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RangeMAX™ **LXMG1611-01**

Digital Dimming CCFL Inverter Module

PRODUCTION DATA SHEET

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.

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

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

PRODUCT HIGHLIGHT

RangeMAX™ vs. Analog Dimming

Standard Analog Dimming Inverter

Microsemi's RangeMAX™

Power Used (Watts) — Light Output (Nits)
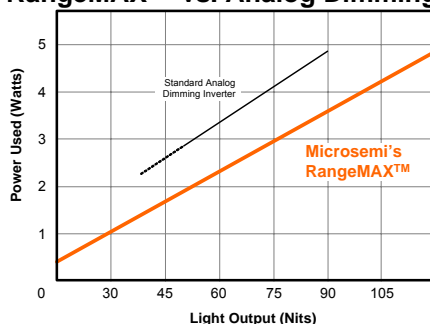
- RangeMAX™ technology allows the designer to operate in a lower "brightness" and therefore at lower "power consumption" than can be reached using traditional analog dimming inverters.
- Dotted line indicates area where panel variations and parasitics will impact minimum light level with analog dimming.
- 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

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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 ($\overline{SLEEP}$, $V_{SYNC(-)}$, $V_{SYNC(+)}$ 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, bet 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.

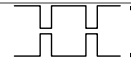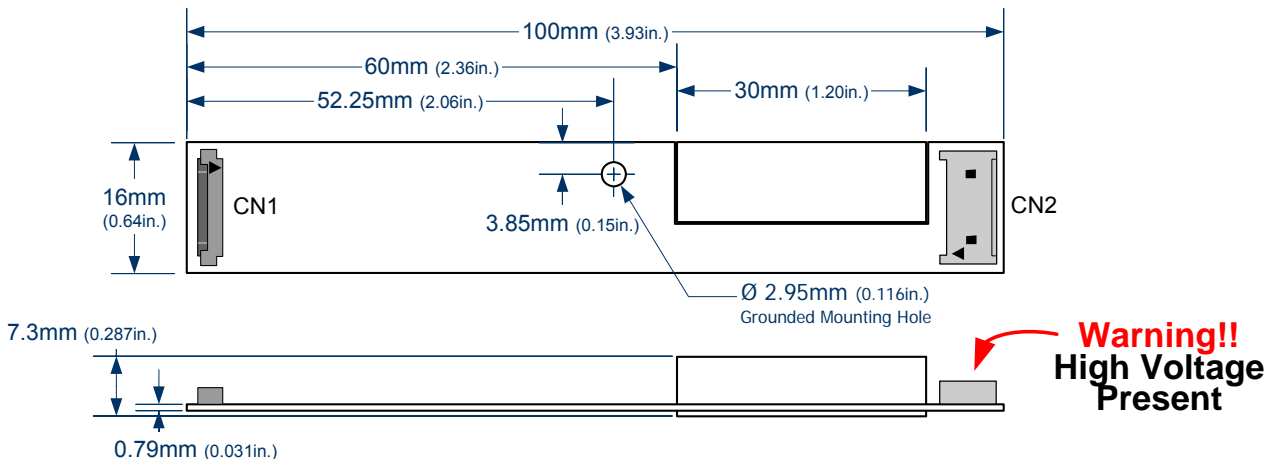| Parameter	Symbol	LXMG1611-01 Min	LXMG1611-01 R.C.	LXMG1611-01 Max	Units
Input Supply Voltage Range (Functional)	V_{IN}	8	12	18	V
Input Supply Voltage (Fully Regulated Lamp Current)		9	12	16	V
Output Power	P_O		4	5	W
Brightness Control Input Voltage Range	$V_{BRT\ ADJ}$	0		2.5	V
Lamp Operating Voltage	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 Min	LXMG1611-01 Typ	LXMG1611-01 Max	Units
OUTPUT PIN CHARACTERISTICS						
Full Bright Lamp Current	$I_{L(MAX)}$	$V_{BRT\ ADJ}$ = 2.5V_{DC}, $\overline{SLEEP}$ = 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}, $\overline{SLEEP}$ = HIGH, Burst Duty = 2%, V_{IN} = 9V_{DC}		0.14		mA_{RMS}
Lamp Start Voltage	V_{LS}	0°C < T_A < 40°C, $V_{IN} \geq$ 7V_{DC}	1500		1800	V_{RMS}
Operating Frequency	f_O	$V_{BRT\ ADJ}$ = 2.5$V_{DC,}$ $\overline{SLEEP}$ = HIGH, VIN = 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}
$\overline{SLEEP}$ INPUT						
RUN Mode	$V_{\overline{SLEEP}(HI)}$		2.2		V_{IN}	V_{DC}
SLEEP Mode	$V_{\overline{SLEEP}(LO)}$		-0.3		0.8	V_{DC}
Input Current	$I_{\overline{SLEEP}}$	$\overline{SLEEP}$ = 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_{SYNC}		49		150	Hz
POWER CHARACTERISTICS						
Sleep Current	$I_{IN(MIN)}$	V_{IN} = 15V_{DC}, $\overline{SLEEP} \leq$ 0.8V		10	50	µA_{DC}

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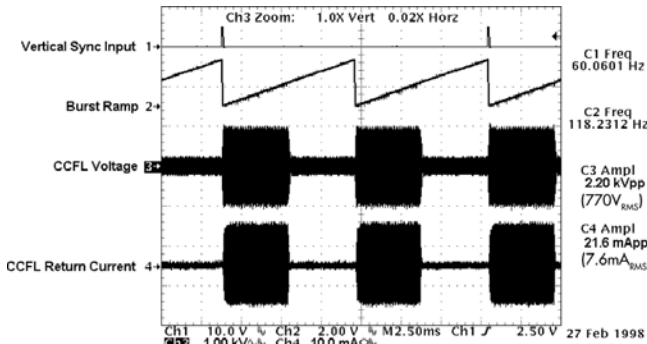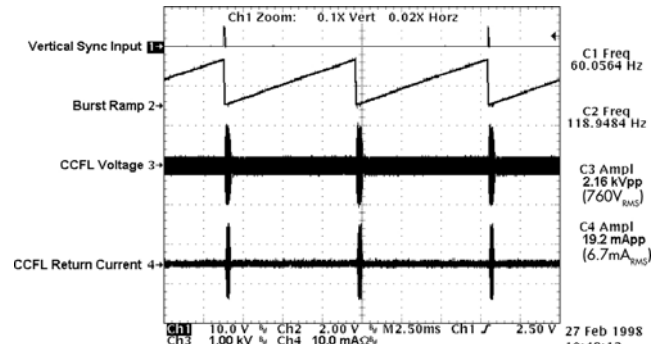   3. The module will be functional with pulse widths much larger than 250µs, but will have limited dimming.

PACKAGE DATA

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FUNCTIONAL PIN DESCRIPTION

Conn.	Pin	Description	
CN1			
CN1-1	V_{IN}	Input Power Supply ($8V \leq V_{IN} \leq 18V$).	
CN1-2			
CN1-3	GND	Power Supply Return.	
CN1-4			
CN1-5	$\overline{SLEEP}$	ON/OFF Control. ($2.2V < \overline{SLEEP} < V_{IN}$ = ON, $-0.3V < \overline{SLEEP} < 0.8V$ = OFF)	
CN1-6			
CN1-7	$V_{SYNC(-)}$	Vertical Synchronization Input, negative going	$25\mu s < t_{PW} < 250\mu s$,
CN1-8	$V_{SYNC(+)}$	Vertical Synchronization Input, positive going	$49Hz < f_{SYNC} < 150Hz$
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

100mm (3.93in.)
60mm (2.36in.)
52.25mm (2.06in.)
30mm (1.20in.)
16mm (0.64in.)   CN1   CN2
3.85mm (0.15in.)
Ø 2.95mm (0.116in.)
Grounded Mounting Hole
7.3mm (0.287in.)
0.79mm (0.031in.)

Warning!!
High Voltage Present

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

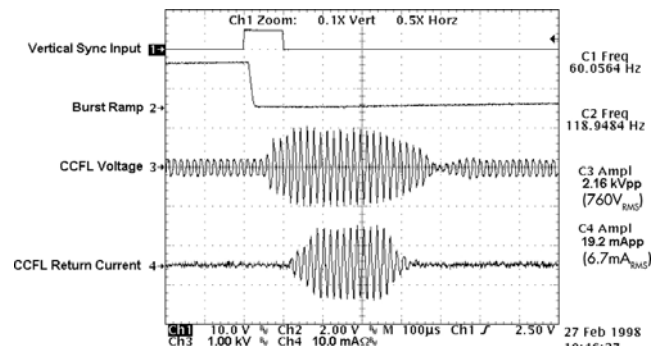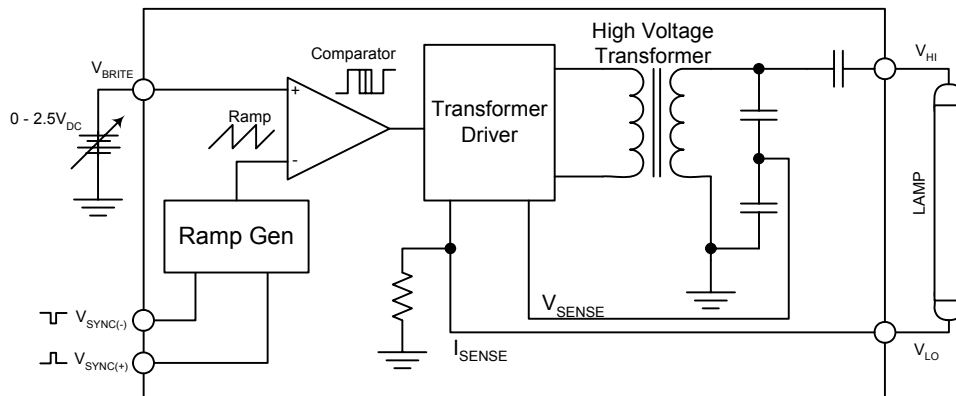|	Connectors:		Recommended Mate
CN1	Molex 53261-0871		Pins: 50079-8100*, Housing: 51021-0800 *Loose (-8000, Chain) Recommended #26 AWG wiring
CN2	JST SM02(8.0)B-BHS-1-TB Or Yeon Ho 20015WR-05A00		Pins: 5BH-001T-P0.5, Housing: BHR-03VS-1

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HOW RANGEMAX™ 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, RangeMAX™ 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 – RangeMAX™ Block Diagram

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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 APPLICAITON
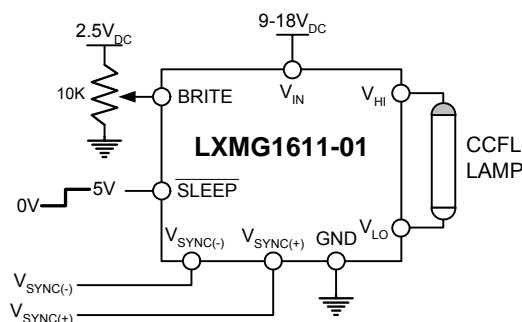
Figure 5 – Potentiometer Brightness Control
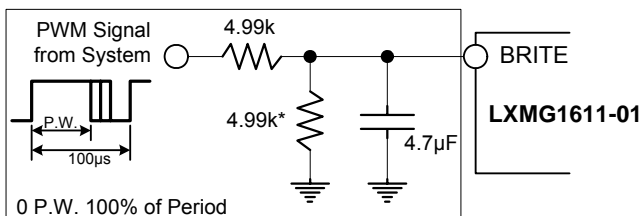
* Use 4.99k for 5V PWM amplitude, 15k for 3.3V PWM amplitude, and omit for 2.5V PWM amplitude.

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.

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