Cold energizes the lamp Cathode Fluorescent Lamp) Inverter specifically to ensure that no premature Module specifically designed for driving lamp degradation occurs, while allowing LCD backlight lamps. It is ideal for significant power savings at lower dim driving typical 6.4" to 10.4" TFT panels.

LXMG1623 modules provide the designer with a vastly superior display the system battery or AC adapter directly brightness range. This brightness range is to high frequency, high-voltage waves

dimming input that permits brightness available (LXMG1623-05-4x), as well as control from either a DC voltage source or 6W versions (LXMG1623-xx-6x) for a PWM signal or external Potentiometer. driving larger higher voltage panels. The maximum output current is externally programmable over a range of 5 to 6.5mA Microsemi's new LX1689 backlight in 0.5mA steps to allow the inverter to properly match to a wide array of LCD cost and performance advantages due to panel lamp current specifications.

Digital RangeMAX **Dimming** Technique provides flicker-free brightness are stable fixed-frequency operation, control in any wide range typically (50:1+) dimming application.

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

The resultant "burst drive" was designed levels.

The modules convert DC voltage from achievable with virtually any LCD display. required to ignite and operate CCFL The modules are available with a lamps. A 5V input inverter also is

> The modules design is based on controller, which provides a number of the controller's high level of integration.

> Other benefits of this new topology 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
- Fixed Frequency Operation
- Rated From -20 to 70°C
- UL60950 E175910
- RoHS Compliant

#### **APPLICATIONS**

- High Brightness Displays
- Portable Instrumentation
- **Desktop Displays**
- Industrial Display Controls

#### **BENEFITS**

- Smooth, Flicker Free 2%-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

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

PRODUCT HIGHLIGHT

# Universal Dimming Input "PWM", V<sub>DC</sub>, OR POTENTIOMETER **PWM** DC Voltage Potentiometer Signa SELECTABLE MAXIMUM OUTPUT CURRENT 5MA TO 6.5MA RMS

PACKAGE ORDER INFO						
PART NUMBER	OUTPUT CONNECTOR	INVERTER MATES DIRECTLY TO PANEL CONNECTORS				
LXMG1623-12-41	JST SM02(8.0)B-BHS-1-TB (LF)(SN) or Yeon Ho 20015WR-05A00	JST BHR-03VS-1				
LXMG1623-12-42	JST SM02B-BHSS-1-TB (LF)(SN) or Yeon Ho 35001WR-02A00	JST BHSR-02VS-1				



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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	
i didiletei	Gyilliboi	Min	R.C.	Max	Office	
Input Supply Voltage Range (Fully Regulated Lamp Current)	V <sub>IN1</sub>	10.8	12	13.2	V	
Input Supply Voltage Range (Functional)		10.2	12	13.8		
Output Power (each output)	Po		3.5	4.0	W	
Linear BRITE Control Input Voltage Range	$V_{BRT\ ADJ}$	0.5		2.0	V	
Lamp Operating Voltage	$V_{LAMP}$	350	440	530	$V_{RMS}$	
Lamp Current (Full Brightness)	I <sub>OLAMP</sub>	5		6.5	mA <sub>RMS</sub>	
Operating Ambient Temperature Range	T <sub>A</sub>	-20		70	°C	

#### **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		LXMG1623-12-4x		
Farameter	Symbol	rest Conditions	Min	Тур	Max	Units
OUTPUT PIN CHARACTERISTICS						
Full Bright Lamp Current (each output)	I <sub>L(MAX)</sub>	$V_{BRT\_ADJ} \ge 2.0V_{DC}$ , $\overline{SLEEP} \ge 2.0V$ , $V_{IN1} = 12V_{DC}$ $I_{SET1} = Ground$ , $I_{SET2} = Ground$	4.5	5	5.5	mA <sub>RMS</sub>
Full Bright Lamp Current (each output)	I <sub>L(MAX)</sub>	$V_{BRT\_ADJ} \ge 2.0V_{DC}$ , $\overline{SLEEP} \ge 2.0V$ , $V_{IN1} = 12V_{DC}$ $I_{SET1} = Ground$ , $I_{SET2} = Open$	5.0	5.5	6.0	mA <sub>RMS</sub>
Full Bright Lamp Current (each output)	I <sub>L(MAX)</sub>	$V_{BRT\_ADJ} \ge 2.0V_{DC}$ , $\overline{SLEEP} \ge 2.0V$ , $V_{IN1} = 12V_{DC}$ $I_{SET1} = Open$ , $I_{SET2} = Ground$	5.5	6	6.5	mA <sub>RMS</sub>
Full Bright Lamp Current (each output)	I <sub>L(MAX)</sub>	$V_{BRT\_ADJ} \ge 2.0V_{DC}$ , $\overline{SLEEP} \ge 2.0V$ , $V_{IN1} = 12V_{DC}$ $I_{SET1} = Open$ , $I_{SET2} = Open$	6.0	6.5	7.0	mA <sub>RMS</sub>
Output Current Lamp to Lamp Deviation	I <sub>LL%DEV</sub>	$V_{BRT\_ADJ} \ge 2.0V_{DC}$ , $\overline{SLEEP} \ge 2.0V$ , $V_{IN1} = 12V_{DC}$ $I_{SET1} = Open$ , $I_{SET2} = Open$		3	10	%
Min. Average Lamp Current (each output)	I <sub>L(MIN)</sub>	$V_{BRT\_ADJ} \le 0.5 V_{DC}$ , $\overline{SLEEP} \ge 2.0 V$ , $V_{IN1} = 12 V_{DC}$ $I_{SET1} = I_{SET2} = Ground$		0.30		mA <sub>RMS</sub>
Lamp Start Voltage	$V_{LS}$	-20°C < T <sub>A</sub> < 70°C, V <sub>IN1</sub> > 10.8V <sub>DC</sub>	1250	1400		$V_{RMS}$
Operating Frequency	f <sub>O</sub>	$V_{BRT\_ADJ} = 2.5V_{DC}, \overline{SLEEP} \ge 2.0V, V_{IN1} = 12V$	76	80	83	kHz
Burst Frequency	f <sub>BURST</sub>	Output Burst Frequency	148	156	163	Hz



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## **ELECTRICAL CHARACTERISTICS (CONTINUED)**

Unless otherwise specified, the following specifications apply over the recommended operating condition and ambient temperature of  $25^{\circ}$ C except where otherwise noted.

	Parameter	Symbol Test Conditions		LXM	LXMG1623-12-4x			
	Parameter	Symbol	rest Conditions	Min	Тур	Max	Units	
•	BRITE INPUT							
	Input Current	I <sub>BRT</sub>	$V_{BRT\_ADJ} = 0V_{DC}$		-300		$\mu A_{DC}$	
		IBRI	$V_{BRT\_ADJ} = 3V_{DC}$		50		$\mu A_{DC}$	
	Minimum Input for Max. Lamp Current	$V_{BRT\_ADJ}$	I <sub>O(LAMP)</sub> = Maximum Lamp Current		2.0	2.05	$V_{DC}$	
	Maximum Input for Min. Lamp Current	$V_{BRT\_ADJ}$	I <sub>O(LAMP)</sub> = Minimum Lamp Current	0.4	0.5		$V_{DC}$	
▶	SLEEP INPUT							
	RUN Mode	V <sub>SLEEP</sub>		2.0		$V_{IN1}$	V <sub>DC</sub>	
	SLEEP Mode	V <sub>SLEEP</sub>		-0.3		0.8	$V_{DC}$	
•	SET <sub>1,2</sub> INPUT							
	SET <sub>1,2</sub> Low Threshold	VL				0.4	V	
	Input Current	I <sub>SET</sub>	V <sub>SET</sub> ≤ 0.4V		-300		μΑ	
▶	POWER CHARACTERISTICS							
	Sleep Current	I <sub>IN(MIN)</sub>	$V_{IN1} = 12V_{DC}, \overline{SLEEP} \le 0.8V$	0.0	10	50	μA <sub>DC</sub>	
	Run Current	I <sub>IN(RUN)</sub>	V <sub>IN1</sub> = 12V <sub>DC</sub> , SLEEP ≥ 2.0V, I <sub>SET1</sub> = Open		530		mA <sub>DC</sub>	
		IIN(RUN)	$I_{SET2}$ = Ground, $V_{LAMP}$ = 440 $V_{RMS}$				, (DC	
	Efficiency	η	$V_{IN1} = 12V_{DC}$ , $\overline{SLEEP} \ge 2.0V$ , $I_{SET1} = Open$		85		%	
			$I_{SET2}$ = Ground, $V_{LAMP}$ = 440 $V_{RMS}$					

FUNCTIONAL PIN DESCRIPTION							
Conn	PIN	DESCRIPTION					
<b>CN1</b> (Molex 53261-0871) Mates with 51021-0800 housing, 50079-8100 pins. Mates with LX9501G input cable assembly							
CN1-1	$V_{IN1}$	Main Input Power Supply (10.8V < V <sub>IN1</sub> < 13.2V)					
CN1-2	VINT	Main input i ower oupply (10.00 \(\sigma\) \(\sigma\) (10.20)					
CN1-3	GND	Power Supply Return					
CN1-4	OND	1 Ower Suppry Return					
CN1-5	SLEEP	ON/OFF Control. (0V < SLEEP < 0.8 = OFF, SLEEP >= 2.0V = ON					
CN1-6	BRITE	Brightness Control (0.5V to 2.0V <sub>DC</sub> ). 2.0V <sub>DC</sub> gives maximum lamp current.					
CN1-7	SET₁	SET <sub>1</sub> MSB Connecting this pin to ground decreases the output current (see Table 1)					
CN1-8	SET <sub>2</sub>	SET <sub>2</sub> LSB Connecting this pin to ground decreases the output current (see Table 1)					
		<b>3-12-41 and -42</b> (JST SM02(8.0)B-BHS-1-TB (LF)(SN)   Yeon Ho 20015WR-05A00 or SM02B-BHSS- 35001WR-02A00)					
CN2-1 CN3-1	V <sub>HI</sub>	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 CN3-2	$V_{LO}$	Connection to low side of lamp. Connect to lamp terminal with longer lead length. <b>DO NOT</b> connect to Ground					



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# TABLE 1

#### **OUTPUT CURRENT SETTINGS**

SET₁ (Pin 7)	SET <sub>2</sub> (Pin 8)	Nominal Output Current
Open*	Open*	6.5mA
Open*	Ground	6.0mA
Ground	Open*	5.5mA
Ground	Ground	5.0mA

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

#### PHYSICAL DIMENSIONS LXMG1623-12-4X 115mm 109mm GROUNDED MOUNTING HOLE 3MM X 2 DIA. ±0.08 6MM SCREW HEAD CLEARANCE 4.29in. **(1)** 30mm 1.18in. 26mm CN3 4mm Warning 6mm High Voltage 1.0mm 0.0392in. 0.23in 6.5mm Max Present at high 0.256in. side of transformer Weight: (15g) typ and Output PCB tolerances ± 0.5mm Connector

Dimensions are in millimeters (inches for reference only)

### SIMPLIFIED BLOCK DIAGRAM High Voltage Controller Transformer V<sub>HI</sub> 10K Comparator $V_{BRITE}$ ШГ 0.5 -Transformer Ramp Driver Ramp +3V OC <sub>SENSE</sub> Gen SET, OV\_SENSE $\rm V_{\rm LO}$ SET<sub>2</sub> I<sub>SENSE</sub> One of two



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#### TYPICAL APPLICATION

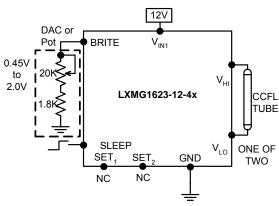


Figure 1 – Brightness Control (Output current set to maximum)

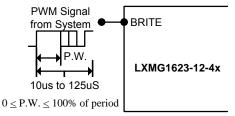


Figure 1A - PWM Brightness Control

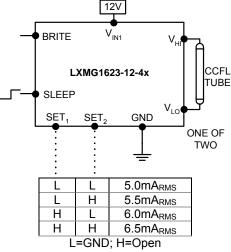


Figure 2 – Max Output Current (SET<sub>1</sub> and SET<sub>2</sub> Inputs)

- 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 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 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 SET₁ and SET₂ (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 SET₁ and SET₂ 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 is open (lamp disconnected or broken) or shorted the inverter will attempt to strike the lamp for several seconds. After about 2 seconds without success the inverter will shutdown. In order to restart the inverter it is necessary to toggle the sleep input or cycle the V<sub>IN1</sub> input supply



**PanelMatch**<sup>TM</sup>

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NOTES

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