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DESCRIPTION

RangeMAX™ Wide Range Dimming, Single Output Inverter. The LXMG1611 series of *Direct Drive™* CCFL (Cold Cathode Fluorescent Lamp) Inverter Modules are specifically designed for driving LCD backlight lamps.

Similar to the LXM1610, the LXMG1611 excels in applications where critical parameters include very wide range dimmability, high efficiency and reliable fail-safe design in a small form factor.

Unlike the LXM1610 or any traditional dimming CCFL inverters, the LXMG1611 provides the designer a vastly superior display brightness range. 100:1+ brightness range is achievable with virtually any LCD display. Our wide range dimming provides exceptional display readability at less than 1% of full brightness, allowing both power savings and low ambient light operating capability (i.e. "night readable").

The LXMG1611 is recommended for use in panels with low-voltage insulation on the lamp return wire.

RangeMAX™ Digital Dimming Technique. Digital dimming provides flicker free brightness control in any wide-range dimming application. Dimming ratios greater than 100:1 can be achieved. Incorporation of a video synchronization feature allows wide ratio dimming without the display disturbances and interference seen with competitive products.

The modules are equipped with a dimming input that permits brightness control from an external potentiometer or DC voltage source. The resultant "burst drive" that energizes the lamp was designed specifically to ensure that no premature lamp degradation occurs. (See "How RangeMAX™ Works" Section)

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

Direct Drive Technology. The module design is based on a new Direct Drive topology, which provides a number of cost and performance advantages. The LXMG1611-01 series *Direct Drive™* inverters eliminate the classic resonant inductor and capacitors, thus reducing cost and allowing a 30% reduction in module size.

Additional Features. Other benefits of this new topology are fixed-frequency operation and secondary-side strike-voltage regulation.

Strike-voltage regulation minimizes corona discharge in the output transformer and related circuitry, providing longer life and higher reliability. All LXMG1611 modules feature both open and shorted lamp protection.

The LXMG1611 is fully customizable (electronically and mechanically) to specific customer requirements.

KEY FEATURES

- RangeMAX™ Wide Range Dimming
- 8V to 18V Input Voltage Range
- 30% Smaller Than CS-ZVS Models
- Easy to Use Brightness Control
- MicroAmp SLEEP Mode
- Output Short-Circuit Protection and Automatic Strike-Voltage Regulation
- 7.3mm Maximum Module Height, 16mm Module Width
- Fixed Frequency Operation
- RoHS Compliant
- UL 60950 E175910

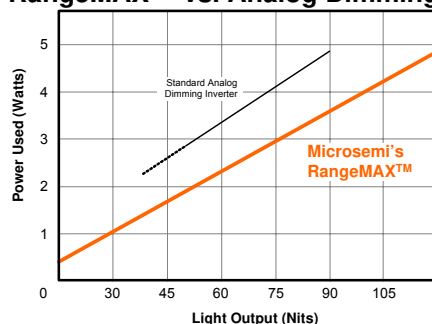
APPLICATIONS

- Notebook and Sub-Notebook Computers
- Portable Instrumentation
- Desktop Displays
- Low Ambient Light Conditions (i.e. Aircraft Cabins, Automobile)

BENEFITS

- High Efficiency and Sleep mode Feature Extends Computer Battery Life
- Smooth, Flicker Free 1-100% Full-Range Brightness Control Gives Product a High Quality Image
- Output Open Circuit Voltage Regulation Minimizes Corona Discharge for Long Life and High Reliability
- Power Efficient, "Low Brightness" Capability Allows for Advanced Power Management

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; Patents Pending

PRODUCT HIGHLIGHT
RangeMAX™ vs. Analog Dimming


- RangeMAX™ technology allows the designer to operate in a lower "brightness" and therefore at lower "power consumption" than can be reached using traditional analog dimming inverters.
- Dotted line indicates area where panel variations and parasitics will impact minimum light level with analog dimming.
- Data presented for a RangeMAX™ inverter driving a 13.3" LCD with a 1.2 Nit to 120 Nit brightness range. The minimum power levels were 0.4 watts (RangeMAX™) vs. 2.1 watts (analog dimming) for a power consumption savings of 1.7 watts.

PACKAGE ORDER INFO
LXMG1611-01



ABSOLUTE MAXIMUM RATINGS

Input Supply Voltage (VIN).....	-0.3V to 18V
Output Voltage, no load	Internally Limited to 1800V _{RMS}
Output Current	10mA _{RMS} (Internally Limited)
Output Power	6W
Input Signal Voltage (BRITE Input)	-0.3V to 6.5V
Input Signal Voltage (SLEEP, V _{SYNC(-)} , V _{SYNC(+)} Inputs)	-0.3V to V _{IN}
Ambient Operating Temperature Range	0°C to 70°C
Storage Temperature Range	-40°C to +85°C

Note: 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

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 function optimally.

Parameter	Symbol	LXMG1611-01			Units
		Min	R.C.	Max	
Input Supply Voltage Range (Functional)	V _{IN}	8	12	18	V
Input Supply Voltage (Fully Regulated Lamp Current)		9	12	16	V
Output Power	P _O		4	5	W
Brightness Control Input Voltage Range	V _{BRT ADJ}	0		2.5	V
Lamp Operating Voltage	V _{LAMP}	300	675	800	V _{RMS}
Lamp Current (Full Brightness)	I _{OLAMP}		7		mA _{RMS}
Operating Ambient Temperature Range	T _A	0		70	°C

ELECTRICAL CHARACTERISTICS

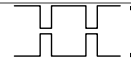
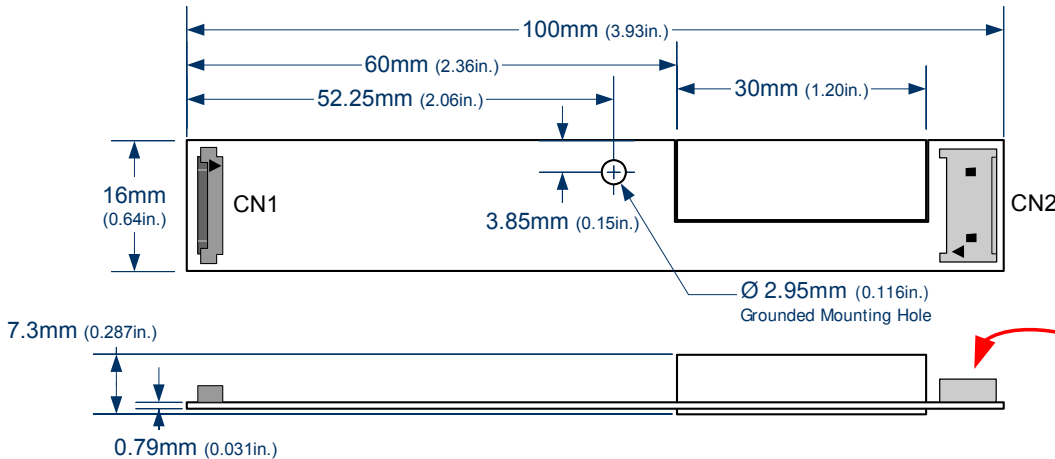
Unless otherwise specified, these specifications apply over the recommended operating conditions and 25°C ambient temperature for the LXMG1611.

Parameter	Symbol	Test Conditions	LXMG1611-01			Units
			Min	Typ	Max	
OUTPUT PIN CHARACTERISTICS						
Full Bright Lamp Current	I _{L(MAX)}	V _{BRT ADJ} = 2.5V _{DC} , SLEEP = HIGH, Burst Duty = 100%, V _{IN} = 9V _{DC}	6.3	7.0	7.7	mA _{RMS}
Minimum Lamp Current (Note 2)	I _{L(MIN)}	V _{BRT ADJ} = 0V _{DC} , SLEEP = HIGH, Burst Duty = 2%, V _{IN} = 9V _{DC}		0.14		mA _{RMS}
Lamp Start Voltage	V _{LS}	0°C < T _A < 40°C, V _{IN} ≥ 7V _{DC}	1500		1800	V _{RMS}
Operating Frequency	f _O	V _{BRT ADJ} = 2.5V _{DC} , SLEEP = HIGH, V _{IN} = 12V _{DC}	52	57	62	kHz
BRITE INPUT						
Input Current	I _{BRT}	V _{BRT ADJ} = 0V _{DC}	-10	-12	-14	μA _{DC}
Input Voltage for Max. Lamp Current	V _C	I _{O(LAMP)} = 100% Duty Cycle		2.5	2.6	V _{DC}
Input Voltage for Min. Lamp Current	V _C	I _{O(LAMP)} = Minimum Duty Cycle		0	0	V _{DC}
SLEEP INPUT						
RUN Mode	V _{SLEEP(HI)}		2.2		V _{IN}	V _{DC}
SLEEP Mode	V _{SLEEP(LO)}		-0.3		0.8	V _{DC}
Input Current	I _{SLEEP}	SLEEP = 5V		120	180	μA _{DC}
V_{SYNC(-)} / V_{SYNC(+)} CHARACTERISTICS						
Logic High Level	V _{SYNCH(HI)}		4.0		6.5	V _{DC}
Logic Low Level	V _{SYNCH(LO)}		-0.3		1.0	V _{DC}
Input Impedance	Z _{IN}		60	66	75	kΩ
Pulse Width (Note 3)	t _{PW}		25		250	μs
Input Frequency	f _{SYNCH}		49		150	Hz
POWER CHARACTERISTICS						
Sleep Current	I _{IN(MIN)}	V _{IN} = 15V _{DC} , SLEEP ≤ 0.8V		10	50	μA _{DC}

Note: 2. Minimum lamp current required to maintain even light output may vary with display panel.
3. The module will be functional with pulse widths much larger than 250μs, but will have limited dimming.

FUNCTIONAL PIN DESCRIPTION

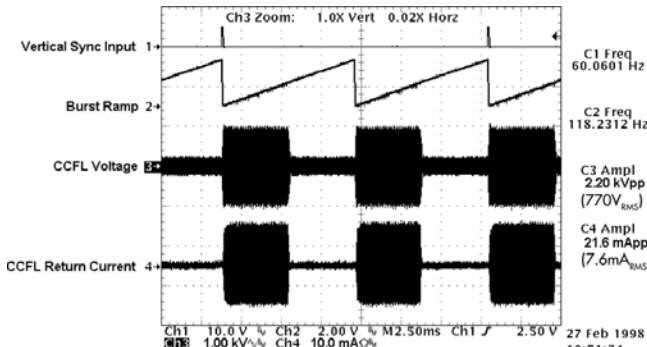
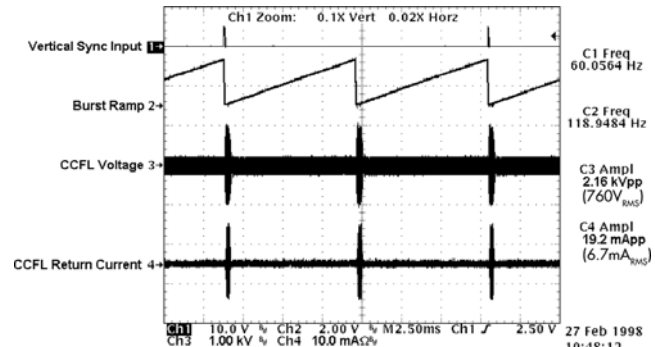
Conn.	Pin	Description
CN1		
CN1-1	V _{IN}	Input Power Supply ($8V \leq V_{IN} \leq 18V$).
CN1-2		
CN1-3		
CN1-4		
CN1-5	SLEEP	ON/OFF Control. ($2.2V < \overline{SLEEP} < V_{IN} = \text{ON}$, $-0.3V < \overline{SLEEP} < 0.8V = \text{OFF}$)
CN1-6		
CN1-7	V _{SYNC(-)}	Vertical Synchronization Input, negative going
CN1-8	V _{SYNC(+)}	
CN2		
CN2-1	V _{HI}	High Voltage connection to high side of lamp. Connect to lamp 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.


PHYSICAL DIMENSIONS


Warning!!
High Voltage Present

All dimensions are in millimeters, inches are for reference only.

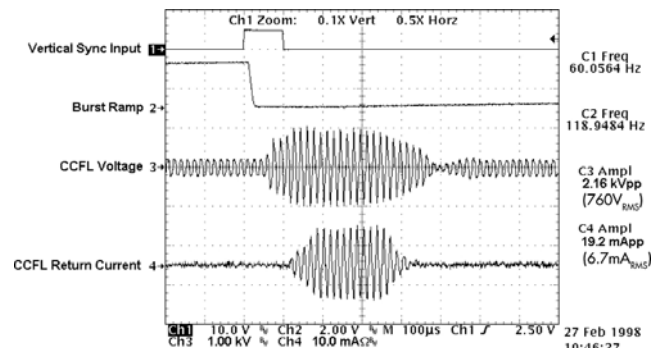
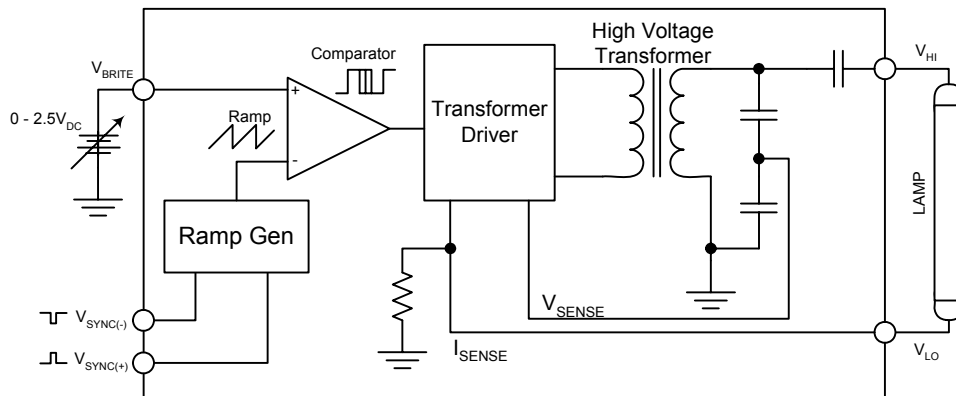
Connectors:		Recommended Mate
CN1	Molex 53261-0871	Pins: 50079-8100*, Housing: 51021-0800 *Loose (-8000, Chain) Recommended #26 AWG wiring
CN2	JST SM02(8.0)B-BHS-1-TB Or Yeon Ho 20015WR-05A00	Pins: 5BH-001T-P0.5, Housing: BHR-03VS-1

HOW RANGEMAXTM WORKS

Figure 1 – 50% Burst Duty Cycle

Figure 2 – 2% Burst Duty Cycle

Rather than using the traditional dimming technique of varying lamp current magnitude to adjust light output, RangeMAXTM inverters use a fixed lamp current value with a duty cycle control method.

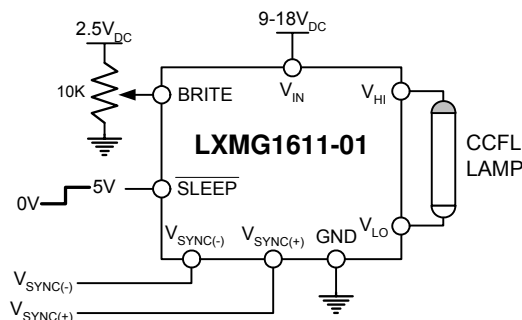
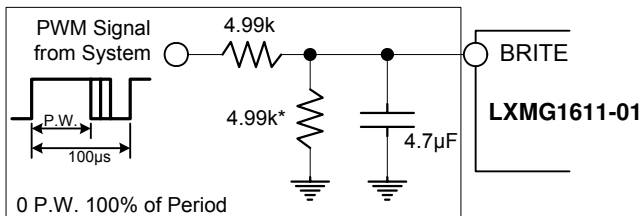
The lamp current burst width can be modulated from 100% (continuous lamp current) down to a 2% duty cycle, allowing the lamp to be dimmed to less than 1% of its full brightness.

As can be seen in Trace 4 of Figure 3 photo at right, careful design consideration was given to controlling lamp start voltage to softly start current flow. This eliminates current overshoot that can result in premature cathode wear and reduce lamp life.


Figure 3 – 2% Burst Duty Cycle (Expanded Time Base)

Figure 4 – RangeMAXTM Block Diagram



HOW RANGEMAX™ WORKS (CONTINUED)

- On-board brightness control circuit includes a DC voltage to pulse width converter that minimizes system design work and system noise susceptibility. This provides a familiar and convenient interface while reducing the potential for externally induced noise which can cause lamp flicker.
- An on-board oscillator operates the inverter BURST rate above 95Hz, well beyond standard 50/60Hz video refresh rates where the eye can perceive pulsing light.
- RangeMAX inverter modules are designed to operate with the burst frequency synchronized to the video frame rate. This provides operation with no visible display disturbances caused by beat frequencies between the lamps and video frame rates.
- In applications with no access to a vertical sync, the inverter burst frequency can be allowed to "free run" at 95Hz. In this non-synchronous mode, minor display disturbances can be found under certain video conditions. This performance may be acceptable for many applications, but synchronization must be used when no disturbance can be tolerated.
- Separate inputs are provided for negative and positive vertical sync pulses so external inversion is not needed.
- Separate feedback loops for lamp current and open circuit voltage regulation insure reliable strike under all operating conditions, automatic over-voltage prevention with broken or failed lamps, and accurate lamp current regulation.

TYPICAL APPLICATION

Figure 5 – Potentiometer Brightness Control


* Use 4.99k for 5V PWM amplitude, 15k for 3.3V PWM amplitude, and omit for 2.5V PWM amplitude.

Figure 5a – PWM Brightness Control

- The brightness control may be a simple 10k potentiometer or a voltage output DAC. A PWM signal from a micro-controller may also be used with a suitable filter such as shown in Figure 5A.
- If synchronization to the video framerate is desired, connect the vertical sync pulse from the system video controller to the appropriate V_{SYNC} input. If the pulse is negative going (), connect it to $V_{SYNC(-)}$. If positive going (), connect it to $V_{SYNC(+)}$. If no video synchronization is desired, leave both $V_{SYNC(-)}$ and $V_{SYNC(+)}$ floating.
- If you need to turn the inverter ON/OFF remotely, connect a 3V or 5V logic signal to the \overline{SLEEP} input. If remote ON/OFF is not needed, connect the \overline{SLEEP} input to V_{IN} or any other voltage greater than 2.2V_{DC}.
- 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} .

RangeMAX™ Inverters

Also available in Dual Output **LXMG1621-01** and Quad Output **LXMG1643-12-6x** versions for multiple lamp applications.



Microsemi[®]

Not Recommended For New Design

RangeMAX[™]

LXMG1611-01

Digital Dimming CCFL Inverter Module

PRODUCTION DATA SHEET

NOTES

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