

**DESCRIPTION**

The LXMG1645-12-51 and LXMG1645-12-52 are Quad 5W Output CCFL (Cold Cathode Fluorescent Lamp) Inverter Modules specifically designed for driving 15" to 18" quad lamp LCD panels.

The inverters include two dimming inputs that provide brightness control, V\_BRITE and P\_BRITE. A voltage on V\_BRITE pin adjusts the lamp current amplitude with 0V providing maximum brightness. The P\_BRITE input accepts a low frequency PWM signal which directly controls the lamp drive waveform. This PWM RangeMAX™ Digital Dimming Technique provides flicker-free brightness control over a wide range (typically 50:1+).

The maximum output current is externally programmable using the SET<sub>1</sub> and SET<sub>2</sub> pins on the input connector over a range of 6mA to 7.5mA in 0.5mA steps.

This allows the inverter to be properly matched to a wide array of LCD panel lamp current specifications, a function which we call PanelMatch™.

In addition the inverter has a dedicated V\_STATUS pin that indicates a fault has occurred such as an open or shorted lamp. V\_STATUS is an open drain configuration whose output is low during normal operation. When one or more lamps sustain a fault the other lamp(s) will continue to operate and the V\_STATUS pin will toggle high. This mode of operation during lamp(s) failure is called StayLIT™ since the panel is able to still remain on although at reduced brightness.

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

**KEY FEATURES**

- StayLIT™ Redundancy
- PanelMatch™ Adjustable Output Current
- V\_STATUS Fault Output
- Dual Brightness Control Inputs
- RangeMAX™ Wide Range Dimming
- Output Short-Circuit Protection and Automatic Strike-Voltage Regulation
- Fixed Frequency Operation
- Rated From -30 to 80°C
- UL 60950 Pending
- RoHS Compliant

**APPLICATIONS**

- High Brightness Displays
- Desktop Displays
- Medical Monitors

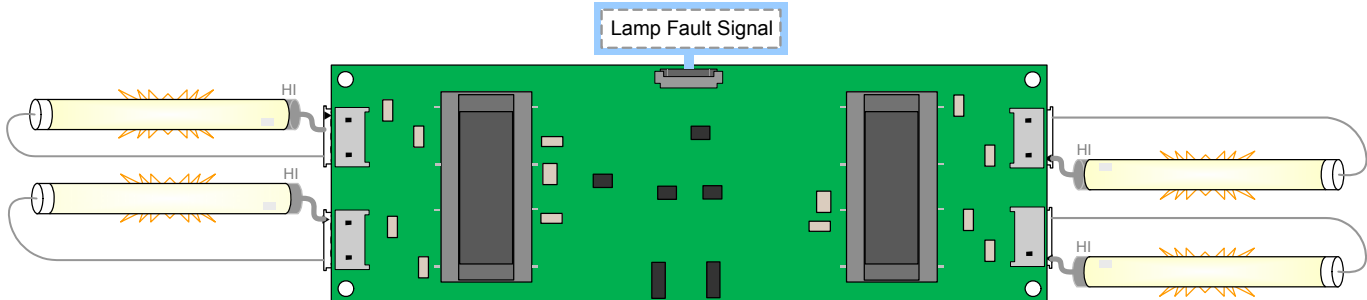
**BENEFITS**

- Smooth, Flicker Free 10-100% Full-Range Brightness Control

**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

**PRODUCT HIGHLIGHT**
**LXMG1645-12-51**

TWO DIMMING INPUTS - PWM" AND V<sub>DC</sub>, OR POTENTIOMETER



Lamp Current Programmable from 6mA to 7.5mA per Lamp in 0.5mA Steps

**PACKAGE ORDER INFO**

PART NUMBER	OUTPUT CONNECTORS	INVERTER MATES DIRECTLY TO PANEL CONNECTORS
LXMG1645-12-51	Four JST SM02(8.0) B-BHS-1-TB(LF)(SN) or Yeon Ho 20015WR-05A00 or equivalent connectors	JST BHR-03VS-1 or equivalent connectors
LXMG1645-12-52	Four JST SM02B-BHSS-1-TB(LF)(SN) or Yeon Ho 35001WR-02A00 or equivalent connectors	JST BHSR-02VS-1 or equivalent connectors



**ABSOLUTE MAXIMUM RATINGS**

Input Signal Voltage (V <sub>IN</sub> , ENABLE ).....	-0.3V to 15V
Input Signal Voltage (V <sub>STATUS</sub> with Series Resistor).....	-0.3V to 30V
Input Power .....	26.4W
Output Voltage, No Load .....	1900V <sub>RMS</sub>
Output Current (Each Output) .....	9.0mA
Output Power (Each Output) .....	6.0W
Input Signal Voltage (V <sub>BRITE</sub> , P <sub>BRITE</sub> , SET <sub>1</sub> , SET <sub>2</sub> ).....	-0.3V to 5.5V
Ambient Operating Temperature, Zero Airflow .....	-30°C to 85°C
Operating Relative Humidity, Non-Condensing .....	0% to 95%
Storage Temperature Range .....	-40°C to 90°C

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, may not function optimally.

Parameter	Symbol	Recommended Operating Conditions			Units	
		Min	R.C.	Max		
Input Supply Voltage Range (Fully Regulated Lamp Current)	V <sub>IN</sub>	10.8	12	13.2	V	
Output Power (Each Output)	P <sub>O</sub>		3.6	5.5	W	
DC BRITE Control Input Voltage Range	V <sub>BRT</sub>	0		2.5	V	
Direct Low Frequency PWM	Duty Control Range	F <sub>DUTY</sub>	10	100	%	
	Burst Frequency <sup>1</sup>	F <sub>PWM</sub>	100	120	250	Hz
	Amplitude	V <sub>PWM</sub>	3.0		5.5	V
	Rise/Fall Time	t <sub>r</sub> , t <sub>f</sub>	0		3	µs
Lamp Current (Full Brightness)	I <sub>O100</sub>	6		7.5	mA <sub>RMS</sub>	
Lamp Operating Voltage	V <sub>LAMP</sub>	510	600	690	V <sub>RMS</sub>	
Operating Ambient Temperature Range	T <sub>A</sub>	-20		80	°C	
Operating Humidity Range ( Non-condensing)	RH <sub>A</sub>	0		95	%	

<sup>1</sup> Direct Low Burst PWM frequency should be selected such to not have optical interference. At input voltages below 12V the inverter may not be able to output the full 7.5mA<sub>RMS</sub> at the maximum lamp voltage.

**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;  $V_{IN} = 12V$ ,  $ENABLE \geq 2.1V$ ,  $V\_BRITE = 0V$  or  $0\Omega$ ,  $P\_BRITE = 100\%$  or Open

Parameter	Symbol	Test Conditions / Comment	Min	Typ	Max	Units
<b>OUTPUT CHARACTERISTICS</b>						
Full Bright Lamp Current (Each Lamp)	$I_{OLMAXHH}$	SET <sub>1</sub> = Open, SET <sub>2</sub> = Open	7.0	7.5	8.0	mA <sub>RMS</sub>
	$I_{OLMAXHL}$	SET <sub>1</sub> = Open, SET <sub>2</sub> = Ground	6.5	7.0	7.5	
	$I_{OLMAXLH}$	SET <sub>1</sub> = Ground, SET <sub>2</sub> = Open	6.0	6.5	7.0	
	$I_{OLMAXLL}$	SET <sub>1</sub> = Ground, SET <sub>2</sub> = Ground	5.5	6.0	6.5	
Full Dim Lamp Current (Each Lamp)	$I_{OLVMINHH}$	SET <sub>1</sub> = Open, SET <sub>2</sub> = Open, V <sub>BRITE</sub> = 2.5V		2.15		mA <sub>RMS</sub>
	$I_{OLVMINHL}$	SET <sub>1</sub> = Open, SET <sub>2</sub> = Ground, V <sub>BRITE</sub> = 2.5V		2.00		
	$I_{OLVMINLH}$	SET <sub>1</sub> = Ground, SET <sub>2</sub> = Open, V <sub>BRITE</sub> = 2.5V		1.85		
	$I_{OLVMINLL}$	SET <sub>1</sub> = Ground, SET <sub>2</sub> = Ground, V <sub>BRITE</sub> = 2.5V		1.65		
	$I_{OLPMINHH}$	SET <sub>1</sub> = Open, SET <sub>2</sub> = Open, P <sub>BRITE</sub> = 10%		1.95		
	$I_{OLPMINHL}$	SET <sub>1</sub> = Open, SET <sub>2</sub> = Ground, P <sub>BRITE</sub> = 10%		1.80		
	$I_{OLPMINLH}$	SET <sub>1</sub> = Ground, SET <sub>2</sub> = Open, P <sub>BRITE</sub> = 10%		1.65		
Lamp Start Voltage (Each Lamp)	$V_{L\_STK0}$	T <sub>A</sub> = 0°C, V <sub>IN</sub> > 10.8V		1820		V <sub>RMS</sub>
	$V_{L\_STK25}$	T <sub>A</sub> = 25°C, V <sub>IN</sub> > 10.8V		1720		V <sub>RMS</sub>
Operating Frequency	F <sub>O</sub>		45.5	47.5	48.0	kHz
V <sub>BRITE</sub> Optical Dim Range	N:1 <sub>VBRT</sub>	Center Area Brightness, Full/Min, T <sub>A</sub> = 25°		43		Ratio
P <sub>BRITE</sub> Optical Dim Range	N:1 <sub>PBRT</sub>	Center Area Brightness, Full/Min, T <sub>A</sub> = 25°		47		Ratio
Output Current Lamp to Lamp Deviation	$\Delta I_{OLm,n}$	$\frac{ I_{OLm} - I_{OLn} }{I_{OLm}}$ m = 1,2,3,4, n = 1~4 not m		5		%
<b>V<sub>BRITE</sub> INPUT, VDC</b>						
Input Bias Current	$I_{VBRT}$	V <sub>BRITE</sub> = 0V or 0Ω		107		μA
		V <sub>BRITE</sub> = 2.5V or 50kΩ		52		
BRITE Adjust Voltage Range	$V_{BRT}$	$I_{OLMAXx}$		0	0.2	V
		$I_{OLVMINx}$		2.5		
	% <sub>BRT_PWM</sub>	Minimum P <sub>BRITE</sub> Control Duty, V <sub>BRITE</sub> = 2.5V		11	15	%
BRITE Adjust Resistor Range	$R_{BRT(k\Omega)}$	$I_{OLMAXx}$		0	2	kΩ
		$I_{OLVMINx}$		50		
	% <sub>BRT_PWM</sub>	Minimum P <sub>BRITE</sub> Control Duty, R <sub>BRITE</sub> = 50kΩ	9	11	13	%
BRITE Burst Mode Frequency	F <sub>BRT_PWM</sub>	V <sub>BRITE</sub> > 0.3V ≤ 2.5V	120	142	165	Hz
<b>P<sub>BRITE</sub> INPUT, PWM</b>						
PWM High Level Amplitude	V <sub>PWMH</sub>		3		5	V
PWM Low Level Amplitude	V <sub>PWML</sub>		0		0.3	V

**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;  $V_{IN} = 12V$ ,  $ENABLE \geq 2.1V$ ,  $V_{BRITE} = 0V$  or  $0\Omega$ ,  $P_{BRITE} = 100\%$  or Open

Parameter	Symbol	Test Conditions / Comment	Min	Typ	Max	Units
PWM Jitter	Jitter				3	$\mu s$
PWM Frequency Range	$F_{PWM}$		100	120	250	Hz
PWM Duty Range	$\%_{PWM}$		10		100	%
<b>ENABLE INPUT</b>						
Disable OFF	$V_{EN\_OFF}$		0		0.8	V
ENABLE ON	$V_{EN\_ON}$		2.1		$V_{IN}$	V
Enable Bias Current	$I_{EN\_ON}$	ENABLE = 2.1V (68k $\Omega$ Pull-up 12 $V_{IN}$ )		150		$\mu A$
$V_{IN}$ Quiescent Current	$I_{IQ}$	ENABLE $\leq 0.8V$		230		$\mu A$
<b>POWER CHARACTERISTICS</b>						
$V_{IN}$ Under Voltage Lock Out Threshold	$V_{IN\ UVLO}$	$V_{IN}$ Rising Edge		10.6		V
$V_{IN}$ UVLO Hysteresis	$V_{HYS}$			350		mV
Supply Current	$I_{RUN}$	No Lamp Fault Condition, $I_{LAMP} = 6.0mA$		1.37	1.75	A
Supply Current During Fault Timeout	$I_{FAULT}$	All Four Lamps Open		32		mA
Efficiency	$\eta$	Load = 100k $\Omega$ Resistive Load	85	90		%
<b>STRIKE TIMEOUT</b>						
Strike (All Open Lamps)	$T_{S\_DWELL}$	All Four Lamps Open		1650		ms
Open Lamp Output Voltage	$V_{STK}$			1650		$V_{RMS}$
<b>V_STATUS PIN</b>						
$V_{STATUS}$ Pin Max Voltage	$V_{STATUS\_MAX}$	750 $\Omega \geq$ Series Resistor to Voltage Source			30	V
$V_{STATUS}$ Pin Leakage Current	$I_{STATUS\_LKG}$	Fault, $V_{STATUS}$ Pull-up 750 $\Omega$ to $V_{IN}$		155		$\mu A$
$V_{STATUS}$ Pin Max Sink Current	$I_{STATUS\_SNK}$	No Fault, $V_{STATUS}$ Pull-up 750 $\Omega$ to $V_{IN}$	10	15.5	20	mA
$V_{STATUS}$ Pin Voltage	$VOL_{STATUS}$	No Fault, $V_{STATUS}$ Pull-up 750 $\Omega$ to $V_{IN}$			0.4	V
$V_{STATUS}$ Invalid Time Power ON	$T_{STRIKE}$	ENABLE to $V_{STATUS} = LOW$			2.5	sec
$V_{STATUS}$ Pin Invalid Time In Run Mode	$T_{D\_FLT}$	Open Lamp(s) to $V_{STATUS} = high$		150	275	ms
<b>STRIKE MODE</b>						
StayLIT™ Strike Time Period	$T_{D\_FLT}$	Only One of Two Lamps Ignited on CN2 ~ CN3 or CN4 ~ CN5		750		ms
<b>LAMP CURRENT DURING StayLIT™</b>						
Max Lamp Current Of No-Fault Side (Open)	FIL1~4a	SET <sub>1</sub> = Open, SET <sub>2</sub> = Open, One Lamp Open	7.2	7.7	8.2	$mA_{RMS}$
	FIL1~4b	SET <sub>1</sub> = Open, SET <sub>2</sub> = Ground, One Lamp Open	6.7	7.2	7.7	
	FIL1~4c	SET <sub>1</sub> = Ground, SET <sub>2</sub> = Open, One Lamp Open	6.2	6.7	7.2	
	FIL1~4d	SET <sub>1</sub> = Ground, SET <sub>2</sub> = Ground, One Lamp Open	5.7	6.2	6.7	
Max Lamp Current Of No-Fault Side (Short)	FIL1~4a'	SET <sub>1</sub> = Open, SET <sub>2</sub> = Open, One Lamp Short	7.3	7.8	8.3	$mA_{RMS}$
	FIL1~4b'	SET <sub>1</sub> = Open, SET <sub>2</sub> = Ground, One Lamp Short	6.8	7.3	8.3	

**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;  $V_{IN} = 12V$ ,  $ENABLE \geq 2.1V$ ,  $V_{BRITE} = 0V$  or  $0\Omega$ ,  $P_{BRITE} = 100\%$  or Open

Parameter	Symbol	Test Conditions / Comment	Min	Typ	Max	Units
	FIL1~4c'	SET <sub>1</sub> = Ground, SET <sub>2</sub> = Open, One Lamp Short	6.3	6.8	7.3	mA <sub>RMS</sub>
	FIL1~4d'	SET <sub>1</sub> = Ground, SET <sub>2</sub> = Ground, One Lamp Short	5.8	6.3	6.8	
Min Lamp Current Of No-Fault Side (Open)	IL1~4e	SET <sub>1</sub> = Open, SET <sub>2</sub> = Open, V <sub>BRITE</sub> = 2.5V, One Lamp Open		2.20		mA <sub>RMS</sub>
	IL1~4f	SET <sub>1</sub> = Open, SET <sub>2</sub> = Ground, V <sub>BRITE</sub> = 2.5V, One Lamp Open		2.05		
	IL1~4g	SET <sub>1</sub> = Ground, SET <sub>2</sub> = Open, V <sub>BRITE</sub> = 2.5V, One Lamp Open		1.90		
	IL1~4h	SET <sub>1</sub> = Ground, SET <sub>2</sub> = Ground, V <sub>BRITE</sub> = 2.5V, One Lamp Open		1.70		
Min Lamp Current Of No-Fault Side (Short)	IL1~4e'	SET <sub>1</sub> = Open, SET <sub>2</sub> = Open, V <sub>BRITE</sub> = 2.5V, One Lamp Short		2.25		mA <sub>RMS</sub>
	IL1~4f'	SET <sub>1</sub> = Open, SET <sub>2</sub> = Ground, V <sub>BRITE</sub> = 2.5V, One Lamp Short		2.10		
	IL1~4g'	SET <sub>1</sub> = Ground, SET <sub>2</sub> = Open, V <sub>BRITE</sub> = 2.5V, One Lamp Short		1.95		
	IL1~4h'	SET <sub>1</sub> = Ground, SET <sub>2</sub> = Ground, V <sub>BRITE</sub> = 2.5V, One Lamp Short		1.87		

<sup>1</sup> ENABLE should be pull up from V<sub>IN</sub> using 68kΩ, with open collector or open drain

**FUNCTIONAL PIN DESCRIPTION**

CONN	PIN	DESCRIPTION
<b>CN1 (Molex 053261-1071 or equivalent)</b>		
CN1-1, CN1-2	V <sub>IN</sub>	Main Input Power Supply 10.8V to 13.2V
CN1-3, CN1-4	GND	Power Supply Return
CN1-5	ENABLE	ON/OFF Control. ON: Pull-Up 68kΩ from V <sub>IN</sub> and OC or OD or ≥ 2.1V, OFF: 0 ~ 0.8V
CN1-6	V <sub>BRITE</sub>	Analog Brightness Control (0V to 2.5V), 0V = Full brightness, 2.5V = Min brightness Resistor 0 ~ 50kΩ (Max ~ Min brightness), No Connection to P <sub>BRITE</sub> to Use V <sub>BRITE</sub> Option
CN1-7	P <sub>BRITE</sub>	Low Frequency Burst PWM Dimming Input, Connection to P <sub>BRITE</sub> Overrides V <sub>BRITE</sub> Option
CN1-8	V <sub>STATUS</sub>	Fault Status Output: Normal State: Low, Fail State : High Open Drain (Internally Pulled up with 47kΩ to 5V)
CN1-9	SET <sub>1</sub>	SET <sub>1</sub> MSB Connecting This Pin to Ground Decreases the Output Current
CN1-10	SET <sub>2</sub>	SET <sub>2</sub> LSB Connecting This Pin to Ground Decreases the Output Current
<b>CN2, CN3, CN4, CN5</b> <b>LXMG1645-12-51 (JST SM02(8.0)B-BHS-1-TB(LF)(SN) or Yeon Ho 20015WR-05A00 or equivalent)</b> <b>LXMG1645-12-52 (JST SM02B-BHSS-1-TB(LF)(SN) or Yeon Ho 35001WR-02A00 or equivalent)</b>		
CN2-1 to CN5-1	LAMP <sub>HI</sub>	High Voltage Connection to High Side of Lamp. Connect to Lamp Terminal with Shortest Lead Length. <b>DO NOT</b> Connect to Ground.
CN2-2 to CN5-2	LAMP <sub>LO</sub>	Low Voltage Connection to Return Side of Lamp. Connect Lamp Terminal with Longer Lead Length. <b>DO NOT</b> Connect to Ground.

**STAYLIT FUNCTION TABLE**
**FAULT Definition: (F)**

1. OPEN : (O) Lamp is not connected (either high side wire open or return wire open)
2. SHORT1 : (S1) Lamp high side wire is shorted to lamp return side wire
3. SHORT2 : (S2) Lamp high side wire is shorted to GROUND
4. SHORT3 : (S3) Lamp return wire is shorted to GND
5. ARCING: Lamp High side wire is creating the arcing path after the inverter is enabled.

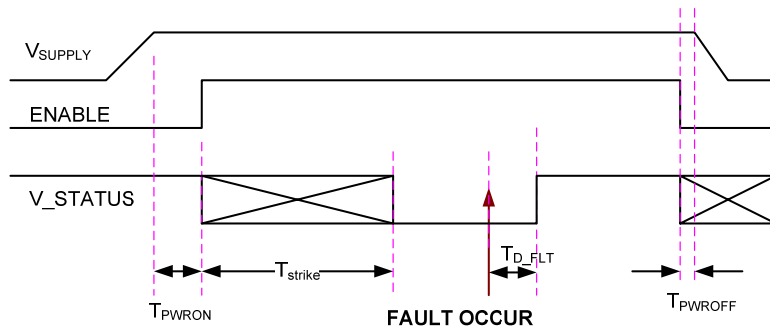
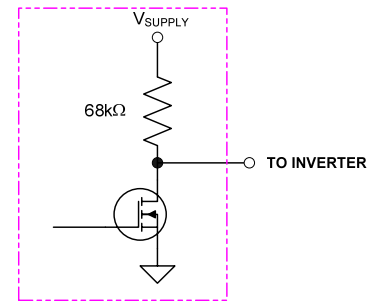
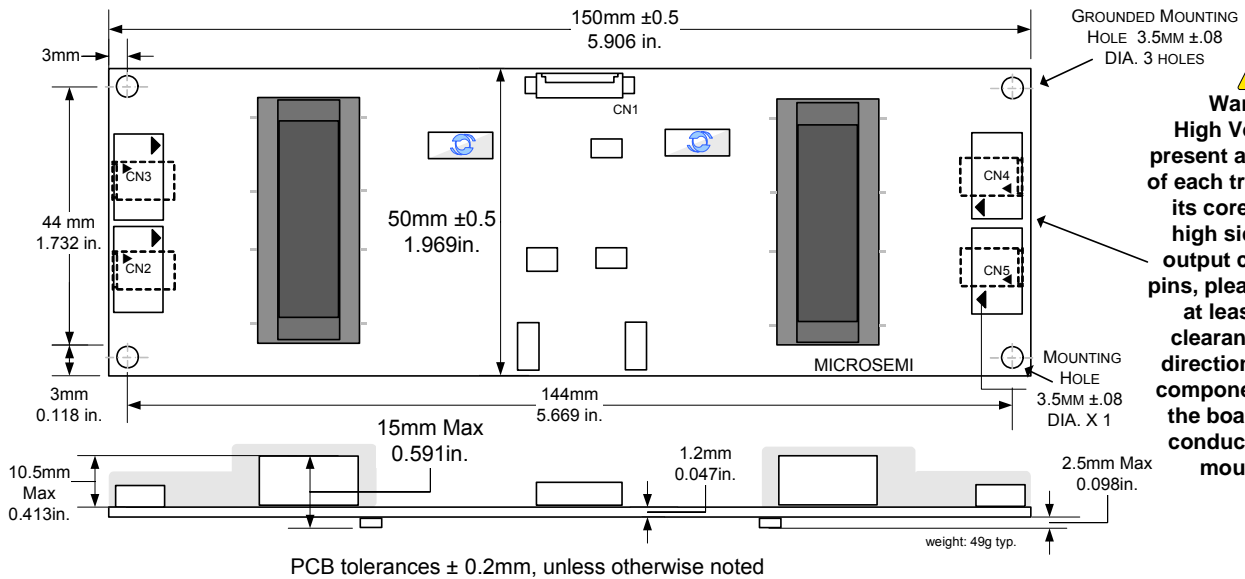
**F** means either **O**, **S1**, **S2**, or **S3** Fault Condition

**N** = Connected Lamp and Normal Operation

Fault Conditions				Inverter Operation	V_STATUS SIGNAL		
Lamp 1	Lamp 2	Lamp 3	Lamp 4		Fault Exists Prior to Turn-on	Fault Occurs During Ignition	Fault Occurs During Run Mode
N	N	N	N	<b>ALL ON</b>	Action after T <sub>STRIKE</sub>	Action after T <sub>STRIKE</sub>	Action after T <sub>D_FLT</sub>
N	N	N	F	With Exception of Affected Lamps for 'O, S1, S2' Fault Conditions, All Unaffected Lamps Are <b>ON</b> , Including Affected Lamp in a Single <b>S3</b> Fault Condition.  An <b>S1</b> Fault Will Typically Reduce Opposing Operational Lamp Current By 38%	Low to High	Low to High	Low to High
N	N	F	N				
N	N	F	F				
N	F	N	N				
N	F	N	F				
N	F	F	N				
N	F	F	F				
F	N	N	N				
F	N	N	F				
F	N	F	N				
F	N	F	F				
F	F	N	N				
F	F	N	F				
F	F	F	N				
F	F	F	F	<b>ALL OFF</b>			

**OTHER FAULT PROTECTION OPERATION**

Fault Condition	Protection Methods
Board Internal Short, V_STATUS always High and Operates or Fail Safe	Operates if Not Fault Shutdown, Fuse Protected if Over Current from V <sub>IN</sub>


**V\_STATUS Timing Diagram**

**ENABLE Interface from System Side (Note<sup>1</sup> above)**
**MECHANICAL DIMENSIONS**




RangeMax™ StayLIT™

LXMG1645-12-5x

12V Quad 5W CCFL Inverter Module

PRODUCTION DATA SHEET

NOTES

PRODUCTION DATA – Information contained in this document is proprietary to Microsemi and is current as of publication date. This document may not be modified in any way without the express written consent of Microsemi. Product processing does not necessarily include testing of all parameters. Microsemi reserves the right to change the configuration and performance of the product and to discontinue product at any time.