## DESCRIPTION

The LXM1618-12-4x is a Single Output 4W Direct Drive™ CCFL (Cold Cathode Fluorescent Lamp) Inverter Module specifically designed for driving LCD backlight lamps. It is ideal for driving typical 8.4" to 12.1" panels.

The maximum output current is externally programmable over a range of 5 to 6.5mA in 0.5mA steps to allow the inverter to properly match to a wide array of LCD panel lamp current specifications. The modules are include a dimming input that permits brightness control from either a DC voltage source, a PWM signal or an external potentiometer.

LXM1618 modules unlike the LXM1617 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. A 5V input inverter is also available (LXM1618-05-4x).

The modules design is based on Microsemi's new LX1689 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 shorted lamp 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
- Output Short-Circuit Protection and Automatic Strike-Voltage Regulation and Timeout
- Analog Current Amplitude Dimming Method
- Fixed Frequency Operation
- Rated From -20 to 70°C
- UL60950 E175910

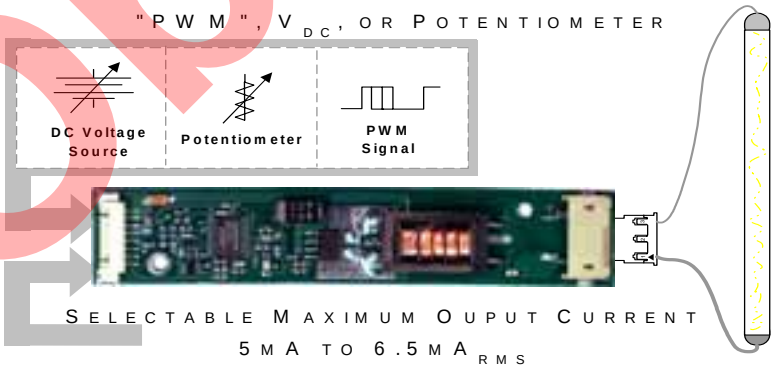
## APPLICATIONS

- Notebook And Sub-Notebook
- Portable Instrumentation
- Desktop Displays
- Industrial Display Controls

## BENEFITS

- Compact, Low Profile Design
- Mates to Wide Variety of LCD Panels
- Output Open Circuit Voltage Regulation Minimizes Corona Discharge For High Reliability

## PRODUCT HIGHLIGHT




## PACKAGE ORDER INFO

| PART NUMBER | OUTPUT CONNECTOR | INVERTER MATES DIRECTLY TO PANEL CONNECTORS |
|---|---|---|
| LXM1618-12-41 | JST SM02(8.0)B-BHS-1-TB or Yeon Ho 20015WR-05A00 | JST BHR-03VS-1 |
| LXM1618-12-42 | JST SM02B-BHSS-1-TB or Yeon Ho 35001WR-02A00 | JST BHSR-02VS-1 |
| LXM1618-12-43 | Honda QZ-19-A3MYL #02 | Honda QZ-19-3F01 |

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## ABSOLUTE MAXIMUM RATINGS (NOTE 1)

Input Signal Voltage ($V_{IN1}$) ..... -0.3V to 15V
Input Power ..... 5.5W
Output Voltage, no load ..... Internally Limited to 1600$V_{RMS}$
Output Current ..... 7.5$mA_{RMS}$ (Internally Limited)
Output Power ..... 4.0W

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
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 | $P_O$ | | 3.5 | 4.0 | W |
| Linear BRITE Control Input Voltage Range[1] | $V_{BRT\ ADJ}$ | 0.65 to 0.9 | | 2.0 | V |
| Lamp Operating Voltage | $V_{LAMP}$ | 465 | 550 | 635[2] | $V_{RMS}$ |
| Lamp Current (Full Brightness) | $I_{OLAMP}$ | 5 | | 6.5 | $mA_{RMS}$ |
| Operating Ambient Temperature Range | $T_A$ | -20 | | 70 | °C |

[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

[2] Total output power must not exceed 4W. Higher voltage lamps may require maximum output current to be set lower than 6.5$mA_{RMS}$

## 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 | LXM1618-12-4x | | | Units |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| **OUTPUT PIN CHARACTERISTICS** | | | | | | |
| Full Bright Lamp Current | $I_{L(MAX)}$ | $V_{BRT_ADJ} \geq 2.0V_{DC}$, $\overline{SLEEP} \geq 2.0V$, $V_{IN1} = 12V_{DC}$ $I_{SET1}$ = Ground, $I_{SET2}$ = Ground | 4.5 | 5 | 5.5 | $mA_{RMS}$ |
| Full Bright Lamp Current | $I_{L(MAX)}$ | $V_{BRT_ADJ} \geq 2.0V_{DC}$, $\overline{SLEEP} \geq 2.0V$, $V_{IN1} = 12V_{DC}$ $I_{SET1}$ = Ground, $I_{SET2}$ = Open | 5.0 | 5.5 | 6.0 | $mA_{RMS}$ |
| Full Bright Lamp Current | $I_{L(MAX)}$ | $V_{BRT_ADJ} \geq 2.0V_{DC}$, $\overline{SLEEP} \geq 2.0V$, $V_{IN1} = 12V_{DC}$ $I_{SET1}$ = Open, $I_{SET2}$ = Ground | 5.5 | 6 | 6.5 | $mA_{RMS}$ |
| Full Bright Lamp Current | $I_{L(MAX)}$ | $V_{BRT_ADJ} \geq 2.0V_{DC}$, $\overline{SLEEP} \geq 2.0V$, $V_{IN1} = 12V_{DC}$ $I_{SET1}$ = Open, $I_{SET2}$ = Open | 6.0 | 6.5 | 7.0 | $mA_{RMS}$ |
| Min. Average Lamp Current | $I_{L(MIN)}$ | $V_{BRT_ADJ} = 0.65V_{DC}$, $\overline{SLEEP} \geq 2.0V$, $V_{IN1} = 12V_{DC}$ $I_{SET1} = I_{SET2}$ = Ground | | 1.5 [3] | | $mA_{RMS}$ |
| Lamp Start Voltage | $V_{LS}$ | -20°C < $T_A$ < 70°C, $V_{IN1} > 10.8V_{DC}$ | 1300 | 1400 | | $V_{RMS}$ |
| Operating Frequency | $f_O$ | $V_{BRT_ADJ} = 2.5V_{DC}$, $\overline{SLEEP} \geq 2.0V$, $V_{IN1} = 12V$ | 76 | 80 | 83 | kHz |

[3] 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.

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## 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 | LXM1618-12-4x Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **BRITE INPUT** | | | | | | |
| Input Current | $I_{BRT}$ | $V_{BRT_ADJ}$ = 0$V_{DC}$ | | -300 | | $\mu A_{DC}$ |
| | | $V_{BRT_ADJ}$ = 3$V_{DC}$ | | 50 | | $\mu A_{DC}$ |
| 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 | | 5 | $V_{DC}$ |
| 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 | $I_{IN(MIN)}$ | $V_{IN1}$ = 12$V_{DC}$, $\overline{SLEEP} \leq 0.8V$ | 0.0 | 8 | 20 | $\mu A_{DC}$ |
| Run Current | $I_{RUN}$ | $V_{IN1}$ = 12$V_{DC}$, $\overline{SLEEP} \geq 2.0V$, $I_{SET1}$ = Open<br>$I_{SET2}$ = Ground, $V_{LAMP}$ = 550$V_{RMS}$ | | 330 | | $mA_{DC}$ |
| Efficiency | $\eta$ | $V_{IN1}$ = 12$V_{DC}$, $\overline{SLEEP} \geq 2.0V$, $I_{SET1}$ = Open<br>$I_{SET2}$ = Ground, $V_{LAMP}$ = 550$V_{RMS}$ | | 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 53261-0890) Mates with 51021-0800 housing, 50079-8100 pins. Mates with LX9501 input cable assembly | | |
| 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 = OFF, $\overline{SLEEP}$ >= 2.0V = ON |
| CN1-6 | BRITE | Brightness Control (0.65V to 2.0$V_{DC}$). 2.0$V_{DC}$ gives maximum lamp current. |
| 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 for LXM1618-12-41 and -42**<br>(JST SM02(8.0)B-BHS-1-TB \| Yeon Ho 20015WR-05A00 or SM02B-BHSS-1-TB \| Yeon Ho 35001WR-02A00) | | |
| CN2-1 | $V_{HI}$ | High voltage connection to high Side of lamp. Connect to lamp terminal with shortest lead length. **DO NOT** connect to Ground. |
| CN2-2 | $V_{LO}$ | Connection to low side of lamp. Connect to lamp terminal with longer lead length. **DO NOT** connect to Ground |
| **CN2 for LXM1618-12-43** (Honda QZ-19-A3MYL #02) | | |
| CN2-3 | $V_{HI}$ | High voltage connection to high side of lamp. Connect to lamp terminal with shortest lead length. **DO NOT** connect to Ground. |
| CN2-1 | $V_{LO}$ | 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

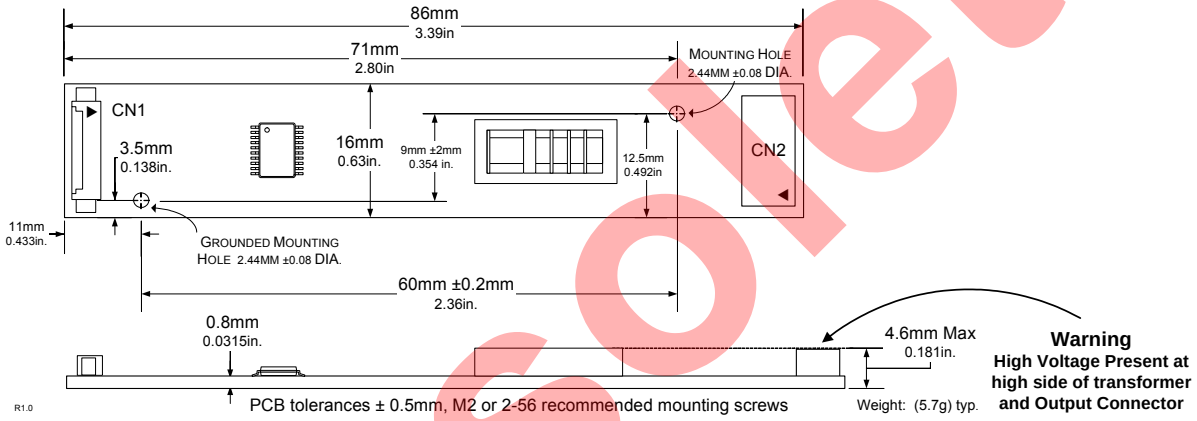
### OUTPUT CURRENT SETTINGS

| $SET_1$ (Pin 7) | $SET_2$ (Pin 8) | Nominal Output Current |
|---|---|---|
| Open* | Open* | 6.5mA |
| Open* | Ground | 6.0mA |
| Ground | Open* | 5.5mA |
| Ground | Ground | 5.0mA |

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

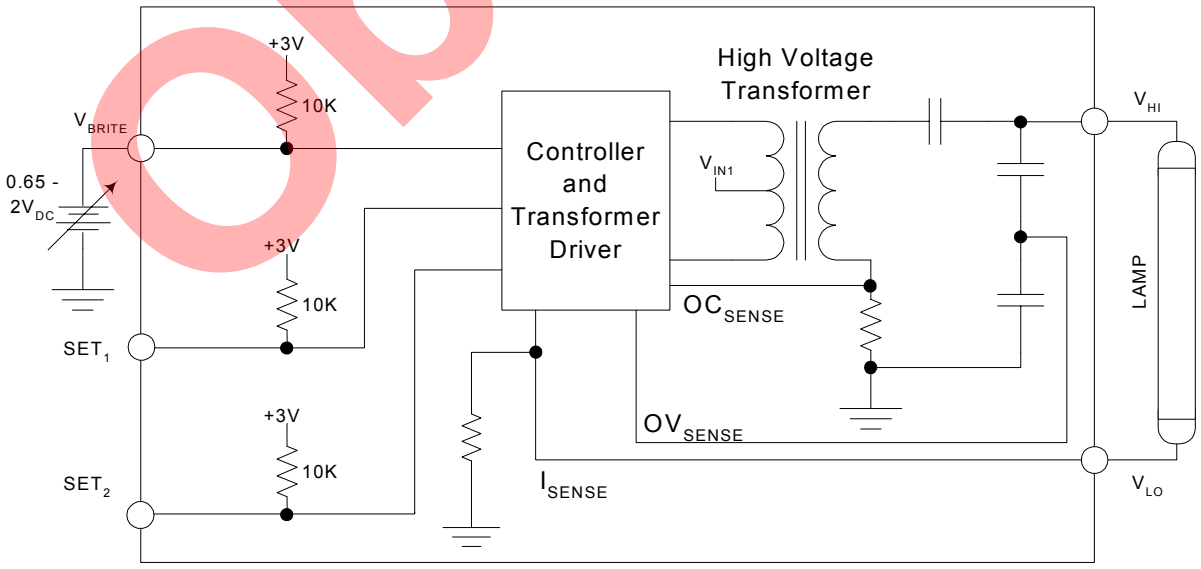
## PHYSICAL DIMENSIONS

### LXM1618-12-4X




All dimensions are in millimeters, inches are for reference.

## SIMPLIFIED BLOCK DIAGRAM




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## TYPICAL APPLICATION

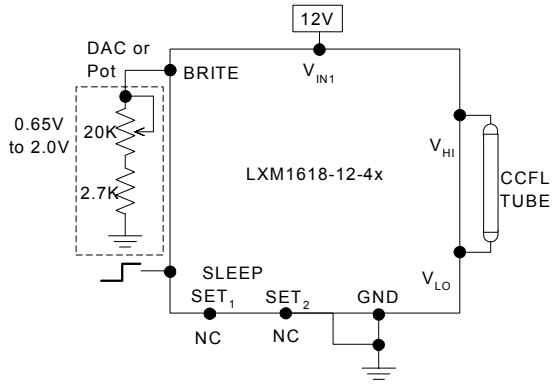



**Figure 1** – Brightness Control
(Output current set to maximum)

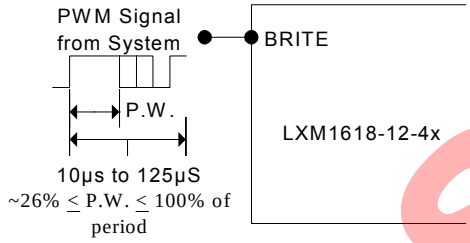
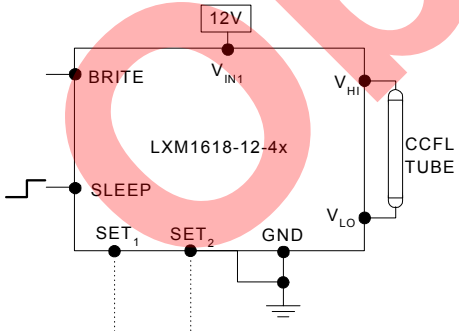



**Figure 1A** – PWM Brightness Control




| | | |
|---|---|---|
| L | L | 5.0mA$_{RMS}$ |
| L | H | 5.5mA$_{RMS}$ |
| H | L | 6.0mA$_{RMS}$ |
| H | H | 6.5mA$_{RMS}$ |

L=GND; H=Open

**Figure 2** – Max 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 20K manual pot. The inverter contains an internal 10K pull-up to 3V to bias the pot add a 2.7K 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 and efficiency 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 the peak output current, using this technique the effective dim ratio can be increased. 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 as 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 $V_{IN1}$ input supply

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## NOTES

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