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*Microsemi*®

## DESCRIPTION

The LXMG1627-12-6x is a Dual 6W Output Direct Drive™ CCFL (Cold Cathode Fluorescent Lamp) Inverter Module specifically designed for driving LCD backlight lamps. It is ideal for driving typical 10.4" to 15" TFT panels.

LXMG1627 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 or a PWM signal or external potentiometer. The maximum output current is externally programmable over a range of 5mA to 8mA in 1mA steps to allow the inverter to properly match to a wide array of LCD panel lamp current specifications.

RangeMAX™ Digital Dimming Technique provides flicker-free brightness control in any wide range typically (50:1+) dimming application.

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

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. A 5V input inverter is also available (LXMG1627-05-6x), as well as 4W versions (LXMG1627-xx-4x) for driving smaller lower voltage/power panels.

The module's design is based on Microsemi's LX6512 backlight controller, which provides a number of cost and performance advantages due to the controller's high level of integration.

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

**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

## 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 -30°C to 80°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

## PRODUCT HIGHLIGHT

**UNIVERSAL DIMMING INPUT**
**"PWM", V$_{DC}$, or POTENTIOMETER**



**DC Voltage Source**    **Potentiometer**    **PWM Signal**
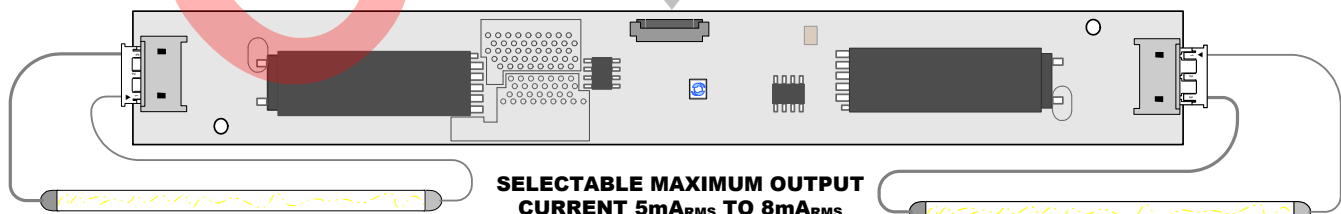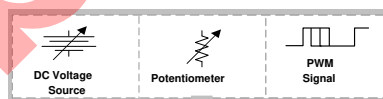
**SELECTABLE MAXIMUM OUTPUT CURRENT 5mA$_{RMS}$ TO 8mA$_{RMS}$**

## PACKAGE ORDER INFO

| PART NUMBER | OUTPUT CONNECTOR | INVERTER MATES DIRECTLY TO PANEL CONNECTORS |
|---|---|---|
| LXMG1627-12-61 | JST SM02(8.0)B-BHS-1-TB(LF)(SN) or Yeon Ho 20015WR-05A00 | JST BHR-03VS-1 |
| LXMG1627-12-62 | JST SM02B-BHSS-1-TB(LF)(SN) or Yeon Ho 35001WR-02A00 | JST BHSR-02VS-1 |

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## ABSOLUTE MAXIMUM RATINGS

Input Signal Voltage ($V_{IN}$)..................................................................................................................-0.3V to 15V
Input Power ........................................................................................................................................ 15W
Output Voltage, no load ................................................................................. Internally Limited to 1800$V_{RMS}$
Output Current ..........................................................................................9.5mA$_{RMS}$ (Internally Limited)
Output Power (each output) ............................................................................................................ 6.0W
Input Signal Voltage ($\overline{SLEEP}$ Input) ............................................................................................ -0.3V to $V_{IN}$
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

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, may not function optimally.

| Parameter | Symbol | Recommended Operating Conditions | | | Units |
|---|---|---|---|---|---|
| | | Min | R.C. | Max | |
| Input Supply Voltage Range (Fully Regulated Lamp Current) | $V_{IN}$ | 10.8 | 12 | 13.2 | V |
| Input Supply Voltage Range (Functional) | | 10.2 | 12 | 13.8 | |
| Output Power (each output) | $P_O$ | | 5.5 | 6.0 | W |
| Linear BRITE Control Input Voltage Range | $V_{BRT\ ADJ}$ | 0 | | 2.5 | V |
| Lamp Operating Voltage | $V_{LAMP}$ | 480 | 600 | 720 | $V_{RMS}$ |
| Lamp Current (Full Brightness) | $I_{OLAMP}$ | 5.0 | | 8.0 | mA$_{RMS}$ |
| Operating Ambient Temperature Range | $T_A$ | -30 | | 80 | °C |

## 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; BRITE ≥ 2.5V, $\overline{SLEEP}$ ≥ 2.0V, $V_{IN}$ = 12V.

| Parameter | Symbol | Test Conditions | LXMG1627-12-6x | | | Units |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| **OUTPUT PIN CHARACTERISTICS** | | | | | | |
| Full Bright Lamp Current (each output) | $I_{L(MAX)}$ | $SET_1$ = Ground, $SET_2$ = Ground | 4.4 | 5.0 | 5.6 | mA$_{RMS}$ |
| Full Bright Lamp Current (each output) | $I_{L(MAX)}$ | $SET_1$ = Ground, $SET_2$ = Open | 5.4 | 6.0 | 6.6 | mA$_{RMS}$ |
| Full Bright Lamp Current (each output) | $I_{L(MAX)}$ | $SET_1$ = Open, $SET_2$ = Ground | 6.4 | 7.0 | 7.6 | mA$_{RMS}$ |
| Full Bright Lamp Current (each output) | $I_{L(MAX)}$ | $SET_1$ = Open, $SET_2$ = Open | 7.4 | 8.0 | 8.6 | mA$_{RMS}$ |
| Output Current Lamp to Lamp Deviation | $I_{LL\%DEV}$ | $SET_1$ = Open, $SET_2$ = Open | | 2 | 5 | % |
| Min. Average Lamp Current (each output) | $I_{L(MIN)}$ | BRITE = 0V $SET_1$ = $SET_2$ = Ground $I_{L(MIN)} = I_{LMAX} * \sqrt{Burst\ Duty\ Cycle}$ | | 1.0 | | mA$_{RMS}$ |
| Lamp Start Voltage | $V_{LS}$ | -30°C < $T_A$ < 80°C, $V_{IN}$ > 10.8V | 1500 | 1650 | | $V_{RMS}$ |
| Operating Frequency | $f_O$ | | 55 | 60 | 65 | kHz |
| Burst Frequency | $f_{BURST}$ | Output Burst Frequency | 165 | 200 | 235 | Hz |

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## ELECTRICAL CHARACTERISTICS (CONTINUED)

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; BRITE ≥ 2.5V, $\overline{SLEEP}$ ≥ 2.0V, $V_{IN}$ = 12V

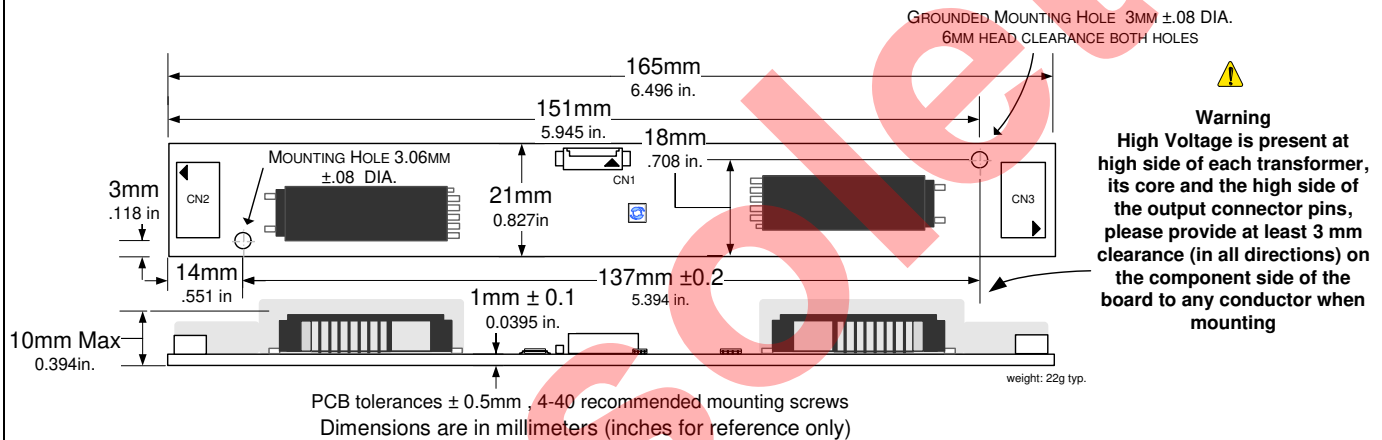| Parameter | Symbol | Test Conditions | LXMG1627-12-6x Min | LXMG1627-12-6x Typ | LXMG1627-12-6x Max | Units |
|---|---|---|---|---|---|---|
| **BRITE INPUT** | | | | | | |
| Input Current | $I_{BRT}$ | BRITE = 0V | | -13.4 | | µA |
| | | BRITE = 3V | | -5 | | µA |
| Minimum Input for Max. Lamp Current | $V_{BRT\_ADJ}$ | $I_{O(LAMP)}$ = Maximum Lamp Current | 2.1 | 2.3 | 2.5 | V |
| Maximum Input for Min. Lamp Current | $V_{BRT\_ADJ}$ | $I_{O(LAMP)}$ = Minimum Lamp Current | 0 | | | V |
| **SLEEP INPUT** | | | | | | |
| RUN Mode | $V_{\overline{SLEEP}}$ | | 2.0 | | $V_{IN}$ | V |
| SLEEP Mode | $V_{\overline{SLEEP}}$ | | 0 | | 0.8 | V |
| **SET$_{1,2}$ INPUT** | | | | | | |
| SET$_{1,2}$ Low Threshold | $V_L$ | | 0 | | 0.4 | V |
| Input Current | $I_{SET}$ | SETx = 0V | | -85 | | µA |
| **POWER CHARACTERISTICS** | | | | | | |
| Sleep Current | $I_{IN(MIN)}$ | $\overline{SLEEP}$ ≤ 0.8V | | 2 | 20 | µA |
| Run Current | $I_{IN(RUN)}$ | SET$_1$ = Open, SET$_2$ = Ground, $V_{LAMP}$ = 600$V_{RMS}$ | | 875 | | mA |
| Strike (Open Lamps) | $T_{S\_DWELL}$ | | 1.0 | 1.5 | | Sec |
| Supply Current After Fault Timeout | $I_{FAULT}$ | Fault Timeout | | 7 | | mA |
| Efficiency | η | SET$_1$ = Open, SET$_2$ = Ground, $V_{LAMP}$ = 600$V_{RMS}$ | | 80 | | % |

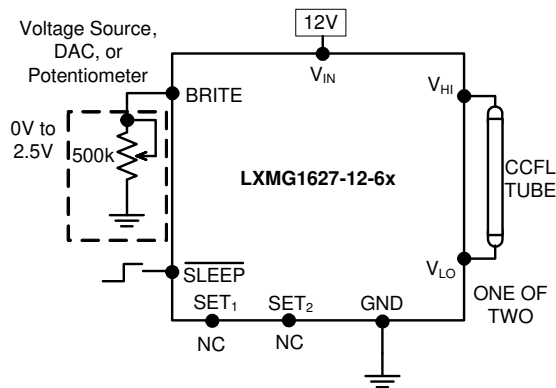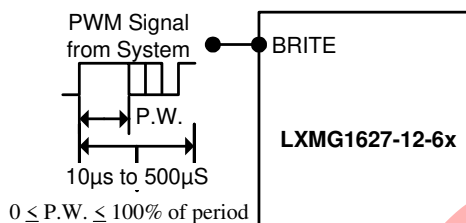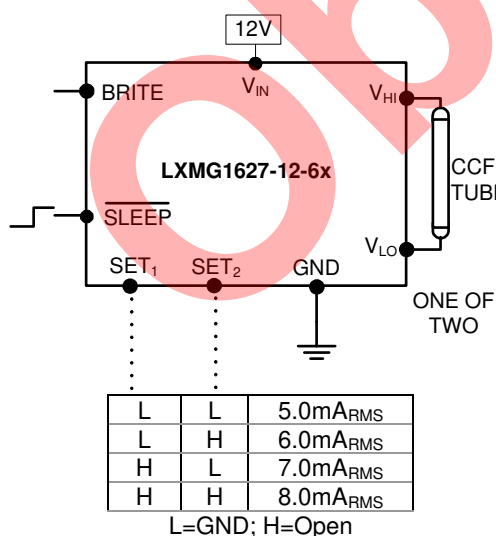## FUNCTIONAL PIN DESCRIPTION

| CONN | PIN | DESCRIPTION |
|---|---|---|
| **CN1** (Molex 53261-0871) Mates with 51021-0800 housing, 50079-8100 pins. Mates with LX9501G input cable assembly | | |
| CN1-1 | $V_{IN}$ | Main Input Power Supply (10.8V ≤ $V_{IN}$ ≤ 13.2V) |
| CN1-2 | | |
| CN1-3 | GND | Power Supply Return |
| CN1-4 | | |
| CN1-5 | $\overline{SLEEP}$ | ON/OFF Control. (0V ≤ $\overline{SLEEP}$ ≤ 0.8 = OFF, $\overline{SLEEP}$ ≥ 2.0V = ON |
| CN1-6 | BRITE | Brightness Control (0V to 2.5V). 2.5V gives maximum lamp current; 500k manual pot; PWM signal. |
| CN1-7 | SET$_1$ | SET$_1$ MSB Connecting this pin to ground decreases the output current (see Table 1) |
| CN1-8 | SET$_2$ | SET$_2$ LSB Connecting this pin to ground decreases the output current (see Table 1) |
| **CN2, CN3 for LXMG1627-12-61 and -62** (JST SM02(8.0)B-BHS-1-TB(LF)(SN) \| Yeon Ho 20015WR-05A00 or SM02B-BHSS-1-TB(LF)(SN) \| Yeon Ho 35001WR-02A00) | | |
| CN2-1 CN3-1 | $V_{HI}$ | High voltage connection to high side of lamp. Connect to lamp terminal with shortest lead length. **DO NOT** connect to Ground. |
| CN2-2 CN3-2 | $V_{LO}$ | Connection to low side of lamp. Connect to lamp terminal with longer lead length. **DO NOT** connect to Ground |

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## TABLE 1

### OUTPUT CURRENT SETTINGS

| SET$_1$ (Pin 7) | SET$_2$ (Pin 8) | Nominal Output Current |
|---|---|---|
| Open* | Open* | 8.0mA |
| Open* | Ground | 7.0mA |
| Ground | Open* | 6.0mA |
| Ground | Ground | 5.0mA |

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

## PHYSICAL DIMENSIONS

### LXMG1627-12-6x

GROUNDED MOUNTING HOLE 3MM ±.08 DIA.
6MM HEAD CLEARANCE BOTH HOLES

165mm
6.496 in.

151mm
5.945 in.

18mm
.708 in.

MOUNTING HOLE 3.06MM ±.08 DIA.

CN2

21mm
0.827in.

CN1

CN3

3mm
.118 in

14mm
.551 in

137mm ±0.2
5.394 in.

1mm ± 0.1
0.0395 in.

10mm Max
0.394in.

⚠️

**Warning**
**High Voltage is present at high side of each transformer, its core and the high side of the output connector pins, please provide at least 3 mm clearance (in all directions) on the component side of the board to any conductor when mounting**

weight: 22g typ.

PCB tolerances ± 0.5mm , 4-40 recommended mounting screws
Dimensions are in millimeters (inches for reference only)

## SIMPLIFIED BLOCK DIAGRAM

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**PACKAGE DATA**

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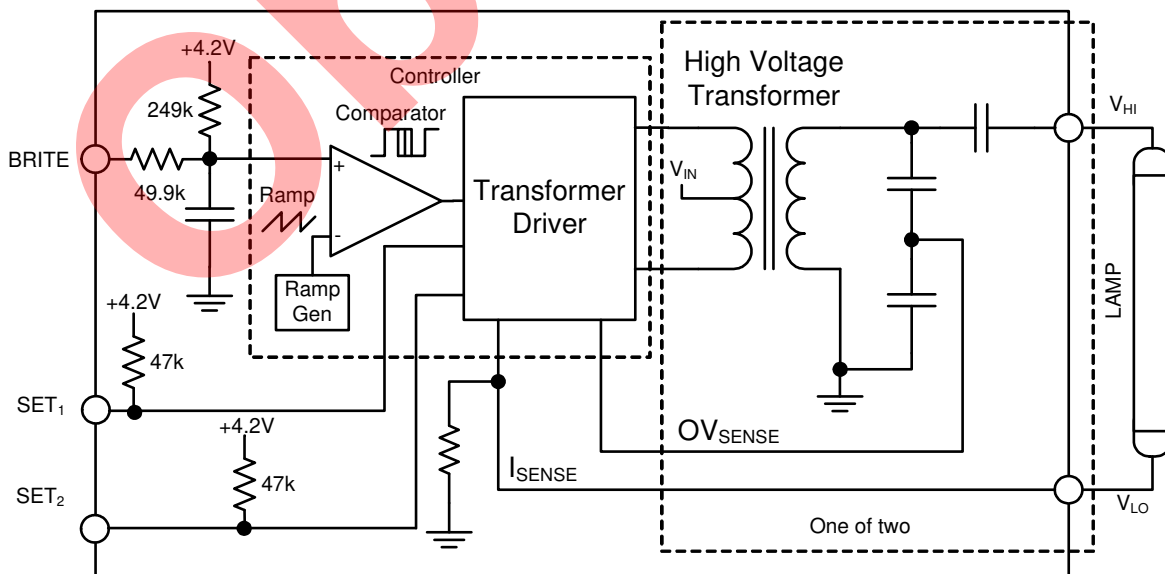
## TYPICAL APPLICATION



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



**Figure 1A** – PWM Brightness Control

$0 \leq$ P.W. $\leq 100\%$ of period



| SET$_1$ | SET$_2$ | |
|---|---|---|
| L | L | 5.0mA$_{RMS}$ |
| L | H | 6.0mA$_{RMS}$ |
| H | L | 7.0mA$_{RMS}$ |
| H | H | 8.0mA$_{RMS}$ |

L=GND; H=Open

**Figure 2** – Maximum Output Current
(SET$_1$ and SET$_2$ Inputs)

- 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 300k pull-up to typically 4.2V to bias the pot. A PWM logic level signal (figure 1A) may be used up to 5V; however the inverter will reach maximum current at less than 100% duty cycle. This can be calculated as approximately 2.3V divided by the logic high voltage level; with 3.3V logic level this corresponds to about 70% duty cycle for maximum lamp current.

- 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 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 manufacturers. Generally the best lamp lifetime correlates with driving the CCFL at the manufacturer's 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. 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 either or both outputs are open (lamp disconnected or broken) the inverter will attempt to strike for about a 1.5 seconds and then shutdown for safety purposes. In order to restart the inverter it is necessary to toggle the sleep input or cycle the V$_{IN}$ input supply.

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**NOTES**

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