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MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

PATENT PENDING   **LIN DOC #: 1596**

LXM1596-01

WIDE INPUT CCFL INVERTER MODULES

PRELIMINARY DATA SHEET

DESCRIPTION

LXM1596-01 CCFL (cold cathode florescent lamp) Inverter Modules are specifically designed for driving LCD back light lamps in applications where dimmability, ultrahigh efficiency, high light output, low noise emissions, reliable fail safe design, and small form factors are critical parameters. Both monochrome and color displays are supported.

The modules convert unregulated DC voltage from the system battery or AC adapter directly to high-frequency, high-voltage sine waves required to ignite and operate CCFL lamps. The module design is based on a proprietary Linfinity IC that provides important new performance advances.

Remarkable improvements in efficiency and RF emissions result from its *single* stage resonant inverter featuring a patent pending Current Synchronous, Zero Voltage Switching (CS-ZVS) topology. CS-ZVS produces nearly pure sine wave currents in the lamp enabling maximum light delivery while reducing both conducted and radi-ated noise. This topology simultaneously performs three tasks consisting of line voltage regulation, lamp current regulation, and lamp dimming in a single power stage made up of one pair of low loss FET's. The FET's drive an LC resonant circuit that feeds the primary of a high voltage transformer with a sinusoidal voltage.

Required L and C values in the resonant circuit are such that very low loss components can be used to obtain higher electrical efficiency than is possible with previous topologies.

The half bridge LXM1596-01 is optimized to efficiently operate with up to 4 watt lamps over the full 7V to 30V input voltage range.

The modules are equipped with a dimming input that permits full range brightness control from an external potentiometer, and a sleep input that reduces module power to a few microwatts in shut down mode.

All modules feature output open and short circuit protection.

IMPORTANT: For the most current data, consult LinFinity's web site: **http://www.linfinity.com**.

KEY FEATURES

- 15 to 30% More Light Output
- Closed Loop, Fully Regulating Design
- 7V To 30V Input Voltage Range
- Versatile Brightness Control Input
- 3 MicroAMP Sleep Current
- Output Short Circuit Protection And Automatic Over-Voltage Limiting
- 8mm Max. Height, Narrow Footprints
- Single Sided PCB Is Self Insulating

APPLICATIONS

- Notebook And Sub-Notebook Computers
- Personal Digital Assistants
- Portable Instrumentation
- Automotive Displays
- Desktop Displays
- Airline Entertainment Centers

BENEFITS

- Ultra-High Efficiency, Line Voltage Regulation And Sleep Mode Extend Computer Battery Life
- Cool Operation PermitS Close Proximity To LCD Panel Without Display Distortion
- Smooth, Full-Range Brightness Control Gives Your Product A High Quality Image
- Low EMI / RFI Design Minimizes Shielding Requirements
- Narrow, Low-Profile Standard Modules Fit Into Most LCD Enclosures
- Single Sided PCB Saves Expensive High Voltage Insulating Tapes

PRODUCT HIGHLIGHT

BACKLIGHT INVERTER LIGHT OUTPUT EFFICIENCY COMPARISON
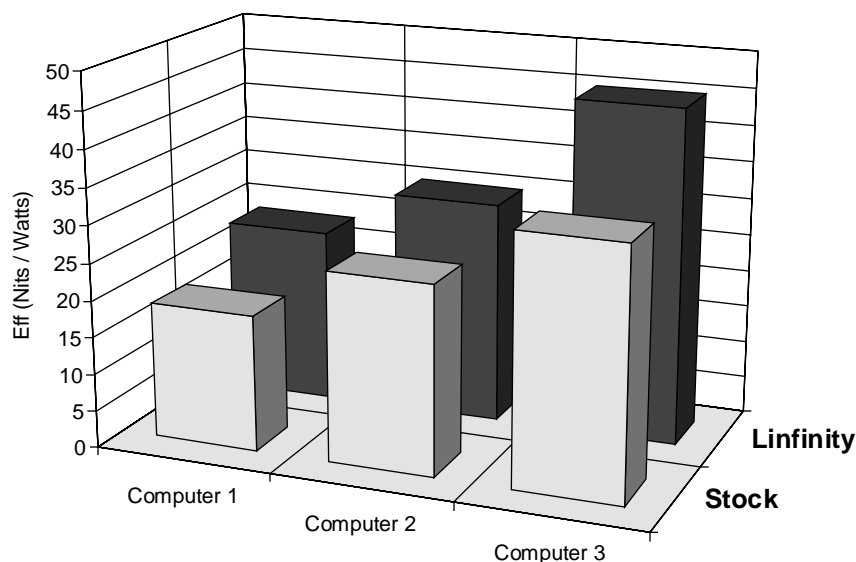
MODULE ORDER INFO

7V - 30V INPUT

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ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Supply Voltage (V_{IN}) .... -0.3V to 30V
Output Voltage, no load .... Internally Limited to $1900V_{RMS}$
Output Current .... $8.0mA_{RMS}$ (Internally Limited)
Output Power 4.2W
Input Signal Voltage, (SLEEP and BRITE Inputs).. -0.3V to 6.5V
Ambient Operating Temperature, zero airflow .... 0°C to 60°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 the 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	V_{IN}	7	12	30	V
Output Power	P_O		2.5	4.0	W
Brightness Control Input Voltage Range	V_{BRITE}	0.8		2.5	V
Lamp Operating Voltage	V_{LAMP}	240	500	650	V_{RMS}
Lamp Current - Full Brightness	I_{OLAMP}		5	7	mA_{RMS}
Operating Ambient Temperature Range	T_A	0		60	°C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, these specifications apply over the recommended operating conditions and 25°C ambient temperature for the LXM1596.

Parameter	Symbol	Test Conditions	LXM1596			Units
			Min.	Typ.	Max.	
Output Pin Characteristics						
Full Bright Lamp Current	$I_{L (MAX)}$	V_{BRITE} = 2.5 V_{DC}, $\overline{SLEEP}$ = Logic High	6.2	6.6	7.0	mA
Minimum Lamp Current	$I_{L (MIN)}$	V_{BRITE} = 0.8 V_{DC}, $\overline{SLEEP}$ = Logic High		2.6		mA_{RMS}
Lamp Start Voltage	V_{LS}	0°C < T_A < 60°C	1300			V_{RMS}
Operating Frequency	f_O	V_{BRITE} = 2.5V_{DC}, $\overline{SLEEP}$ = Logic High, V_{IN} = 12V		50		KHz
Brightness Control						
Input Current	I_{BRITE}	V_{BRITE} = 0V_{DC}		-200	-1000	nA_{DC}
Input Voltage for Max. Lamp Current	V_C	$I_{O (LAMP)}$ = 100%	2.4	2.5	2.6	V_{DC}
Input Voltage for 50% Lamp Current	V_C	$I_{O (LAMP)}$ = 50%		1.25		V_{DC}
$\overline{SLEEP}$ Input						
Input Logic 1	V_{IH}		2.2		5.5	V_{DC}
Input Logc 0	V_{IL}		0		0.8	V_{DC}
Input Current	I_{IN}	$V_{\overline{SLEEP}}$ = 0 - 5V_{DC}		50	100	μA_{DC}
Voltage Reference						
Output Voltage	V_{REF}	0 < I_{REF} < 500μA	2.40	2.50	2.60	V_{DC}
Output Current	I_{REF}		500			μA_{DC}
Power Characteristics						
Sleep Current	$I_{IN (MIN)}$	V_{IN} = 5V_{DC} , $\overline{SLEEP}$ = Logic 0		3	10	μA_{DC}
Electrical Efficiency (calculated values)	η	LXM1596, V_{IN} = 12V_{DC}, $I_{O (LAMP)}$ = 5mA_{RMS}		90		%

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P R E L I M I N A R Y   D A T A   S H E E T

FUNCTIONAL PIN DESCRIPTION

Conn.	Pin	Description
CN1		
CN1-1 CN1-2	V_{IN}	Input voltage. (+7 to +30V_{DC})
CN1-3	N.C.	No Connect.
CN1-4 CN1-5	GND	Power supply return.
CN1-6	$\overline{SLEEP}$	Logical high on this pin enables inverter operation. Logical low removes power from the module and the lamp. A floating input is sensed as a logical low and will disable inverter operation. If not used, connect $\overline{SLEEP}$ through a 33kΩ resistor to V_{IN} or directly to any voltage between 2.5 and 5.5V.
CN1-7	BRITE	Brightness control input. Apply 0.8 to 2.5 volts DC to control lamp brightness. Lamp current varies linearly with input voltage. 2.5V gives maximum brightness.
CN1-8	V_{REF}	Reference Voltage Output. 2.5V @ 500µA max. For use with external dimming circuit.
CN2		
CN2-1	LAMP LO	High voltage connection to low side of lamp. Connect to lamp terminal with longer lead length. Do not connect to ground.
CN2-2	LAMP HI	High voltage connection to high side of lamp. Connect to lamp terminal with shortest lead length. Do not connect to ground.

MECHANICAL OUTLINE

All dimensions in inches (mm)
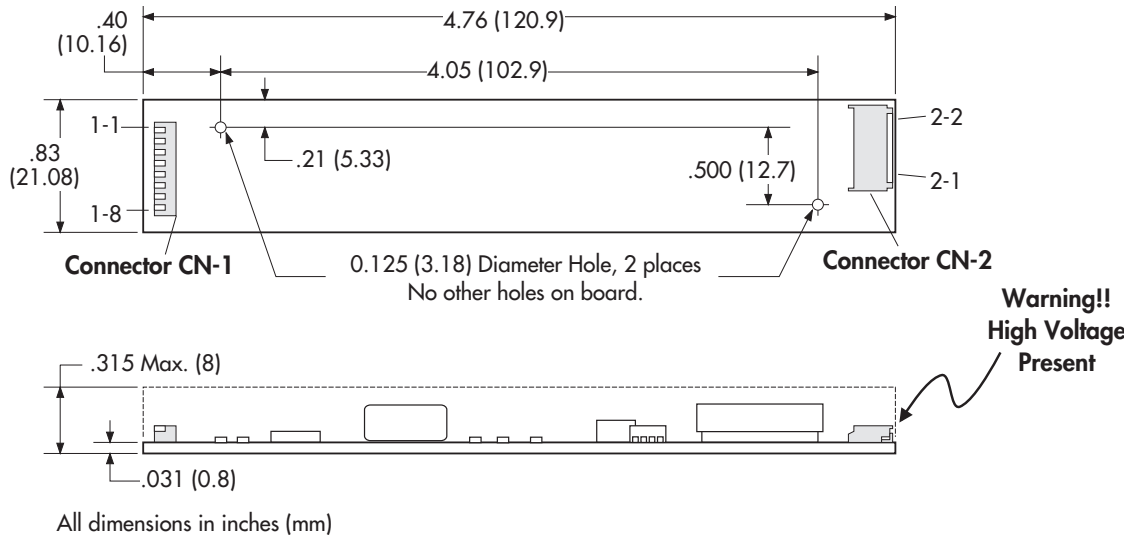
Connectors:
CN-1 = MOLEX 53261-0890

CN-2 = JST SM02(8.0) B-BHS-TB

Recommended Mate:
Pins: 50079-8100*,   Housing: 51021-0800
* Loose (-8000, Chain) Recommended #26 AWG wiring

Pins: 5BH-001T-P0.5,   Housing: BHR-03VS-1

Note: All samples are equipped with connector mates and cable.

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P R E L I M I N A R Y   D A T A   S H E E T

CONNECTION DIAGRAM

$$\text{Lamp Current (\%)} = \frac{V_{BRITE}}{V_{REF}} \times 100$$

R_1 = 100k typical, 5k minimum
R_2 = Value optional to determine lowest brightness setting
R_2 = 0.5 R_1 minimum
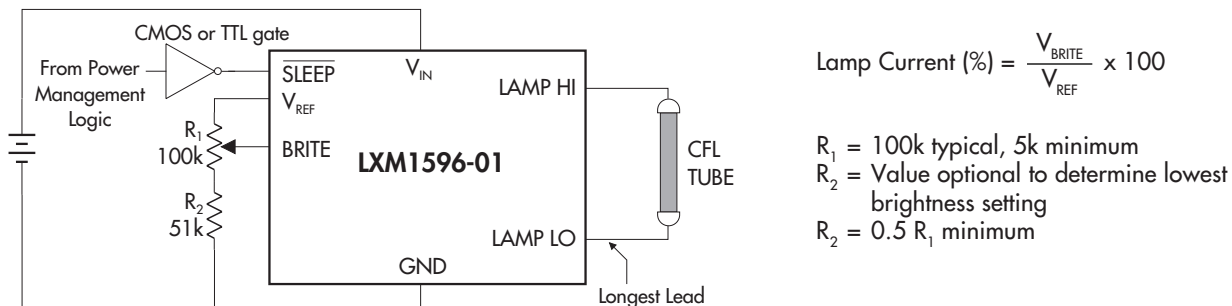
FIGURE 1 — Recommended Connection Diagram

EFFICIENCY MEASUREMENT SETUP

INTRODUCTION

The best method for evaluating high voltage, high frequency inverters is by directly measuring light output versus power input. This method is highly recommended when evaluating inverter modules.

The following sections outline the recommended method for testing these modules.

EQUIPMENT REQUIRED

1) Two DVM's with 0.1% or better accuracy.
2) A lab power supply. (0 - 20V, 0 - 2A)
3) The target notebook or LCD panel.
4) A Tektronix J1803 Luminance Head.
5) A Tektronix J17 Luminance Color Photometer.
6) A non-contact infrared temperature sensor (i.e. Fluke 80T-IR) with a mV meter.

MEASUREMENT SETUP

Figure 2 shows the connection diagram for light output measurements. The photometer luminance head (J1803) is positioned directly in the center of the LCD screen. For best results open an application such as the Paintbrush program and choose the maximized view so that the entire screen is "white".

After application of the power to the CCFL wait at least 30 minutes to allow for the lamp and light output to stabilize. At the end of the 30 minute period read the light output in cd/m² (1 cd/m² = 1 Nit), as well as input voltage and current. Typical applications require about 70 to 100 Nits out of the screen. With the temperature probe record the temperature rises of critical components such as the high voltage transformer and the inductor.

The light output efficiency of the module can be calculated by the following equation:

$$\text{Eff} = \frac{\text{Light Output (in Nits)}}{V_{IN\,(DC)} * I_{IN\,(DC)}} = \frac{\text{Nits}}{\text{Watt}}$$

For competitive evaluation with another module from Linfinity or another manufacturer repeat the above steps for the second module.

After taking the data on the second module, compare the temperature rises on the transformer and inductors. The main figure of merit comparison is done between the two Eff numbers as follows:

$$\text{Percent More Efficient} = \frac{\text{Eff}_1 - \text{Eff}_2}{\text{Eff}_2} * 100$$

The result of the above shows how much more efficient module #1 is than module #2.

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EFFICIENCY MEASUREMENT SETUP (continued)

DC Power Supply   DC Amp Meter   DC Volt Meter

$P_{IN} = V_{DC} * I_{DC}$

Sleep Control = Logic "1"

Dimming Control

Inverter Module

CCFL

J1803 Luminance Head

J17 Photometer
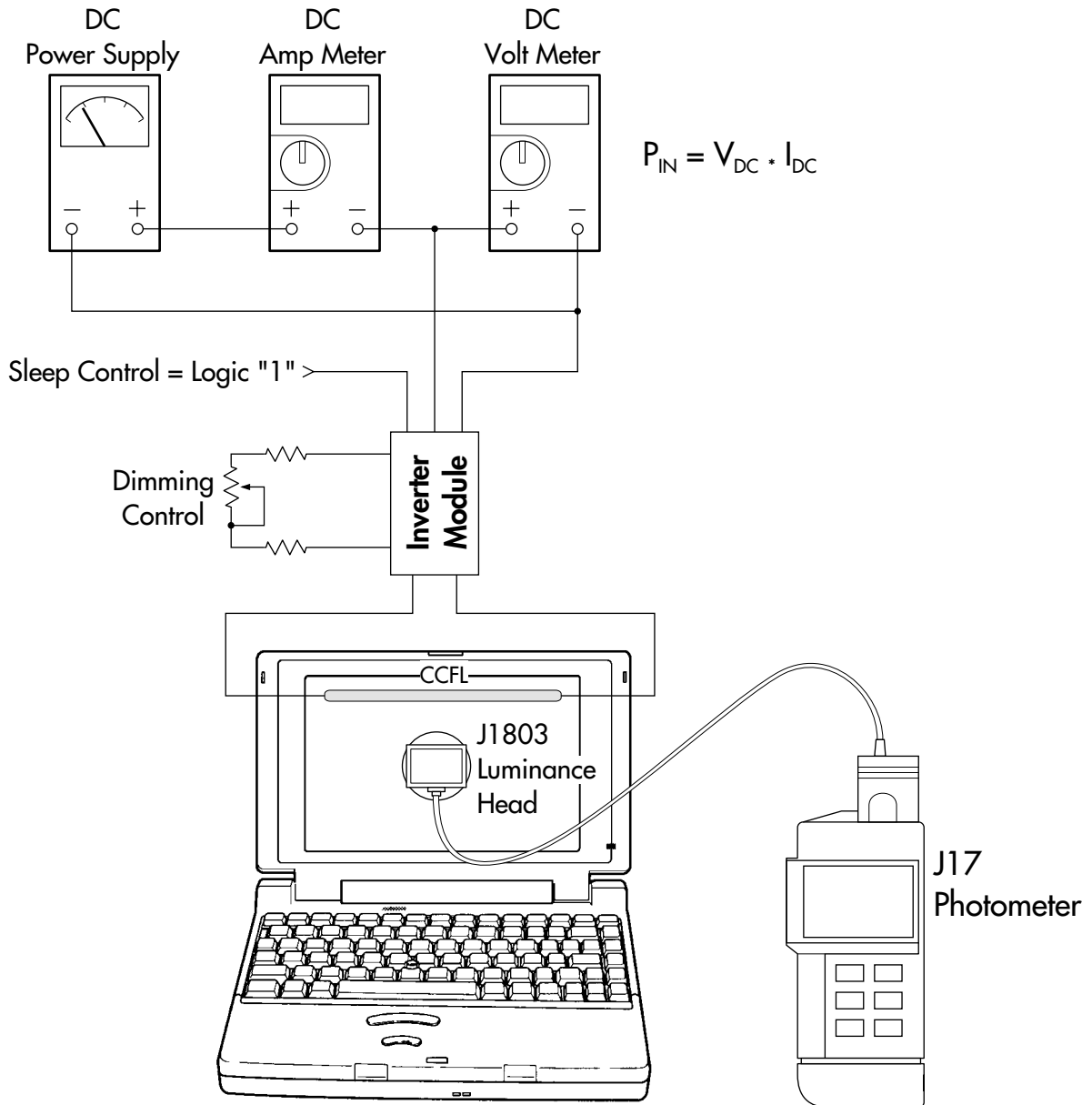
FIGURE 2 — Light Output Measurement Setup

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