

LED Driver IC BCR450

Power Management and
Multimarket



Never stop thinking

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BCR450, LED Driver IC

Revision History: 2013-02-21, Rev. 3.1

Previous Version: 2009-10-15, Rev. 3.0

| Page | Subjects (major changes since last revision) |
|-----------------|---|
| Figure 1 | Block diagram: Pin 3 (EN), ESD protection and base resistor added |
| Table 5 | Note 1) added to Enable voltage range |
| Table 6 | Typical input capacitance of pin 3 (EN) added |
| Figure 5 | Units added to figure title |
| Figure 6 | Units added to figure title |
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1 BCR450 Power LED Driver IC

Features

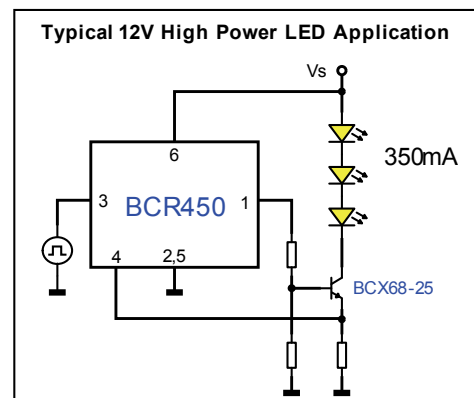
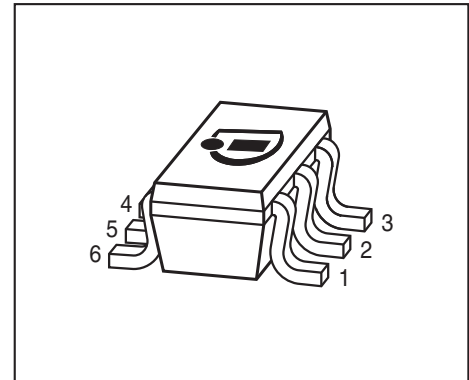
- Low voltage drop across sense resistor, 0.15 V typical
- High output current precision
- Operating voltage from 8 to 27 V
- Over voltage protection
- Overtemperature current foldback and Thermal shut down function
- Adjustable Constant LED Current up to 85 mA in stand alone operation
- Precise Internal bandgap enables High output current accuracy
- Up to 2.5 A LED current possible by using external transistor
- EN Input for PWM LED brightness control and On/Off control
- Very Low Standby Current
- Minimum number of external components required, no inductors
- Very small SC-74 package: 2.9 mm x 2.5 mm x 1.1 mm

Benefits

- High level of colour control due to high output current precision
- Small space requirement
- No electro- magnetic interference
- Active thermal monitoring of chip and LED temperature with current fold- back to avoid thermal overstress
- Low cost device
- Scalable output stage optimizing cost and space

Typical Applications

- General lighting e.g. retrofits
- Architectural lighting, Medical and Dental lighting
- Transportation like train and aircraft lighting
- Strobe lighting
- Universal constant current source
- Signal and marker lights for orientation or navigation
- LED controller for industrial applications, not qualified to AECQ-100



2 Description

The BCR450 is a LED driver IC optimized for usage with an external power transistor for driving LEDs above 100 mA. For currents up to 85 mA the BCR450 can be used in stand alone operation. The output current level can be adjusted with an external sense resistor.

The IC can be switched on and off by an external signal, which is also suitable to regulate brightness of the LEDs by PWM dimming.

The precise internal bandgap stabilizes the circuit and provides stable current conditions over temperature range. Additional features are included to protect the LEDs from overload, short circuit events as well as from over voltage. The LEDs can be also protected against thermal overload by thermally coupling the LEDs to the BCR450.

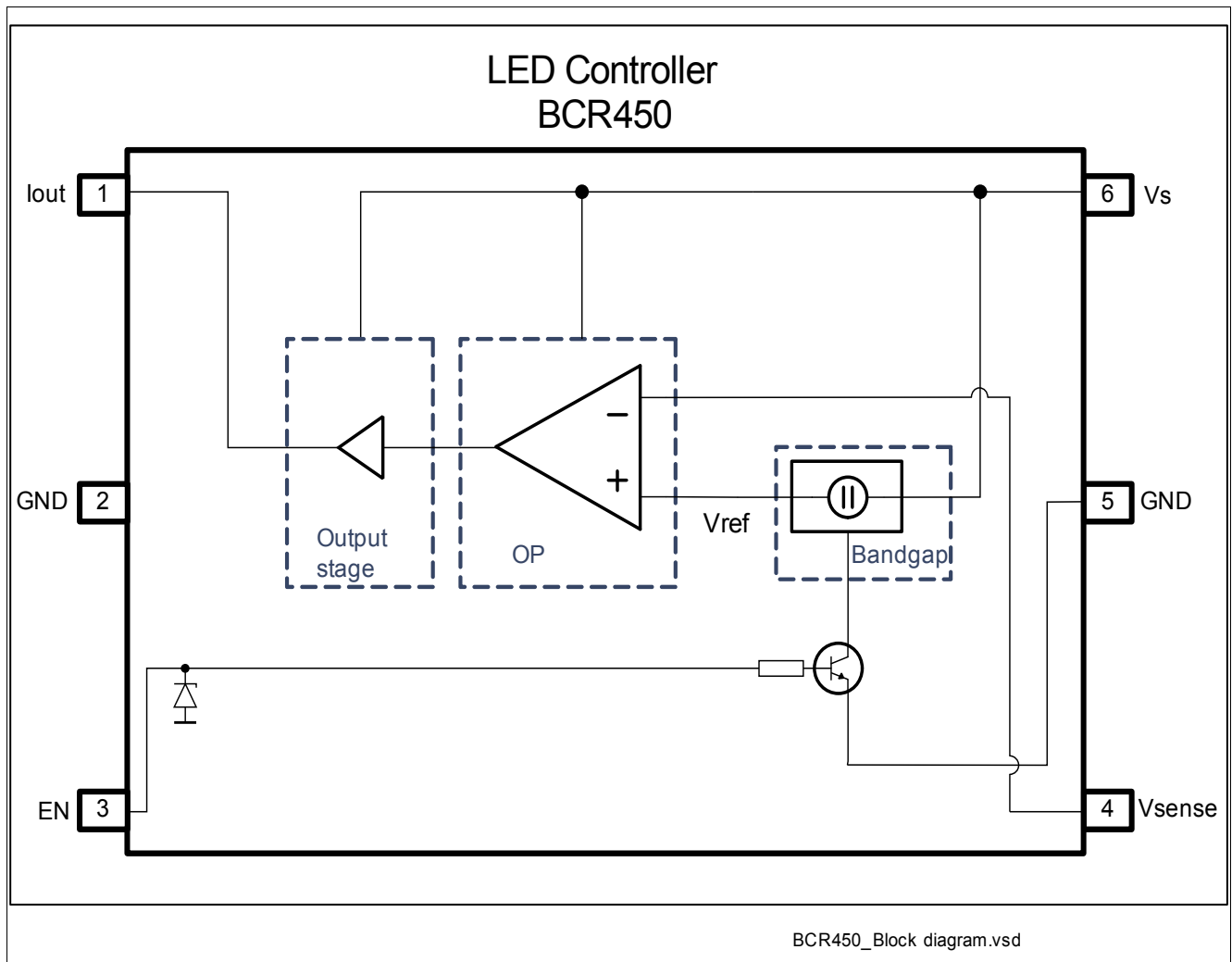


Figure 1 Block diagram

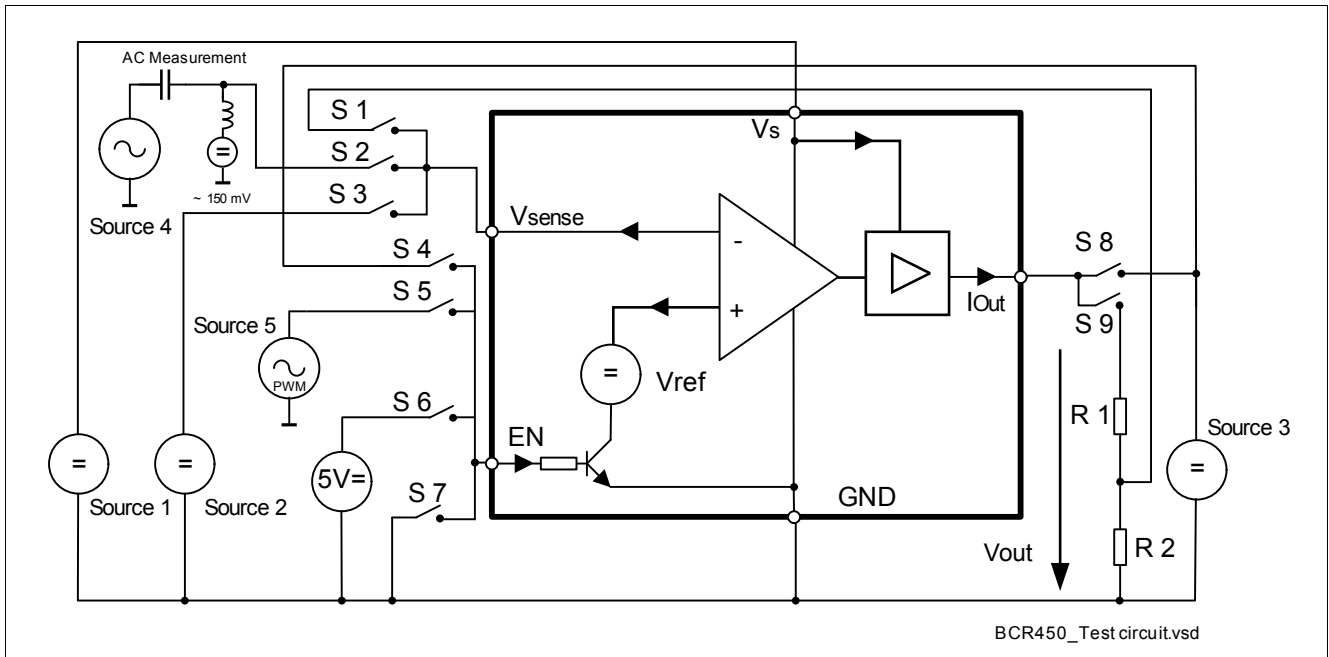
Pin Definition

Table 1 Pin definition and function

| Pin number | Pin Symbol | Function |
|------------|-------------|---|
| 1 | I_{out} | Controlled output current to drive LEDs |
| 2 | GND | IC ground |
| 3 | EN | Power On control voltage pin (<i>PWM input</i>) |
| 4 | V_{sense} | Sense control voltage pin for internal feedback mechanism |
| 5 | GND | IC ground |
| 6 | V_s | Supply voltage |

Table 2 Marking

| Type | Marking | Package |
|--------|---------|---------|
| BCR450 | 50s | SC74 |


Figure 2 Electrical test circuit
Thermal resistance
Table 3 Thermal resistance

| Parameter | Symbol | Value | Unit |
|-------------------------|------------|-------|------|
| Junction - solder point | R_{thJS} | 75 | K/W |

Absolute Maximum Ratings
Table 4 Absolute Maximum ratings

| Parameter | Symbol | Limit Value | Unit |
|--|----------------|-------------|------------------|
| Supply voltage | V_s | 40 | V |
| Sense Voltage | V_{sense} | 200 | mV |
| Output current | I_{out} | 100 | mA |
| Total Power Dissipation; $T_s = 112.5^\circ\text{C}$ | P_{tot} | 500 | mW |
| Junction temperature | T_J | 150 | $^\circ\text{C}$ |
| Storage temperature range | T_{STG} | -65... 150 | $^\circ\text{C}$ |
| ESD capability Human Body Model ¹⁾ | V_{ESD_HBM} | 2000 | V |

1) For ESD testing, the chip was mounted in a SC74 package on an application board, where GND is electrically connected to the chip GND

3 Electrical Characteristics

3.1 DC Characteristics

$8\text{ V} < V_s < 27\text{ V}$; $-40\text{ }^\circ\text{C} < T_J < 150\text{ }^\circ\text{C}$, all voltages with respect to ground; current directions as given in [Figure 2](#); unless otherwise specified

All parameters are tested at $25\text{ }^\circ\text{C}$, unless otherwise specified

Table 5 DC Characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-------------------------------------|---------------------------|--------|------|-----------------|------------------|--|
| | | Min. | Typ. | Max. | | |
| Overall current consumption | $I_{S_{\text{short}}}$ | 70 | 90 | | mA | I_s short; $V_s = 8..27\text{ V}$ $V_{\text{sense}} = 20\text{ mV}$ |
| Overall current consumption | $I_{S_{\text{short}}}$ | | | 600 | μA | I_s short; $V_s = 42\text{ V}$ $V_{\text{sense}} = 20\text{ mV}$ |
| Overall standby current consumption | $I_{S_{\text{standby}}}$ | | | 200 | nA | EN = 0 V; $V_s = 8..27\text{ V}$ $V_{\text{sense}} = 20\text{ mV}$ |
| Current of enable input | I_{EN} | 20 | 40 | 70 | μA | $V_{\text{sense}} = 0..200\text{ mV}$ |
| Current of driver output | I_{outhigh} | 70 | 90 | | mA | $V_{\text{sense}} = 20\text{ mV}$; $V_s = 8\text{ V}$ |
| Current of driver output | I_{outlow} | | | 100 | nA | $V_{\text{sense}} = 200\text{ mV}$; $V_s = 8\text{ V}$ |
| Current of Sense input | I_{sense} | | | 200 | nA | $V_{\text{sense}} = 20..200\text{ mV}$ |
| Voltage of Driver output | V_{out} | | 6 | | V | $I_{\text{out}} = 15\text{ mA}$; S1, S6, S8, S9 = on; R1 = $390\ \Omega$; R2 = $10\ \Omega$; see Figure 2 |
| Voltage of Sense input | V_{sense} | 135 | 150 | 165 | mV | $I_{\text{out}} = 15\text{ mA}$; $V_s = 8..27\text{ V}$ S3, S6, S8 = on; R1 = $390\ \Omega$; R2 = $10\ \Omega$ $T_J = 115\text{ }^\circ\text{C}$ see Figure 2 |
| Enable voltage range | U_{Pon} | -0.3 | | 5 ¹⁾ | V | |
| Control voltage for power on | U_{On} | 0.6 | 0.85 | 5 | V | |
| Control voltage for power off | U_{Off} | -0.3 | | 0.35 | V | |
| Over voltage Protection | $V_{s, \text{OV}}$ | 27 | | | V | $I_{\text{out}} \rightarrow 0\text{ A}$ |
| Delta sense voltage | ΔV_{sense} | 2 | 10 | 50 | mV | $I_{\text{out}}: 0 \rightarrow 50\text{ mA}$ |
| Drop Voltage | $V_s - V_{\text{out}}$ | | 1.2 | | V | $I_{\text{out}} < 40\text{ mA}$ |
| Temperature shut down | T_{SD} | 130 | 150 | 170 | $^\circ\text{C}$ | $I_{\text{out}} \rightarrow 0\text{ A}$; refer to T_J |

1) ESD protection diode of pin 3 (EN) will breakdown above 5 V input voltage to GND

3.2 Digital Signals

All parameters are tested at 25 °C, unless otherwise specified

Table 6 Digital Control Parameter (EN)

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-----------------------------|-----------------------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| PWM signal frequency | f_{PWM} | | | 1000 | Hz | $t_{\text{duty cycle}} = 1\%$; signal level reaches 100% in on and off mode |
| PWM Duty cycle | $t_{\text{duty PWM}}$ | 5 | | | % | $F = 5 \text{ kHz}$; signal level reaches 100% in on and off mode |
| PWM voltage | U_{PWM} | | | 5 | V | |
| EN input capacitance to GND | C_{EN} | | 130 | | pF | EN = 0 V |

3.3 Transient Parameters

$8 \text{ V} < V_{\text{S}} < 27 \text{ V}$; $-40 \text{ °C} < T_{\text{J}} < 150 \text{ °C}$, all voltages with respect to ground; current directions as given in [Figure 2](#); unless otherwise specified

All parameters are tested at 25 °C, unless otherwise specified

Table 7 Digital Control Parameter (EN)

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---------------|------------------|--------|------|------|---------------|---|
| | | Min. | Typ. | Max. | | |
| Response Time | T_{ON} | | | 10 | μs | EN: 0 -> 5 V @ $t_{\text{rise}} < 20 \text{ ns}$ $t_{\text{risetime}} @ (10\% \dots 90\%) * V_{\text{sense}}$ ($I_{\text{out}} \sim 15 \text{ mA}$); $R_{\text{sense}} = 10 \Omega$ |
| | T_{OFF} | | | 70 | μs | EN: 5 V -> 0 @ $t_{\text{fall}} < 20 \text{ ns}$ $t_{\text{falltime}} @ (90\% \dots 10\%) * V_{\text{sense}}$ ($I_{\text{out}} \sim 15 \text{ mA}$); $R_{\text{sense}} = 10 \Omega$ |

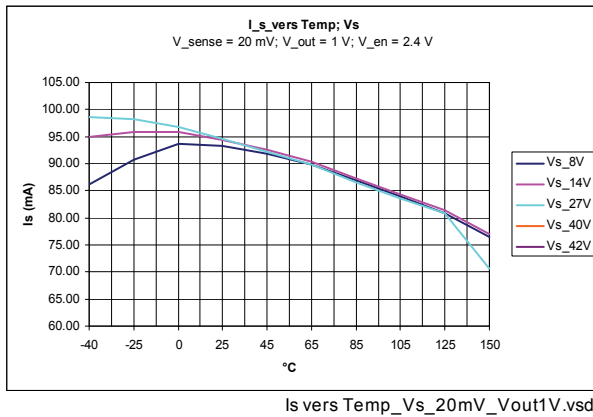
4 Measured Parameters

BCR450 IC has been measured in test bench with undefined high thermal resistance
This is valid for all diagramed DC- and AC- Parameters

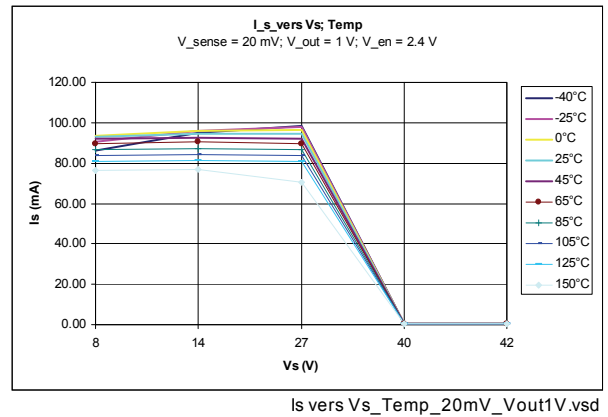
4.1 DC- Parameter

$$V_{out} = 1.0 \text{ V, EN} = 2.4 \text{ V}$$

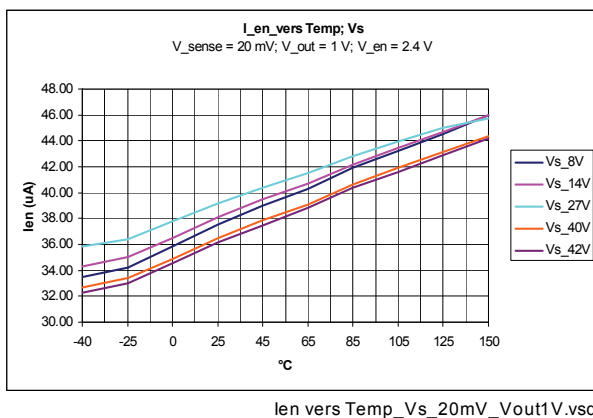
I_S vers Temperature (V_S); $V_{sense} = 20 \text{ mV}$



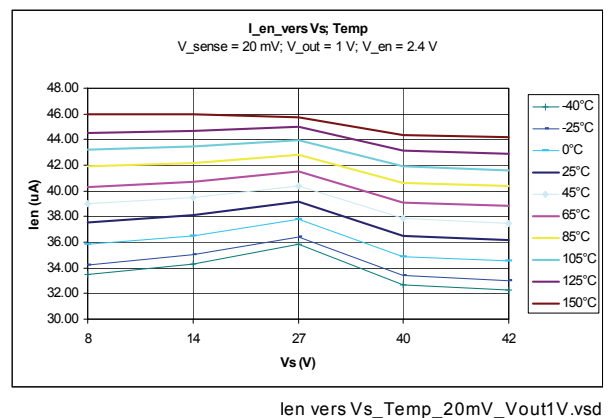
I_S vers V_S (Temperature); $V_{sense} = 20 \text{ mV}$



I_{en} vers Temperature (V_S); $V_{sense} = 20 \text{ mV}$

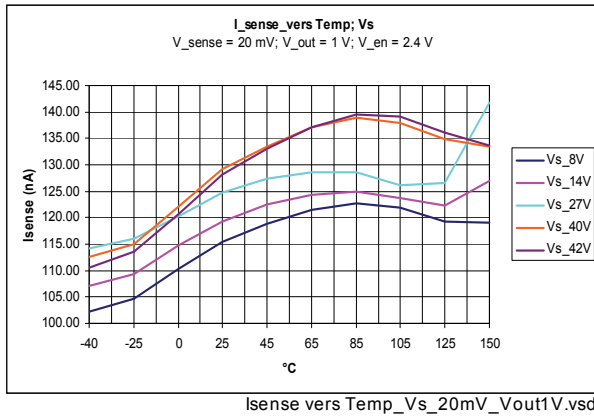


I_{en} vers V_S (Temperature); $V_{sense} = 20 \text{ mV}$

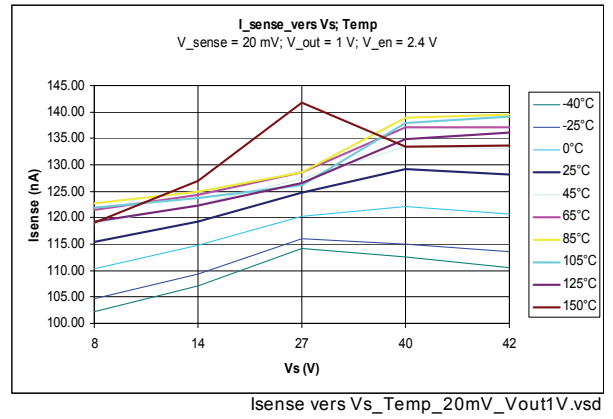


Measured Parameters

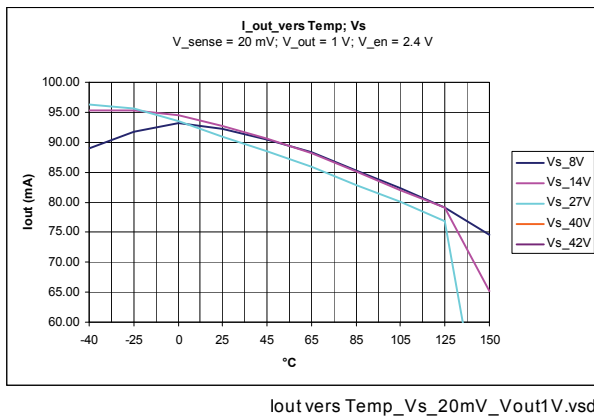
I_{sense} vers Temperature (V_s); $V_{sense} = 20$ mV



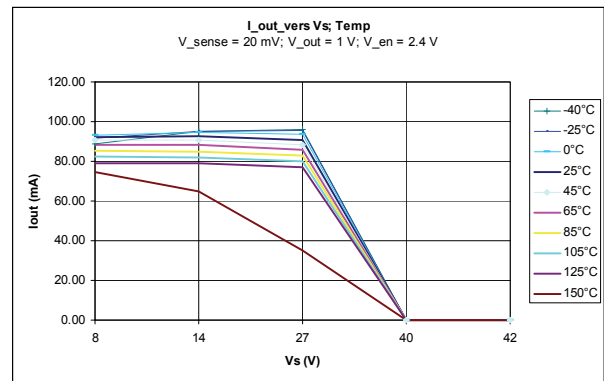
I_{sense} vers V_s (Temperature); $V_{sense} = 20$ mV



I_{out} vers Temperature (V_s); $V_{sense} = 20$ mV

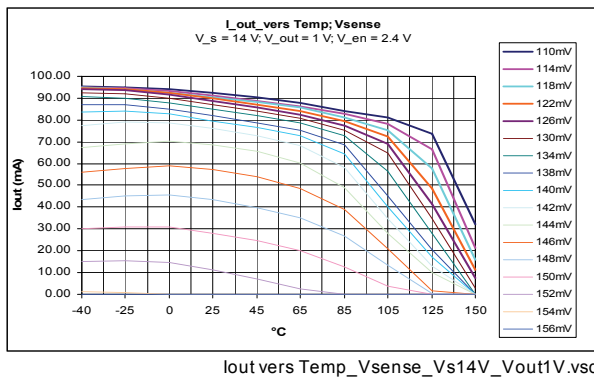


I_{out} vers V_s (Temperature); $V_{sense} = 20$ mV

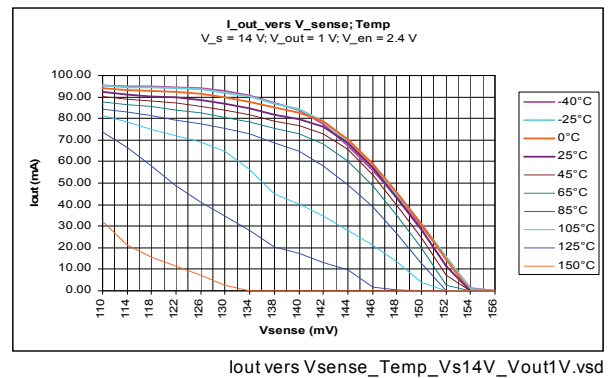


$V_s = 14$ V, $V_{out} = 1$ V; $EN = 2.4$ V

I_{out} vers Temperature (V_{sense})

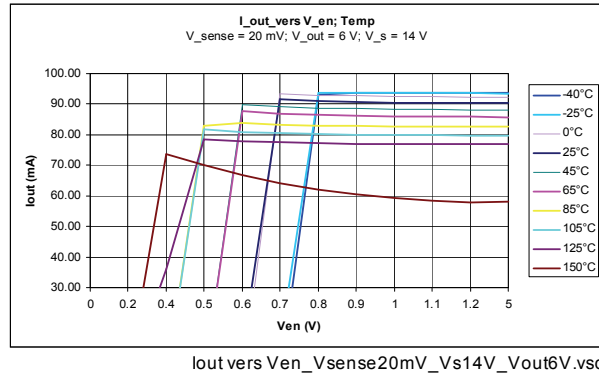


I_{out} vers V_{sense} (Temperature)



$V_s = 14\text{ V}$, $V_{out} = 6\text{ V}$; $EN = 20\text{ mV}$

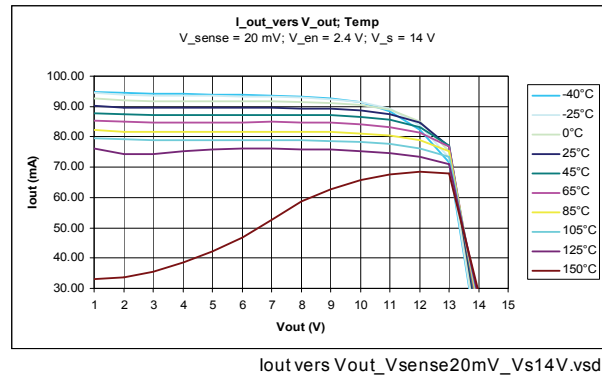
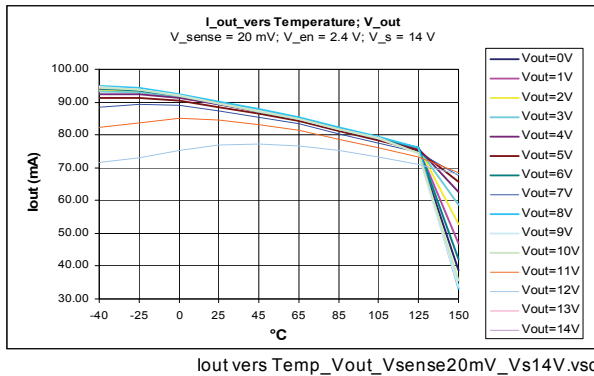
I_{out} vers EN (Temperature)



$V_s = 14\text{ V}$, $V_{sense} = 20\text{ mV}$; $EN = 2.4\text{ V}$

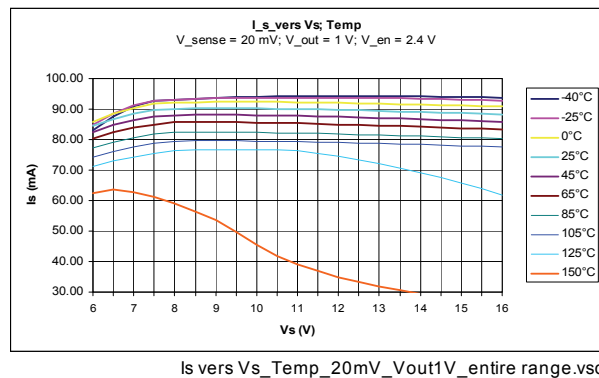
I_{out} vers Temperature (V_{out})

I_{out} vers V_{out} (Temperature)



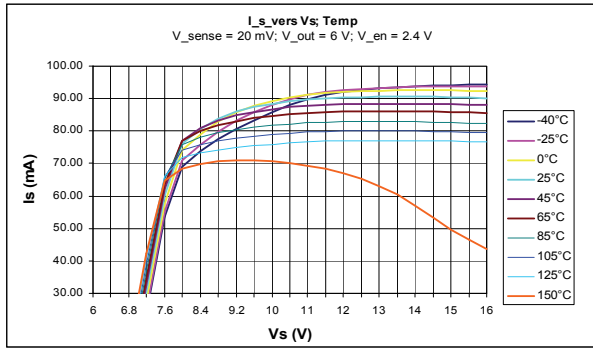
$V_{out} = 1\text{ V}$, $V_{sense} = 20\text{ mV}$; $EN = 2.4\text{ V}$

I_s vers V_s (Temperature)



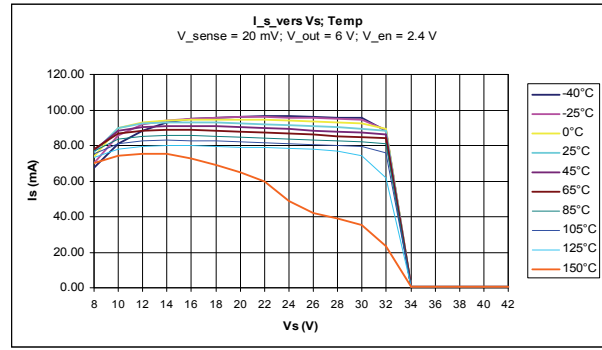
$V_{out} = 6\text{ V}$, $V_{sense} = 20\text{ mV}$; $EN = 2.4\text{ V}$

I_s vers V_S (Temperature)



Is vers Vs_Temp_20mV_Vout6V.vsd

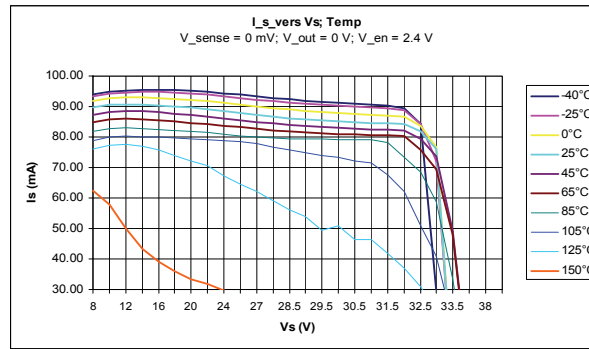
I_s vers V_S (Temperature)



Is vers Vs_Temp_20mV_Vout6V_entire range.vsd

$I_{s\text{ short}} \rightarrow V_{out} = 0\text{ V}$, $V_{sense} = 0\text{ mV}$; $EN = 2.4\text{ V}$

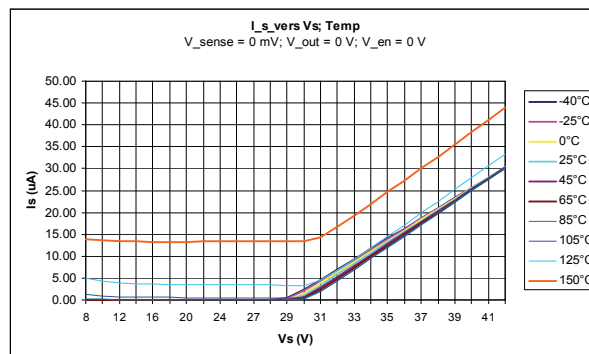
I_s vers V_S (Temperature)



Is vers Vs_Temp_0mV_Vout0V.vsd

$I_{s\text{ standby}} \rightarrow V_{out} = 0\text{ V}$, $V_{sense} = 0\text{ mV}$; $EN = 0\text{ V}$

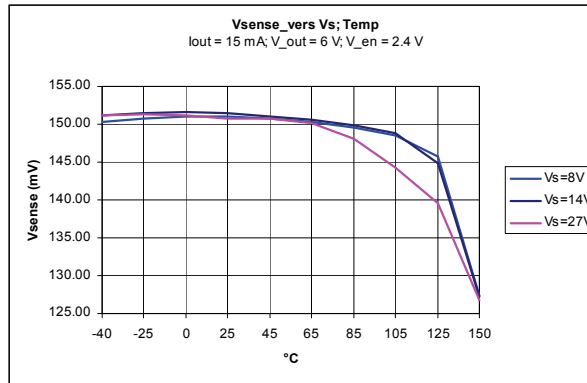
I_s vers V_S (Temperature)



Is vers Vs_Temp_0mV_Vout0V_EN0V.vsd

$V_{out} = 6\text{ V}$, $I_{out} = 15\text{ mA}$; $EN = 2.4\text{ V}$

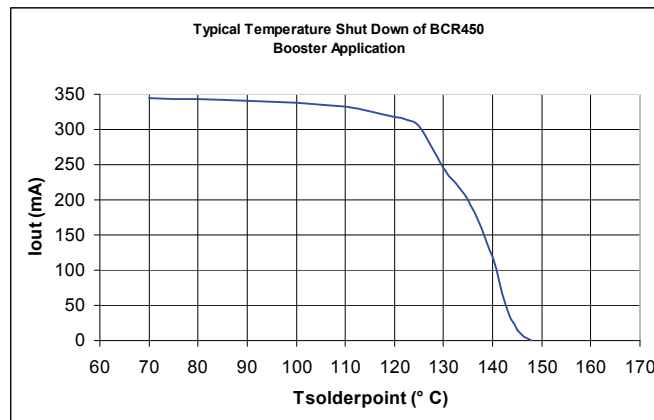
V_{sense} vers V_S (Temperature)



Vsense vers Vs_Temp_Iout15mA_Vout6V.vsd

$V_S = 12\text{ V}$, $I_{out} = 350\text{ mA}$, **Booster Application**, see Figure 3

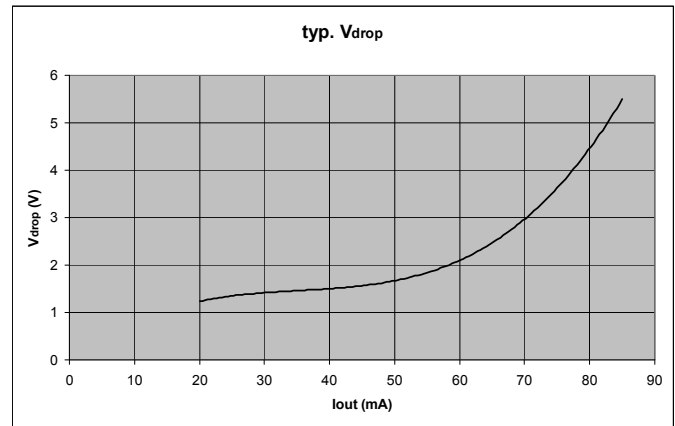
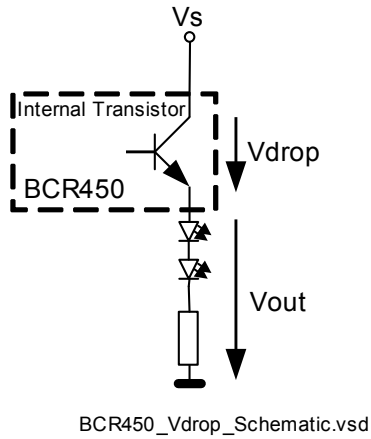
I_{out} vers T_{solder}



TSD.vsd

EN = 2.4 V

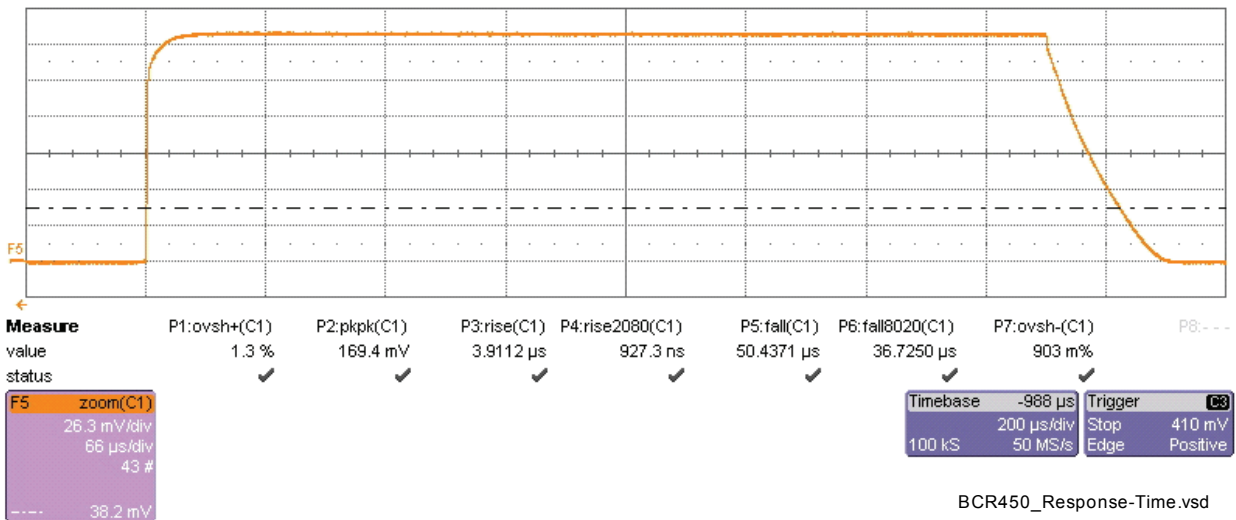
V_{drop} vers I_{out}



4.2 AC- Parameter

Response Time

T_{on} & T_{off} ; $V_s = 12\text{ V}$; $f_{Pulse} = 1\text{ kHz}$; $t_{duty} = 50\%$



5 Evaluation Board

The evaluation board is designed to test the BCR450 as a stand alone device for lower LED current applications and also with additional external “booster” transistors for high current, high brightness LEDs. Up to three external transistors BCX68 or BC817SU each could be used on the PCB to minimize thermal problems.

3 LEDs in series for high current mode or 3 LEDs for low current applications can be chosen by setting resistors (for further application hints see **AN105**). The particular sense voltage can be derived by jumpers which are provided in the layout for each test case. Additional test circuit is included to measure AC characteristics, and the ENABLE input is designed to connect a PWM signal. The PCB is manufactured in double sided FR4 with substrate thickness of 1.0 mm.

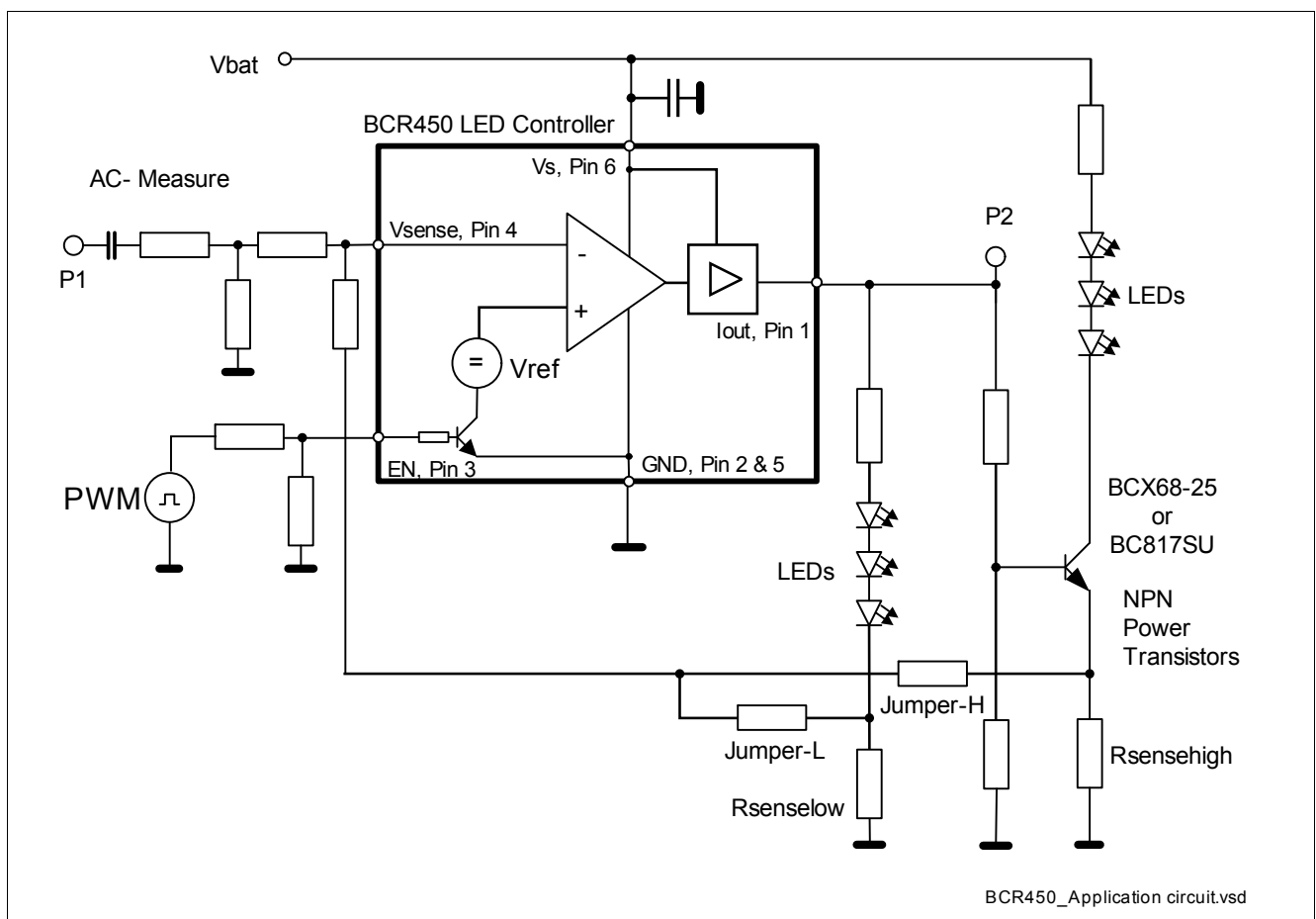


Figure 3 Evaluation board schematic

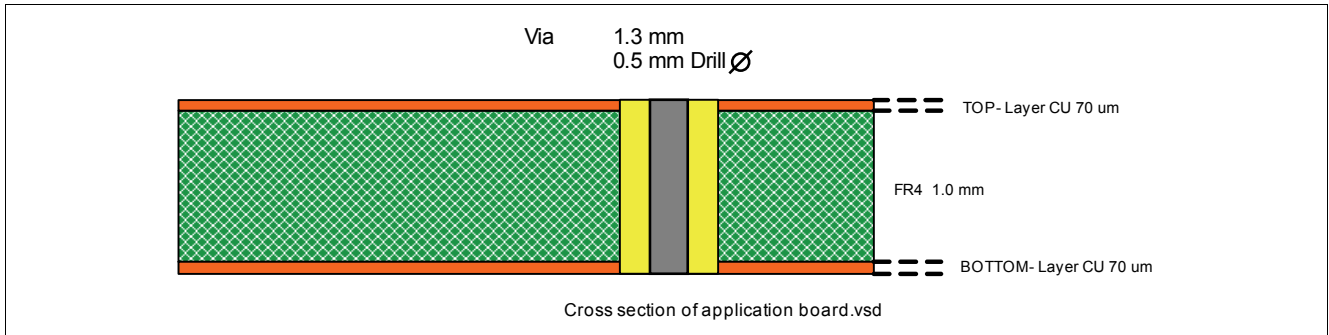


Figure 4 Cross section of evaluation board

6 Package Information

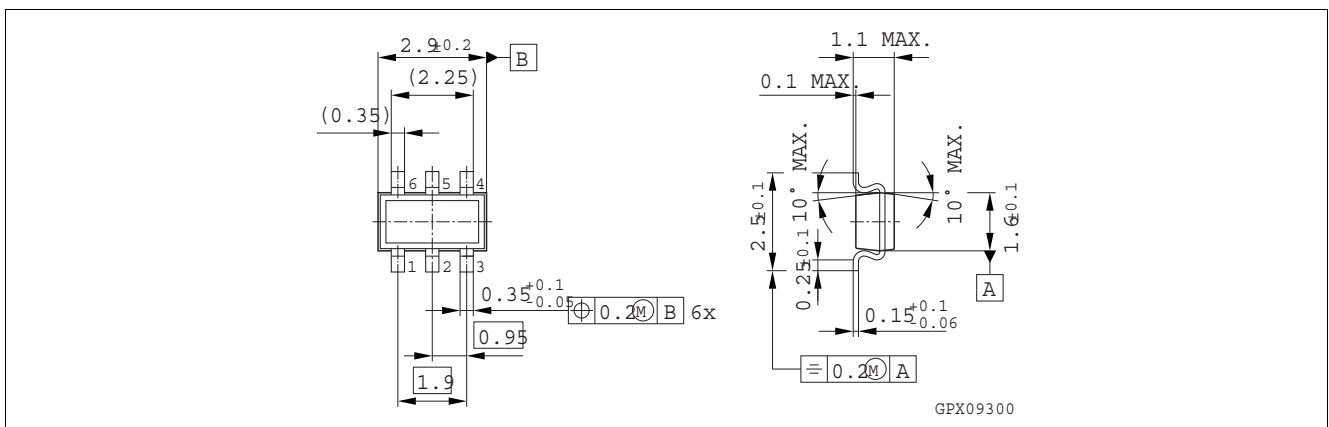


Figure 5 Package outline; SC74 (dimensions in mm)

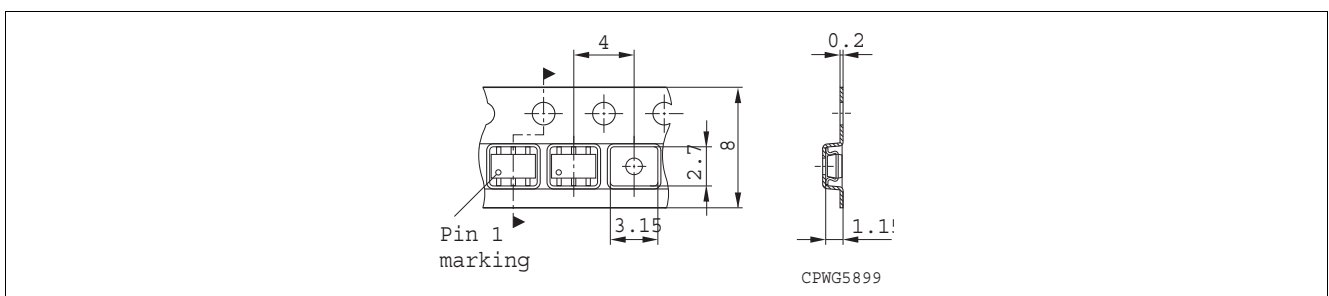


Figure 6 Tape loading (dimensions in mm)



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