

## 5-V Low Drop Fixed Voltage Regulator

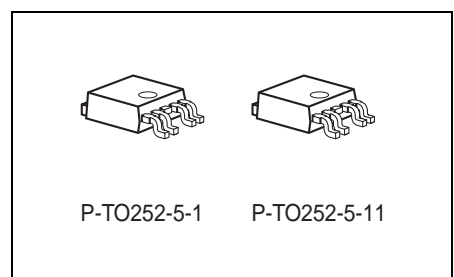
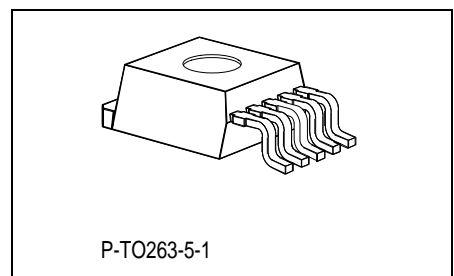
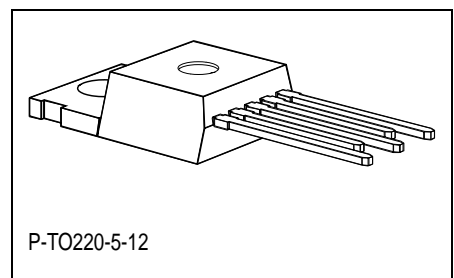
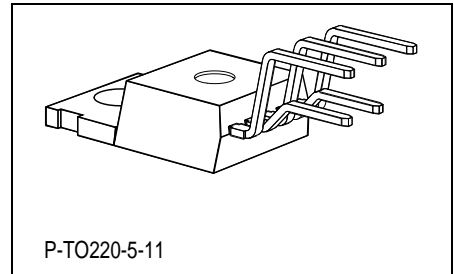
TLE 4270

### Features

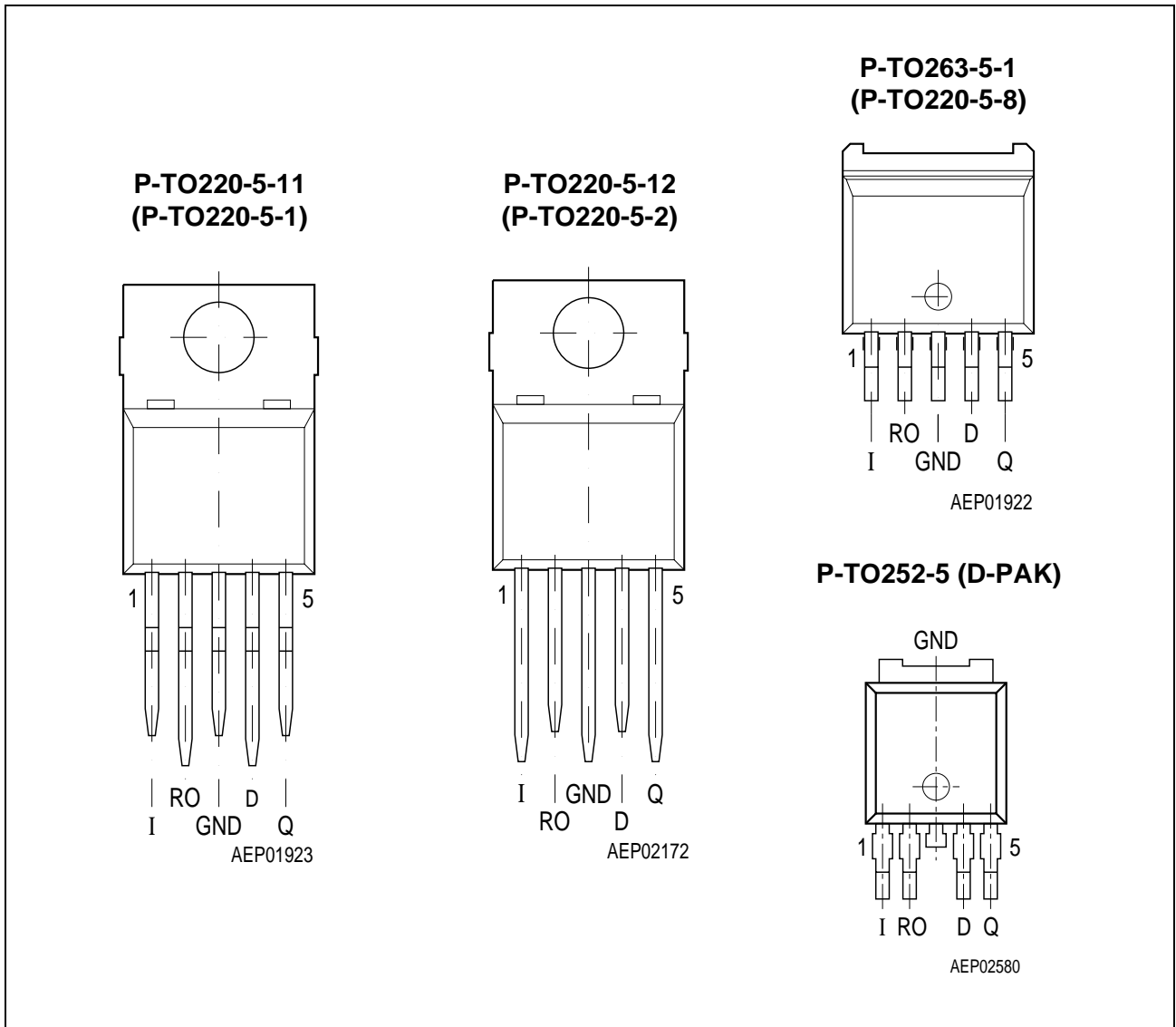
- Output voltage tolerance  $\leq \pm 2\%$
- 650 mA output current capability
- Low-drop voltage
- Reset functionality
- Adjustable reset time
- Suitable for use in automotive electronics
- Integrated overtemperature protection
- Reverse polarity protection
- Input voltage up to 42 V
- Overvoltage protection up to 65 V ( $\leq 400$  ms)
- Short-circuit proof
- Wide temperature range
- ESD protection  $> 4000$  V

### Functional Description

This device is a 5-V low drop fixed-voltage regulator. The maximum input voltage is 42 V (65 V,  $\leq 400$  ms). Up to an input voltage of 26 V and for an output current up to 650 mA it regulates the output voltage within a 2% accuracy. The short circuit protection limits the output current of more than 650 mA. The device incorporates overvoltage protection and a temperature protection which turns off the device at high temperatures.



Type	Ordering Code	Package
TLE 4270	Q67000-A9209	P-TO220-5-11
TLE 4270 S	Q67000-A9243	P-TO220-5-12
TLE 4270 G	Q67006-A9201	P-TO263-5-1
TLE 4270 D	Q67006-A9360	P-TO252-5-1, P-TO252-5-11



**Figure 1 Pin Configuration (top view)**

**Table 1 Pin Definitions and Functions**

Pin	Symbol	Function
1	I	<b>Input</b> ; block to ground directly at the IC with a ceramic capacitor.
2	RO	<b>Reset Output</b> ; the open collector output is connected to the 5-V output via an integrated resistor of 30 kΩ.
3	GND	<b>Ground</b> ; internally connected to heatsink.
4	D	<b>Reset Delay</b> ; connect a capacitor to ground for delay time adjustment.
5	Q	<b>5-V Output</b> ; block to ground with 22 μF capacitor, ESR < 3 Ω.

## Circuit Description

The control amplifier compares a reference voltage, which is kept highly accurate by resistance adjustment, to a voltage that is proportional to the output voltage and drives the base of a series transistor via a buffer. Saturation control as a function of the load current prevents any over-saturation of the power element.

The IC also incorporates a number of internal circuits for protection against:

- Overload
- Overvoltage
- Overtemperature
- Reverse polarity

## Application Description

The IC regulates an input voltage in the range of  $5.5\text{ V} < V_I < 36\text{ V}$  to  $V_{Q,\text{nom}} = 5.0\text{ V}$ . Up to  $26\text{ V}$  it produces a regulated output current of more than  $650\text{ mA}$ . Above  $26\text{ V}$  the save-operating-area protection allows operation up to  $36\text{ V}$  with a regulated output current of more than  $300\text{ mA}$ . Overvoltage protection limits operation at  $42\text{ V}$ . The overvoltage protection hysteresis restores operation if the input voltage has dropped below  $36\text{ V}$ . A reset signal is generated for an output voltage of  $V_Q < 4.5\text{ V}$ . The delay for power-on reset can be set externally with a capacitor.

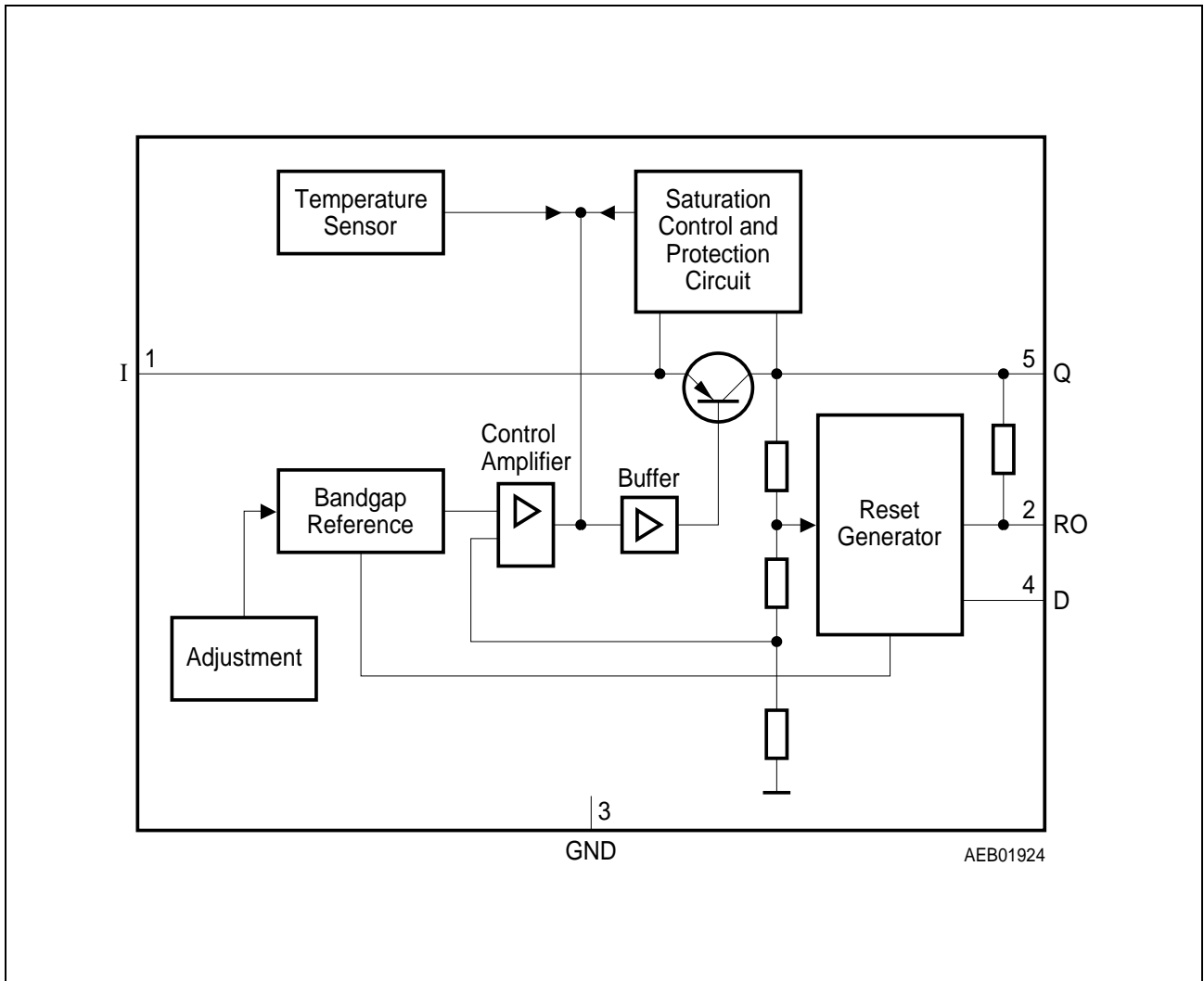


Figure 2 Block Diagram

**Table 2 Absolute Maximum Ratings**

$T_j = -40$  to  $150$  °C

Parameter	Symbol	Limit Values		Unit	Notes
		Min.	Max.		
<b>Input I</b>					
Voltage	$V_I$	-42	42	V	–
Voltage	$V_I$	–	65	V	$t \leq 400$ ms
Current	$I_I$	–	–	–	internally limited
<b>Reset Output RO</b>					
Voltage	$V_{RO}$	-0.3	7	V	–
Current	$I_{RO}$	–	–	–	Internally limited
<b>Reset Delay D</b>					
Voltage	$V_D$	-0.3	7	V	–
Current	$I_D$	–	–	–	Internally limited
<b>Output Q</b>					
Voltage	$V_Q$	-1.0	16	V	–
Current	$I_Q$	–	–	–	Internally limited
<b>Ground GND</b>					
Current	$I_{GND}$	-0.5	–	A	–
<b>Temperatures</b>					
Junction temperature	$T_j$	–	150	°C	–
Storage temperature	$T_{stg}$	-50	150	°C	–

**Table 3 Operating Range**

Parameter	Symbol	Limit Values		Unit	Notes
		Min.	Max.		
Input voltage	$V_I$	6	42	V	–
Junction temperature	$T_j$	-40	150	°C	–
<b>Thermal Resistance</b>					
Junction ambient	$R_{thj-a}$	–	65 79	K/W K/W	– TO263, TO252 <sup>1)</sup>
Junction case	$R_{thj-c}$	–	3	K/W	TO-220/263 Packages

1) Mounted on PCB,  $80 \times 80 \times 1.5$  mm<sup>3</sup>; 35µ Cu; 5µ Sn; Footprint only; zero airflow.

**Table 4 Characteristics**
 $V_I = 13.5 \text{ V}; -40 \text{ }^\circ\text{C} \leq T_j \leq 125 \text{ }^\circ\text{C}$  (unless otherwise specified)

Parameter	Symbol	Limit Values			Unit	Test Condition
		Min.	Typ.	Max.		
Output voltage	$V_Q$	4.90	5.00	5.10	V	$5 \text{ mA} \leq I_Q \leq 550 \text{ mA};$ $6 \text{ V} \leq V_I \leq 26 \text{ V}$
Output voltage	$V_Q$	4.90	5.00	5.10	V	$26 \text{ V} \leq V_I \leq 36 \text{ V};$ $I_Q \leq 300 \text{ mA}$
Output current limiting	$I_{Qmax}$	650	850	–	mA	$V_Q = 0 \text{ V}$
Current consumption $I_q = I_I - I_Q$	$I_q$	–	1	1.5	mA	$I_Q = 5 \text{ mA}$
Current consumption $I_q = I_I - I_Q$	$I_q$	–	55	75	mA	$I_Q = 550 \text{ mA}$
Current consumption $I_q = I_I - I_Q$	$I_q$	–	70	90	mA	$I_Q = 550 \text{ mA}; V_I = 5 \text{ V}$
Drop voltage	$V_{DR}$	–	350	700	mV	$I_Q = 550 \text{ mA}^{1)}$
Load regulation	$\Delta V_{Q,Lo}$	–	25	50	mV	$I_Q = 5 \text{ to } 550 \text{ mA};$ $V_I = 6 \text{ V}$
Line regulation	$\Delta V_{Q,Li}$	–	12	25	mV	$V_I = 6 \text{ to } 26 \text{ V}$ $I_Q = 5 \text{ mA}$
Power supply Ripple rejection	$PSRR$	–	54	–	dB	$f_r = 100 \text{ Hz};$ $V_r = 0.5 \text{ Vpp}$
<b>Reset Generator</b>						
Switching threshold	$V_{RT}$	4.5	4.65	4.8	V	–
Reset High voltage	$V_{ROH}$	4.5	–	–	V	–
Reset low voltage	$V_{ROL}$	–	60	–	mV	$R_{int} = 30 \text{ k}\Omega^{2)}$ ; $1.0 \text{ V} \leq V_Q \leq 4.5 \text{ V}$
Reset low voltage	$V_{ROL}$	–	200	400	mV	$I_R = 3 \text{ mA}, V_Q = 4.4 \text{ V}$
Reset pull-up	$R_{int}$	18	30	46	k $\Omega$	internally connected to Q
Charge current	$I_{D,c}$	8	14	25	$\mu\text{A}$	$V_D = 1.0 \text{ V}$

**Table 4 Characteristics (cont'd)**
 $V_I = 13.5 \text{ V}; -40 \text{ }^\circ\text{C} \leq T_j \leq 125 \text{ }^\circ\text{C}$  (unless otherwise specified)

Parameter	Symbol	Limit Values			Unit	Test Condition
		Min.	Typ.	Max.		
Upper reset timing threshold	$V_{DU}$	1.4	1.8	2.3	V	–
Lower reset timing threshold	$V_{DL}$	0.2	0.45	0.8	V	$V_Q < V_{RT}$
Delay time	$t_{rd}$	–	13	–	ms	$C_D = 100 \text{ nF}$
Reset reaction time	$t_{rr}$	–	–	3	$\mu\text{s}$	$C_D = 100 \text{ nF}$

**Overvoltage Protection**

Turn-Off voltage	$V_{I, ov}$	42	44	46	V	–
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- 1) Drop voltage =  $V_I - V_Q$  (measured when the output voltage has dropped 100 mV from the nominal value obtained at 13.5 V input)
- 2) Reset peak is always lower than 1.0 V.

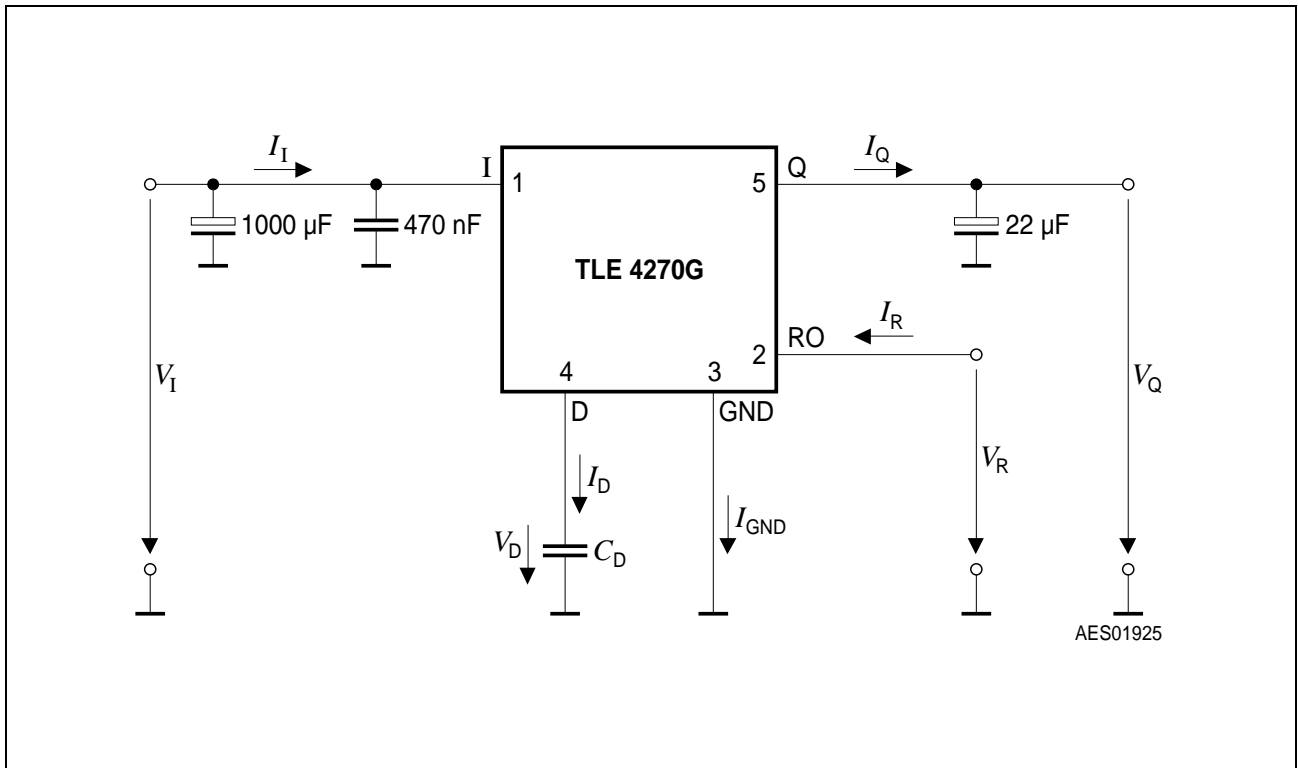


Figure 3 Test Circuit

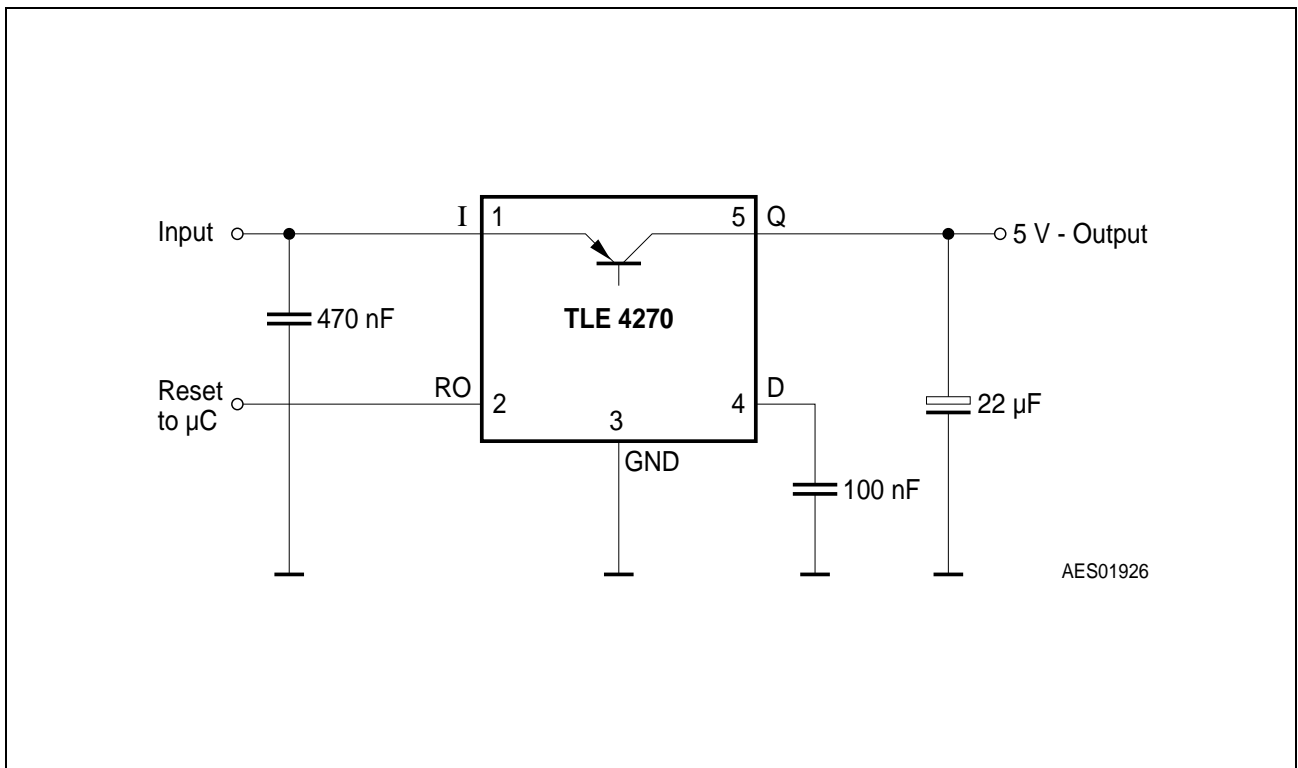


Figure 4 Application Circuit



## Design Notes for External Components

An input capacitor  $C_I$  is necessary for compensation of line influences. The resonant circuit consisting of lead inductance and input capacitance can be damped by a resistor of approx.  $1 \Omega$  in series with  $C_I$ . An output capacitor  $C_O$  is necessary for the stability of the regulating circuit. Stability is guaranteed at values of  $C_O \geq 22 \mu\text{F}$  and an ESR of  $< 3 \Omega$ .

## Reset Circuitry

If the output voltage decreases below  $4.5 \text{ V}$ , an external capacitor  $C_D$  on pin 4 (D) will be discharged by the reset generator. If the voltage on this capacitor drops below  $V_{DL}$ , a reset signal is generated on pin 2 (RO), i.e. reset output is set low. If the output voltage rises above the reset threshold,  $C_D$  will be charged with constant current. After the power-on-reset time the voltage on the capacitor reaches  $V_{DU}$  and the reset output will be set high again. The value of the power-on-reset time can be set within a wide range depending of the capacitance of  $C_D$ .

## Reset Timing

The power-on reset delay time is defined by the charging time of an external capacitor  $C_D$  which can be calculated as follows:

$$C_D = (\Delta t \times I_{D,c}) / \Delta V \quad (1)$$

Definitions:

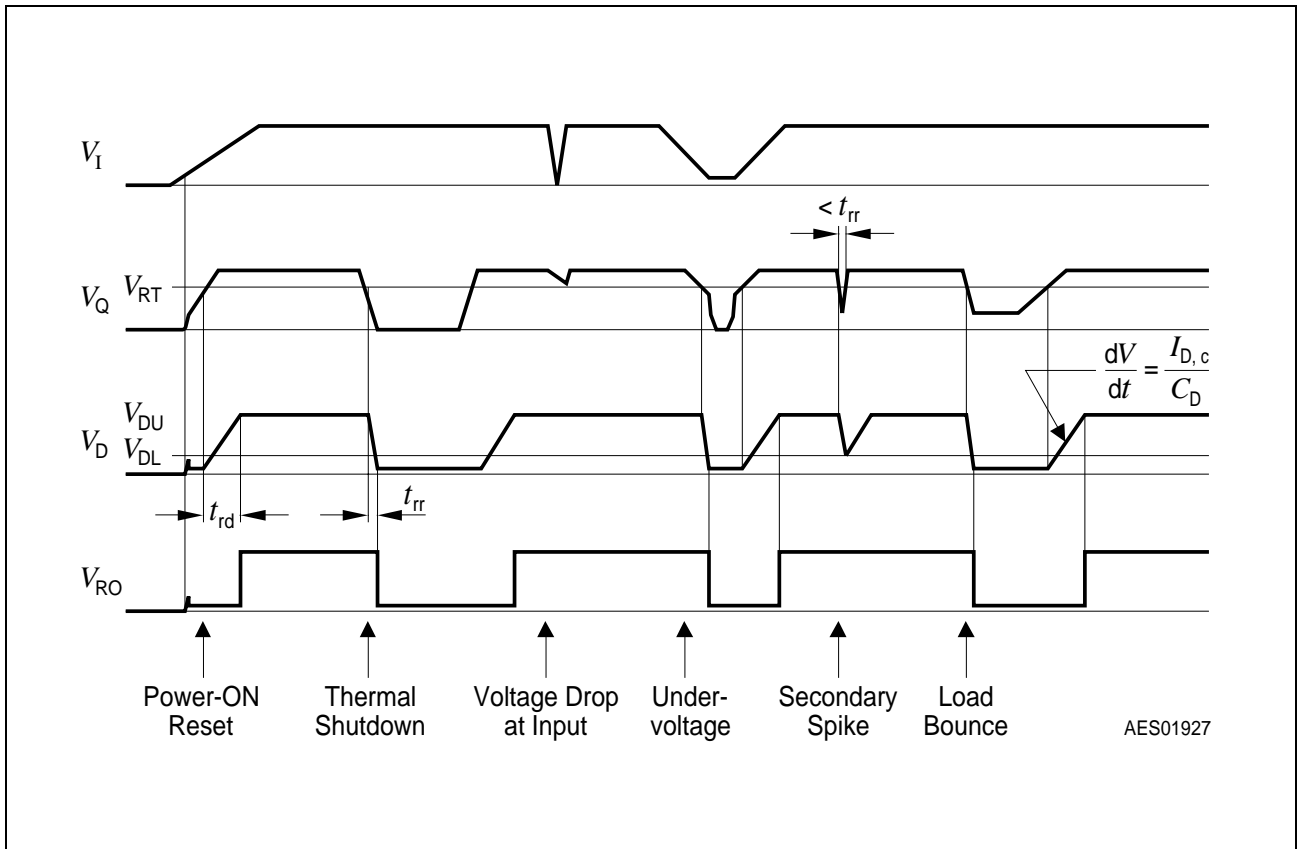
- $C_D$  = delay capacitors
- $\Delta t$  = reset delay time  $t_{rd}$
- $I_{D,c}$  = charge current, typical  $14 \mu\text{A}$
- $\Delta V = V_{DU}$ , typical  $1.8 \text{ V}$

$V_{DU}$  = upper reset timing threshold at  $C_D$  for reset delay time

$$t_{rd} = \Delta V \times C_D / I_{D,c} \quad (2)$$

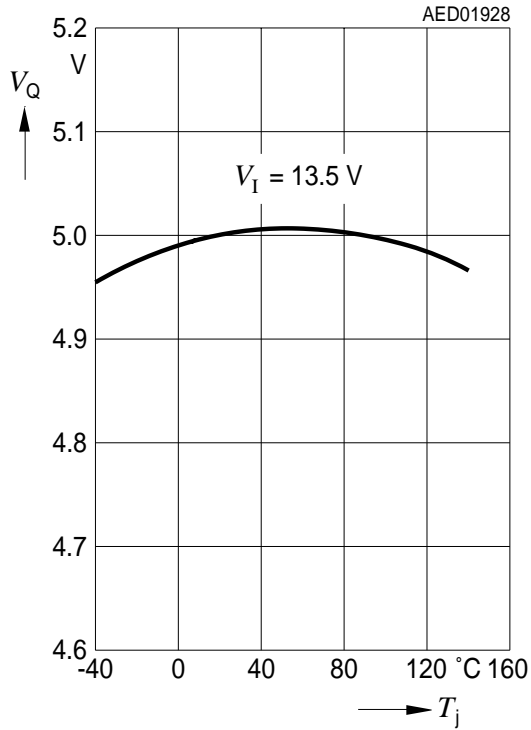
The reset reaction time  $t_{rr}$  is the time it takes the voltage regulator to set the reset out LOW after the output voltage has dropped below the reset threshold. It is typically  $1 \mu\text{s}$  for delay capacitor of  $47 \text{ nF}$ . For other values for  $C_D$  the reaction time can be estimated using the following equation:

$$t_{rr} \approx 20 \text{ s/F} \times C_D \quad (3)$$

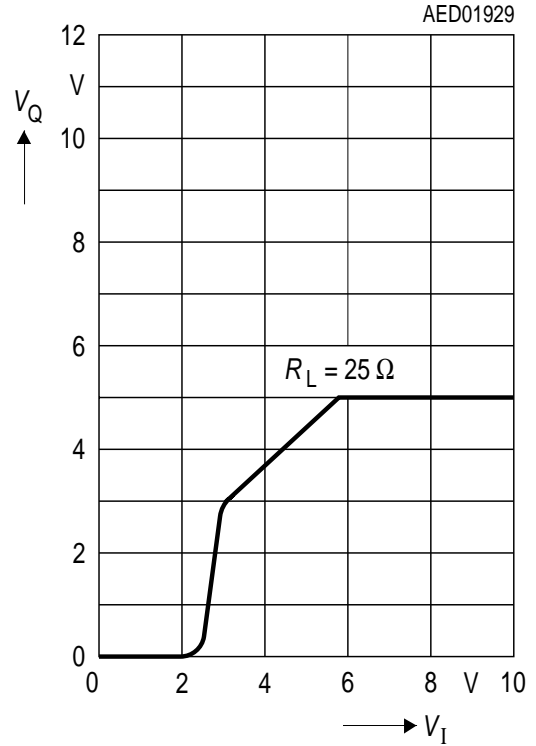


**Figure 5 Reset Time Response**

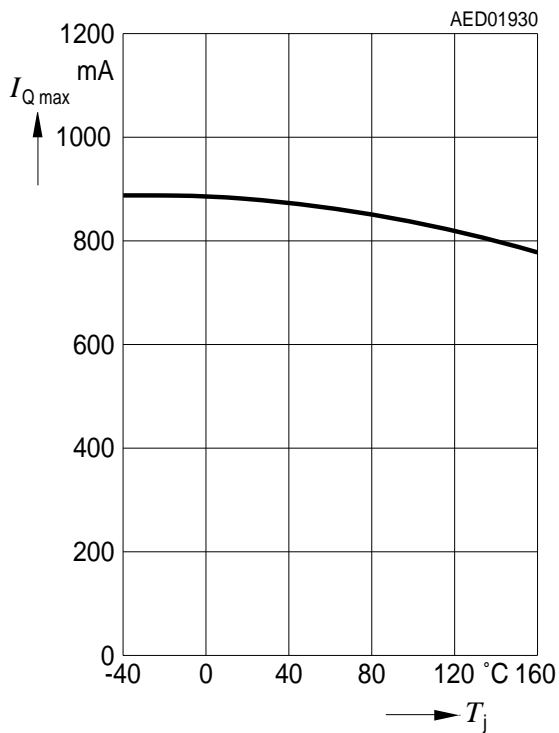
**Output Voltage  $V_Q$  versus Temperature  $T_j$**



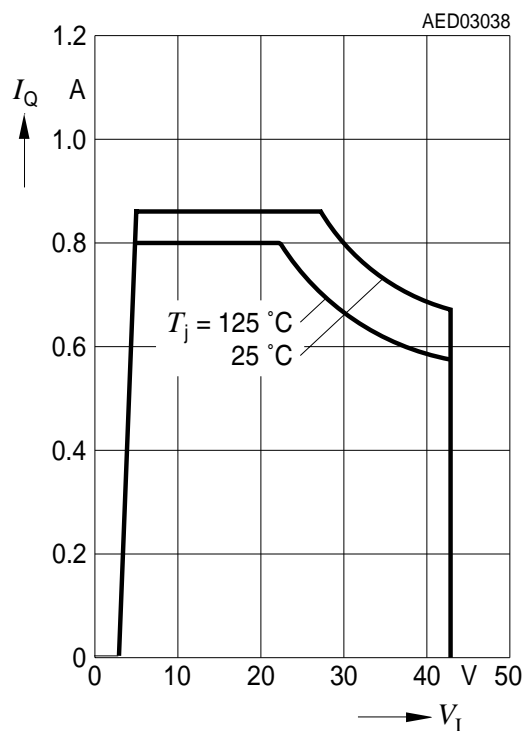
**Output Voltage  $V_Q$  versus Input Voltage  $V_I$**



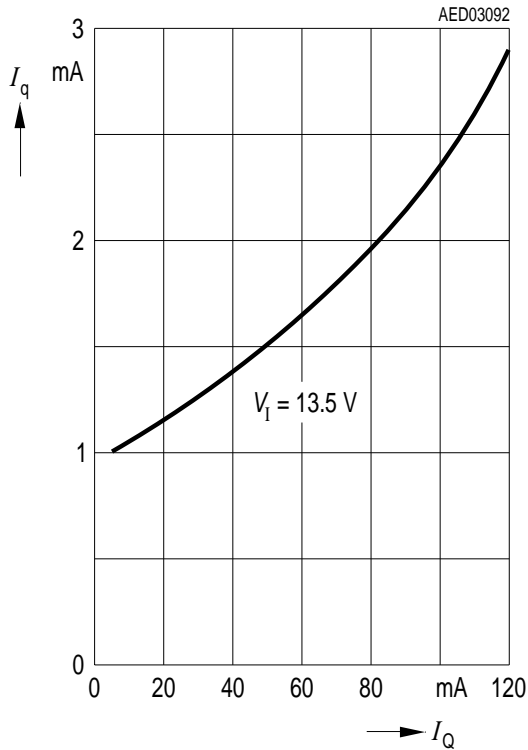
**Output Current  $I_Q$  versus Temperature  $T_j$**



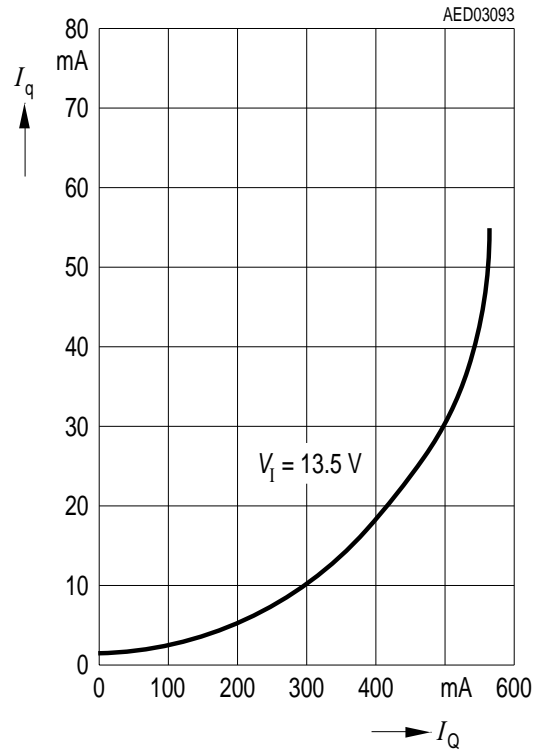
**Output Current  $I_Q$  versus Input Voltage  $V_I$**



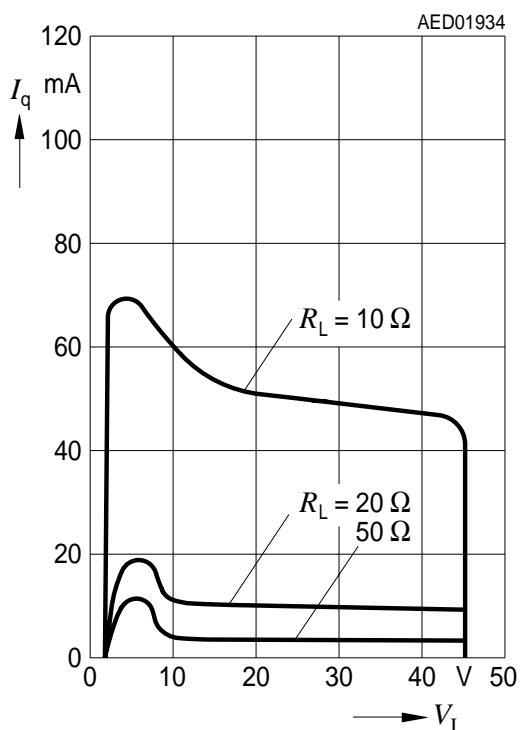
**Current Consumption  $I_q$  versus Output Current  $I_Q$**



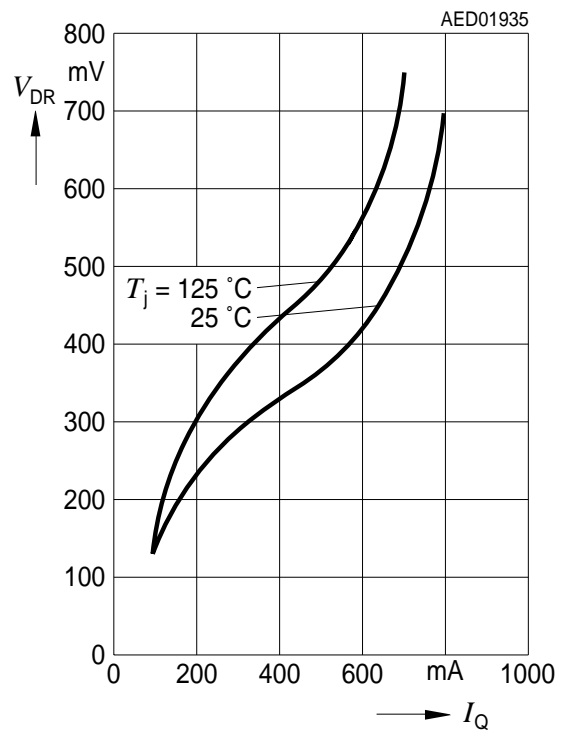
**Current Consumption  $I_q$  versus Output Current  $I_Q$**



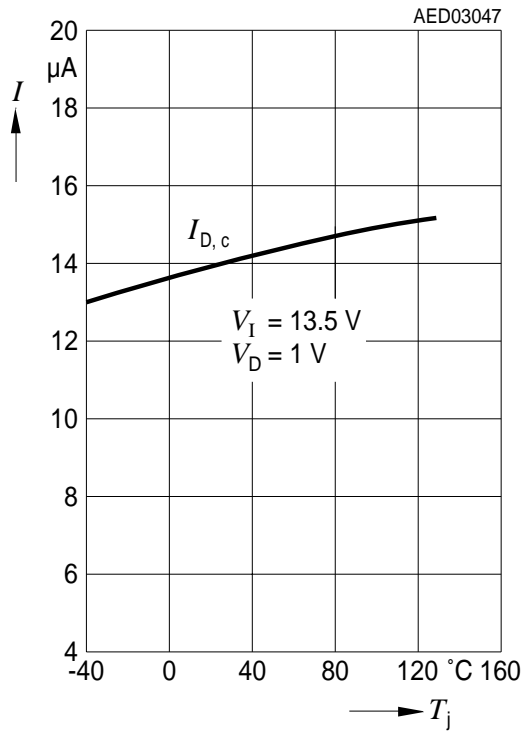
**Current Consumption  $I_q$  versus Input Voltage  $V_1$**



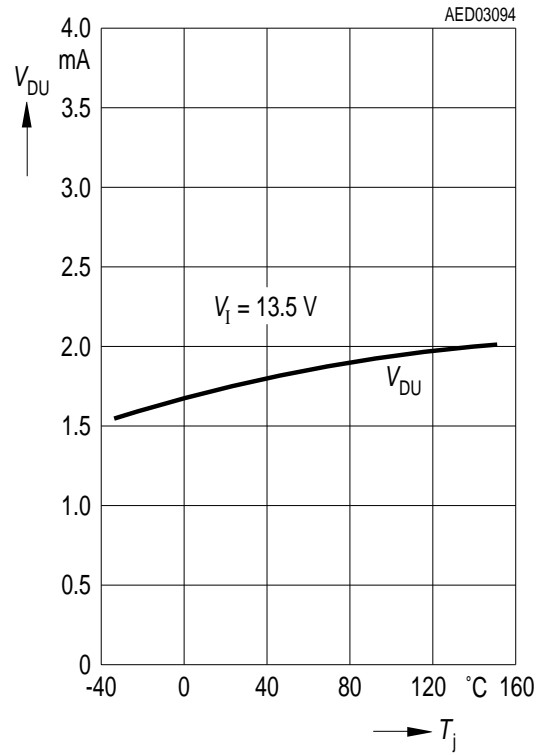
**Drop Voltage  $V_{DR}$  versus Output Current  $I_Q$**



**Charge Current  $I_{D,c}$  versus Temperature  $T_j$**



**Upper Reset Timing Threshold  $V_{DU}$  versus Temperature  $T_j$**



Package Outlines

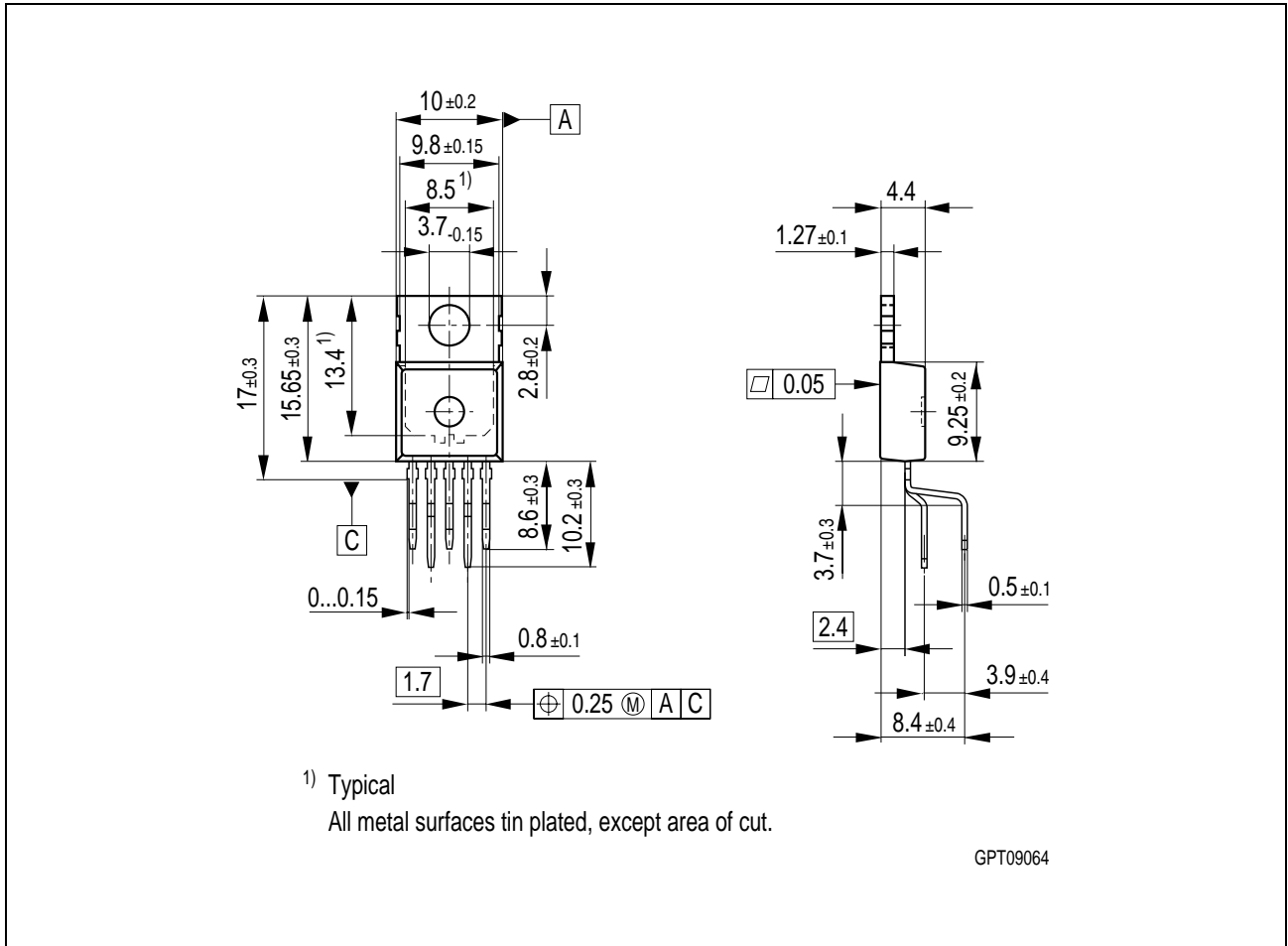
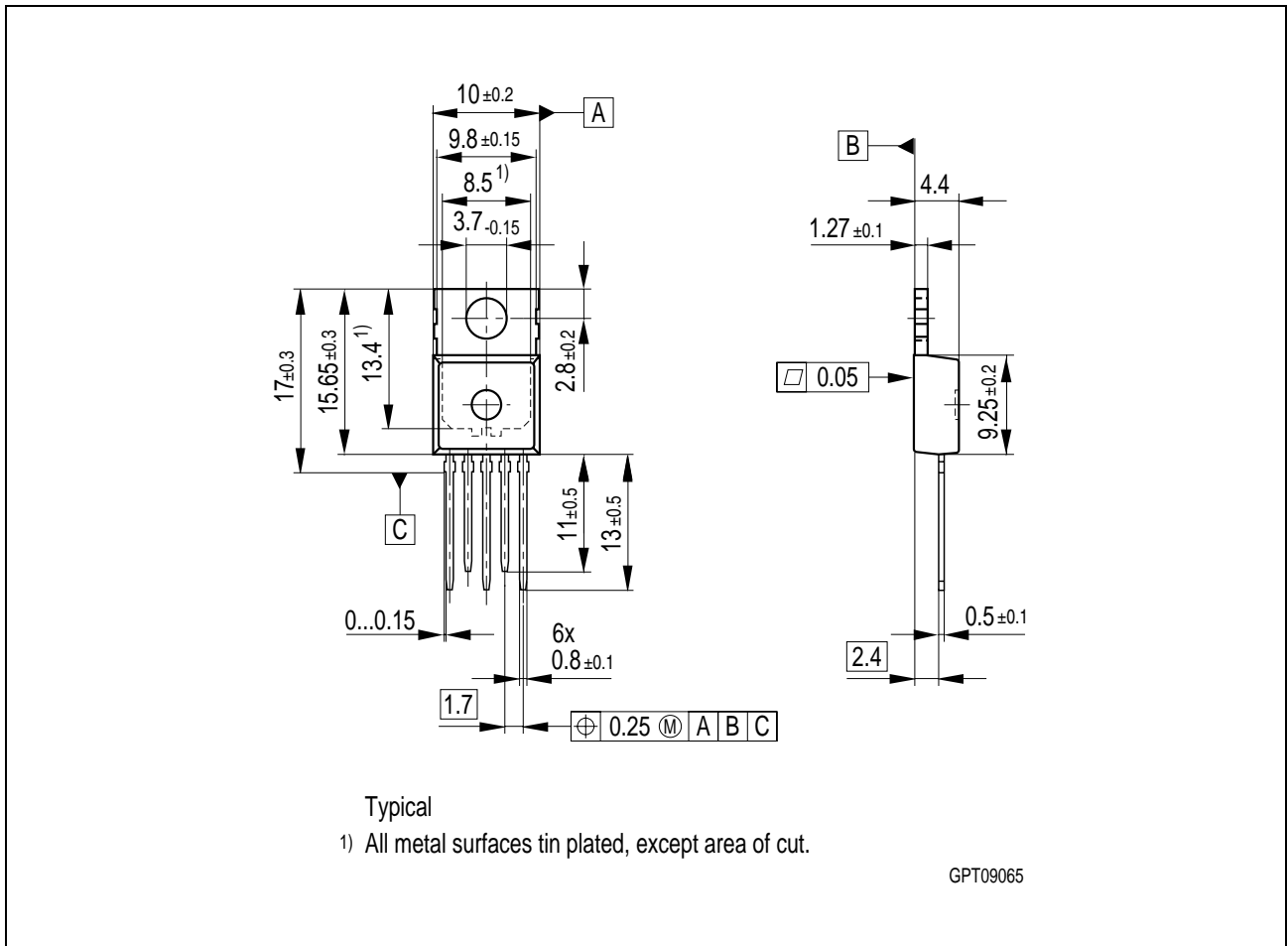


Figure 6 P-TO220-5-11 (Plastic Transistor Single Outline)

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SMD = Surface Mounted Device

Dimensions in mm

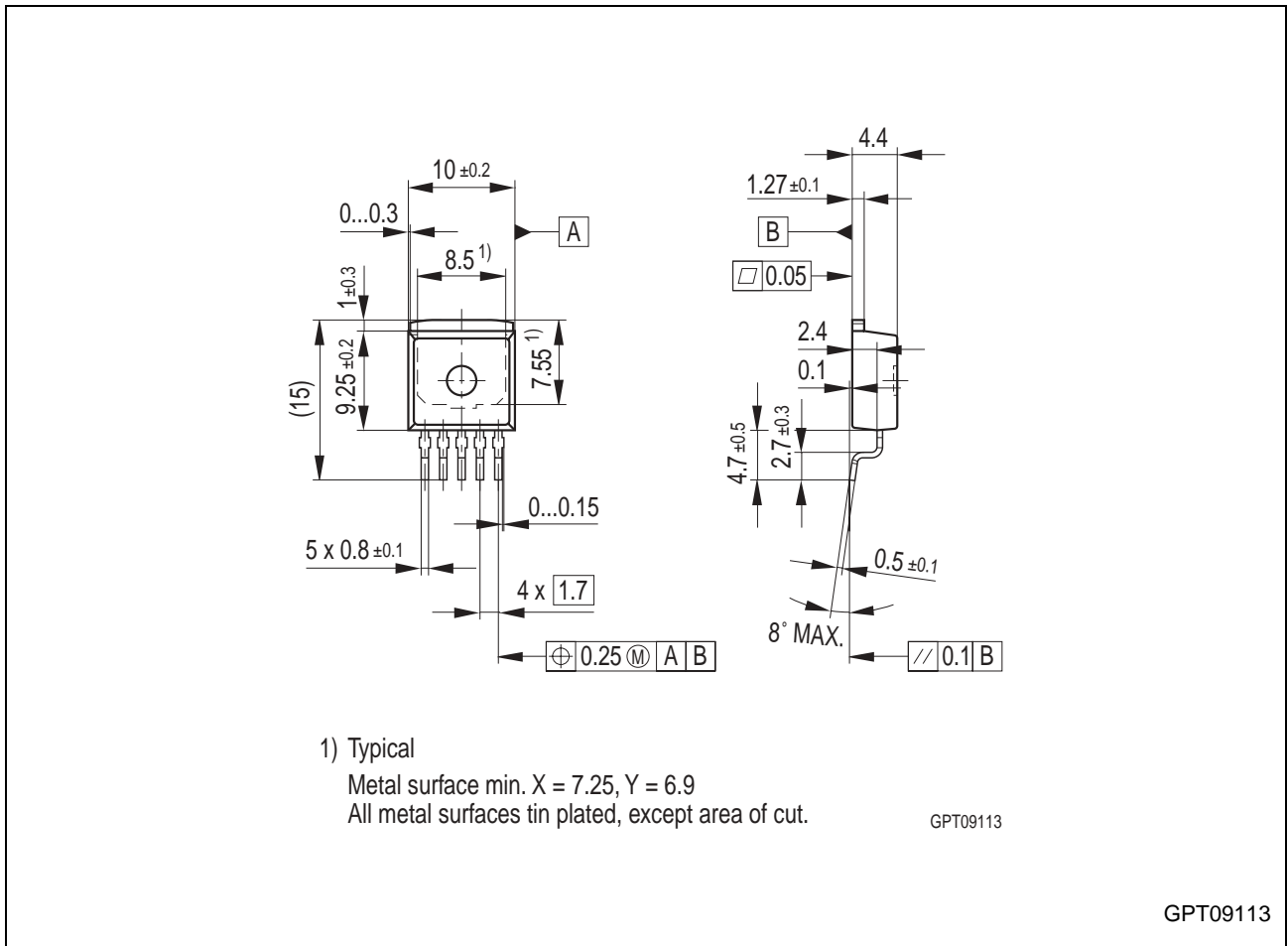


**Figure 7 P-TO220-5-12 (Plastic Transistor Single Outline)**

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Dimensions in mm



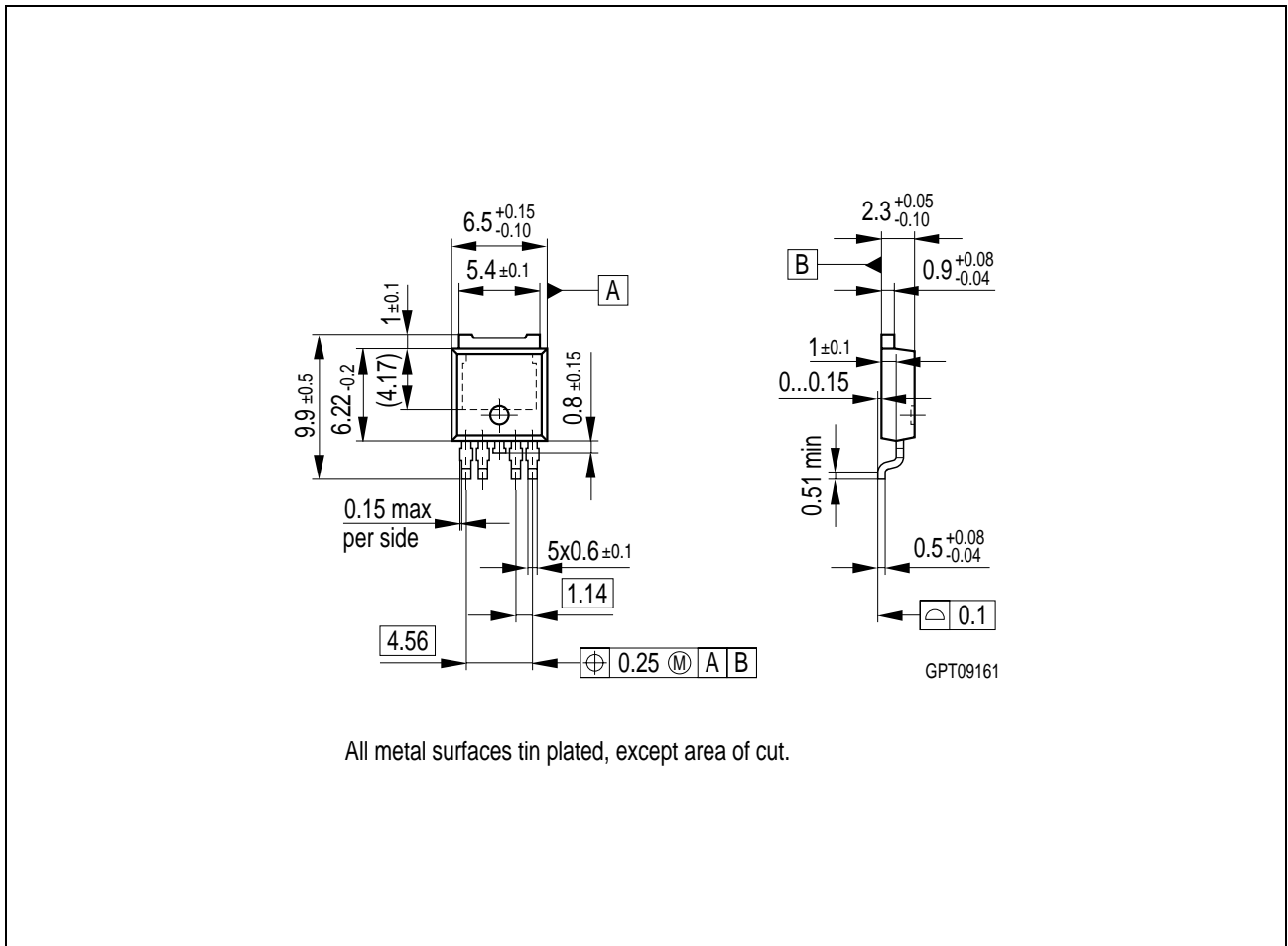
**Figure 8 P-TO263-5-1 (Plastic Transistor Single Outline)**

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SMD = Surface Mounted Device

Dimensions in mm



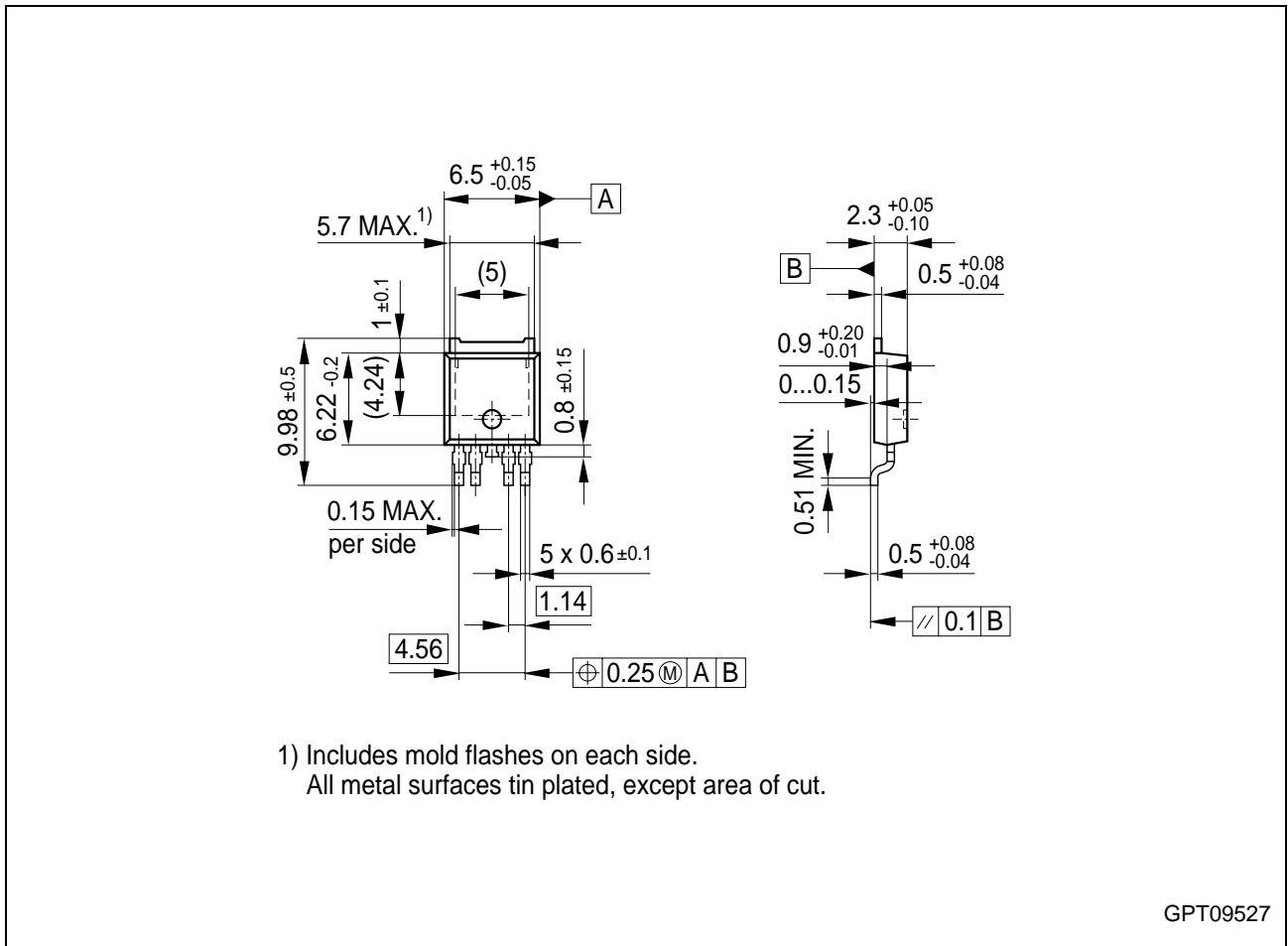


**Figure 9** P-T0252-5-1 (Plastic Transistor Single Outline)

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SMD = Surface Mounted Device

Dimensions in mm



**Figure 10 P-TO252-5-11 (Plastic Transistor Single Outline)**

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SMD = Surface Mounted Device

Dimensions in mm

**Remarks**

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