Adjustable LED Driver   TLE 4242 G
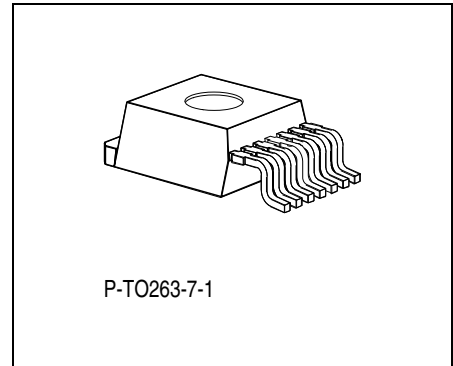
Features

- Adjustable constant current up to 500 mA ($\pm$5%)
- Wide input voltage range up to 42 V
- Low drop voltage
- Open load detection
- Overtemperature protection
- Short circuit proof
- Reverse polarity proof
- Wide temperature range: -40 °C to 150 °C

P-TO263-7-1

Functional Description

The TLE 4242 G is an integrated adjustable constant current source driving loads up to 500 mA. The output current level can be adjusted via an external resistor. The IC is designed to supply high power LEDs (e.g. Osram Dragon LA W57B) under the severe conditions of automotive applications resulting in constant brightness and extended LED lifetime. It is provided in the surface mounted P-TO263-7-1 package. Protection circuits prevent damage to the device in case of overload, short circuit, reverse polarity and overheat. The connected LEDs are protected against reverse polarity as well as excess voltages up to 45 V.

The integrated PWM input of the TLE 4242 G permits LED brightness regulation by pulse width modulation. Due to the high input impedance of the PWM input the LED driver can be operated as a protected high side switch.

| Type	Ordering Code	Package
TLE 4242 G	Q67006-A9674	P-TO263-7-1

Circuit Description
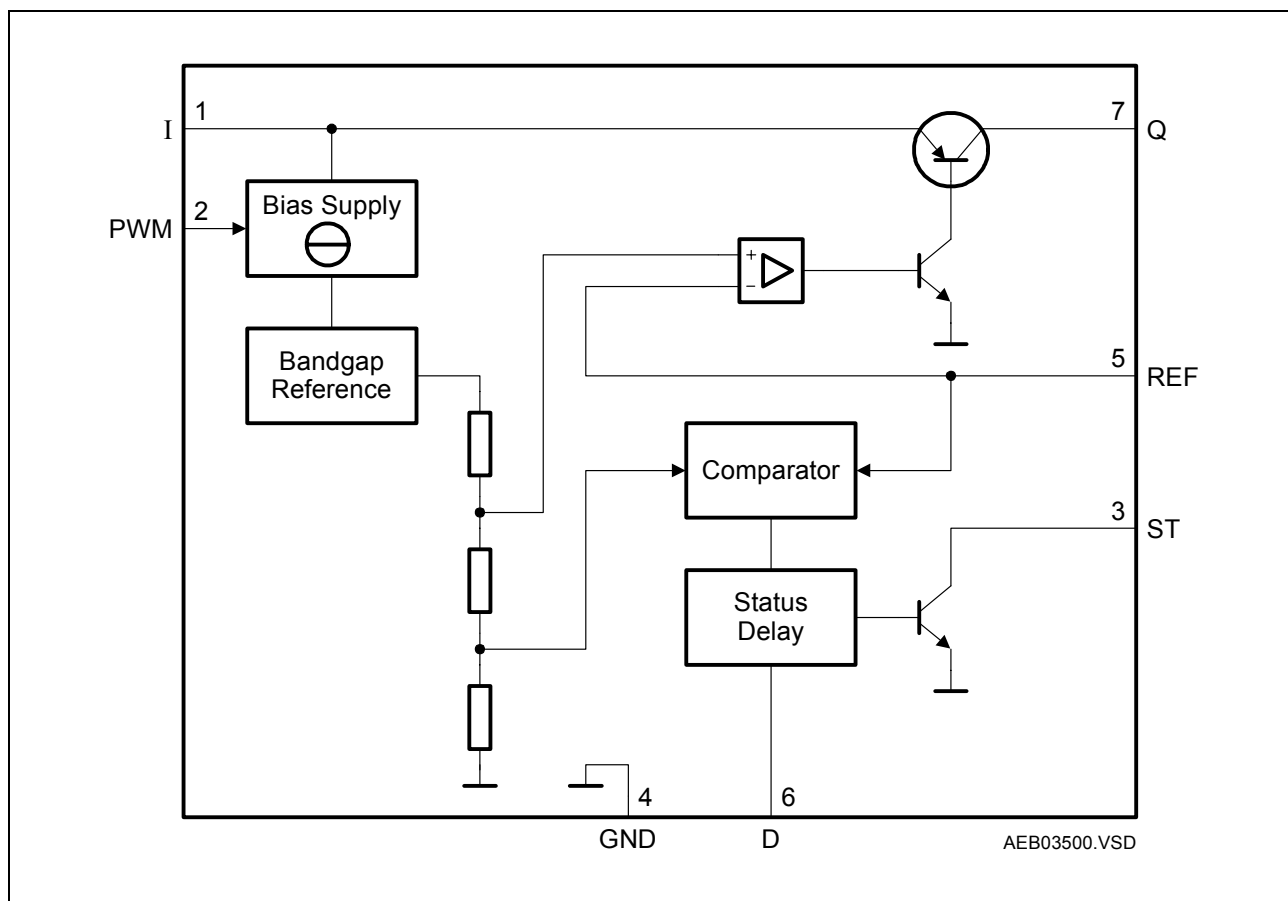
Figure 1   Block Diagram

An external shunt resistor in the ground path of the connected LEDs is used to sense the LED current. A regulation loop helds the voltage drop at the shunt resistor on a constant level of typ. 177 mV. Selecting the shunt resistance permits to adjust the appropriate constant current level. The typ. output current calculates

$$I_{Q, typ} = \frac{V_{REF}}{R_{REF}} \tag{1}$$

where V_{REF} is the reference voltage with a typical level of 177 mV (see **Page 10**). The equation applies in a range of $0.39\ \Omega \le R_{REF} \le 1.8\ \Omega$.

The output current is shown as a function of the reference resistance on **Page 10**. With the PWM input the LED brightness can be regulated via duty cycle. Also PWM = L sets the TLE 4242 in sleep mode resulting in a very low current consumption of << 1 μA typ. Due to the high impedance of the PWM input (see **"PWM Pin Input Current versus PWM Voltage" on Page 11**) the PWM pin can thus also be used as an enable input.
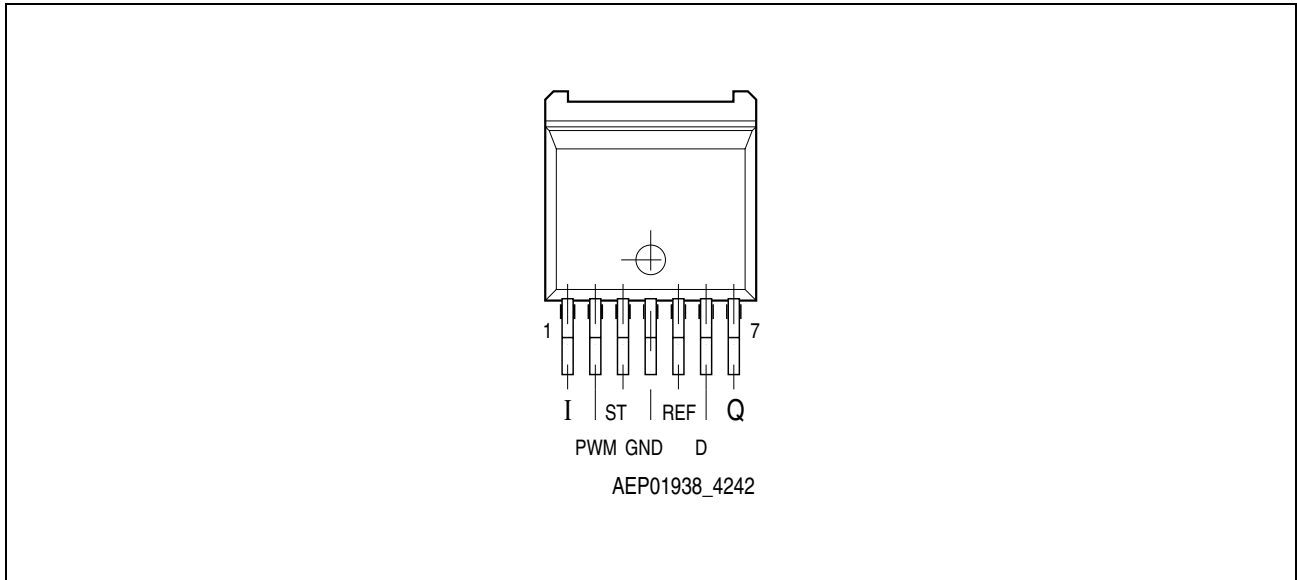
Figure 2 **Pin Configuration** (top view)

Table 1 **Pin Definitions and Functions**

| Pin No.	Symbol	Function
1	I	**Input;** block to GND directly at the IC with a 100 nF ceramic capacitor.
2	PWM	**Pulse Width Modulation Input;** if not needed connect to I
3	ST	**Status Output;** open collector output, connect to external pull-up resistor ($R_{\text{pull-up}} \geq 4.7\ k\Omega$).
4	GND	**Ground**
5	REF	**Reference Input;** connect to shunt resistor.
6	D	**Status Delay;** connect to GND via an optional capacitor to set status reaction delay. Leave open if no ST delay is needed.
7	Q	**Output**

Application Information
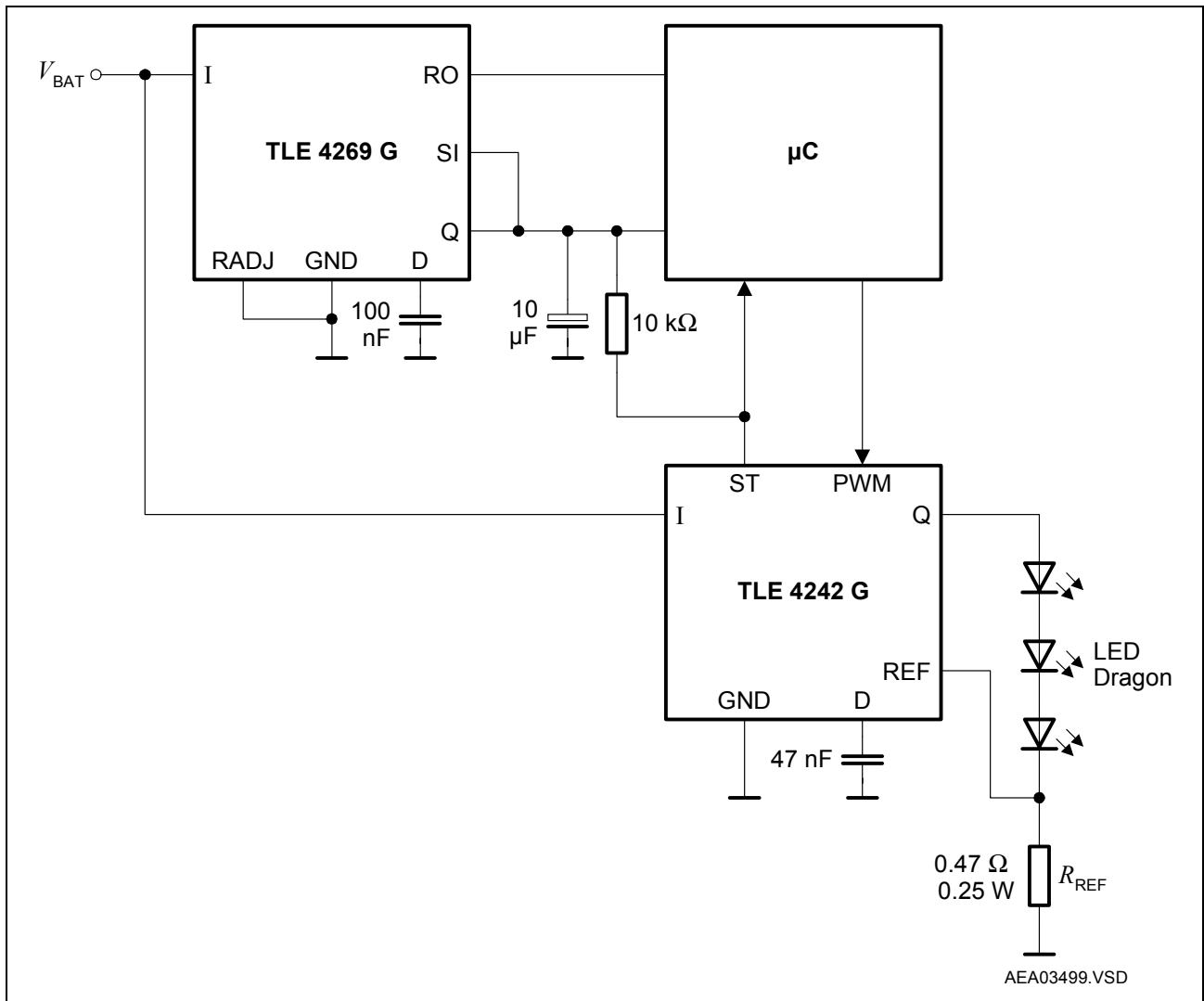
Figure 3   Application Circuit

Figure 3 shows a typical application with the TLE 4242 G LED driver. The 3 LEDs are driven with an adequate supply current adjusted by the resistor R_{REF}. Thus brightness variations due to forward voltage spread of the LEDs are prevented. The luminosity spread arising from the LED production process can be compensated via software by an appropriate duty cycle applied to the PWM pin. Hence selection of the LEDs to forward voltage as well as to luminosity classes can be spared. The minimum supply voltage calculates as the sum of the LED forward voltages, the TLE 4242 G drop voltage (max. 0.7 V at a LED current of 300 mA) and the max. voltage drop at the shunt resistor R_{REF} of max. 185 mV.

The status output of the LED driver (ST) detects an open load condition enabling to supervise correct LED function. A LED failure is detected if the voltage drop at the shunt resistor R_{REF} falls below typ. 25 mV. In this case the status output pin ST is set low after a delay time adjustable via an optional capacitor connected to the pin D.

The functionality of the ST and PWM as well as their timings are shown in **Figure 4**. The Status delay can be adjusted via the capacitor connected to the timing Pin D. The delay time scales in linear way with the capacitance C_D:

$$t_{STHL,typ} = \frac{C_D}{47 \text{ nF}} \times 10 \text{ ms} \qquad t_{STLH,typ} = \frac{C_D}{47 \text{ nF}} \times 10 \text{ μs} \tag{2}$$
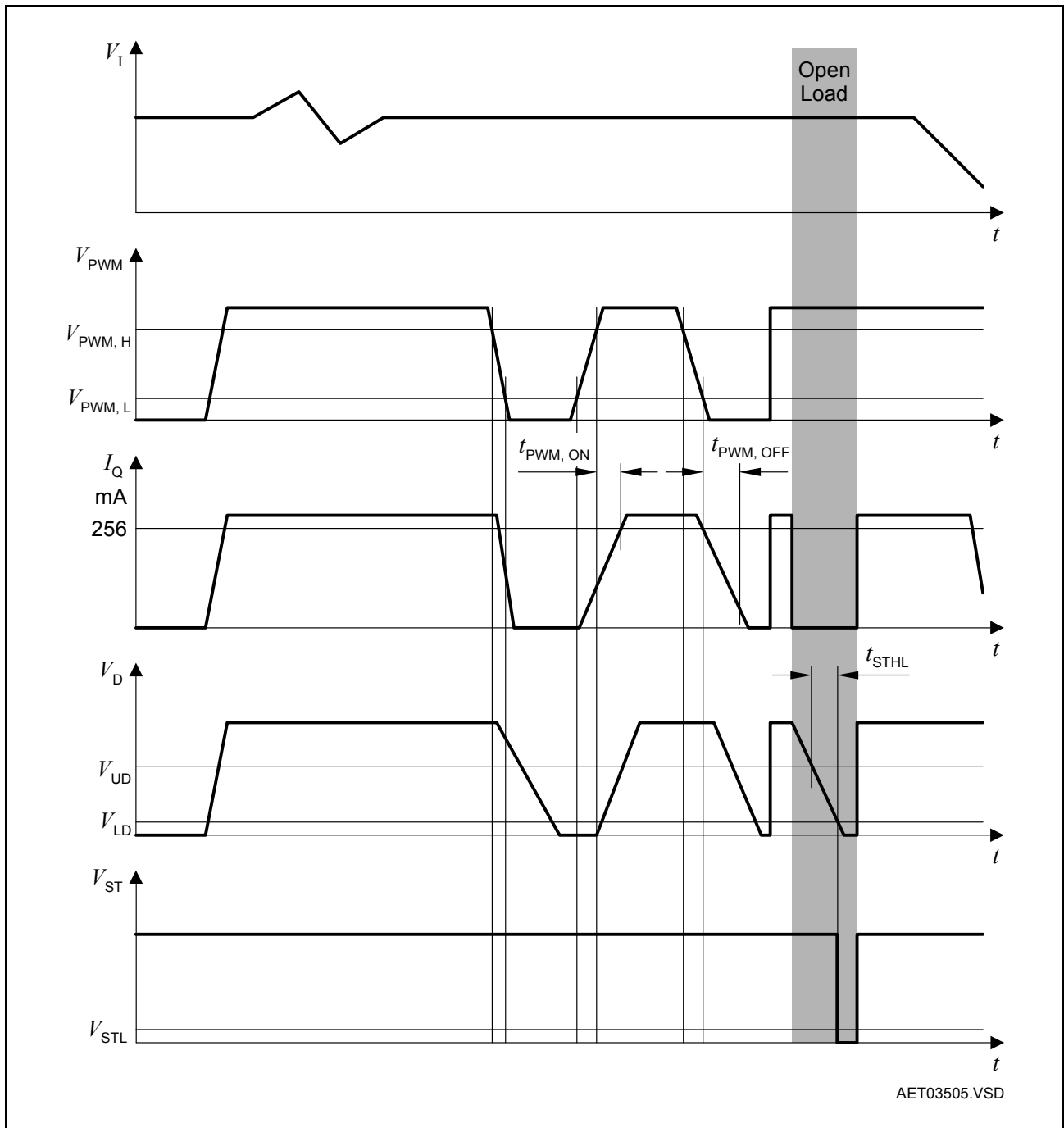
Figure 4   Function and Timing Diagram

Table 2   Absolute Maximum Ratings

-40 °C < T_j < 150 °C

Parameter	Symbol	Limit Values		Unit	Remarks
		Min.	Max.		
Input					
Voltage	V_I	-42	45	V	–
Current	I_I	–	–	mA	internally limited
Output					
Voltage	V_Q	-1	40	V	–
Current	I_Q	–	–	mA	internally limited
Status Output					
Voltage	V_{ST}	-0.3	40	V	–
Current	I_{ST}	-5	5	mA	–
Status Delay					
Voltage	V_D	-0.3	7	V	–
Reference Input					
Voltage	V_{REF}	-1	16	V	–
Current	I_{REF}	-2	2	mA	–
Pulse Width Modulation Input					
Voltage	V_{PWM}	-40	40	V	–
Current	–	-1	1	mA	–
Temperatures					
Junction temperature	T_j	-40	150	°C	–
Storage temperature	T_{stg}	-50	150	°C	–
Thermal Resistances					
Junction ambient	R_{thja}	–	78	K/W	Footprint only[1]
		–	52	K/W	300mm^2 heat sink area
		–	39	K/W	600mm^2 heat sink area
Junction case	R_{thjc}	–	3	K/W	–

1) Worst case regarding peak temperature; mounted on PCB FR4, $80 \times 80 \times 1.5$ mm^3, 35 µm Cu.

Note: Maximum ratings are absolute ratings; exceeding any one of these values may cause irreversible damage to the integrated circuit.

Table 3   Operating Range

Parameter	Symbol	Limit Values		Unit	Remarks
		Min.	**Max.**		
Input voltage	V_I	4.5	42	V	–
Status output voltage	V_ST	–	16	V	–
Status Delay capacitance	C_D	0	2.2	µF	–
PWM voltage	V_PWM	0	40	V	–
Junction temperature	T_j	-40	150	°C	–
Reference resistor	R_REF	0	1.8	Ω	–

Table 4　Electrical Characteristics

$V_I = 13.5$ V; $R_{REF} = 0.47$ Ω; $V_{PWM} \geq V_{PWM,H}$; -40 °C < T_j < 150 °C; all voltages with respect to ground; positive current defined flowing into pin; unless otherwise specified

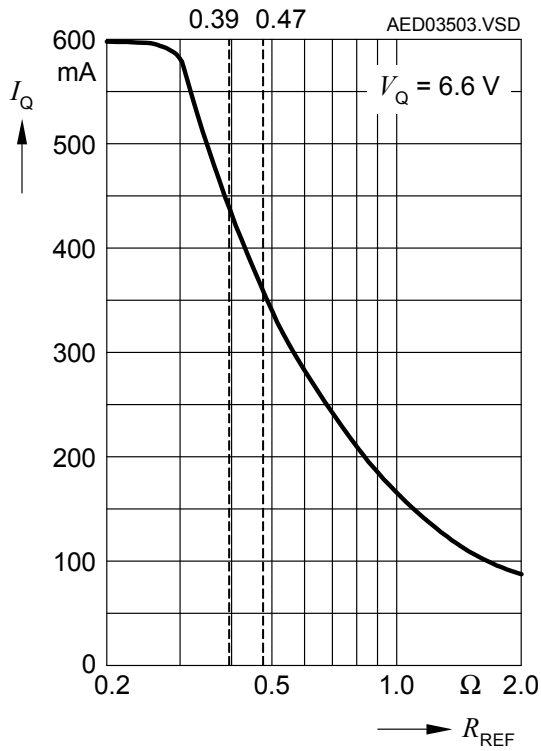| Parameter	Symbol	Limit Values			Unit	Test Condition
		Min.	Typ.	Max.		
Current consumption off mode	I_{qOFF}	–	0.1	2	µA	PWM = L, T_j < 85 °C
Current consumption	I_{qL}	–	12	22	mA	$V_Q = 6.6$ V
Output						
Output current	I_Q	357	376	395	mA	V_Q - V_{REF}[1] = 6.6 V
		168	177	185	mA	V_Q - V_{REF} = 6.6 V; $R_{REF} = 1.0$ Ω
		431	454	476	mA	V_Q - V_{REF} = 6.6 V; $R_{REF} = 0.39$ Ω
		357	376	395	mA	5.4 V ≤ V_Q - V_{REF} ≤ 7.8 V; 9 V ≤ V_I ≤ 16 V
Output current limit	I_{Qmax}	–	600	–	mA	$R_{REF} = 0$ Ω
Drop voltage	V_{dr}	–	0.35	0.7	V	$I_Q = 300$ mA
PWM Input						
PWM high level	$V_{PWM,H}$	2.6	–	–	V	–
PWM low level	$V_{PWM,L}$	–	–	0.7	V	–
PWM input current high level	$I_{PWM,H}$	–	220	500	µA	$V_{PWM} = 5.0$ V
PWM input current low level	$I_{PWM,L}$	-1	–	1	µA	$V_{PWM} = 0.0$ V
Turn on delay time	$t_{PWM,ON}$	0	15	40	µs	70% of I_{Qnom}, see **Figure 4**
Turn off delay time	$t_{PWM,OFF}$	0	15	40	µs	30% of I_{Qnom}, see **Figure 4**

Table 4   Electrical Characteristics (cont'd)

$V_I = 13.5$ V; $R_{REF} = 0.47\ \Omega$; $V_{PWM} \geq V_{PWM,H}$; -40 °C < T_j < 150 °C; all voltages with respect to ground; positive current defined flowing into pin; unless otherwise specified

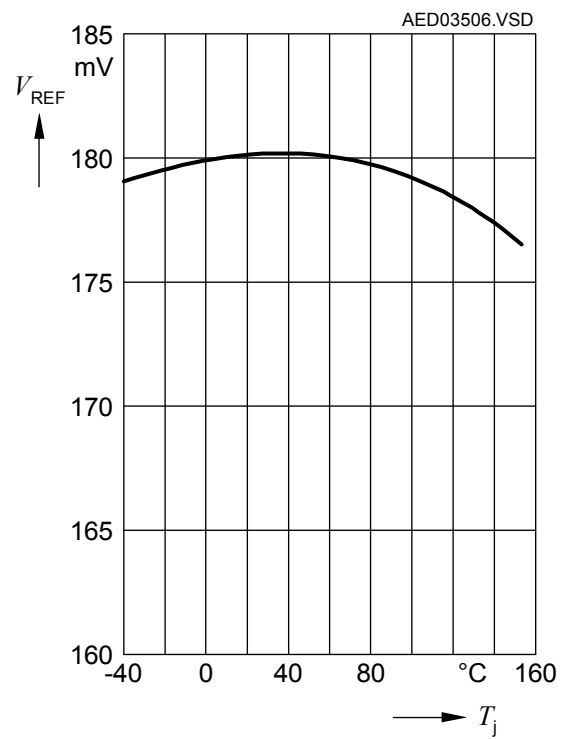| Parameter	Symbol	Limit Values			Unit	Test Condition
		Min.	Typ.	Max.		
Reference						
Reference Voltage	V_{REF}	168	177	185	mV	$0.39 < R_{REF} < 1.0\ \Omega$
Reference Input Current	I_{REF}	-1	0.1	1	µA	$V_{REF} = 180$ mV
Status Output						
Lower status switching threshold	V_{IQL}	15	25	–	mV	ST = L
Upper status switching threshold	V_{IQH}	–	30	40	mV	ST = H
Status low voltage	V_{STL}	–	–	0.4	V	$I_{ST} = 1.5$ mA
Leakage current	I_{STLK}	–	–	5	µA	$V_{ST} = 5.0$ V
Status Delay						
Status reaction delay	t_{STHL}	6	10	14	ms	$C_D = 47$ nF, ST H → L
Status release delay	t_{STLH}	–	10	20	µs	$C_D = 47$ nF, ST L → H

1) V_Q - V_{REF} equals the forward voltage sum of the connected LEDs, see **Figure 3**.
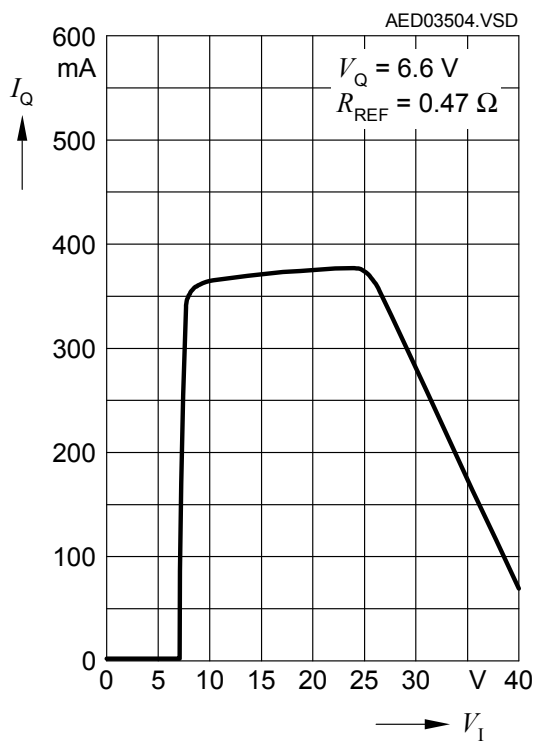
Typical Performance Characteristics
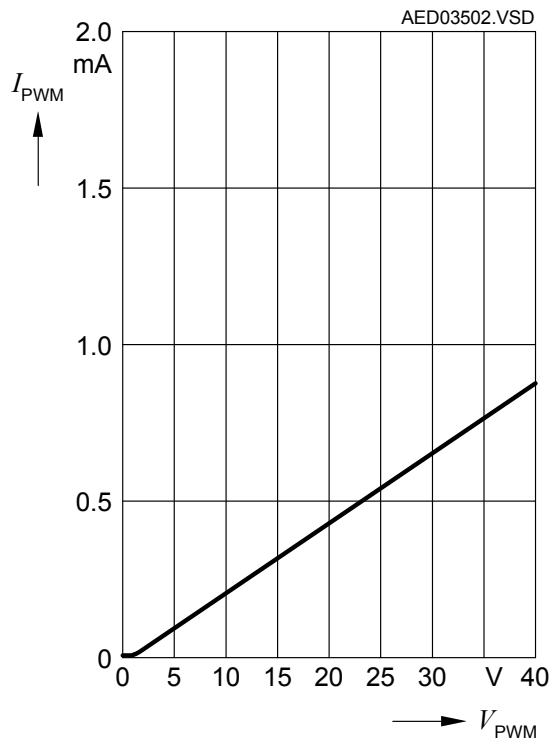
Output Current versus External Resistor

AED03503.VSD

$V_Q = 6.6$ V

(y-axis: I_Q / mA: 0, 100, 200, 300, 400, 500, 600)
(x-axis: R_{REF} / Ω: 0.2, 0.5, 1.0, 2.0; dashed lines at 0.39, 0.47)

Reference Voltage versus Junction Temperature

AED03506.VSD

(y-axis: V_{REF} / mV: 160, 165, 170, 175, 180, 185)
(x-axis: T_j / °C: -40, 0, 40, 80, 160)

Output Current versus Supply Voltage

AED03504.VSD

$V_Q = 6.6$ V
$R_{REF} = 0.47$ Ω

(y-axis: I_Q / mA: 0, 100, 200, 300, 400, 500, 600)
(x-axis: V_I / V: 0, 5, 10, 15, 20, 25, 30, 40)

PWM Pin Input Current versus PWM Voltage

PWM Pin Input Current versus PWM Voltage
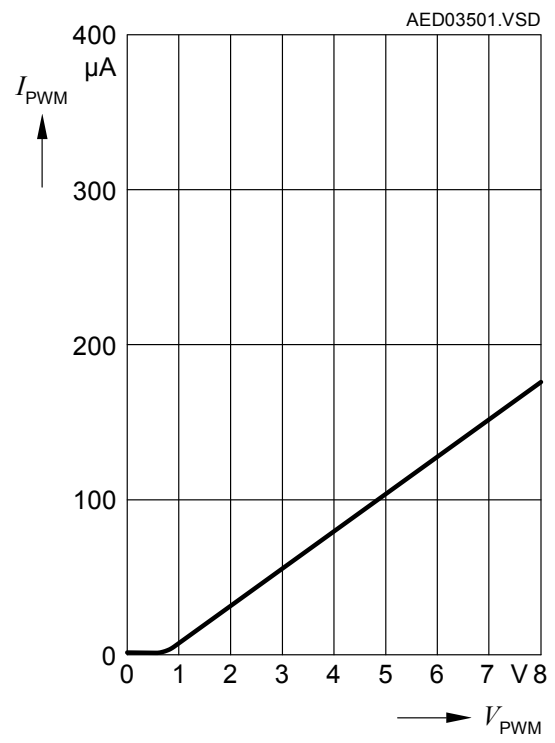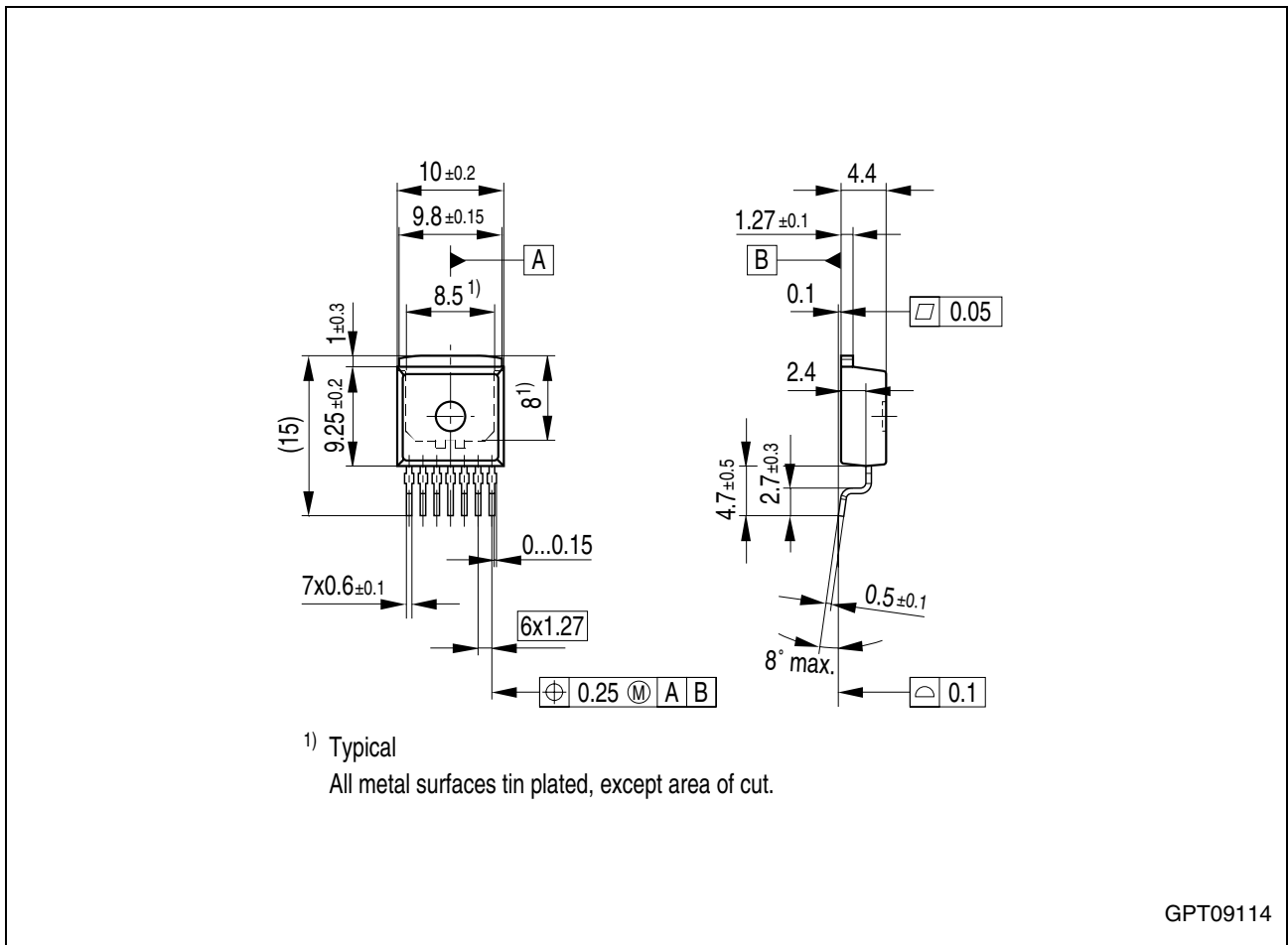
Package Outlines

Figure 5   **P-TO263-7-1** (Plastic Transistor Single Outline)

You can find all of our packages, sorts of packing and others in our Infineon Internet Page "Products": **http://www.infineon.com/products**.

SMD = Surface Mounted Device

Dimensions in mm

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