Application Note No. 105

LED Driver IC BCR450, using OSRAM Platinum Dragon LW_W5SN

Small Signal Discretes

Never stop thinking

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Page	**Subjects (major changes since last revision)**

1 Description

The BCR450, realized in a bipolar power technology, is a low cost linear regulator LED controller IC for industrial applications designed to operate as a constant current source. The LED controller is capable of driving high current, high brightness LEDs up to 2.5 A by using additional external output stages as “booster” transistors.

This device operates over a 8 V - 27 V input voltage range and high output accuracy is maintained over a broad current range, from 0 to 85 mA.

For LED currents up to 85 mA the IC can be used as a stand alone device and requires only one external low side current sense resistor which monitors the output current to guarantee accurate current regulation.

The voltage drop across the sense resistor is only in the range of 0.12 V - 0.15 V, which contributes to a very small supply voltage overhead of typically 0.5 V. This low voltage drop minimizes wasted DC power and maximizes the number of LEDs that can be used in a series ’stack’.

The IC can be switched on and off by applying an external signal to the EN (Enable) pin of the device, which also linearly varies the LED brightness up to the programmed LED current by PWM (Pulse Width Modulation) dimming.

The precise internal bandgap stabilizes the circuit and provides constant current over the full temperature range. In addition, the current supply uses a sense control function with feedback mechanism that regulates the LED current.

Finally, an over voltage/current protection and temperature shut down mechanism is provided, which protects the LEDs and an Output Short Circuit protection block avoids to damage the IC in the event of a short- circuit at the output pin of the BCR450.

The BCR450 typically draws only 1.5 mA when operating in the no-load condition and draws typically less than 50 nA when the device is shut down.

In “boost” mode, where an external transistor is used for LED currents over 85 mA, the BCR450 is designed to work with a PWM frequency up to 1KHz in addition with a typical PWM range from 1% to 100%. The IC provides a wide dimming range of 1100:1 at a PWM frequency of 1 kHz.

The BCR450 is supplied in a small 6-pin TSOP6 / SC74 package.

Advantage of Linear Regulation of LED current

A key benefit to use a constant-current LED lamp driving is the ability to measure the change in LED lamp current. Through series configuration of the LEDs, current matching is guaranteed.

Electromagnetic Interference (EMI) is minimized with linear regulation methods. Therefore designing with the BCR450 allows faster time to market, system integration and qualification.

Additional filters or shielding required to suppress unwanted electromagnetic radiation are therefore not necessary.

Furthermore, the linear- mode BCR450 does not need a switching inductor. By eliminating the inductor required for a switching design, overall cost is reduced.

Given the rapidly increasing DC power efficiency / efficacy of modern LEDs, a switch-mode driver is often not required to meet overall system DC energy efficiency requirements.

The BCR450 can be used with an external power transistor (boost transistor) for 1/2 W and 1 W LEDs, which helps the lighting designer to realize a low cost, EMI-free solution in a small area, while reducing the power dissipation in the BCR450 itself.

This modular approach to driver design - using BCR450 in “stand alone” mode for currents up to 85 mA, and in “boost” mode with an external transistor for currents over 85 mA - lets the designer use a building- block approach to different LED lighting designs, enabling the designer to use a common core LED driver (BCR450) for multiple designs, adding a “boost” transistor where necessary. This approach can simplify logistics and reduce overall costs.

Features

- Voltage drop across sense resistor only 0.12 V - 0.15 V; low side current sensing
- Maximum operation voltage: 27 V
- Over voltage protection
- Over current protection
- Temperature shut down mechanism
- Extremely precise bandgap voltage reference
- Maximum operating output current: 85 mA
- Maximum LED current of 2.5 A possible by using external transistors (boost transistors)
- Digital On/Off switch
- PWM control for LED brightness possible
- Minimum external component required (only one current sense resistor)
- Small 6-pin package TSOP6 / SC74
- Low shutdown current: <50 nA typ. at operational voltage range

Applications

- LED Controller for industrial applications (not qualified for automotive applications)
- General purpose constant current source
- General purpose constant current LED driver
- General illumination, e.g. Halogen Retrofit
- Residential architectural and industrial commercial lighting for indoor and outdoor
- Decorative and entertainment lighting
- Backlighting (illuminated advertising, general lighting)
- Display backlight where high brightness is required e.g. TFT
- Reading lamps (aircraft, car, bus)
- Substitution of micro incandescent lamps
- Signage, Gasoline Canopies, Beacons, Hotel Lighting
- Signal and symbol luminaries for orientation
- Marker lights (e.g. steps, exit ways, etc.)

2 Pin description

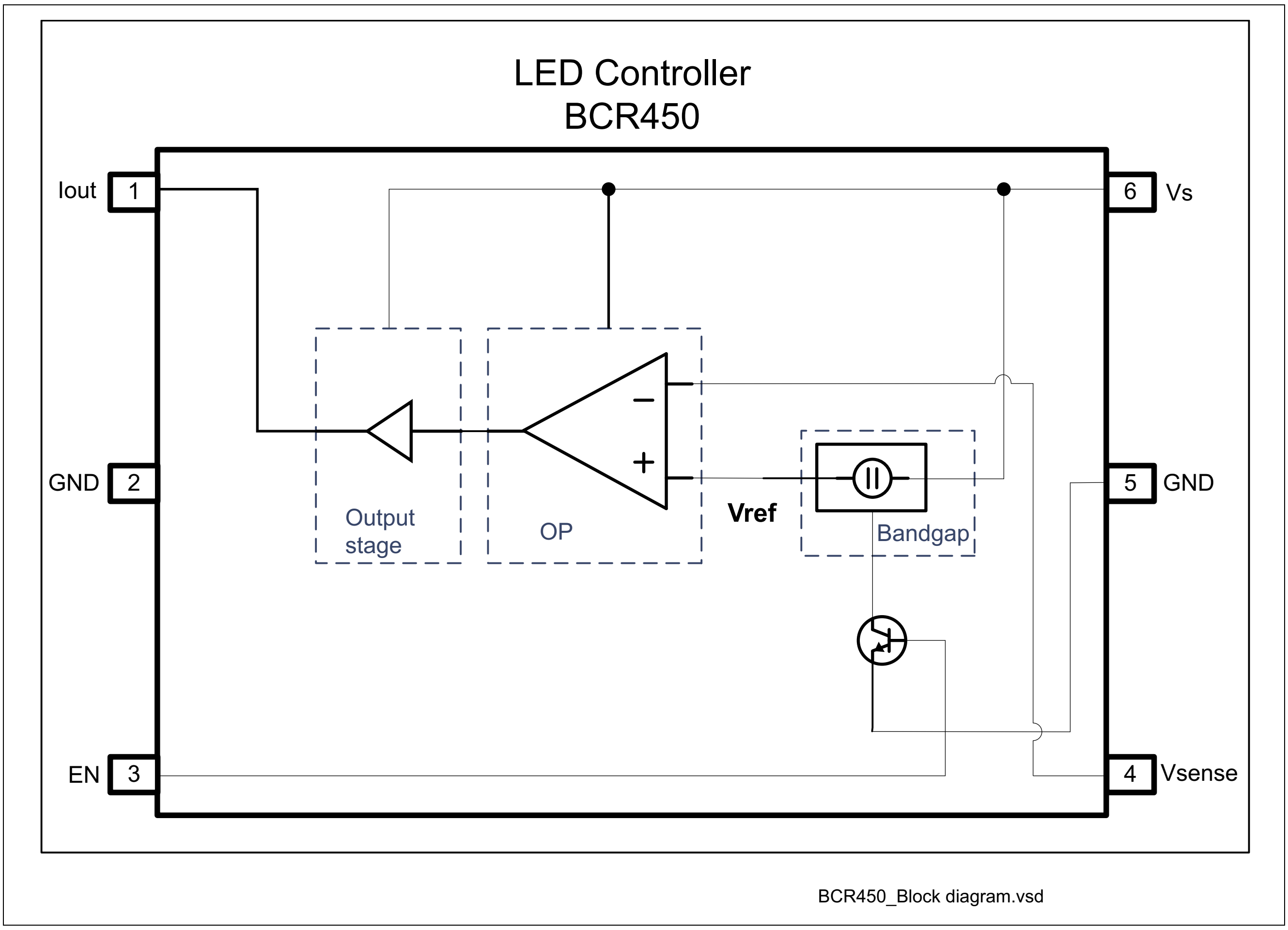


Figure 1 BCR450 block diagram

Table 1 Pin description

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 (PWM input)
4	V_{sense}	Sense control voltage pin for internal feedback mechanism
5	*GND*	IC ground
6	V_S	Supply voltage

3 Application Board

The application board is designed to test the BCR450 with additional external "booster" transistors for high current, high brightness LEDs. 3 LEDs are "stacked" in series, which guarantees the matching of the LED current.

An optional Reverse Polarity Protection (RPP) based on Infineon Schottky Diodes BAS3010A-03W is provided on the application board to avoid inverting the inputs when connecting the DC power plug.

The MCPCB (Metal Clad Printed Circuit Board) for the current application contains only one diode. The board incorporates two power transistors (boost transistors) to minimize thermal problems in high current high voltage applications. To distribute the hot spots on PCB, a cost effective solution could be the use of some Infineon BC817SU transistors in parallel.

Due to the fact that the EN Line of the application board is directly connected to the supply voltage a 270 kΩ resistor is inserted in series to the EN pin of the IC to protect that pin against higher voltages than the pernitted 5 V.

A supply voltage of 8 V - 27 V may be applied and depending on the resulting power dissipation a LED current up to 1 A can be realized.

However the booster transistor requires a minimum of ~0.5 V from collector-to-emitter to operate properly. The controller BCR450 has to deliver a very small driver current due to the h_{FE} of the power transistor, which drastically reduces the power dissipation in the BCR450 IC.

The temperature of the LED is sensed by the BCR450 via two capacitors operating as thermal bridges, which are connected between the ground plane of the IC and one LED. If the ground plane heats up, the BCR450 will also warm up and if the BCR450's chip temperature exceeds 170 °C (typically), the internal temperature shut down will become active and reduce the LED current.

Based on the enable input, the IC can be switched on or off or a PWM signal can be applied, making PWM dimming possible via controlling the output current I_{out}.

Due to the fact that LED junction temperatures must be kept below their maximum ratings in order to ensure long LED lifetime, the PCB is manufactured as a metal-clad-circuit board (MCPCB). Flex-Circuit material (DuPont "Kapton"®) is attached with adhesive (DuPont "LF"®) low cost "3003" series aluminium sheet for the circuit board design.

The aluminium back-plate of the PCB serves as a heat sink for the LEDs, the LED driver IC BCR450 and booster transistor. Only one side of the dielectric has traces or metallization on it. A cross-section diagram of the circuit is given in **Figure 3**. Note the thin dielectric layer (flex-circuit) of 0.05 mm thickness minimizes thermal resistance, permitting heat to flow from the high power LEDs and circuit components into the aluminium base plate relatively easily.

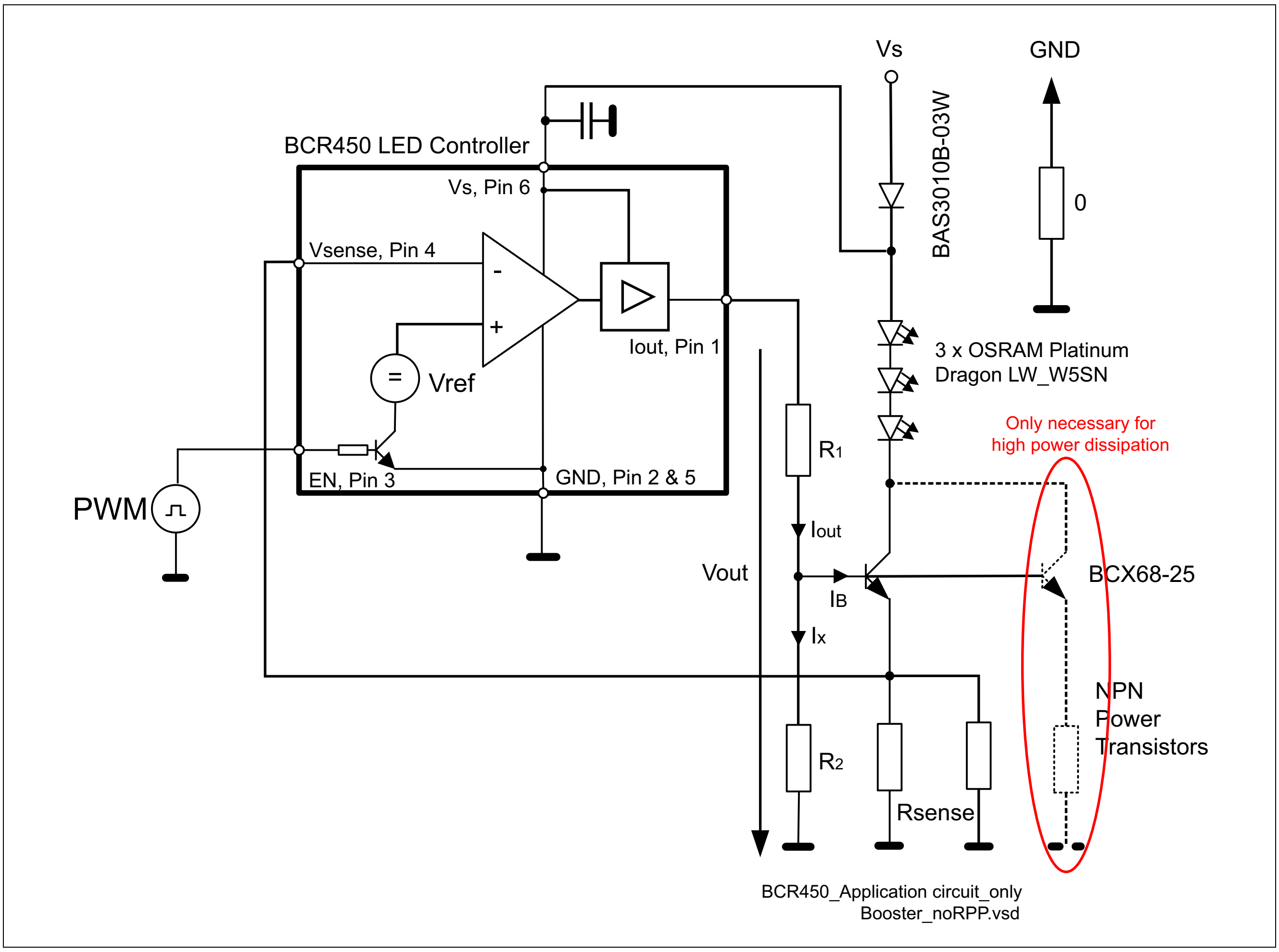


Figure 2 Application circuit with booster transistors

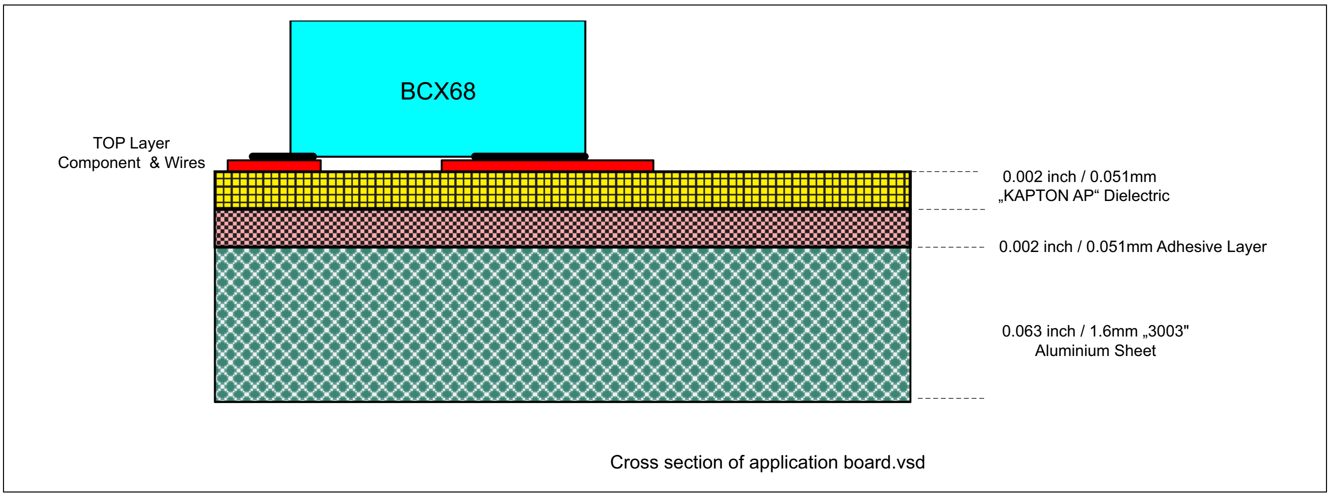


Figure 3 Cross section of the MCPCB

OSRAM Platinum Dragon

Table 2 Technical key parameters of OSRAM Platinum Dragon

Symbol	Min.	Typ.	Max.	Value
V_F	2.9	3.6	4.3	V
I_F	100		1000	mA
R_{thJS}		11		K/W
P_{tot}		4.6		W

4 The BCR450 in “boost” operation for high brightness LEDs

4.1 Calculation of the base voltage divider

Assuming an application with one power transistor BCX68-25 and an I_{LED} current of 350 mA.

h_{FE} is typically 250.

V_{sense} ~ 150 mV

V_S = 12 V

Referring to **Figure 2**

→ base current of the transistor: $I_B = I_{LED} / h_{FE}$ = 1.4 mA

Assuming I_x should be 5 times higher than I_{Btot}

V_{BE} of the power transistor is ~ 0.56 V (if transistor is heated up)

→ $I_{out} = I_B + I_X = I_B + 5 \times I_B = 6\ I_B$

→ V_{R2} ~ 0.56 V + V_{sense} = 0.56 V + 0.15 V = 0.71 V

→ R_2 = 0.71 V / 5 x I_B = 0.71 V / 7 mA = 101.4 Ω; Next value E24: 100 Ω

Assuming V_{out} = 8 V, which results in 4 V V_{CE} at the output stage (between pin 6 and pin 1 of the BCR450). Lower V_{CE} helps to minimize the power dissipation in the IC (V_{CE} x I_{CE}). A V_{CE} up to approx. 1 V is feasible for boost operation.

→ $V_{R1} = V_{out}$ - 0.71 V = 7.29 V

→ $R_1 = V_{R1}$ / 6 x I_B = 7.29 V / 8.4 mA = 867.86 Ω; Next value E24: 820 Ω

Providing two power transistors results in the same resistor values for the base voltage divider.

Note, that the values of the bias circuit are not critical

4.2 How to calculate and choose the booster transistor

The external boost transistor is the key component to get a design which has a good efficiency in terms of power consumption, size of the PCB and cost.

1. At first we have to set the supply voltage range V_{supply}
2. Determine the desired LED current I_{LED}
3. Set the number of stacked diodes; this is very important, because the residual voltage will be dropped down at the booster transistor. Be sure to allow for at least 0.5 V across the collector- emitter of the booster transistor for proper operation
4. Depending on the total power dissipation it could be necessary to use 2 transistors in parallel, which is supported in the application board
5. Sufficient heat sink area should be provided for the power transistors

Maximum Power Dissipation calculation as an example:

V_{supply} = 12 V
I_{LED} = 350 mA
3 Platinum Dragon LEDs with a V_{Fmin} = 2.9 V in series
V_{sense} = 150 mV typ.

$V_{F\ total}$ = 3 x 2.9 V = 8.7 V

This results in a value of R_{sense} of
$R_{sense} = V_{sense} / I_{LED}$ = 0.15 V / 350 mA = 0.43 Ω (could be realized 1.8 Ω and 0.56 Ω in parallel)

$V_{CEtransistor}$ = 12 V - 0.15 V - 8.7 V = 3.15 V
$P_{tot} = V_{CE} \times I_{LED}$ = 3.15 V x 350 mA = 1103 mW

If the Total Power Dissipation will exceed 1500 mW, adequate cooling provided by a properly sized heat sink is necessary.

4.3 Calculation with two transistors

The value of the sense resistor of each power transistor is half of that as compared to a design using a single booster transistor.

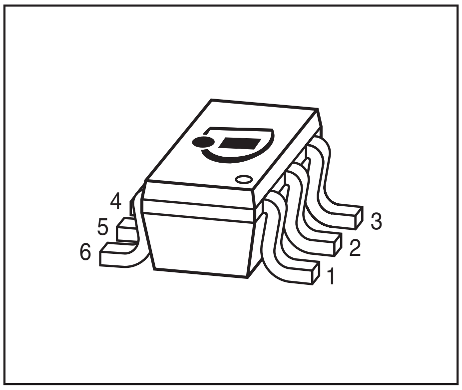
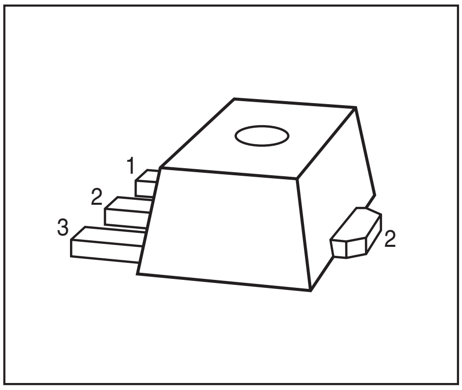
Note: Both resistors should have the same value of the sense resistor to ensure both boost transistors have the same collector currents and share the power dissipation burden equally.

Regarding the power dissipation, each transistor will dissipate half of power as well.

$R_{sense} = V_{sense} / I_{LED} / 2$ = 0.15 V / 175 mA = 0.86 Ω (could be realized 5.6 Ω and 1 Ω in parallel)
$P_{tot\ one\ transistor} = V_{CE} \times I_{LED} / 2$ = 3.15 V x 175 mA = 551.3 mW, which results in enough margin for the design

Three transistor types are recommended

Table 3 Recommended transistors

SC74	**SOT89**	
		
2.9 x 1.6 x 1.1 mm	4.5 x 2.5 x 1.5 mm	
BC817SU P_{tot} = 1000 mW max. I_{Cmax} = 500 mA 45 V breakdown (C-E) Thermal Resistance[1] < 50 K/W	BCX55-16 P_{tot} = 1000 mW max. I_{Cmax} = 1000 mA 60 V breakdown (C-E) Thermal Resistance < 20 K/W	BCX68-25 P_{tot} = 1500 mW max. I_{Cmax} = 1000 mA 20 V breakdown (C-E) Thermal Resistance < 20 K/W

1) Thermal resistance is device **J**unction to package **S**oldering point (R_{thJS})

As mentioned previously, if the power dissipation exceeds the maximum level of all transistor packages, it is necessary to split the power consumption by using two transistors. Without any heat sink two BCX68-25 should be used in order to handle $P_{tot} = V_{CE} \times I_{LED}$. Of course, power consumption issues in the transistor could be relaxed if the number of LEDs used in the stack is increased.

Note: Stacking more LEDs, if possible, reduces the collector-emitter voltage V_{CE} across the boost transistor(s), thereby decreasing the power dissipation in the boost transistor(s). But one must ensure that the boost transistors have at least 0.5 V across their collector- emitter connections under all anticipated operating conditions to ensure they operate properly.

It is also possible to reduce the junction temperature by providing large copper areas on the PCB connected to the collector of the transistor.

If the junction temperature does not exceed 150 °C at the highest ambient temperature, a smaller booster transistor could also be used (e.g. BC817SU).

Three transistors BC817SU with SC74 packages are recommended in order to avoid hot spots on the PCB by splitting up the power dissipation between multiple packages, e.g. this approach "spreads out the heat".

Nevertheless, the power dissipation in the BCR450 is very low due to the fact that the output current of the BCR450 when operated with an external "boost" transistor is calculated as $I_{out} = I_{LED} / h_{FE}$.

In other words, in the "boost" configuration, the current that the BCR450 needs to provide, is the LED current, divided by the DC current gain of the boost transistor(s).

Therefore in this case, the BCR450 acts as a 'controller' with very low power dissipation, and does not require any additional effort in terms of cooling, as the largest part of the power dissipation burden has been shifted to the external boost transistor(s).

4.4 Calculation of the Power Dissipation

We use the example from Chapter 4.2. Only one power transistor will be used.

$P_{tot\ (only\ one\ transistor)} = U_{CE}$ x I_{LED} = 3.15 V x 350 mA = 1103 mW

In most of the case the R_{thSA}[1] is not known. Therefore the only method to determine the junction temperature of the transistor is to measure the temperature of the solder point T_S.

$T_J = T_S + P_{tot} \times R_{thJS}$

If the customer knows the thermal resistance of the board one can easily calculate the temperature of the solder point T_S, too.

$T_S = T_A + P_{tot} \times R_{thSA}$

A combination of both formulas results in

$T_J = T_A + P_{tot} \times (R_{thJS} + R_{thSA})$

4.5 Using BCX68-25

P_{tot}	=	1.5 W (T_S = 120 °C)
I_{max}	=	1 A
R_{thJS}	=	20 K/W (SOT89)

Table 4 $P_{tot\ (only\ one\ transistor)}$ **= 1103 mW**

T_A	T_J @ R_{thSA} = 20 K/W	T_J @ R_{thSA} = 36 K/W	T_J @ R_{thSA} = 85 K/W
25 °C	69.1 °C	86.8 °C	140.8 °C
65 °C	109.1 °C	126.8 °C	180.8 °C[1]
85 °C	129.1 °C	146.8 °C	200.8 °C[1]

1) Values exceed the maximum junction temperature of 150 °C. The transistor requires additional heat sink or a design with two transistors in parallel.

Table 5 $P_{tot\ (each\ transistor)}$ **= 551.3 mW; two power transistors in parallel**

T_A	T_J @ R_{thSA} = 20 K/W	T_J @ R_{thSA} = 36 K/W	T_J @ R_{thSA} = 85 K/W
25 °C	47.1 °C	55.9 °C	82.9 °C
65 °C	87.1 °C	95.9 °C	122.9 °C
85 °C	107.1 °C	115.9 °C	142.9 °C

1) Thermal resistance between soldering point and ambient

4.6 Using two BCX55-16

P_{tot}	=	1 W
I_{max}	=	1 A
R_{thJS}	=	20 K/W (SOT89)

Table 6 $P_{tot\ (each\ transistor)}$ = 551.3 mW; two power transistors in parallel

T_A	T_J @ R_{thSA} = 20 K/W	T_J @ R_{thSA} = 36 K/W	T_J @ R_{thSA} = 85 K/W
25 °C	47.1 °C	55.9 °C	82.9 °C
65 °C	87.1 °C	95.9 °C	122.9 °C
85 °C	107.1 °C	115.9 °C	142.9 °C

4.7 Using BC817SU

This is the most cost effective solution

Note: h_{FE} of the BC817SU degrades at 500 mA by using only one transistor

P_{tot}	=	1 W
I_{max}	=	0.5 A
R_{thJS}	=	50 K/W (SC74)

Table 7 $P_{tot\ (each\ transistor)}$ = 551.3 mW; two power transistors in parallel

T_A	T_J @ R_{thSA} = 20 K/W	T_J @ R_{thSA} = 36 K/W	T_J @ R_{thSA} = 85 K/W
25 °C	63.6 °C	72.4 °C	99.5 °C
65 °C	103.6 °C	112.4 °C	139.5 °C
85 °C	123.6 °C	132.4 °C	159.5 °C

5 Calculation of the maximum number N of stacked diodes with identical V_F in boost mode

1. Determine the supply voltage
2. Set the minimum V_{CE} of the booster transistor. BCX68-25 power transistor works well down to V_{CE} = 0.3 V if I_{CE} is below 1000 mA
3. Calculate the available voltage over the LEDs
   $V_{LED} = V_{supply} - V_{sense} - V_{CE} = V_{supply}$ - 0.15 V - 0.5 V (V_{CE} = 0.5 V with additional 0.2 V margin)
4. N = V_{LED} / V_F; it is recommended to round down the nearest integer value

Example:

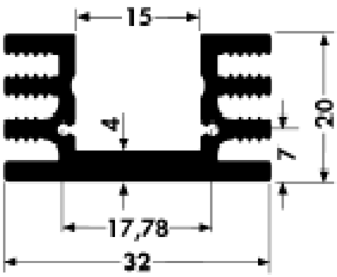
$V_{F\ max}$ = 4.3 V (OSRAM Platinum Dragon)

V_{supply} = 15 V → V_{LED} = 14.35 V

→ N = 14.35 V / 4.3 V ~ 3

6 Using a heat sink to decrease solder point temperature T_S of the LEDs and the booster transistor

If the MCPCB is connected with a heat sink using SK 76 profile, the solder point temperature T_S of the boost transistor would be decreased by 45 °C.



BCR450_Kühlkörper_SK 76.vsd

Figure 4 SK 76 Profile (all readings in mm); R_{th} = 8 K/W

V_S = 12 V

I_{LED} = 350 mA; V_F ~ 2.9 V

T_A = 25 °C

$R_{thJS\ Trans}$ = 20 K/W

$R_{thJS\ LED}$ = 11 K/W

SK 76 : 37.5 mm long (37.5 x 32 x 20mm) => R_{th}= 8 K/W

Table 8 Current MCPCB Board

	Booster Transistor	LED 1	LED 2	LED 3
T_S (°C)	119.0	100.0	101.0	99.5
P_{tot} (W)	1.11	1.00	1.02	0.99
T_J (°C)	141.1	111.0	112.2	110.4
R_{thSA} (K/W)	85.0	75.0	74.9	75.5

Table 9 Using MCPCB Board mounted on a SK 76 cooling element

	Booster Transistor	LED 1	LED 2	LED 3
T_S (°C)	74	61	58	60.5
P_{tot} (W)	1.11	1.05	1.06	1.03
T_J (°C)	96.1	72.6	69.7	71.8
R_{thSA} (K/W)	44.3	34.2	31.0	34.6

$\rightarrow T_{J\ max\ Trans} = 150\ °C$

$\rightarrow T_{J\ max\ Trans} - T_{J\ Trans\ on\ SK76} = 150\ °C - 96.1\ °C = 53.9\ °C$

The ambient temperature T_A could be increased by 53.9 °C (25 °C + 53.9 °C = 78.9 °C) until T_J exceeds 150 °C. This results in a T_J of the LEDs of 125 °C.

7 How to use the BCR450 in “stand alone” mode

--not supported according to the application board--

The application needs only one sense resistor for operation

Assuming again the worst case scenario

Using e.g. OSRAM - Advanced Power Top LED

Table 10 OSRAM Advanced Power Top Key technical data

Symbol	Min.	Typ.	Max.	Unit
V_F	2.9	3.6	4.1	V
I_F	30		250	mA
R_{thJS}		40		K/W
P_{tot}		650		mW

V_{Ftyp} = 3.6 V

I_{LED} = 70 mA

V_S = 12 V

2 LEDs stacked in series

V_{LED} = 2 x 3.6 V = 7.2 V ~ V_{out}

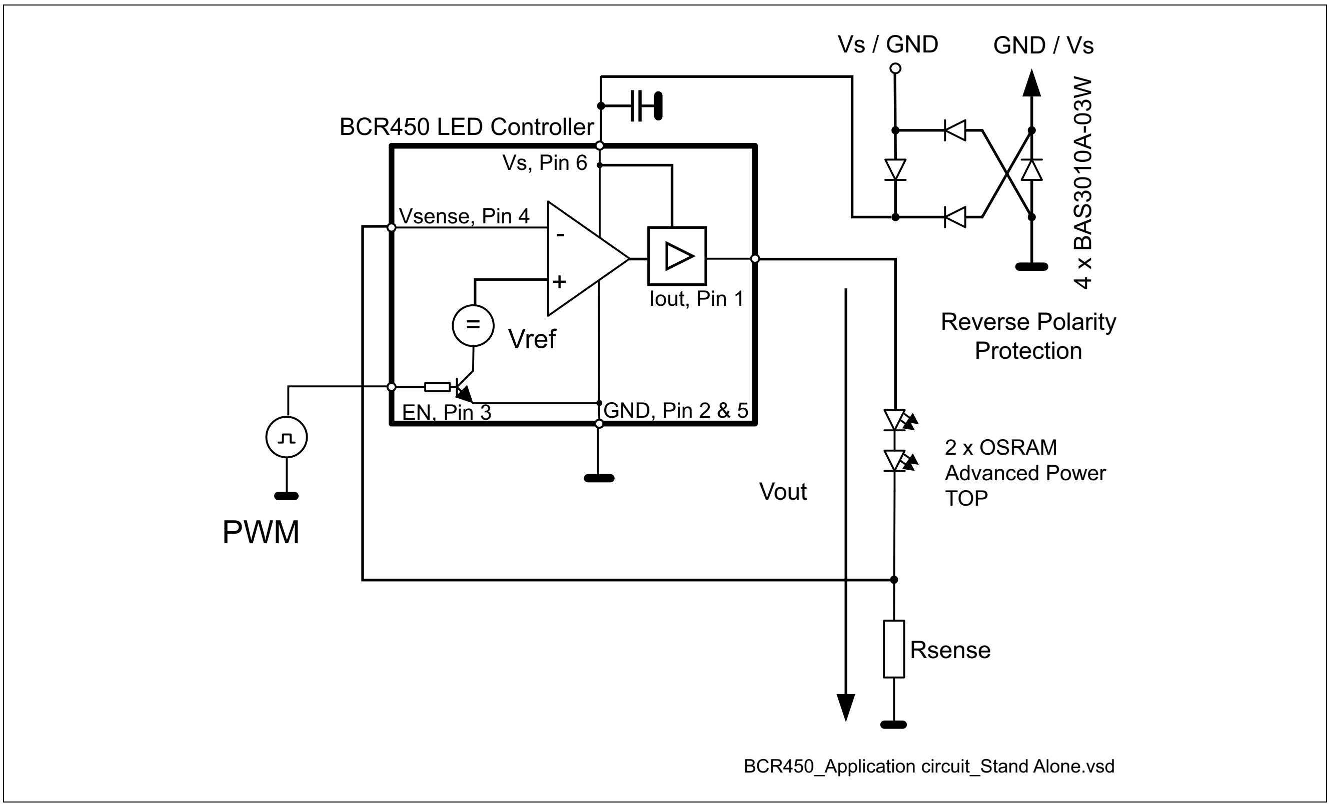
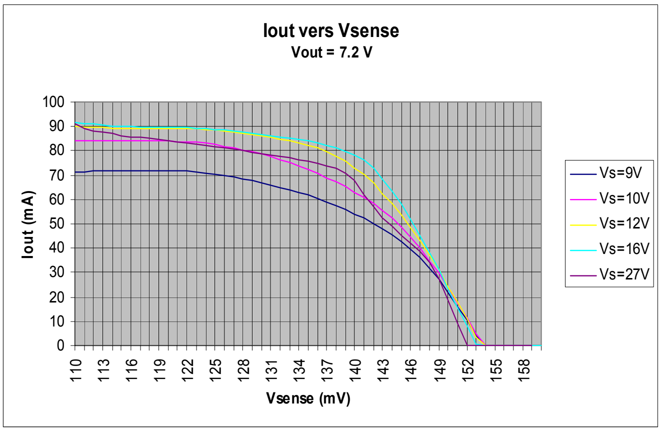


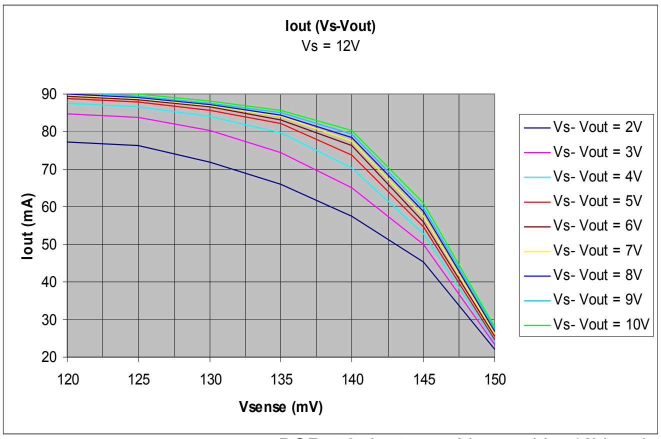
Figure 5 Application circuit BCR450 in “stand alone” mode

The curves below are specified at T_A = 25 °C



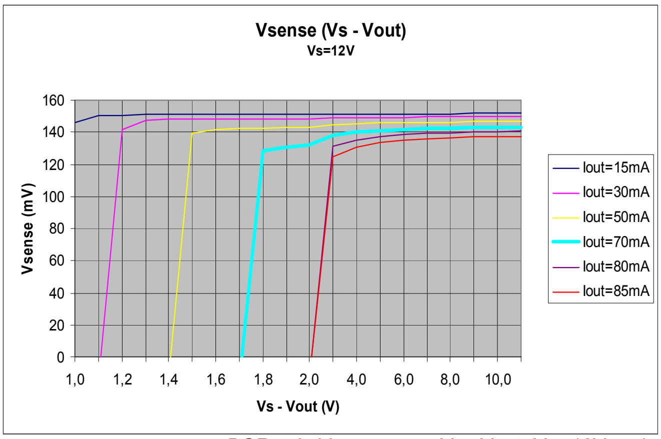
BCR450_Iout vers Vsense_Vout=7.2V.vsd

Figure 6 $I_{out}(V_{sense})$; V_{out}=7.2 V



BCR450_Iout vers Vsense_Vs=12V.vsd

Figure 7 $I_{out}(V_{Sense})$; V_S = 12 V



BCR450_Vsense vers Vs- Vout_Vs=12V.vsd

Figure 8 $V_{sense}(V_S\text{-}V_{out})$; V_S = 12 V

It must be pointed out that there are criteria a designer should be aware:

1. V_S - V_{out} should not fall below a certain value e.g. 70 mA: ~ 2.5 V (see **Figure 8**). If V_F tends to maximum specification value, enough overhead regarding supply voltage should be guaranteed
2. The minimum V_F of the LEDs results in increasing the power dissipation of the output stage transistor in the IC

For a stable linear regulation we use a Vsense which gives enough margin in order to the control range (see **Figure 6** and **Figure 7**)

Derived from **Figure 6**

V_S - V_{out} = 12 V - 7.2 V = 4.8 V

Results in V_{sense} = 141 mV @ 70 mA (yellow curve)

$\rightarrow R_{sense} = V_{sense} / I_{LED} \sim 2\ \Omega$

7.1 Worst case scenario regarding power dissipation

Refer to **Figure 9**

$V_{Trans} = V_S - 2 \times V_{Fmin} - V_{sense}$ = 12 V - 5.8 V - 0.141 V = 6.06 V

P_{tot} = 6.06 V x 70 mA = 424 mW

R_{thSA} = 20 K/W (assuming the R_{thSA} of an imaginary MCPCB Application Board)

R_{thJS} = 75 K/W (BCR450 - Thermal resistance - Junction to Solder Point)

$T_J = T_A + P_{tot} \times (R_{thSA} + R_{thJS}) = T_A$ + 40.28 K

Table 11 T_J (T_A)

T_A (°C)	T_J (°C)
25	65.3
65	105.3
85	125.3
105	145.3

8 General aspects regarding Overhead Voltage for a given Output current I_{out}

$V_{overhead} = V_{Trans} + V_{sense} = V_S - V_{LED}$

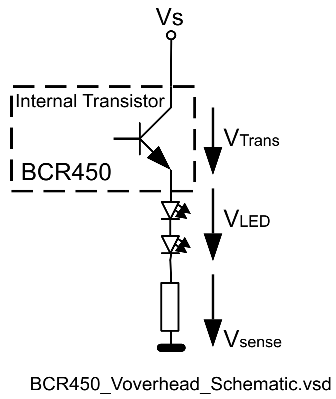


Figure 9 $V_{overhead}$ **principle**

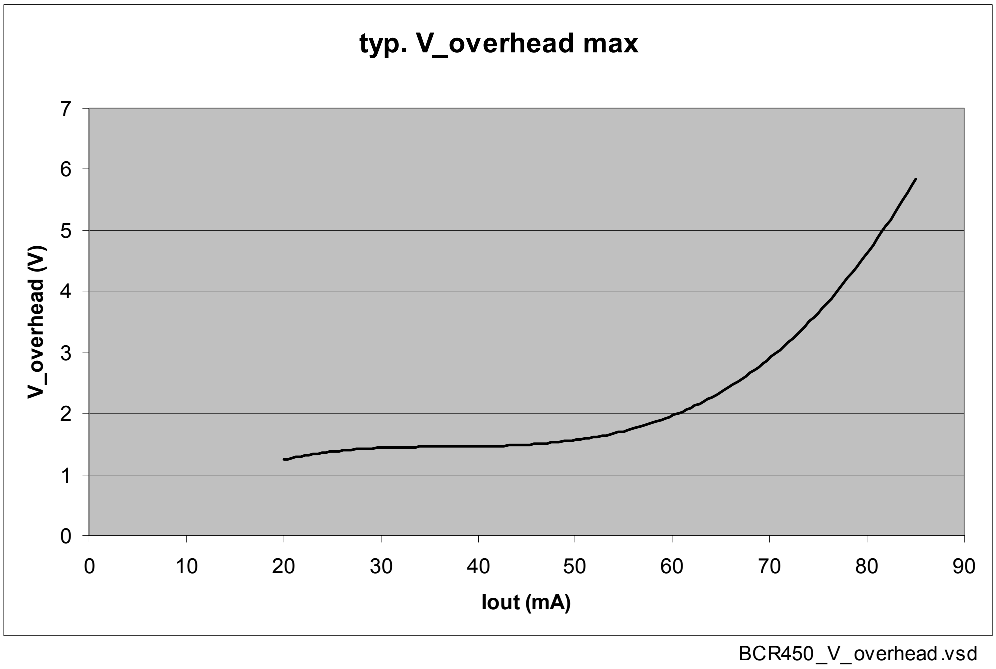


Figure 10 $V_{overhead}$ **(**I_{out}**)**

For a wanted output current I_{out} of 70 mA one needs approx. 3 V overhead, while V_{sense} operates in a range of > 130 mV

e.g. 3 diodes with a V_F of 3 V and 12 V supply voltage

$\rightarrow$ 3 xV_F + $V_{overhead}$ = 9 V + 3 V = 12 V

9 Calculate PWM frequency and duty cycle

To determine the maximum PWM frequency or a certain PWM duty cycle the knowledge of the rise and fall- times of the BCR450 is necessary

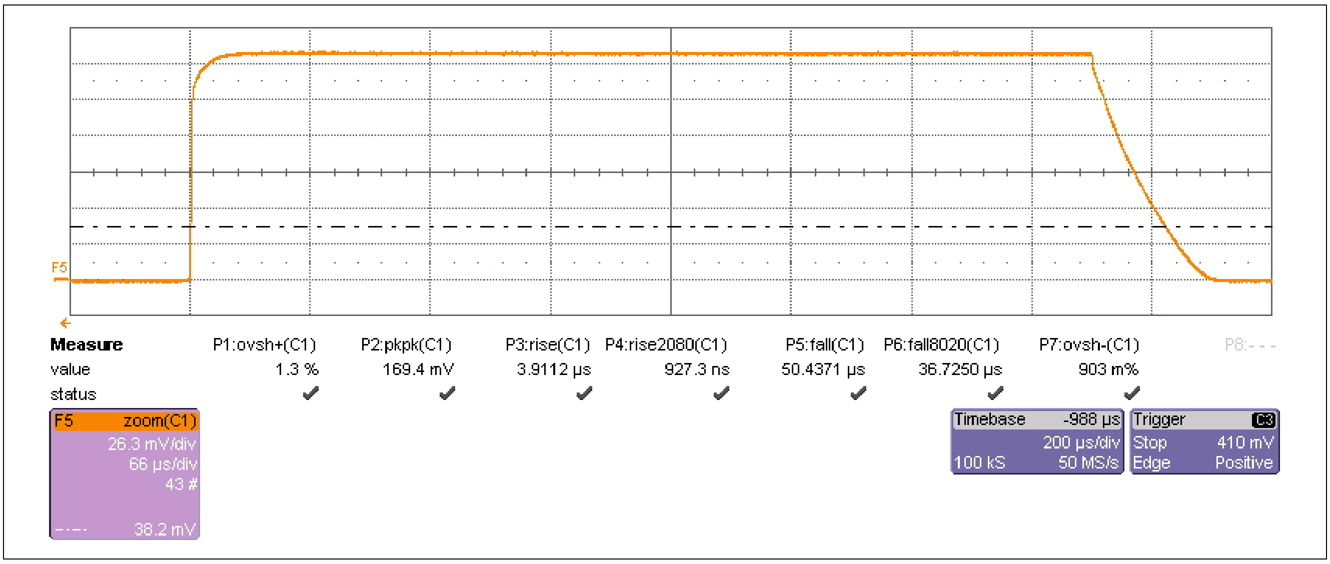


Figure 11 Response Time

T_{on} (10-90%)	4 µs	Maximum value does not exceed 10 µs
T_{off} (90-10%)	50.5 µs	Maximum value: 70 µs

For the calculation the maximum value of T_{on} of 10 µs should be used

$(T_{on} / T_{off}) * 100 = t_{duty}$ in %

$T = (T_{on} + T_{off}) = (T_{on} + T_{on} / t_{duty}) = T_{on} (1 + 100 / t_{duty\ (\%)})$

$F_{PWM} = 1 / T$

Maximum frequency according to 1 % duty cycle

$F_{PWMmax} = 1 / (10\ \mu s\ (1 + 100/1)) = 990$ Hz

Maximum duty cycle for a given PWM frequency

e.g. $F_{PWM} = 2$ KHz

$t_{dutymax}(\%) = 100 / ((1 / (F_{PWM} \times T_{on}) - 1))$

$t_{dutymax}(\%) = 100 / ((1 / (2\ KHz \times 10\ \mu s) - 1))$

$\rightarrow t_{dutymax} = 2.04$ %

Example of PWM- Dimming in boost mode

V_S = 12 V
I_{LED} = 353 mA (100% t_{duty})
F_{PWM} = 300 Hz

Table 12 Dimming Range of 2300 : 1

t_{duty} (%)	I_{LED} (mA)
1	0.15
5	17
10	34
20	68
30	108
40	144
50	180
60	214
70	250
80	286
90	320
95	340
100	353

10 Measurement setup for the boost mode

In order to set up and evaluate the BCR450, the following components and equipment are needed:

- A sense resistor (typically 0.1 Ω to 0.5 Ω depending on the wanted LED current).
  – See **Table 13**
- A power transistor (the type depends on the LED current and the maximum power dissipation, see **Table 3**)
- LED load
- 8 V to 27 V supply
- Enable or PWM- signal
- Digital voltmeter (DVM)

Table 13 Sense Resistor Selection

I_{LED} (mA)	R_{sense} (Ω)
100	1.5
150	1
350	0.43
500	0.3
700	0.21

11 Schematic and Layout

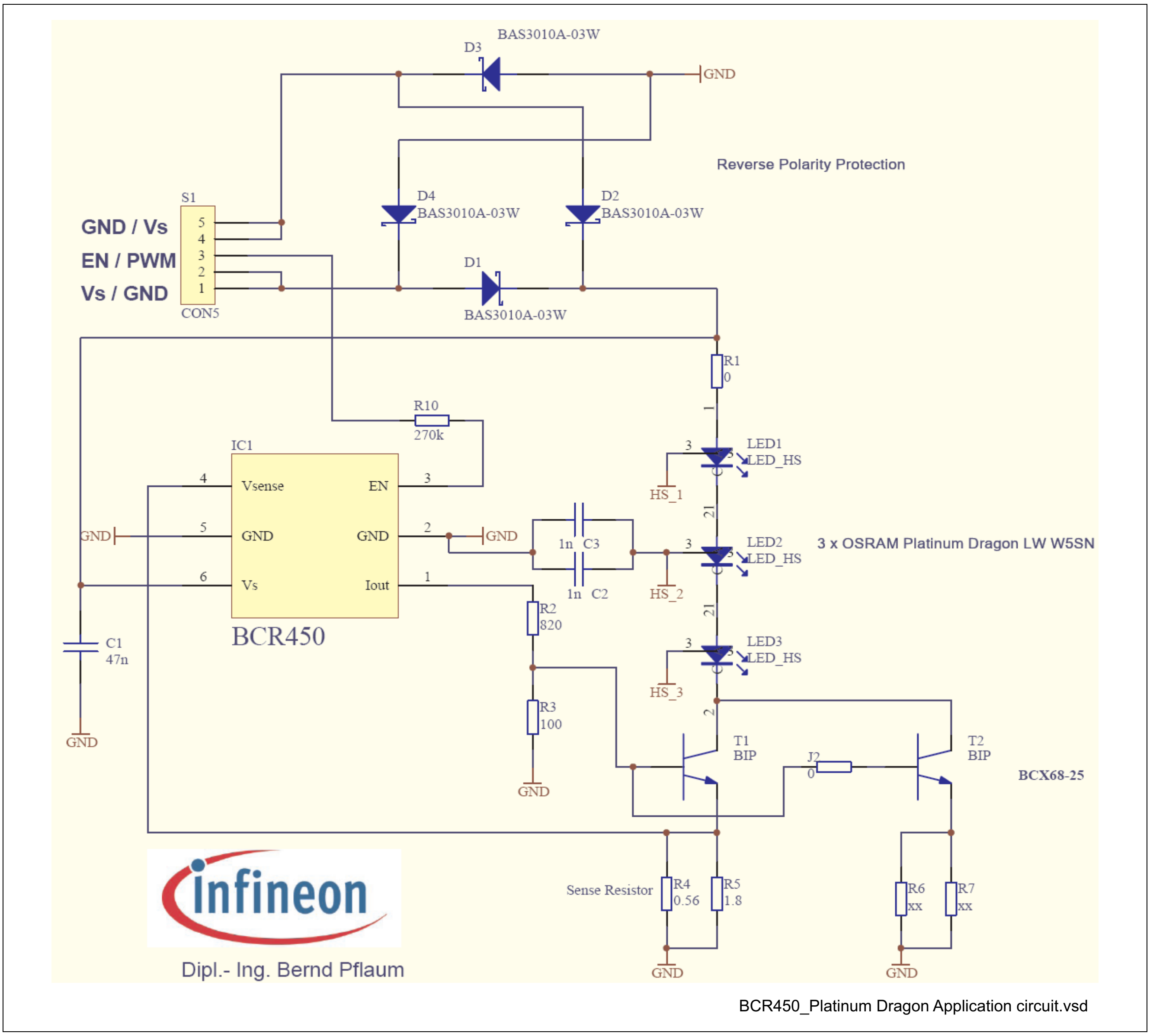
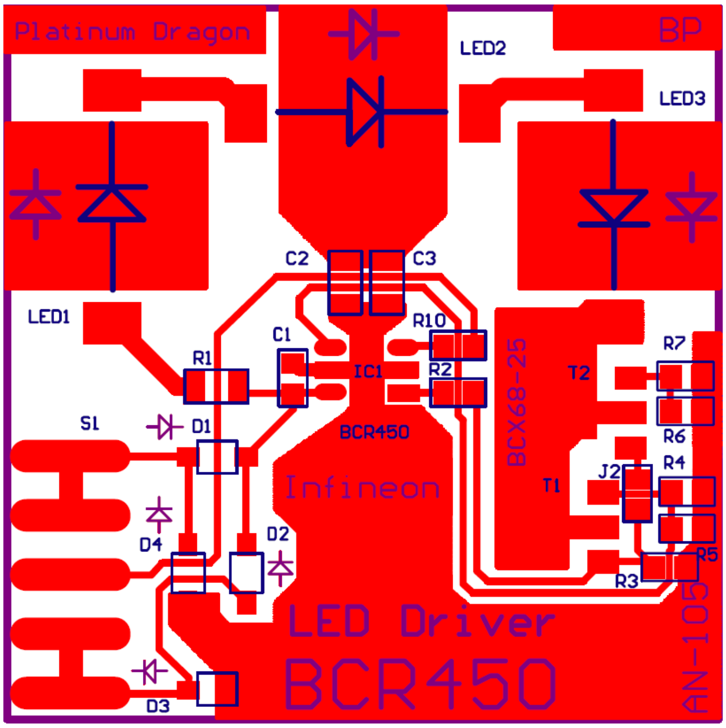
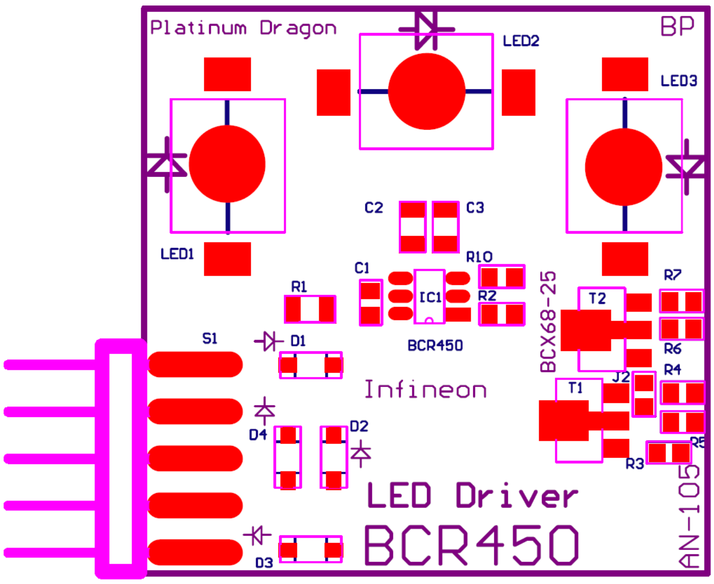


Figure 12 Board Schematic of High Power LED Application with OSRAM Platinum Dragon



BCR450_Platinum Dragon Application_Layout.vsd

Figure 13 Layout



BCR450_Platinum Dragon Application_Assembly.vsd

Figure 14 Component Placement Specification

Table 14 Assembly List

Name	Value	Package	Function
J2	0 Ω	0603	
R1	0 Ω	0805	
R2	820 Ω	0603	
R3	100 Ω	0603	
R4[1)]	0.56 Ω	0805	Set LED current
R5[1)]	1.8 Ω	0603	Set LED current
R6		0603	Only necessary by using a second booster transistor
R7		0603	Only necessary by using a second booster transistor
R10	270 kΩ	0603	
C1	47 nF	0603	
C2	1 nF	0805	For heat sink purposes, optional
C3	1 nF	0805	For heat sink purposes, optional
D1	BAS3010A-03W	SOD323	
D2	BAS3010A-03W	SOD323	Only used in case of RPP circuit
D3	BAS3010A-03W	SOD323	Only used in case of RPP circuit
D4	BAS3010A-03W	SOD323	Only used in case of RPP circuit
IC1	BCR450	TSOP6 / SC74	LED controller
T1	BCX68-25	SOT89	Booster Transistor
T2	BCX68-25	SOT89	Not used in the application board
S1	CON5	EDGE_CON_TOP	DC plug
LED1	LW W5SN	Platinum Dragon	1W LED, white
LED2	LW W5SN	Platinum Dragon	1W LED, white
LED3	LW W5SN	Platinum Dragon	1W LED, white

1) Value is valid only by using one boost transistor

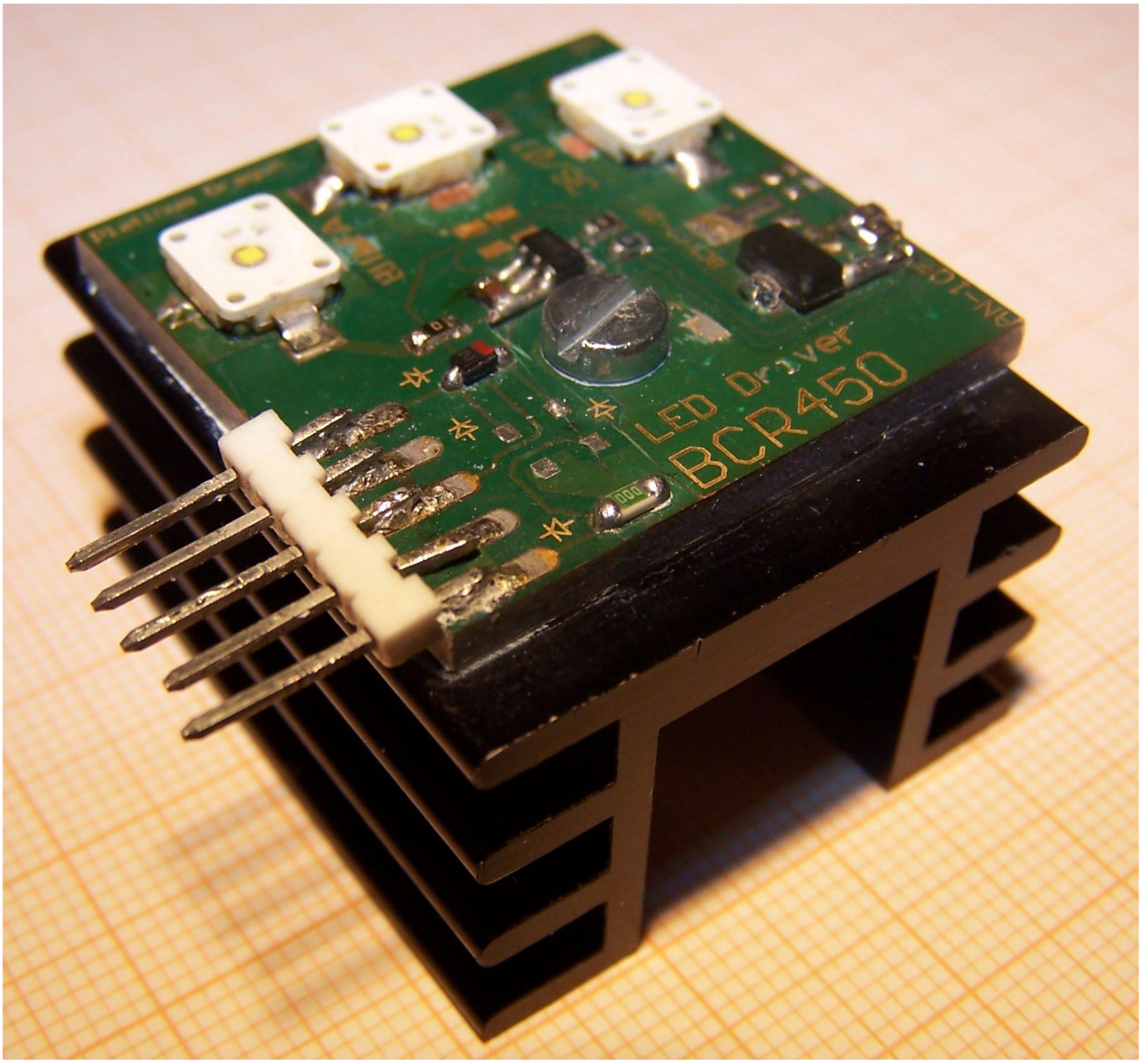


Figure 15 Photograph of the Application of BCR450 with OSRAM Platinum Dragon LEDs and additional cooling element SK 76

12 Package Outline

The BCR450 is assembled in a TSOP6 or SC74 Package

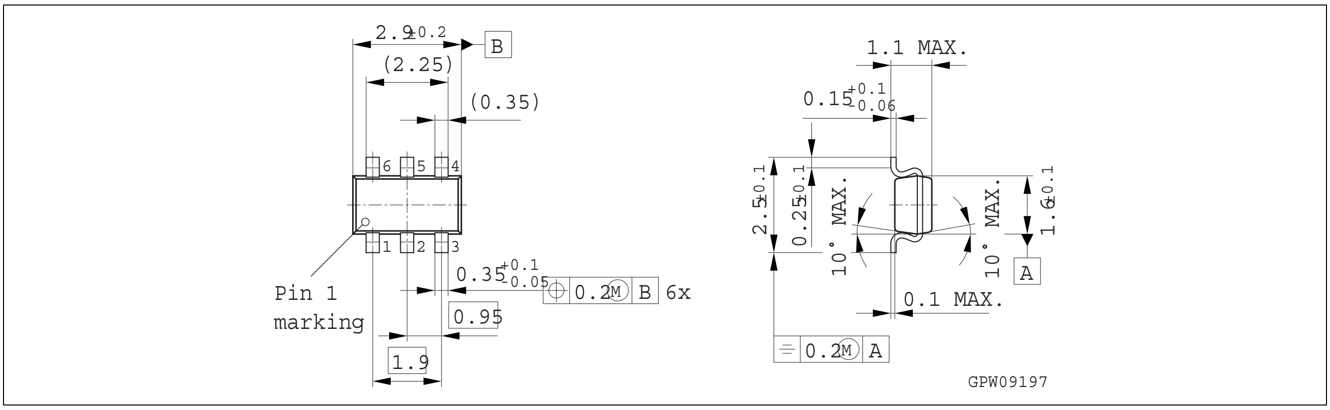


Figure 16 Package Outline SC74

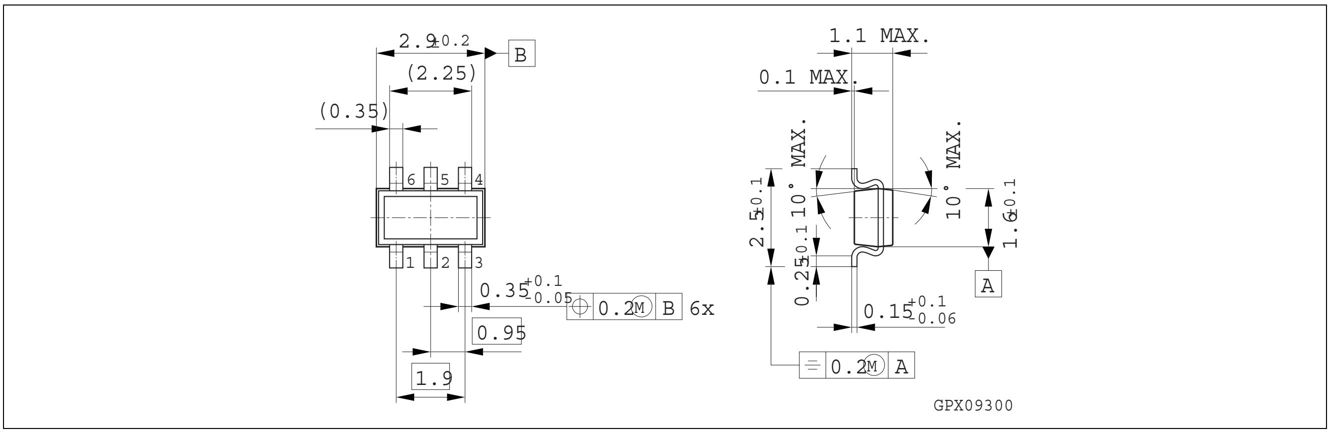


Figure 17 Package Outline TSOP6