

### Introduction

BI200 is a CCFL inverter that operates Landmark Technology 10.4" and 12.1" very high brightness (VHB) backlights including those in the sunlight readable LCD modules. The inverter has an on-board pulse width modulation (PWM) dimming circuit to provide an extremely wide luminance adjustment range. Over the entire dimming range, there is no noticeable lamp flickering and the uniformity of the backlight is well maintained. When using the BI200 with Landmark LCD modules, it is not necessary to synchronize the PWM dimming circuit to the vertical sync signal of the LCD.

The BI200 inverter operates at a 12V DC input and can drive up to 8 CCFLs for a maximum lamp power of 22 Watts. In addition, the inverter has a regulated +5V output which serves as a voltage source for the dimming control circuit.

There are two versions - the BI200A and the BI200AT. The differences are in the dimming voltage  $V_d$  to achieve zero backlight luminance. For the BI200A inverter,  $V_d$  at 0 luminance is 0.34V, and for the BI200AT, the  $V_d$  value for 0 luminance is 0.56V. Please refer to the Electric Characteristics table on Page 2 for detail specification differences.

### Absolute Maximum Rating

Parameters	Min.	Max.	Units
Inverter Input Voltage ( $V_{in}$ )	11.0	13.0	Vdc
Operating Temperature Range	0	50	$^{\circ}$ C
Storage Temperature Range	-20	80	$^{\circ}$ C

## Electrical Characteristics

Parameters	Min.	Typ.	Max.	Units	Conditions
Input Voltage (Vin)	11.5	12	12.5	Vdc	
Input Current (I)					
With 10.4" VHB Backlights		1.9		Adc	Vin = 12V, Vd = 5V (After 15 minute warm-up)
With 10.4" LCD Modules		1.9		Adc	
With 12.1" LCD Modules		2.2		Adc	
Lamp Starting Voltage (Vst)		1,300		Vrms	Vin = 12V, Vd = 5V
Frequency (f)	50	53	58	KHz	
ON/OFF Control					
OFF		0	0.2	Vdc	
ON BI200A		Floating			
ON BI200AT		4.8	5	Vdc	
Dimming Voltage (Vd)					
Maximum Brightness	4.9	5		Vdc	PWM duty cycle = 100%
Zero Brightness BI200A	0.32	0.34	0.36	Vdc	PWM duty cycle = 0%
Zero Brightness BI200AT	0.54	0.56	0.58	Vdc	PWM duty cycle = 0%
+5V Output (+5VOUT)	4.85	5	5.25	Vdc	11.5 < Vin < 12.5V
+5V Output Source Current			5	mA	

## Connector Pin Assignments

Input Connector CN1	Molex 22-23-2071	Output Connectors CN2 & CN3	Molex 22-23-2111
Pin #	Function	Pin #	Function
1	+5 V Output	3, 5, 7, 9	Lamp Connections
2	+12 V Input	11	Lamp Commons
3	+12 V Input	1, 2, 4, 6, 8, 10	No Connection
4	Dimming Control	Mating Connectors	
5	Ground	Housing for CN1	Molex 22-01-3077
6.	Ground	Housing for CN2, CN3	Molex 22-01-3117
7	On/Off Control	Pins for CN1, CN2, CN3	Molex 08-50-0114

## Accessories

- LC07 Inverter input connector (Molex) assembly with 8" long wires.
- DP064 64-level Digital Potentiometer for dimming control with a pair of push buttons.
- PS200 Photosensor for automatic dimming control based on ambient light levels.

### Typical Dimming Characteristics

The BI200 inverter accepts a 0 - 5V analog voltage for dimming control. The inverter has a pulse width modulation (PWM) dimming circuit for luminance adjustment. As the dimming voltage  $V_d$  decreases from +5V, the lamp current waveform is pulse width modulated, and the duty cycle of the PWM waveform reduces from 100% to 0% as the dimming voltage  $V_d$  value reduces. In the meantime, both the backlight luminance and the inverter current drop down roughly in proportion to the duty cycle of the PWM waveform. When the duty cycle reaches 0%, the backlight is turned off and the LCD screen is totally dark.

For the BI200A inverter, when  $V_d$  reaches 0.34V, the PWM waveform duty cycle reaches 0% and the backlight turns “Off”. In order to fully utilize the available dimming range without turning the LCD totally dark, the minimum dimming voltage  $V_d$  should be set slightly above 0.34V and then adjusted to 5.0V for maximum brightness. For the BI200AT, the PWM waveform duty cycle reaches 0% at  $V_d = 0.56V$ . Therefore, the  $V_d$  value should cover the range from slightly above 0.56V to 5.0V.

Typical dimming characteristics with Landmark VHB Backlights and sunlight readable LCD modules are shown in Fig. 2 to Fig. 4. The LCD luminance and the inverter current vary almost linearly if  $V_d$  is plotted in log scale. Thus, it is recommended that a logarithmic dimming voltage generating circuit be used to create a nearly linear luminance adjustment.

In general, inverters with PWM dimming have a very wide luminance adjustment range. For most practical cases, the BI200 inverter can achieve a maximum dimming ratio of about 200:1. Hence, the luminance of the backlight or the LCD screen can be adjusted from 100% to 0.5%.

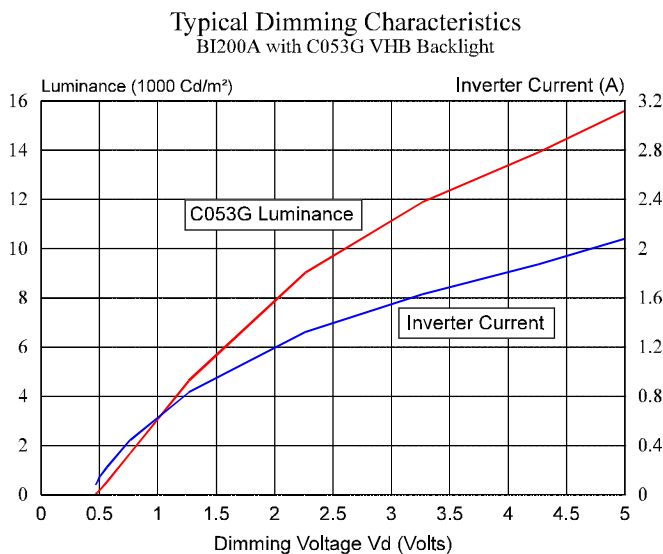


Fig. 2. Typical Backlight Luminance & Inverter Current vs. Dimming Voltage - C053G VHB Backlight driven by BI200A inverter

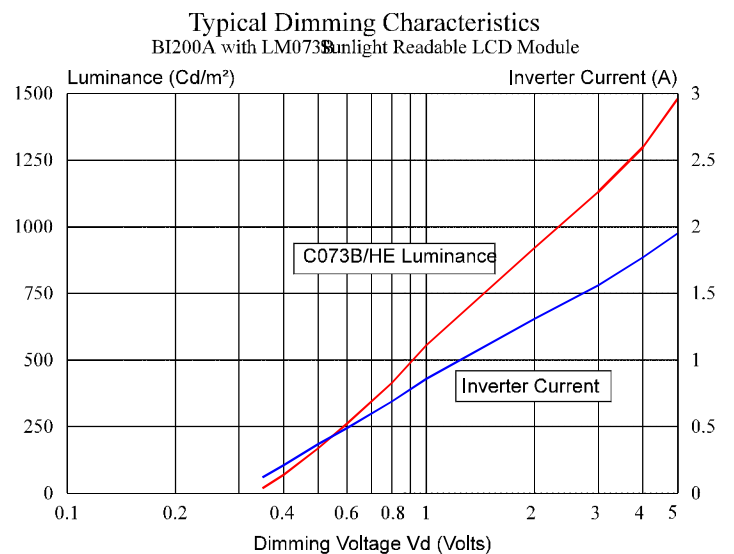


Fig. 3. Typical LCD Screen Luminance & Inverter Current vs. Dimming Voltage - LM073B sunlight readable LCD module with BI200A inverter

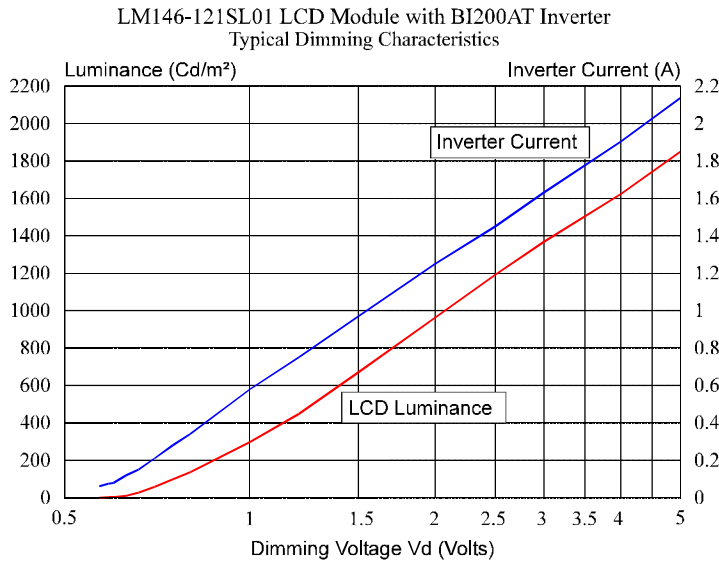


Fig. 4. Typical Backlight Luminance & Inverter Current vs. Dimming Voltage - LM146-121SL01 sunlight readable LCD module driven by BI200AT

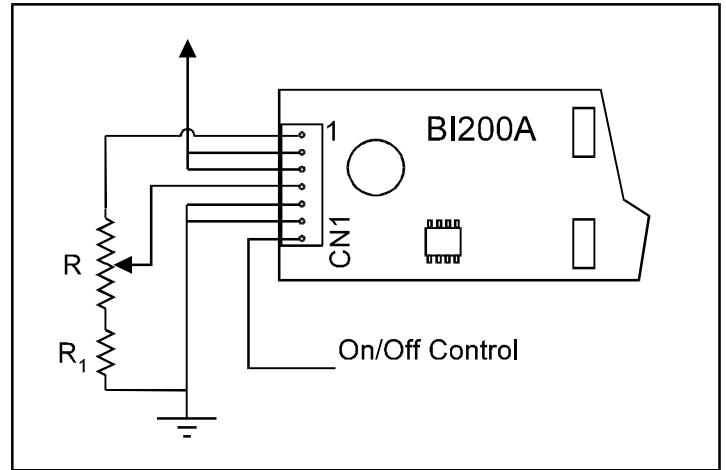


Fig. 5. Dimming control using a potentiometer and a resistor with the on-board +5V regulated supply. Select the  $R_1$  value to set the minimum  $V_d$  to about 0.32V. For example, if  $R$  is a 10 K $\Omega$  potentiometer, then  $R_1 = 680 \Omega$ . When the potentiometer is turned to 0  $\Omega$  (minimum position), the  $V_d$  input is about 0.32V.

## Dimming Control Circuits

The dimming voltage  $V_d$  can be generated simply by using a potentiometer (Fig. 5). The inverter provides a +5V source (pin #1 of the input connector CN1) to power this dimming circuit. However, if a potentiometer with a small resistance value is used, please make sure that the maximum current drain from this +5V source is kept at or less than 5 mA.

In Fig. 5, a series resistor  $R_1$  is added to control the minimum dimming such that the backlight is not completely turned off. It is also possible to add another resistor above the potentiometer to limit the maximum dimming voltage and the maximum screen luminance. This option runs the backlight at a lower brightness and backlight power to relax the thermal issues and/or to increase the lamp life beyond the specified value.

With the BI200A inverter, using an  $R_1$  value of 0.80K $\Omega$  will set the minimum  $V_d$  to about 0.37V. Over the full potentiometer adjustment, a luminance adjustment range

of about 50:1 can be achieved. Use a logarithmic potentiometer to obtain a linear luminance adjustment.

The luminance control range can be increased by lowering the  $R_1$  value, for example, to 0.76 K $\Omega$ . Then, the luminance adjustment range is increased to about 100:1. However, further reducing the value of  $R_1$  may turn the backlight off when the potentiometer is moved to the lowest setting.

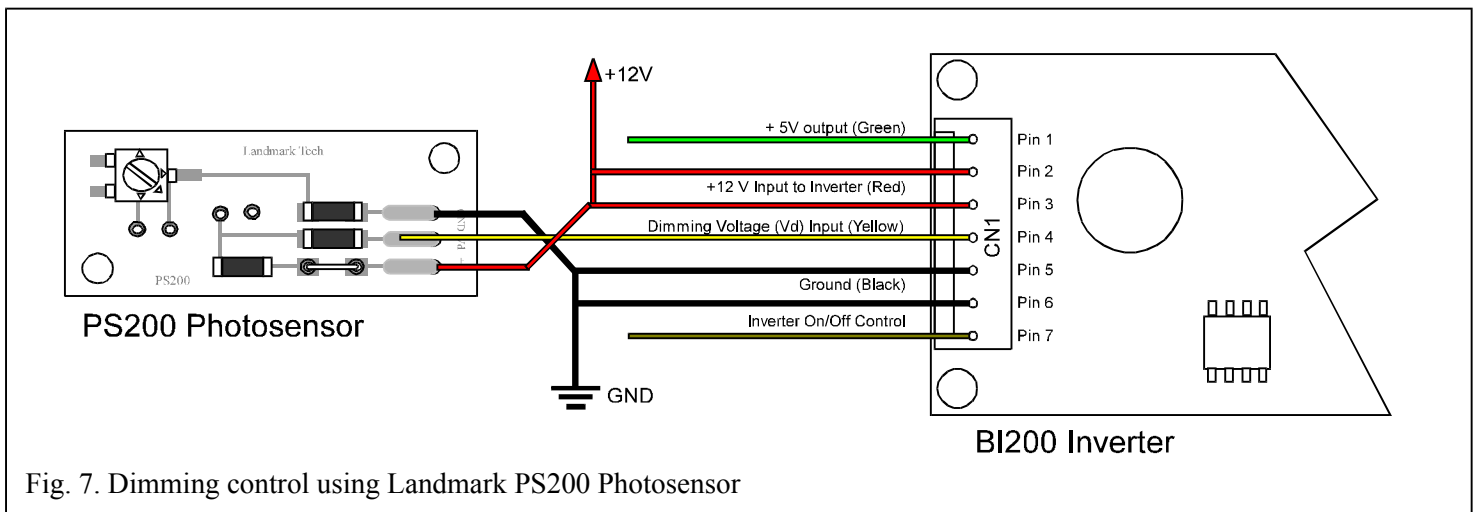
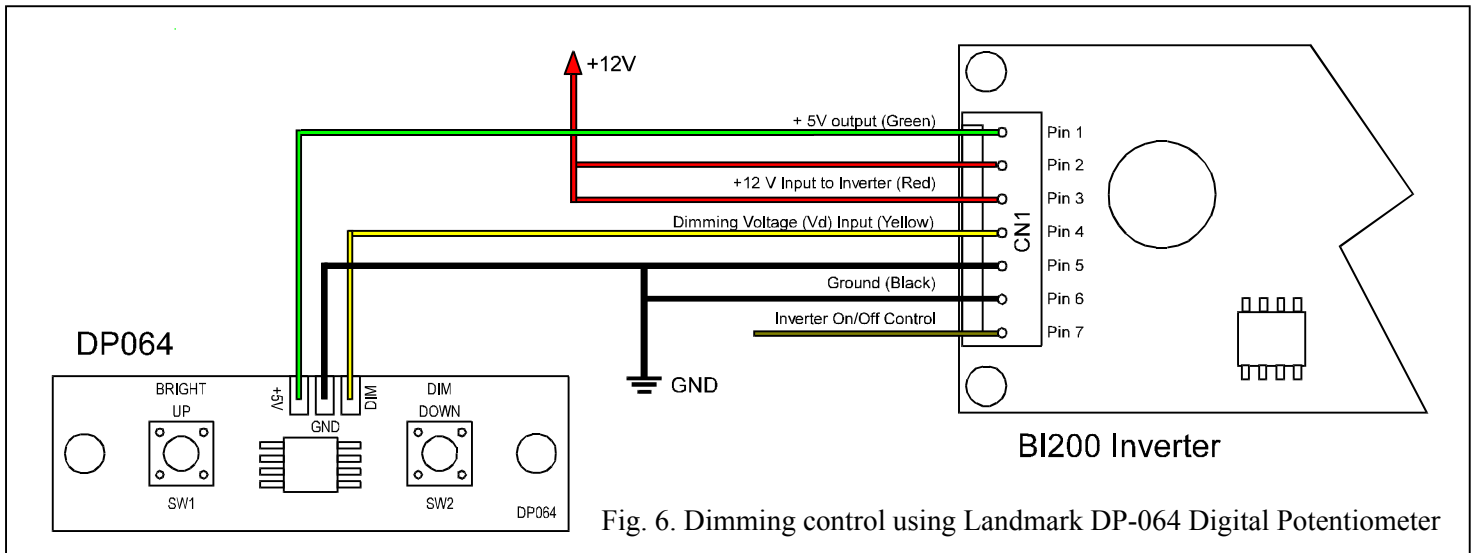
With the BI200AT inverter, the corresponding  $R_1$  values for 50:1 and 100:1 dimming range are 1.5K $\Omega$  and 1.41K $\Omega$  respectively.

Alternatively, the DP-064 digital potentiometer can be used to provide 64 levels of brightness adjustments with two push buttons (Fig. 6). With the BI200AT inverter, the DP-064 can provide a dimming range of about 100:1 with nearly linear luminance adjustment. Please refer to the DP-064 data sheets for details.

## Dimming Control Circuits (continue)

The DP-064 can also be used with the BI200A inverter, However, it only provides a very limited range of dimming of about 8:1.

Landmark PS200 photosensor can be used with the BI200AT to control the brightness automatically in response to the ambient light levels (Fig. 7). Again, when it is used with the BI200A, the range of luminance control will be limited. For details, please refer to the PS200 data sheets.



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