

# LED level meter driver, 12-point, linear scale, dot or bar display

## BA689

The BA689 is a monolithic IC for LED level meter applications. The display level range is  $0\text{mV}_{\text{rms}}$  to  $300\text{mV}_{\text{rms}}$  (typ.) divided into 12 equally-spaced points with  $25\text{mV}_{\text{rms}}$  steps. The constant current outputs can be set using external resistors to allow use of different color LEDs in various combinations.

### ●Applications

Signal meters, battery checkers,  
and air conditioner temperature displays

### ●Features

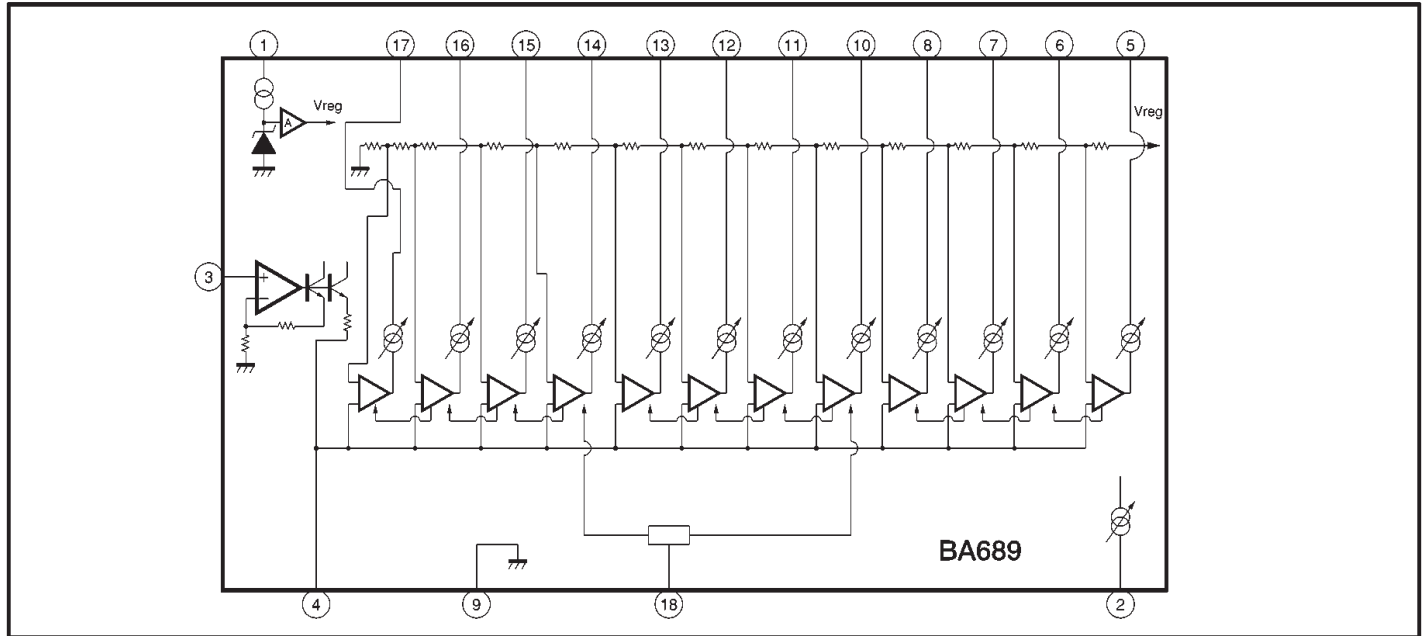
- 1) 12-point level meter driver for bar/dot displays.
- 2) Fixed-current outputs that can directly drive LEDs.
- 3) Output current can be set using external resistors allowing different types of LEDs to be used in combination.
- 4) Built-in half-wave rectifier amplifier.
- 5) LED on and off timing can be set using an external capacitor and resistor.
- 6) With bar-type display, by connecting four LEDs in series, power dissipation is reduced.

### ●Absolute maximum ratings ( $T_a = 25^\circ\text{C}$ )

Parameter	Symbol	Limits	Unit
Power supply voltage	$V_{\text{CC}}$	15	V
Power dissipation	$P_d$	1100*	mW
Operating temperature	$T_{\text{opr}}$	$-20 \sim +60$	$^\circ\text{C}$
Storage temperature	$T_{\text{stg}}$	$-55 \sim +125$	$^\circ\text{C}$

\* Reduced by 11.0mW for each increase in  $T_a$  of  $1^\circ\text{C}$  over  $25^\circ\text{C}$ .

●Block diagram



●Electrical characteristics (unless otherwise noted,  $T_a = 25^\circ\text{C}$ ,  $V_{CC} = 12\text{V}$ , and  $f = 1\text{kHz}$ )

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Power supply voltage	$V_{CC}$	10	12	14	V	When $V_{F(LED)}=2\text{V}$
Quiescent current	$I_Q$	—	5	10	mA	$V_{IN}=0\text{V}$
LED current setting range	$I_{LED}$	—	—	20	mA	Set using $R_1$ (see Fig. 3)
Pin 5 LED current	$I_{LED}$	12	16	20	mA	$R_1=27\text{k}\Omega$
LED current deviation	$\Delta I_{LED}$	-2.0	0	2.0	mA	$R_1=27\text{k}\Omega$ , With respect to the pin 5 $I_{LED}$ value.
Sensitivity	$V_{IN}$	160	250	320	$\text{mV}_{rms}$	$f=1\text{kHz}$ , pin 7 output on level
Comparator level 1	$V_{C1}$	0.05	0.10	0.15	—	Pin 17 output with respect to $V_{C10}$
Comparator level 2	$V_{C2}$	0.15	0.20	0.25	—	Pin 16 output with respect to $V_{C10}$
Comparator level 3	$V_{C3}$	0.25	0.30	0.35	—	Pin 15 output with respect to $V_{C10}$
Comparator level 4	$V_{C4}$	0.35	0.40	0.45	—	Pin 14 output with respect to $V_{C10}$
Comparator level 5	$V_{C5}$	0.45	0.50	0.55	—	Pin 13 output with respect to $V_{C10}$
Comparator level 6	$V_{C6}$	0.55	0.60	0.65	—	Pin 12 output with respect to $V_{C10}$
Comparator level 7	$V_{C7}$	0.65	0.70	0.75	—	Pin 11 output with respect to $V_{C10}$
Comparator level 8	$V_{C8}$	0.75	0.80	0.85	—	Pin 10 output with respect to $V_{C10}$
Comparator level 9	$V_{C9}$	0.85	0.90	0.95	—	Pin 8 output with respect to $V_{C10}$
Comparator level 10	$V_{C10}$	—	1	—	—	Pin 7 output ( $V_{C10}$ level is 1)
Comparator level 11	$V_{C11}$	1.05	1.10	1.15	—	Pin 6 output with respect to $V_{C10}$
Comparator level 12	$V_{C12}$	1.15	1.20	1.25	—	Pin 5 output with respect to $V_{C10}$

Notes: (1) The input must be adjusted at the point that the 10th LED lights. If the input is not adjusted, the measurements may differ slightly from those given above.  
 (2) If component values other than those recommended are used, the circuit current and voltage measurements will differ from those given above.

● Measurement circuit

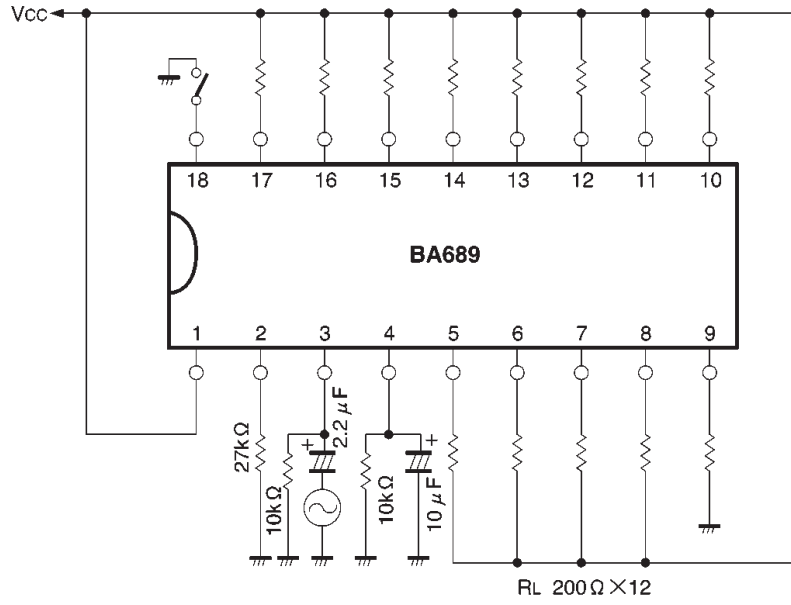
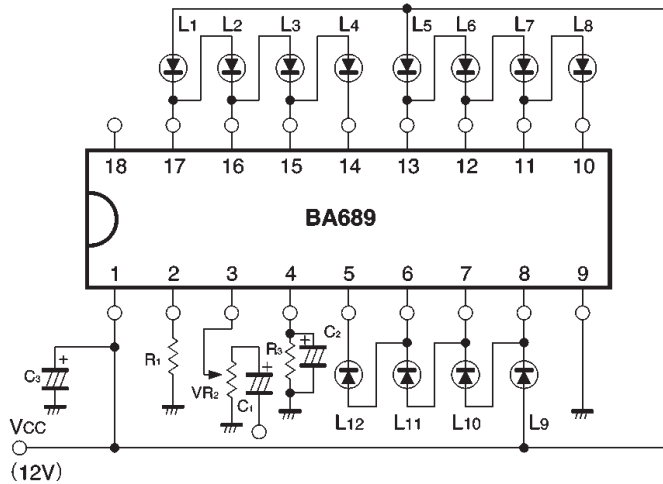
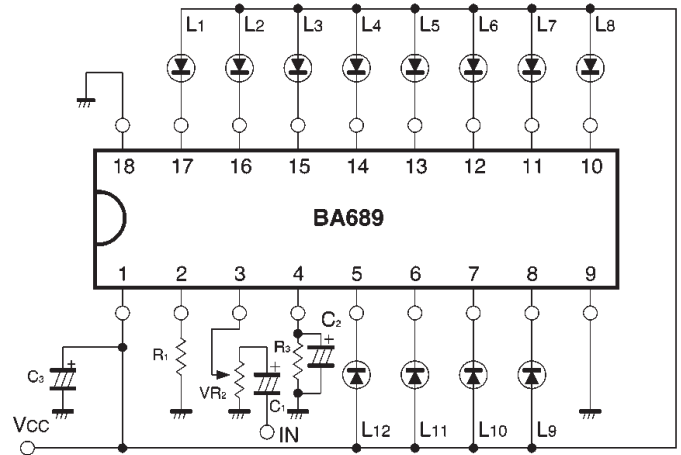


Fig. 1

●Application example



(1) Bar display connections



(2) Dot display connections

Note: Ensure that the voltage on the LED current output pins (5 to 8 and 10 to 17) is always 2V or more. If the voltage is below 2V, the current may drop significantly. Take particular care when using high V<sub>F</sub> LEDs in bar display applications.

Recommended values  
 R<sub>1</sub> = 27kΩ (green LED) or 39 to 47kΩ (red LED)  
 VR<sub>2</sub> = 10kΩ, C<sub>1</sub> = 2.2 μF  
 R<sub>3</sub> = 10kΩ, C<sub>2</sub> = 10 μF  
 C<sub>3</sub> = 10 μF  
 (these values are the same for both bar and dot display)

Fig.2

●Attached components

(1) LED current setting resistor (R<sub>1</sub>)

This resistor sets the LED current value. Refer to Fig. 3 for the relationship between the value of this resistor and the current value. The recommended value is 27kΩ for green LEDs, and 39kΩ for red LEDs. If the LED current is set too high, the allowable power dissipation of the package may be exceeded, so exercise due caution.

(2) Input coupling capacitor (C<sub>1</sub>)

This capacitor connects the BA689 to external input circuits. The recommended value is 2.2μF.

(3) Input bias resistor (R<sub>2</sub>)

This resistor is the input impedance. If the value is set too large, the DC bias voltage will increase, and the input offset will increase and have an effect on the comparators. The recommended value is 10kΩ.

(4) Resistor and capacitor that set the LED operation level discharge time constant (R<sub>3</sub> and C<sub>2</sub>)

These components set the discharge time constant for LED operation level. The recommended values are R<sub>3</sub> = 10kΩ and C<sub>2</sub> = 10μF.

(5) Power supply capacitor (C<sub>3</sub>)

This capacitor stabilizes the power supply line. The recommended value is 10μF. This capacitor will have no effect if its value is 1μF or less.

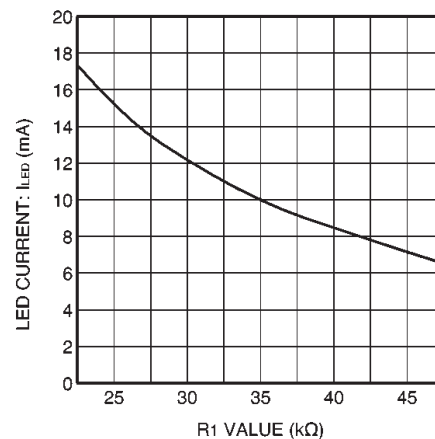


Fig. 3 LED current vs. R<sub>1</sub> setting

●Application example (DC input)

DC input is input directly to pin 3 (see Fig. 4). However, when the input level is high, connect the input directly to the amplifier output (pin 4) as shown in Fig. 5. When this is done dispersion of the rectifier amplifier gain ceases to be a factor, and the comparator dispersion becomes extremely small.

If the resistance of the 100kΩ VR shown in Fig. 5 becomes too small, the discharge time constant determined by R<sub>1</sub> and C<sub>1</sub> will change, and the response time will vary. The maximum input level to pin 4 is 6V.

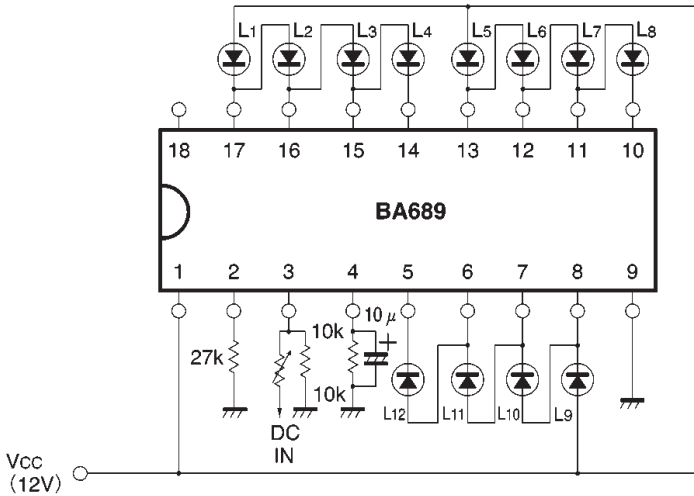


Fig. 4

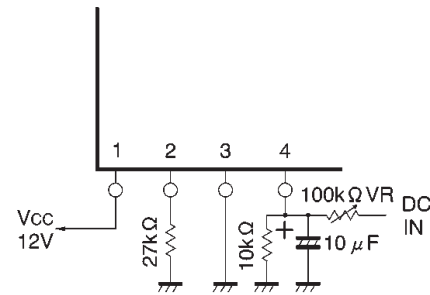


Fig. 5

●Operation notes

(1) LED connection

Connect the LEDs as indicated in Fig. 2. Note that the connection methods are different for bar and dot displays, and that in the case of bar display, pin 18 is open, while for dot display, pin 18 is connected to GND.

When using different color LEDs that have different current values (e.g. green for the lower 10 LEDs and red for the top two) set the value of the current to the larger LED current using the external resistor, and adjust the current value for LEDs that require a smaller current by connecting resistors in parallel them.

If you wish to remove LEDs, be certain to short unused LEDs.

(2) LED current adjustment

The LED current is set using R<sub>1</sub>. The relationship between the value of R<sub>1</sub> and the typical LED current is given in Fig. 3.

(3) Comparator voltage

In the case of the BA689, the comparator voltage is the input voltage when about half LED current setting value (typ.) is flowing in an LED.

Therefore, if the LED current is set to 16mA, the comparator voltage is the value when 8mA is flowing in the LED.

●External dimensions (Units: mm)

