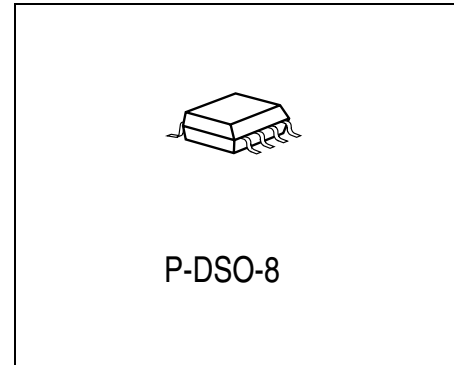# LED Driver with Adjustable Current

TLE 4241 GM

Target Data

Features

- Adjustable constant output current
- Wide input voltage range
- Low drop voltage
- Open load detection
- Overtemperature protection
- Short circuit proof
- Reverse polarity proof
- Wide temperature range : $- 40\ °C < T_j < 150\ °C$
- Very small SMD-Package

P-DSO-8

Type	Ordering Code	Package
▼ TLE 4241 GM	Q67006-A9644	P-DSO-8-9 (SMD)

▼ New type

Functional Description

The **TLE 4241 GM** is an integrated adjustable constant current source. It provides an output current adjustable via different means (SET, PWM, reference resistor) which is kept nearly independent from load and supply voltage changes. The IC is designed to supply LEDs under the severe conditions of automotive applications resulting in constant brightness and extended LED lifetime. It is provided in the very small P-DSO-8-9 (Micro 8) package. Protection circuits prevent damage to the device in case of overload, short circuit, reverse polarity and overtemperature. The connected LEDs are protected against reverse polarity as well as excess voltages up to 45 V. A status output allows handling of open load and short circuit at the main output.

A PWM input offers the possibility to adjust the LED brightness by pulse width modulation.

With an implemented high/low current switch the output current level can be reduced e.g. for brake/tail light application.

The implemented features such as adjustable output current, the high/low current switch and the provided PWM input make the device well suited for a broad range of LED and other applications.

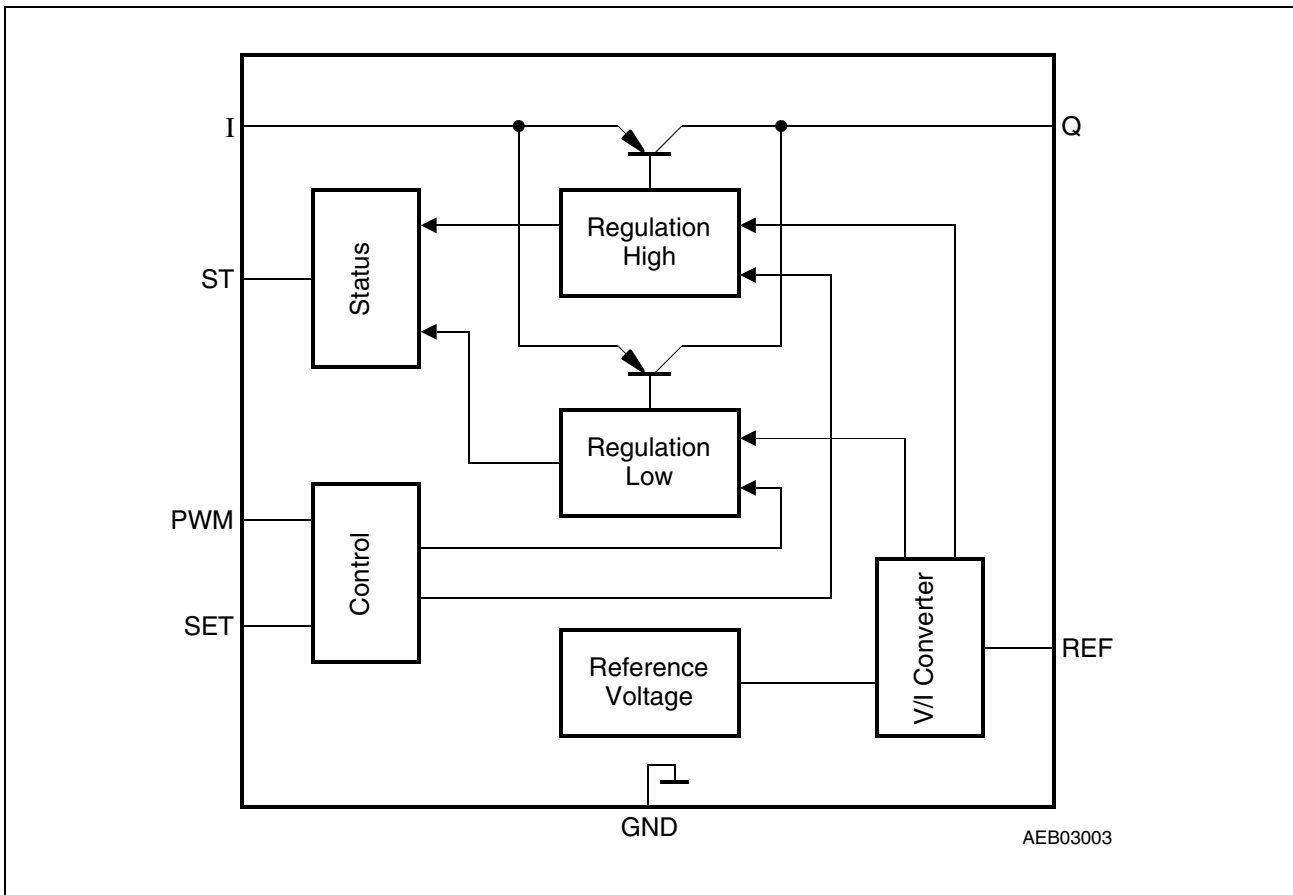## Circuit Description

Figure 1   Block Diagram

An internal reference voltage of typ. 1.20V supplies the REF pin which is connected to GND via an external resistor. In the SET=H mode the reference current flowing on the REF pin is mirrored with an amplification to form the desired output current. The typ. output current in the SET=H mode calculates

$$I_{Q,\,typ}/mA \;=\; \frac{1.20}{R_{REF}/k\Omega} \times 487 + 0.1.$$

The output current is shown as a function of the reference resistance on page 10 for the high as well as for the low current mode.

With the PWM input the LED brightness can be regulated via duty cycle. Also PWM=L sets the TLE 4241 in sleep mode resulting in a very low current consumption of << 1µA typ. Due to the high impedance of the PWM input (see Fig. I_{PWM} versus V_{PWM} on page 12) the PWM pin can thus also be used as an Enable input.
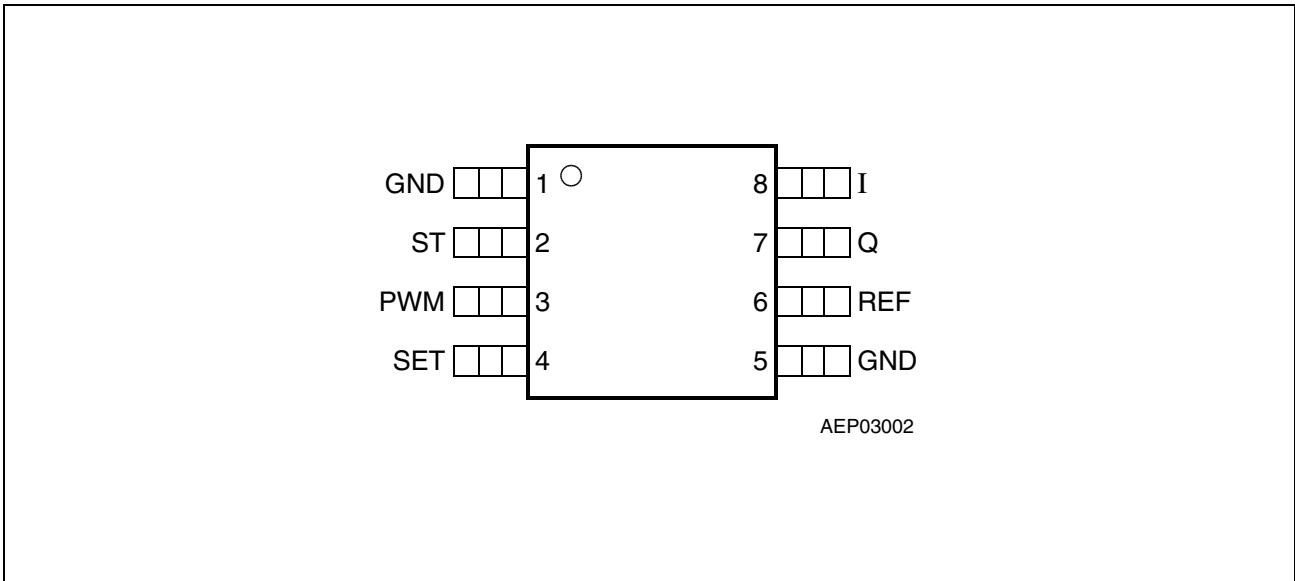
Figure 2   Pin Configuration (top view)

Pin Definitions and Functions

| Pin No.	Symbol	Function
1	GND	**Ground**; internally connected to pin 5
2	ST	**Status Output**; open collector output, connect to external pull up resistor (10 kΩ or higher).
3	PWM	**Pulse Width Modulation Input**; if not needed connect to V_I
4	SET	**High/Low Current Input**; choice of current level
5	GND	**Ground**; internally connected to pin 1
6	REF	**Reference Input**; connect to GND via an external resistor to adjust the output current
7	Q	**Output**
8	I	**Input**; block to GND directly at the IC with a 100 nF ceramic capacitor.

Application Information
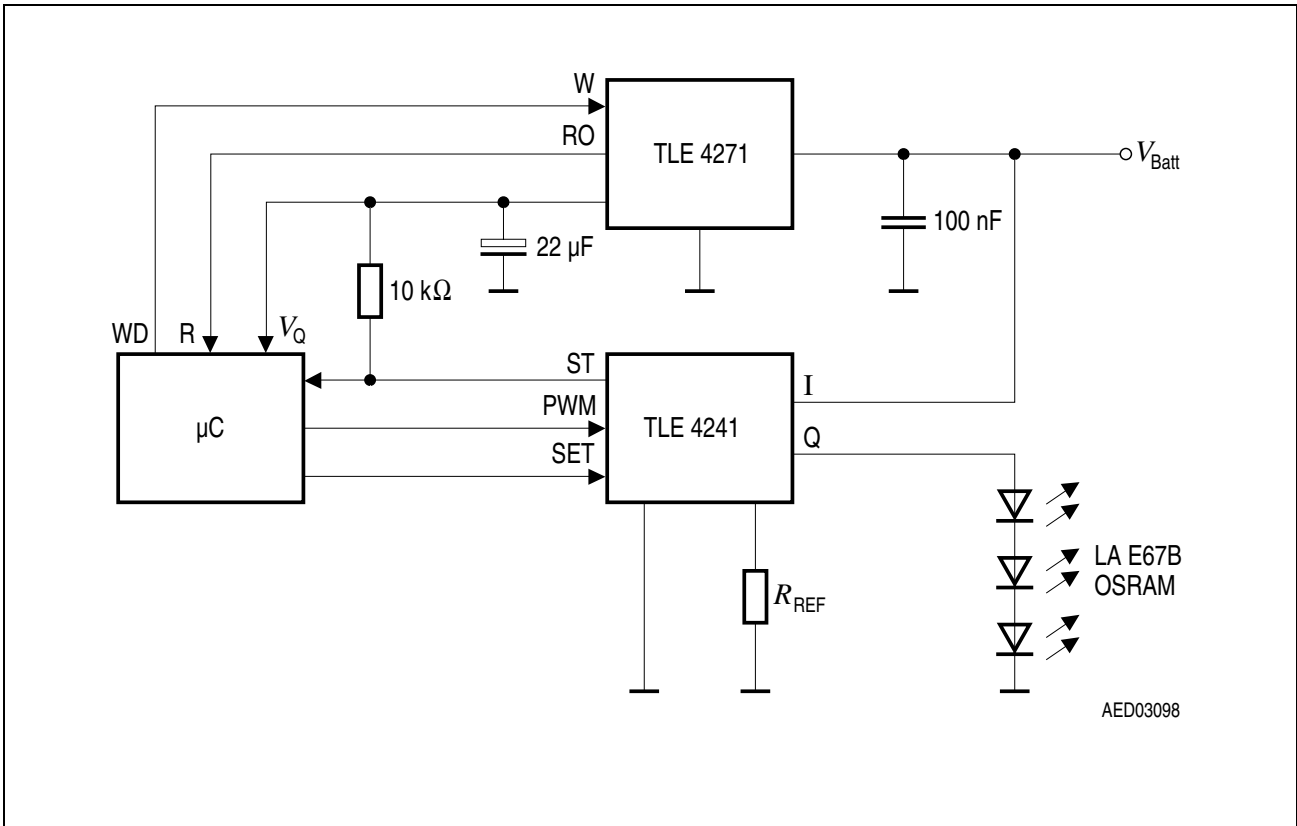
Figure 3   Application Circuit

Fig. 3 shows a typical application with the TLE 4241GM 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 slightly negative temperature coefficient of the TLE 4241GM output current protects the LEDs against overtemperature stress if the IC is placed nearby the LEDs. The status output of the LED driver (ST) detects an open load condition enabling to supervise correct LED function.

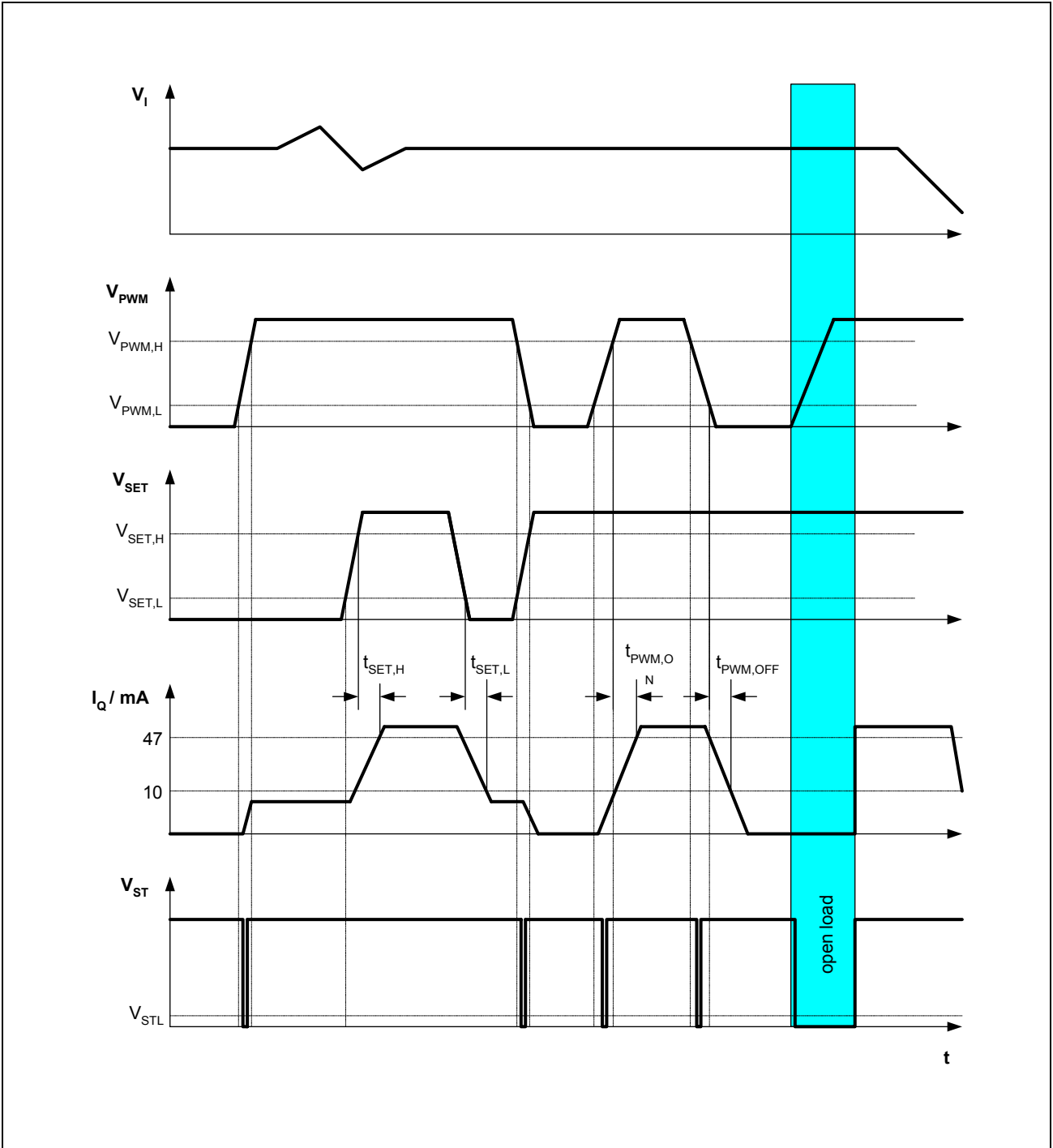The functionality of the ST, SET and PWM as well as their timings are shown in Fig. 4.

Figure 4   Function and Timing Diagram

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	internally limited
Reference Input					
Voltage	V_{REF}	-0.3	7	V	–
Current	I_{REF}	-2	2	mA	–
Pulse Width Modulation Input					
Voltage	V_{PWM}	-40	40	V	–
Current	–	-1	1	mA	–
High/Low Current Input					
Voltage	V_{SET}	-40	40	V	–
Current	I_{SET}	-1	1	mA	–
Temperatures					
Junction temperature	T_j	-40	150	°C	–
Storage temperature	T_{stg}	-50	150	°C	–

Absolute Maximum Ratings (cont'd)

$-40\,°C < T_{j} < 150\,°C$

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		

Thermal Resistances

Junction ambient	R_{thja}	–	105	K/W	–[1]

[1] Worst case regarding peak temperature; mounted on PCB $80 \times 80 \times 1.5$ mm^3, 35 μm Cu, 300 mm^2 heat sink area.

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

Operating Range

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
Input voltage	V_{I}	4	45	V	–
Status output voltage	V_{ST}	–	16	V	–
SET voltage	V_{SET}	0	40	V	–
PWM voltage	V_{PWM}	0	40	V	–
Junction temperature	T_{j}	– 40	150	°C	–
Reference Resistor	R_{REF}	7	100	kΩ	SET=H
		4.7	18	kΩ	SET=L

Electrical Characteristics

$9\text{ V} \leq V_I \leq 16\text{ V}$; $R_{REF} = 10\text{ k}\Omega$; $V_{PWM} \geq V_{PWM,H}$; $-40\text{ °C} < T_j < 150\text{ °C}$; 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}	–	5	10	mA	SET = L; V_Q = 6 V
Current consumption	I_{qH}	–	6	10	mA	SET = H; V_Q = 6 V
Current consumption open load	$I_{qL,O}$	–	–	10	mA	SET = L; V_Q open
Current consumption open load	$I_{qH,O}$	–	–	10	mA	SET = H; V_Q open

Output

Parameter	Symbol	min.	typ.	max.	Unit	Test Condition
Output current	I_Q	6.7	8.4	10	mA	SET = L, V_Q=6V
		–	8.6	–	mA	SET = L, V_Q=4V
Output current	I_Q	47	58.5	70	mA	SET = H, V_Q=6V
		–	60.0	–	mA	SET = H, V_Q=4V
Current Ratio	I_{QH}/I_{QL}	6	7	8		
Output current limit	I_{Qmax}	–	83	–	mA	SET = L; $R_{REF} = 0\ \Omega$
Output current limit	I_{Qmax}	–	83	–	mA	SET = H; $R_{REF} = 0\ \Omega$
Drop voltage	V_{dr}	–	0.2	0.5	V	SET = L; I_Q = 80% of $I_{Q,nom,L}$
Drop voltage	V_{dr}	–	0.3	0.5	V	SET = H; I_Q = 80% of $I_{Q,nom,H}$

PWM Input

Parameter	Symbol	min.	typ.	max.	Unit	Test Condition
PWM high level	$V_{PWM,H}$	2.0	–	–	V	–
PWM low level	$V_{PWM,L}$	–	–	0.5	V	–
PWM input current high level	$I_{PWM,H}$	–	220	500	µA	V_{PWM} = 5.0 V

Electrical Characteristics (cont'd)

$9 \text{ V} \leq V_I \leq 16 \text{ V}$; $R_{REF} = 10 \text{ k}\Omega$; $V_{PWM} \geq V_{PWM,H}$; $-40 \text{ °C} < T_j < 150 \text{ °C}$; 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.		
PWM input current low level	$I_{PWM,L}$	-10	–	10	µA	$V_{PWM} = 0.0 \text{ V}$
Turn on delay time	$t_{PWM,ON}$	0	5	30	µs	20%/80% I_Q, see Fig. 4
Turn off delay time	$t_{PWM,OFF}$	0	10	30	µs	20%/80% I_Q, see Fig. 4

SET Input

Parameter	Symbol	Limit Values			Unit	Test Condition
SET high level	$V_{SET,H}$	2.0	–	–	V	–
SET low level	$V_{SET,L}$	–	–	0.5	V	–
SET input current high level	$I_{SET,H}$	–	220	500	µA	$V_{SET} = 5.0 \text{ V}$
SET input current low level	$I_{SET,L}$	-10	–	10	µA	$V_{SET} = 0.0 \text{ V}$
Delay time L -> H	$t_{SET,H}$	–	–	30	µs	20%/80% I_Q, see Fig. 4
Delay time H -> L	$t_{SET,L}$	–	–	30	µs	20%/80% I_Q, see Fig. 4

Status Output

Parameter	Symbol	Limit Values			Unit	Test Condition
Lower status switching threshold	$V_{dr,LL}$	0.15	–	–	V	SET = L; ST = L
Upper status switching threshold	$V_{dr,LH}$	–	–	0.7	V	SET = L; ST = H
Lower status switching threshold	$V_{dr,HL}$	0.15	–	–	V	SET = H; ST = L
Upper status switching threshold	$V_{dr,HH}$	–	–	0.7	V	SET = H; ST = H
Status low voltage	V_{STL}	–	–	0.4	V	$I_{ST} = 1.0 \text{ mA}$
Leakage current	I_{STLK}	–	–	10	µA	$V_{ST} = 5.0 \text{ V}$

Typical Performance Characteristics

Output Current versus External Resistor, SET=H
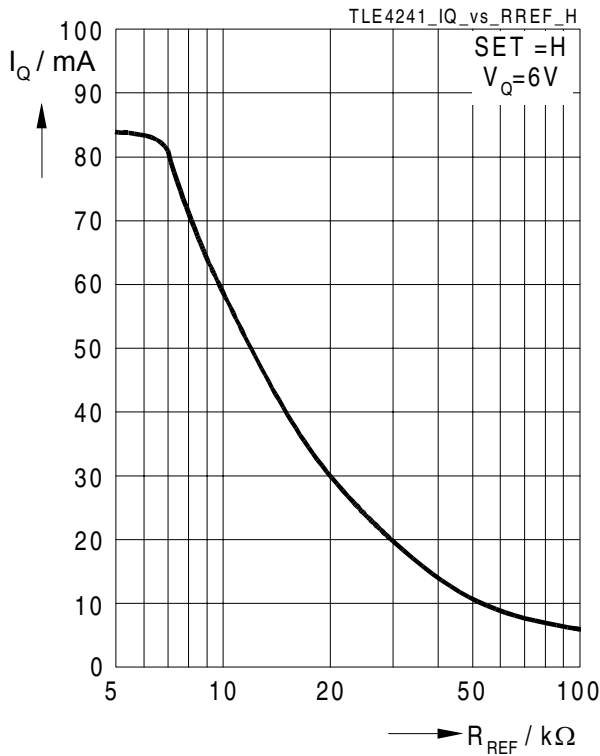
Output Current versus External Resistor, SET=L
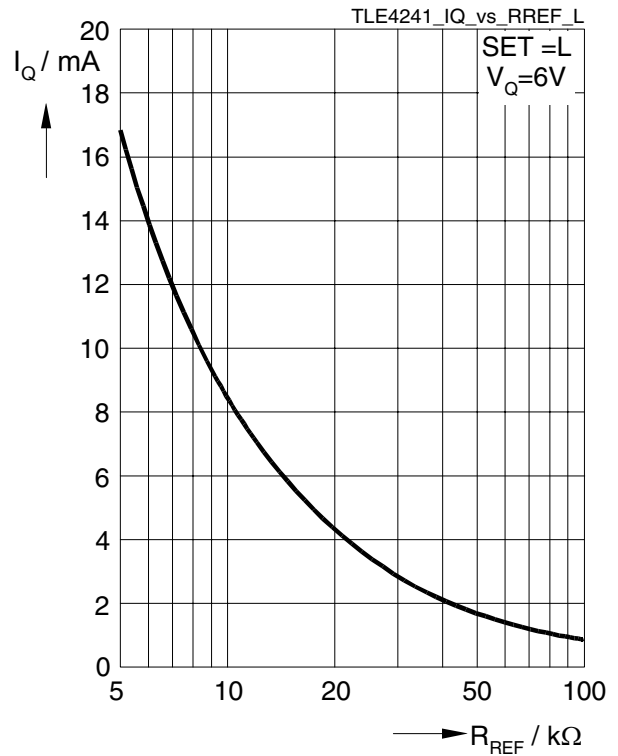
Output Current versus Supply Voltage, SET=H,
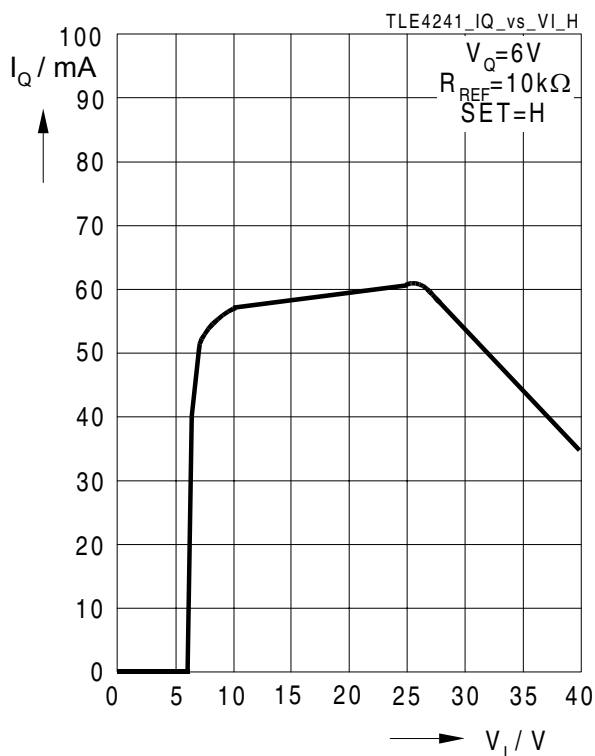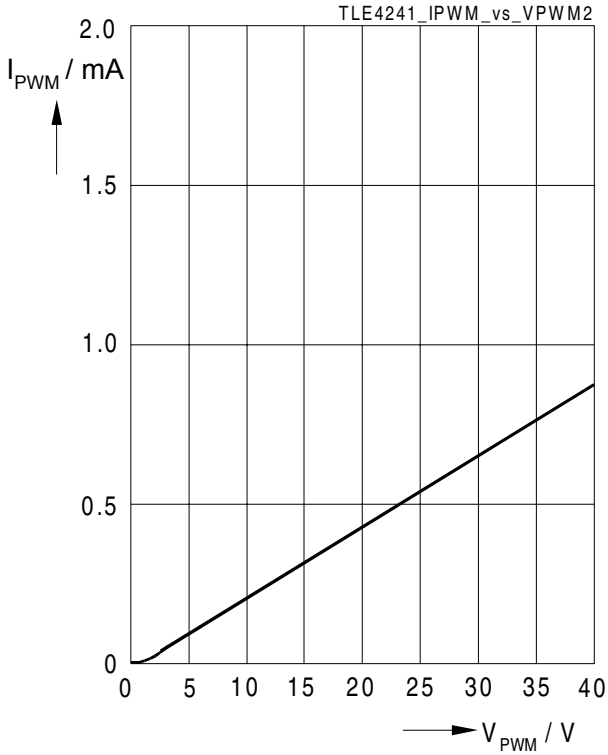

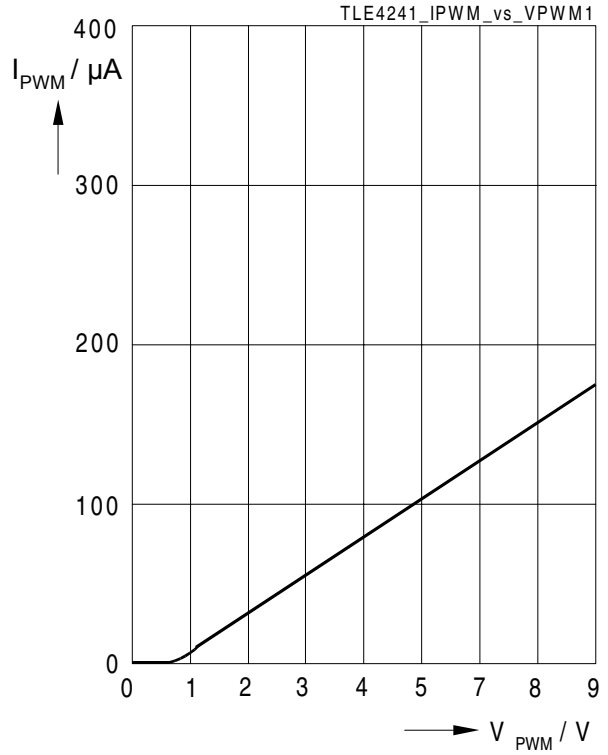### Output Current versus Supply Voltage, SET=L
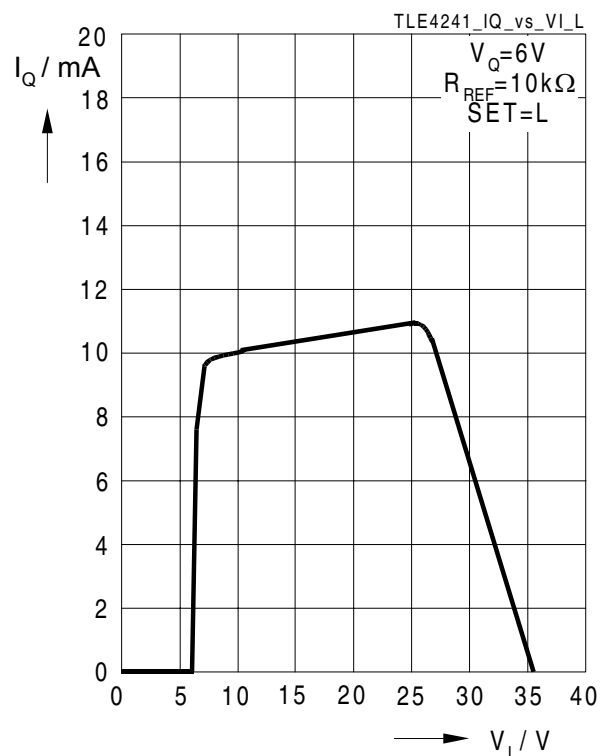
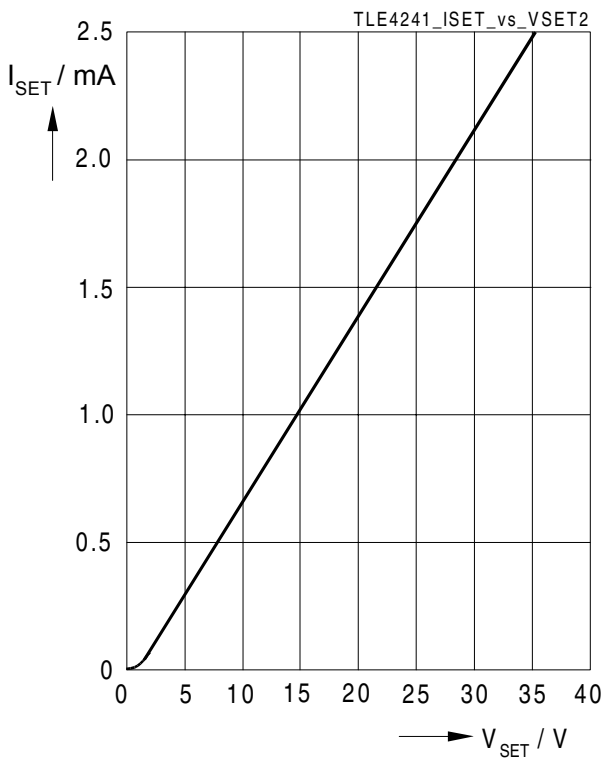## Reference Voltage versus Junction Temperature
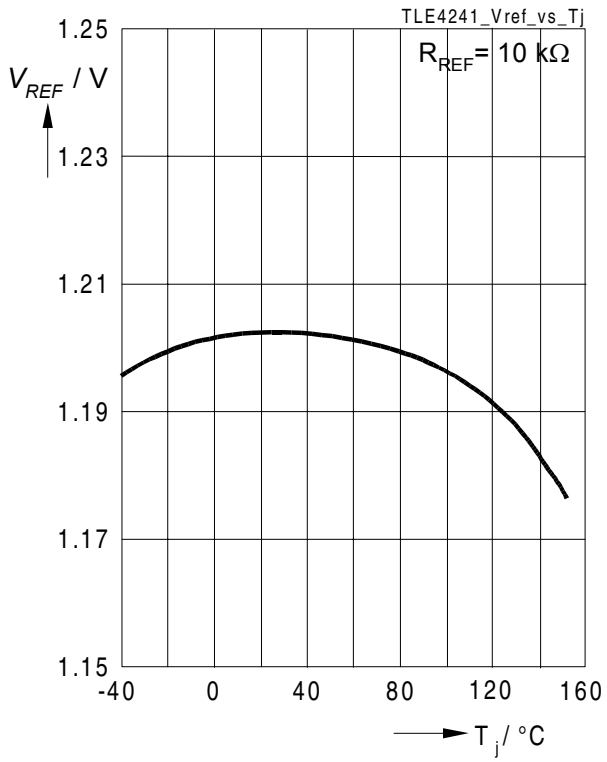
PWM Pin Input Current versus PWM Voltage

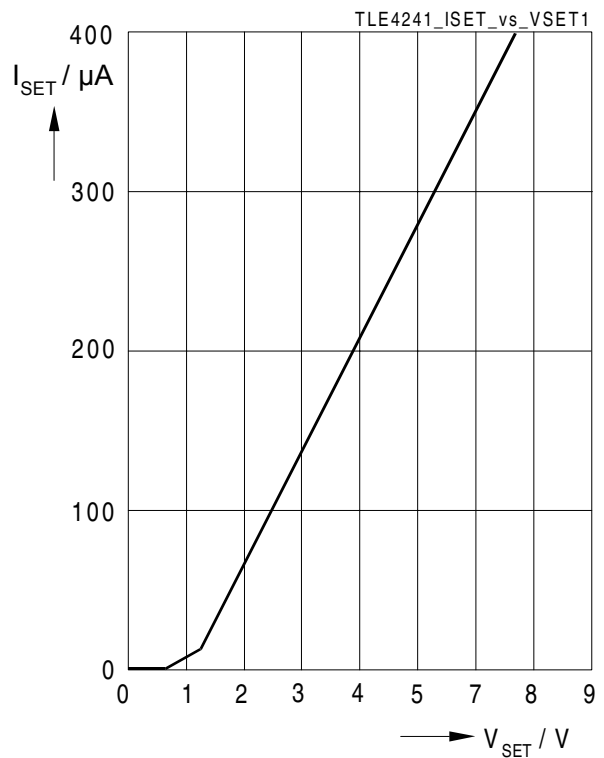## PWM Pin Input Current versus PWM Voltage
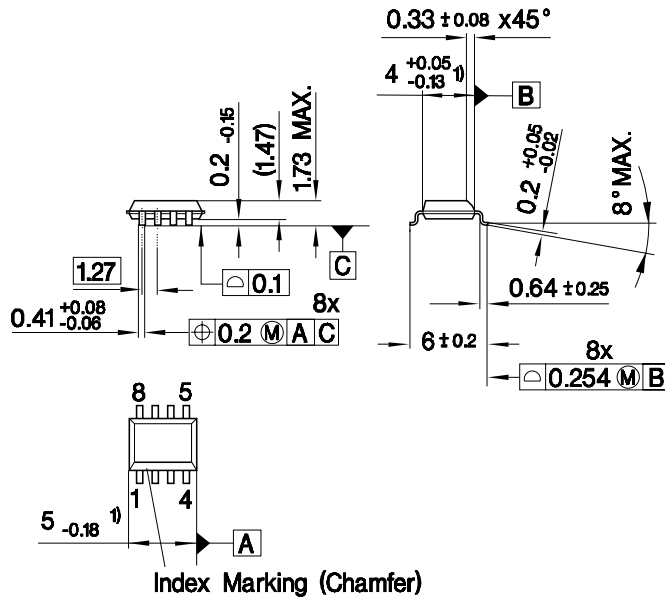

SET Pin Input Current versus SET Voltage

SET Pin Input Current versus SET Voltage

Package Outlines

P-DSO-8-9
(Plastic Dual Small Outline)

1) Does not include plastic or metal protrusion of 0.15 max. per side

Sorts of Packing
Package outlines for tubes, trays etc. are contained in our
Data Book "Package Information".
SMD = Surface Mounted Device

Dimensions in mm