

**DESCRIPTION**

LXMG1960-28-0x module is a boost white LED driver for medium size LCD LED backlight panels. It is designed to drive up to six strings of LEDs to a maximum of 35V at up to 25mA per string.

The module consists of a boost converter and six programmable 10-25 mA precision current sinks. It is designed to work over a wide input voltage range (4.75V to 28V) providing maximum flexibility. However the converter is a boost only design requiring the input supply voltage to not exceed the output LED string voltage.

The module provides a dimming input: BRITE\_A which adjusts the LED display brightness by controlling the amplitude of the LED string current.

The BRITE\_A input is very flexible and can be controlled by a PWM signal, the application of a DC control voltage or use of a potentiometer tied as a rheostat.

Precision current mirror circuitry typically provides for 1% percent string to string matching at the rated output current. The magnitude of the string current is easily programmed, in 1mA steps through an on board DIP switch.

The LXMG1960-28-0x includes over voltage protection (OVP), and short and open LED protection. If one string opens, its current sink will be disabled and the other strings will continue to operate normally. Likewise if one or several LEDs in a string short it will continue to function with no adverse affect on the other strings. With the use of an external thermistor the module can provide LED current fold back in an over temperature situation.

The module comes in a small form factor PCB and uses an 8 pin input and one of two output connectors.

**KEY FEATURES**

- Drives Up To 6 String LED Panels
- Strings Can Be Combined For Higher Current
- Wide Input Voltage 4.75V-28V
- String Voltage Up To 35V
- LED String Current Programmable in 1mA Steps from 10 to 25mA For Matching Various Panel Requirements
- 1% Typical String-to-String Current Matching
- Analog Dimming Provides For a 10:1 Ratio
- Supports Multiple Methods Of Dimming Such As DC Voltage, PWM Signal and Potentiometer
- Over Voltage Protection
- LED Over Temperature Protection Input

**APPLICATIONS**

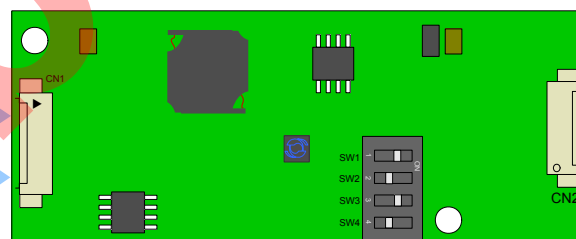
- Medium Size White LED Backlight LCD Displays
- Portable Instrumentation Displays
- Medical Instrument Displays

**IMPORTANT:** For the most current data, consult MICROSEMI's website: <http://www.microsemi.com>  
**Patents Pending**

**PRODUCT HIGHLIGHT**
**LXMG1960-28-01**

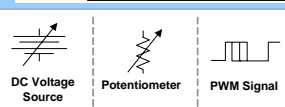
Wide Input  
Voltage Range  
4.75V to 28V

DIMMING INPUT:  
Analog - Current Amplitude  
Dimming



Drives Six String LED  
Panels. LED String  
Voltage up to 35V

Precision  
String-to-String  
Current Matching



Supports Multi-Method  
Analog Dimming

Externally  
Programmable LED  
String Current From  
10mA to 25mA in  
1mA Steps

**ORDER INFORMATION**

Part Number	Input Connector	Output Connector
LXMG1960-28-01	Molex 53261-0871 or equivalent	Molex 53261-0771 or equivalent
LXMG1960-28-03		Hirose DF14A-15P-1.25H or equivalent

**ABSOLUTE MAXIMUM RATINGS**

Input Voltage ( $V_{IN}$ )	-0.3V to 30V
Input Power	6.2W
Output String Current	27mA (Internally Limited)
Output String Voltage	36V (Internally Limited)
Output Power	5.5W
CSx Pins	-0.3V to 28V
Input Signal Voltage (ENABLE Input)	-0.3V to $V_{IN}$
Input Signal Voltage (OT)	-0.3V to 5V
Input Signal Voltage (BRITE_A)	-0.3V to 6V
Ambient Operating Temperature, zero airflow	-30°C to 80°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 (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, might not function optimally.

Parameter	Symbol	Min	R.C.	Max	Units
Input Supply Voltage Range	$V_{IN}$	4.75	12	28	V
Linear BRITE_A Control Input Voltage Range	$V_{BRITE\_A}$	0.2		2.2	V
LED String Voltage	$V_{LED}$	$V_{IN}$		35*	V
Each Cathode Sink Current	$CS_{ISINK}$	10		25	mA
Operating Ambient Temperature Range	$T_A$	-30		75	°C

\* Input supply voltage should not exceed LED string voltage as this will result in excessive power dissipation in the module.

**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;  $V_{IN} = 4.75V$ ; BRITE\_A = Open; ENABLE =  $V_{IN}$ ; DIP-SWI~4 = ON; OT = open

Parameter	Symbol	Test Conditions / Comment	Min	Typ	Max	Units
Input Voltage	$V_{IN}$		4.75	12	28	V
Off Current	$I_{IN(MIN)}$	ENABLE = 0V		13	100	μA
Supply Current	$I_{RUN\_5}$	$V_{IN} = 5V$ ; $V_{LED} = 31.2V$ , $I_{LED} = 25mA$ ; 6 Strings		1.25	1.5	A
Supply Current	$I_{RUN\_12}$	$V_{IN} = 12V$ ; $V_{LED} = 31.2V$ , $I_{LED} = 25mA$ ; 6 Strings		0.5	0.6	A
Supply Current After Fault Timeout	$I_{FAULT}$	Open all output strings Fault Timeout		6	10	mA
Estimated Efficiency	$\eta$	$V_{IN} = 12V$ ; $V_{LED} = 31.2V$ , $I_{LED} = 25mA$ ; 6 Strings	80	85		%

**Logic**

ENABLE Input Low Voltage	ENABLE $V_L$		0		0.8	V
ENABLE Input Hi Voltage	ENABLE $V_H$		2.0		$V_{IN}$	V

**Dimming**

BRITE_A voltage for Full Bright	$V_{BRITE\_A}$		1.8	2.0	2.2	V
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**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;  $V_{IN} = 4.75V$ ; BRITE\_A = Open; ENABLE = VIN; DIP-SW1~4 = ON; OT = open

Parameter	Symbol	Test Conditions / Comment	Min	Typ	Max	Units
Potentiometer Dimming on BRITE_A	POT		400	500	600	kΩ
PWM Frequency Range for BRITE_A	$f_{BRITE\_A}$		100		25000	Hz
BRITE_A PWM Voltage	$V_{BRITE\_A-PWM}$		2.5		5.5	V
BRITE_A Sink Current	$I_{BRITE\_A}$	BRITE_A = 0V		12		μA
Output Current Dim Range (Analog Dimming)		$I_{LED} = 25mA$ , BRITE_A = 0V Versus BRITE_A ≥ 2.2V		10		RATIO
LED Current On Rise Time	$T_{CS\_Rise}$			200		ns
LED Current Off Fall Time	$T_{CS\_Fall}$			400		ns

**Device Protection**

LED Short Protection Threshold	$V_{CS_{SD}}$	Voltage at CSx pin that latches off its respective string.		15		V
CS Pin Over-voltage Limit	$V_{CSOV}$	Voltage at CSx pin that clamps Anode Output	23	25	27	V

**LED Current Sink Outputs**

Nominal LED DC Current Programming Range	$I_{CS}$	Combination of DIP switch1~4 ON/OFF	10		25	mA
LED DC Current	$I_{CS_{MIN}}$	VDIP-SW1~4 = OFF	9.5	10	10.5	mA
LED DC Current	$\Delta I_{CS1}$	Delta current SW1~4 = OFF to DIP-SW1= ON	0.95	1	1.05	mA
LED DC Current	$\Delta I_{CS2}$	Delta current SW1~4 = OFF to DIP-SW2= ON	1.9	2	2.1	mA
LED DC Current	$\Delta I_{CS3}$	Delta current SW1~4 = OFF to DIP-SW3= ON	3.8	4	4.2	mA
LED DC Current	$\Delta I_{CS4}$	Delta current SW1~4 = OFF to DIP-SW4= ON	7.6	8	8.4	mA
LED DC Current	$I_{CS_{MAX}}$	VDIP-SW1~4 = ON	23.75	25	26.25	mA
Current Matching between strings.		$V_{CSX} = 0.8V$ to 5V	-2		2	%
Regulated CS Pin Voltage		At the lowest CS pin, $I_{CSX} = 25mA$ ;	0.5	0.9		V

**LED String Voltage**

LED String Voltage	$V_{LED}$	Rated LED current	$V_{IN}$		35	V
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**LED Panel Thermal Protection**

LED Over Temperature Shut Down Threshold	$V_{OT}$			1.47		V
Over Temperature Recovery Voltage	$V_{OT}$			1.8		V
OT Sink Current	$I_{OT}$	OT = 0V		240		μA

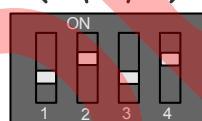
**FUNCTIONAL PIN DESCRIPTION**

Name	Pin #	Description
<b>CN1</b> (Molex 53261-0871) for LXMG1960-28-01/03		
CN1-1	V <sub>IN</sub>	Main Input Power Supply 4.75V to 28V
CN1-2		
CN1-3	GND	Power Supply Return
CN1-4		
CN1-5	ENABLE	ON/OFF Control. (ENABLE = 0V = OFF, ENABLE = 2V = ON)
CN1-6	OT	Operating Temperature Detection Input. A Thermistor Usually Is Connected This Pin To The Ground.
CN1-7	BRITE_A	Analog Dimming Input. BRITE_A 0~2.5V→Io 10%~100%. 100Hz<f <25kHz, 3.3V PWM and 500kohms Rheostat are Equivalent Dimming Methods. Open = Maximum Programmed String Current
CN1-8	NC	No Connect, Leave This Pin Open
<b>CN2</b> (Molex 53261-0771) for LXMG1960-28-01		
CN2-1	Anode	Common LED High Side Drive Voltage
CN2-2	CSA	Channel A Cathode Sink Driver
CN2-3	CSB	Channel B Cathode Sink Driver
CN2-4	CSC	Channel C Cathode Sink Driver
CN2-5	CSD	Channel D Cathode Sink Driver
CN2-6	CSE	Channel E Cathode Sink Driver
CN2-7	CSF	Channel F Cathode Sink Driver
<b>CN3</b> (Hirose DF14A-15P-1.25H) for LXMG1960-28-03		
CN3-1	Anode	Common LED High Side Drive Voltage
CN3-2	CSA	Channel A Cathode Sink Driver
CN3-3	Anode	Common LED High Side Drive Voltage
CN3-4	CSB	Channel B Cathode Sink Driver
CN3-5	Anode	Common LED High Side Drive Voltage
CN3-6	CSC	Channel C Cathode Sink Driver
CN3-7	Anode	Common LED High Side Drive Voltage
CN3-8	CSD	Channel D Cathode Sink Driver
CN3-9	Anode	Common LED High Side Drive Voltage
CN3-10	CSE	Channel E Cathode Sink Driver
CN3-11	Anode	Common LED High Side Drive Voltage
CN3-12	CSF	Channel F Cathode Sink Driver
CN3-13	N/A	No Connection Pin Is Open
CN3-14	N/A	No Connection Pin Is Open
CN3-15	N/A	No Connection Pin Is Open

**DIP SWITCH LED STRING CURRENT SETTINGS**

SW1 (1mA)	SW2 (2mA)	SW3 (4mA)	SW4 (8mA)	LED String Current	Notes
OFF	OFF	OFF	OFF	10mA	Minimum String current
ON	OFF	OFF	OFF	11mA	
OFF	ON	OFF	OFF	12mA	
ON	ON	OFF	OFF	13mA	
OFF	OFF	ON	OFF	14mA	
<b>ON</b>	<b>OFF</b>	<b>ON</b>	<b>OFF</b>	<b>15mA</b>	
OFF	ON	ON	OFF	16mA	
ON	ON	ON	OFF	17mA	
OFF	OFF	OFF	ON	18mA	
ON	OFF	OFF	ON	19mA	
<b>OFF</b>	<b>ON</b>	<b>OFF</b>	<b>ON</b>	<b>20mA</b>	
ON	ON	OFF	ON	21mA	
OFF	OFF	ON	ON	22mA	
ON	OFF	ON	ON	23mA	
OFF	ON	ON	ON	24mA	
<b>ON</b>	<b>ON</b>	<b>ON</b>	<b>ON</b>	<b>25mA</b>	Maximum String Current

DIP Switch  
S1



UP - ON

DOWN - OFF

Example shows S1 programmed for 20mA LED String Current



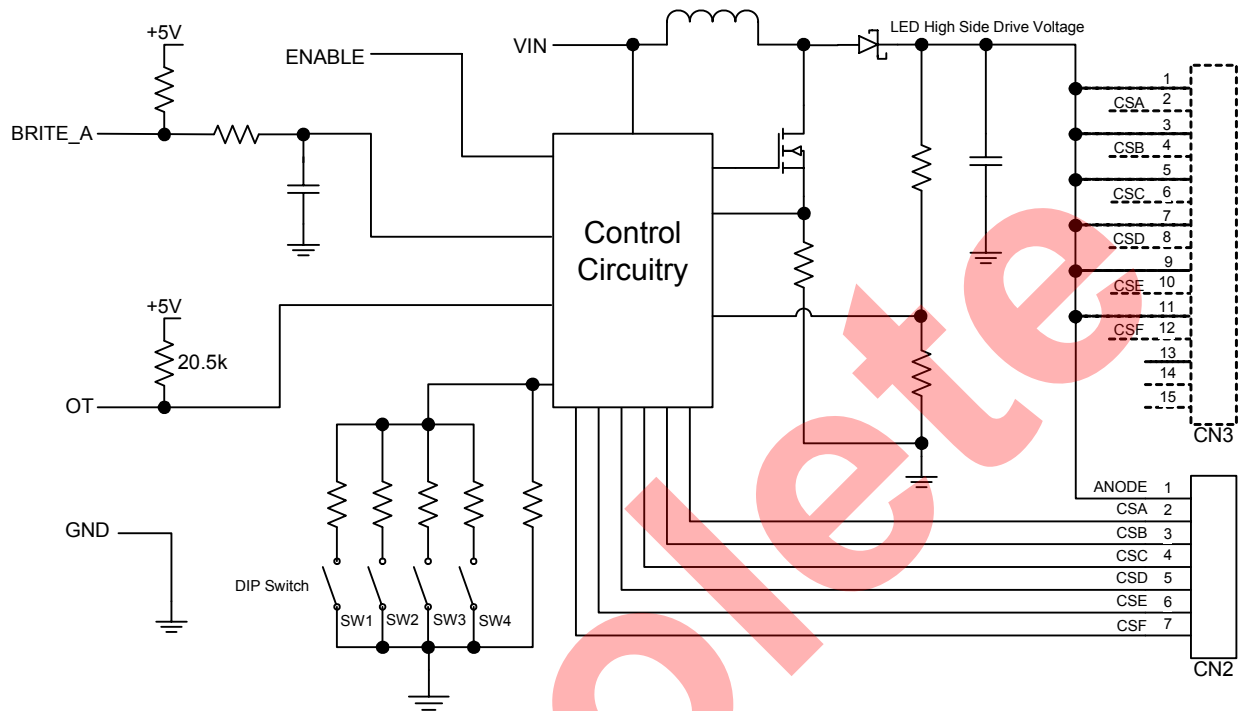
# Microsemi<sup>®</sup>

## LXMG1960-28-0x

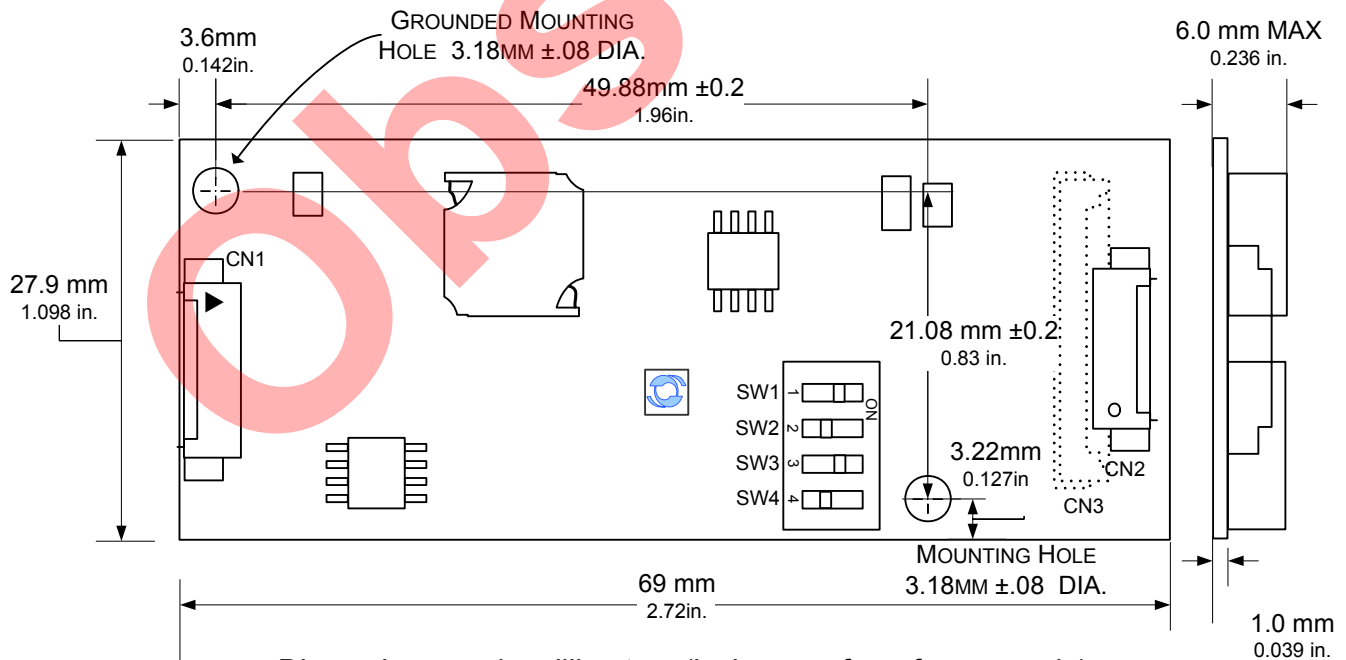
### 6-String 5W LED Backlight Boost Driver Module

#### PRODUCTION DATASHEET

#### SIMPLIFIED BLOCK DIAGRAM



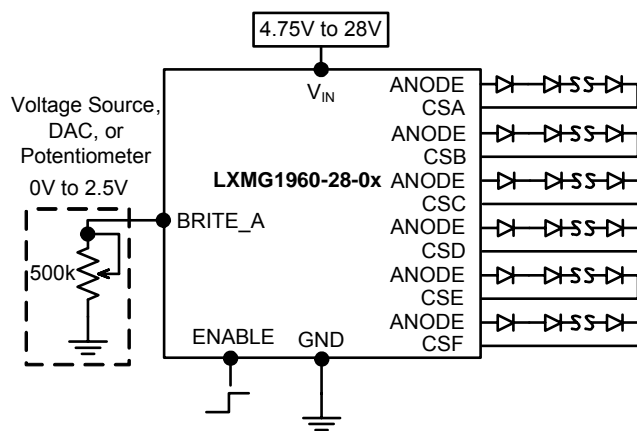
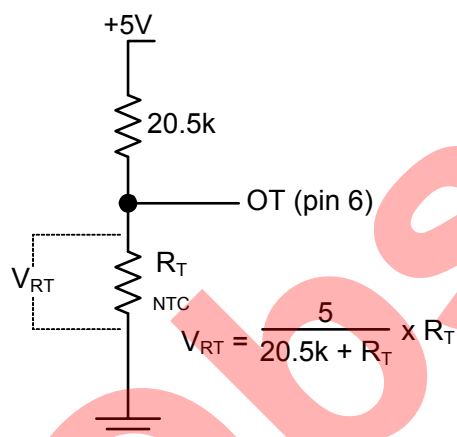
#### MECHANICAL DRAWING



Dimensions are in millimeters (inches are for reference only)

PCB tolerances  $\pm 0.5\text{mm}$ , M3 recommended mounting screws

Weight: (8g) typ.

**APPLICATION INFORMATION**

**Figure 1**

**Figure 2**

- The LED string current and therefore the brightness may be controlled by the BRITE\_A input. The typical dimming range using the BRITE\_A input alone is 10:1.
- The BRITE\_A input may come from a voltage output DAC or other voltage source, a 500k digital or manual pot, or a PWM signal in the range of 100 Hz to 25 kHz. The module contains an internal 422k pull-up to typically 5V to provide bias if using a pot. Logic levels 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 string current.
- If you need to turn the module ON/OFF remotely, connect to TTL logic signal to the ENABLE input.
- It is to be noted that although the module provides for a wide input voltage range 4.75V to 28V it is designed as a boost only converter. Therefore the input voltage should not exceed the LED string voltage.
- Use of an external thermistor connected from OT pin to ground will provide over temperature protection (see figure 2). The module can provide for the gradual scaling back of LED string current until it is completely shut off based on the voltage level impressed on the OT input. When the voltage on the OT pin decreases below 2.48V the string current will begin to decrease until it is completely shut off when OT reaches 1.47V. This corresponds to a thermistor value of about 8542 ohms at string current shutdown.
- As an example using a 100k (at 25°C) NTC thermistor with a B Constant of 4250 will provide a thermal profile where the module will begin to scale back the LED string currents at a temperature (as measured by the thermistor) greater than 60°C and shut down the string current if the temperature exceeds 85°C.
- Although the module provides open circuit string protection, if the common LED high side drive voltage (Anode) is directly shorted to ground this will result in damage to the fuse and possible damage to the Schottky diode. Likewise if any of the low side current sink drivers (CSx) are directly shorted to ground it will result in damage to the fuse, Schottky diode and possibly the LED string.



**NOTES**

Obsolete

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