Automotive 350 mA, 40 V, Ultra-Low Quiescent Current Low-Dropout Regulator

Features

- AEC-Q100 qualified:
  - Device ambient temperature: -40°C ≤ T_A ≤ 125°C
  - Device junction temperature: -40°C ≤ T_J ≤ 150°C
- 3 V to 40 V wide input voltage range with up to 45 V transient
- Operating output voltage range: 1.2 V to 5 V
- Low quiescent current:
  - 4 μA typical at no load
- Maximum output current: 350 mA
- ±2% output voltage accuracy over temperature
- Typical dropout voltage: 500 mV at 350 mA load current for 5 V output version
- Stable with low equivalent series resistance ceramic output-stability capacitor

Applications

- Automotive head units
- Telematics control units
- Headlights
- Body control modules
- Automotive ECUs

Package Information

Part Number	Package	Body Size
DIA7875	TO252-3	6.6 mm × 6.1 mm
	SOT223	6.5 mm × 3.4 mm

Description

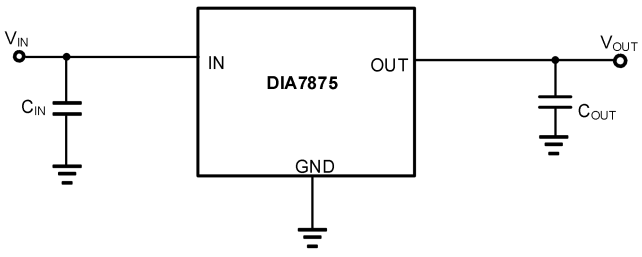
The DIA7875 is a low-dropout linear regulator designed to function with a wide input voltage range from 3 V to 40 V. The 3 V minimum operation voltage allows DIA7875 to function normally during cold-crank and start and stop conditions.

With only 4 μA ultra-low quiescent current at no load, the DIA7875 is quite suitable for microcontrollers and CAN/LIN transceivers power supply in standby systems.

The DIA7875 integrates short-circuit and overcurrent protection. The device operates in ambient temperatures from -40°C to 125°C and with junction temperatures from -40°C to 150°C, which enables the DIA7875 to be used in the harsh automotive environment.

This device uses a thermally conductive package to enable sustained operation despite significant dissipation across the device.

Simplified Schematic



Ordering Information

Ordering Part No.	Top Marking	MSL	RoHS	T_A	Package	
DIA7875BaaTA3	DHG5BX	3	Green	-40 to 125°C	TO252-3	Tape & Reel, 2500
DIA7875BaaTD3	DHG5BX	3	Green	-40 to 125°C	SOT223	Tape & Reel, 2500

Output Voltage Options							
Option Code "**aa**"	**12**	**15**	**18**	**25**	**30**	**33**	**50**
Voltage	1.2 V	1.5 V	1.8 V	2.5 V	3.0 V	3.3 V	5.0 V

Marking Definition	
DHG5BX	DHG5B: product code; X: voltage code

Voltage Code							
Option Code "X"	F	G	H	J	L	M	P
Voltage	1.2 V	1.5 V	1.8 V	2.5 V	3.0 V	3.3 V	5.0 V

If you encounter any issue in the process of using the device, please contact our customer service at marketing@dioo.com or phone us at (+86)-21-62116882. If you have any improvement suggestions regarding the datasheet, we encourage you to contact our technical writing team at docs@dioo.com. Your feedback is invaluable for us to provide a better user experience.

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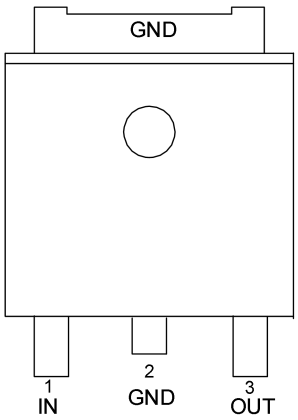


Figure 1. TO252-3 (Top view)

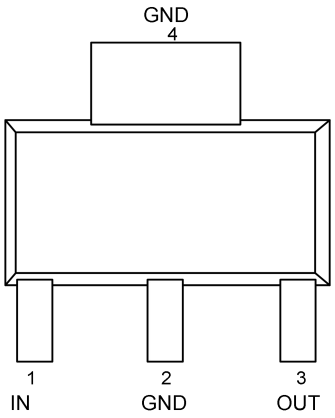


Figure 2. SOT223 (Top view)

Pin Name	Description
IN	Input voltage supply pin
GND	Power supply ground
OUT	Regulated output voltage. The output should be bypassed with a small 1 μF ceramic capacitor.
Thermal pad	Connect the thermal pad to a large area GND plane for improved thermal performance.

2. Absolute Maximum Ratings

Exceeding the maximum ratings listed under Absolute Maximum Ratings when designing is likely to damage the device permanently. Do not design to the maximum limits because long-time exposure to them might impact the device's reliability. The ratings are obtained over an operating free-air temperature range unless otherwise specified.

Symbol	Parameter	Rating	Unit
V_{IN}	Unregulated input voltage(1)	-0.3 to 45	V
V_{OUT}	Regulated output	-0.3 to 7	V
T_J	Junction temperature	-40 to 150	°C
T_{STG}	Storage temperature	150	°C

Note:

(1) Absolute maximum voltage, withstand 45 V for 200 ms.

3. Recommended Operating Conditions

Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. The ratings are obtained over an operating free-air temperature range unless otherwise specified.

Symbol	Parameter	Rating	Unit
V_{IN}	Unregulated input voltage	3 to 40	V
C_{OUT}	Output capacitor requirements(1)	1 to 200	μF
ESR	Output capacitor equivalent series resistance requirements	0.001 to 5	Ω
T_A	Ambient temperature	-40 to 125	°C

Note:

(1) All voltage values are with respect to GND.

4. Thermal Considerations

The thermal resistance determines the heat insulation property of a material. The higher the thermal resistance is, the lower the heat loss. Accumulation of heat energy degrades the performance of semiconductor components.

Symbol	Metric		Value	Unit
$R_{\theta JA}$	Junction-to-ambient thermal resistance	TO252-3	30	°C/W
		SOT223	50	°C/W
$R_{\theta JC}$	Junction-to-case thermal resistance	TO252-3	39.5	°C/W
		SOT223	20	°C/W

5. Electrical Characteristics

V_{IN} = 14 V, 10 µF ceramic output capacitor, T_A = -40°C to 125°C, unless otherwise noted.

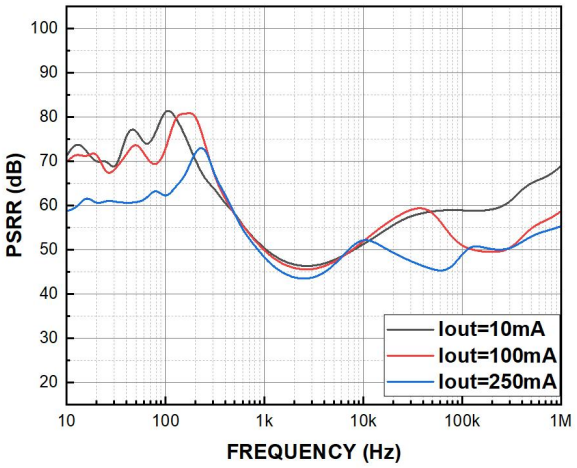
Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IN}	Input voltage		$V_{OUT(NOM)}$ + V_{DO}		40	V
I_Q	Quiescent current	V_{IN} = 6 V to 40 V, I_{OUT} = 0 mA		4	8	µA
$V_{IN, UVLO}$	V_{IN} undervoltage detection	Ramp V_{IN} down until the output turns ON			2.9	V
		Hysteresis		200		mV
V_{OUT}	Regulated output	I_{OUT} = 10 mA	–2		2	%
$V_{Line-Reg}$	Line regulation	V_{IN} = 6 V to 40 V, I_{OUT} = 10 mA			10	mV
$V_{Load-Reg}$	Load regulation	V_{IN} = 14 V, I_{OUT} = 1 mA to 350 mA			10	mV
V_{DO}	Dropout voltage(1)	I_{OUT} = 350 mA, V_{OUT} = 5 V	320	500	1200	mV
I_{OUT}	Output current	V_{OUT} in regulation	0		350	mA
I_{CL}	Output current limit	V_{OUT} short to 90% × V_{OUT}	400			mA
PSRR	Power-supply ripple rejection	$V_{(Ripple)}$ = 0.2 V_{PP}, I_{OUT} = 10 mA, frequency = 100 Hz, C_{OUT} = 2.2 µF		60		dB
T_{SD}	Junction shutdown temperature			160		°C
T_{HYST}	Hysteresis of thermal shutdown			40		°C

Note:

(1) Dropout is not valid for the 2.5 V output because of the minimum input voltage limits.

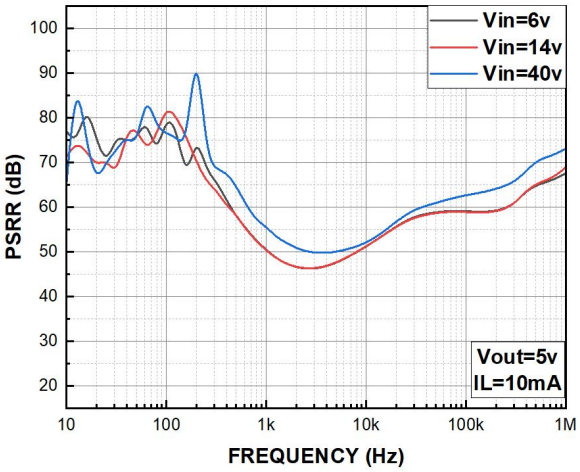
(2) Specification subject to change without notice.

6. Typical Performance Characteristics



V_{IN} = 6 V, V_{OUT} = 5 V, C_{OUT} = 10 µF

Figure 3. PSRR vs. Frequency



V_{OUT} = 5 V, I_L = 10 mA, C_{OUT} = 10 µF

Figure 4. PSRR vs. Frequency

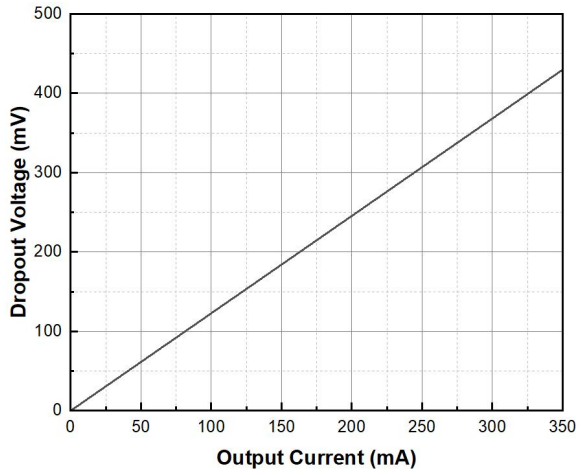


Figure 5. Dropout voltage vs. Output current at V_{OUT} = 5 V

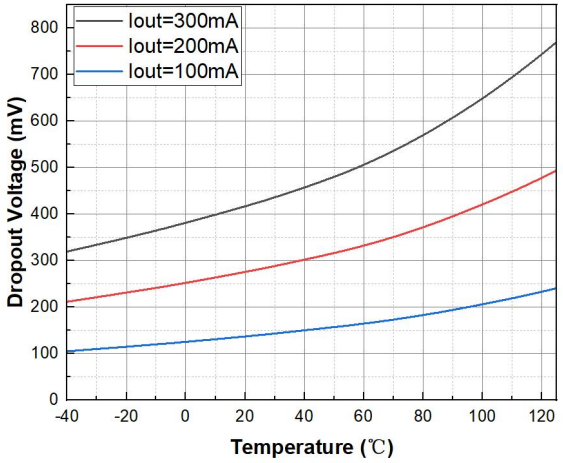


Figure 6. Dropout voltage vs. Temperature at V_{OUT} = 5 V

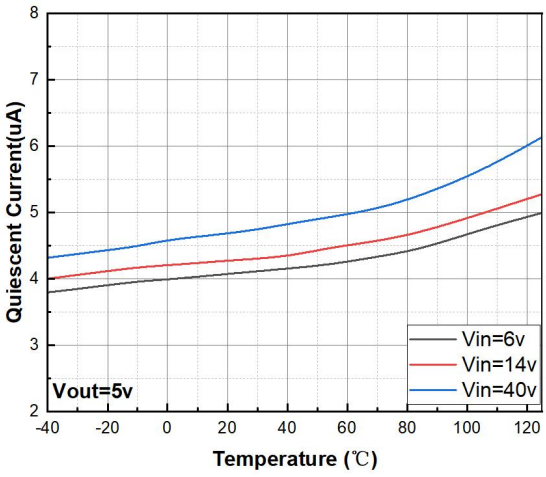


Figure 7. Quiescent current vs. Temperature

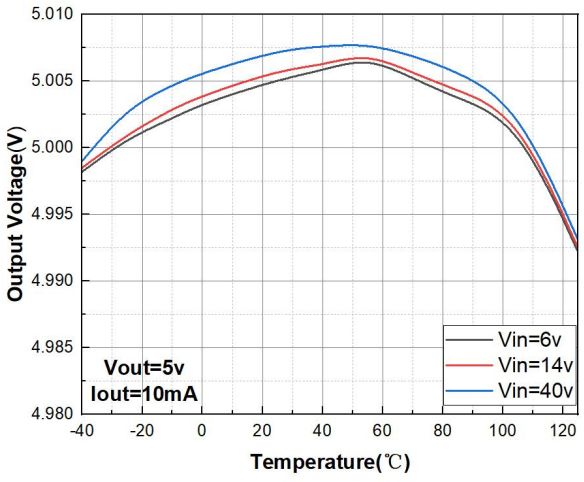


Figure 8. Output voltage vs. Temperature

7. Block Diagram

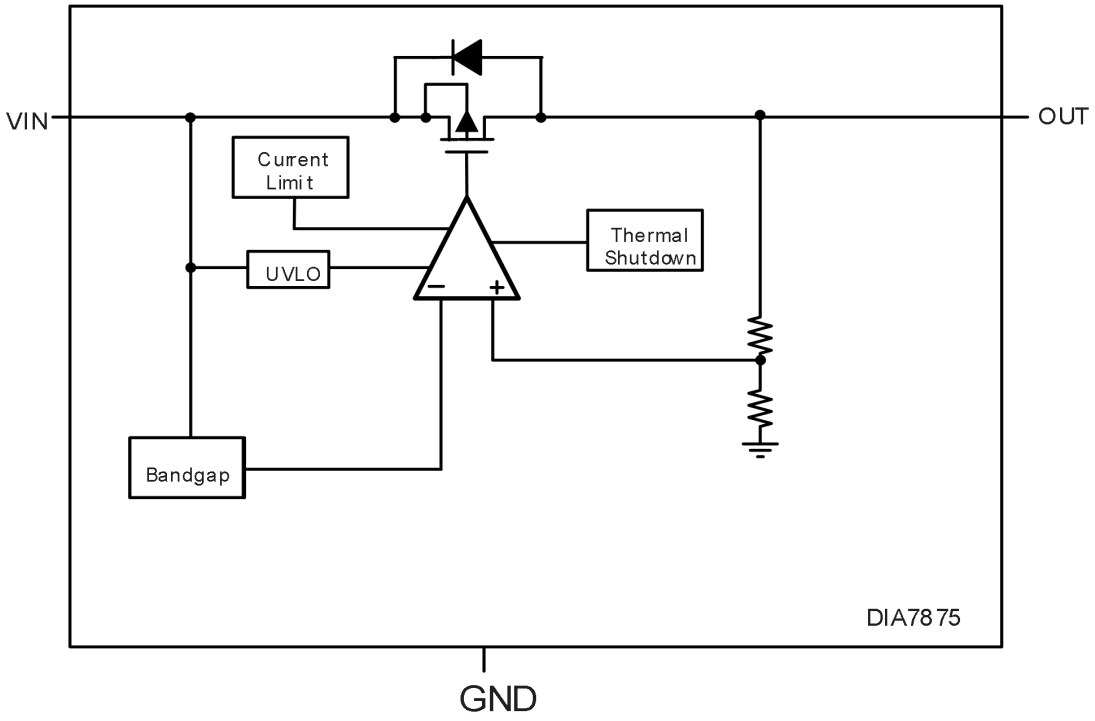


Figure 9. Block diagram

8. Function Description

The DIA7875 is a low-dropout linear regulator designed to function with an input voltage range from 3 V to 40 V and provides 45 V load dump protection. The typical quiescent current of the standby system at no load is only 4 μA, which is designed for the automotive always-on application.

8.1. Undervoltage shutdown

The DIA7875 will be shut down if the input voltage (V_{IN}) falls below an internal UVLO threshold (V_{UVLO}). In the event that the input voltage drops below UVLO threshold and recovers, as soon as the voltage returns to the proper range, the regulator shuts down and powers up with a normal power-up sequence. Ensure that the regulator does not latch into an unknown state during low-input-voltage conditions. The regulator shuts down and powers up with a normal power-up sequence when the input voltage is above the required level.

8.2. Thermal shutdown

The DIA7875 is protected by a thermal shutdown (T_{SD}) circuit from overheating. The junction temperature exceeding the T_{SD} trip point causes the output to turn off, and the output will turn on again when the junction temperature falls below the T_{SD} trip point.

8.3. Operation with V_{IN} lower than 3 V

The DIA7875 can operate with input voltages above 3 V and at lower input voltages, the maximum UVLO voltage is 2.9 V, and the device does not operate at input voltages below the actual UVLO voltage.

8.4. Operation with V_{IN} higher than 3 V

When V_{IN} is higher than the output set value plus the device dropout voltage and higher than 3 V, V_{OUT} is equal to the set value. Otherwise, V_{OUT} is equal to V_{IN} minus the dropout voltage.

9. Application Information

Important notice: Validation and testing are the most reliable ways to confirm system functionality. The application information is not part of the specification and is for reference purposes only.

9.1. Application examples

The DIA7875 is a low-dropout linear regulator designed to function with an input-voltage range from 3 V to 40 V with a 45 V load dump protection.

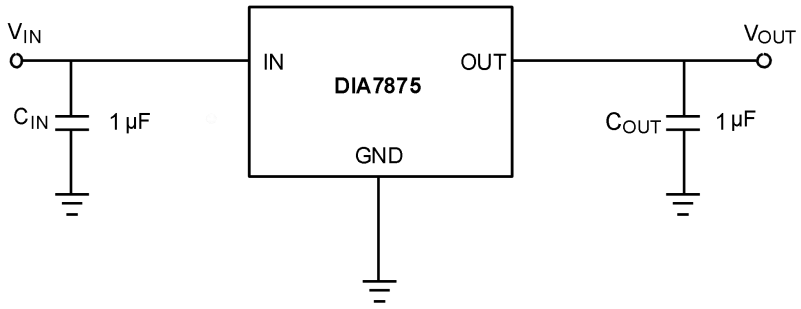


Figure 10. Typical application

9.2. Detailed design procedure

To begin the design process, determine the input and output voltage range and output current.

9.3. Input capacitor

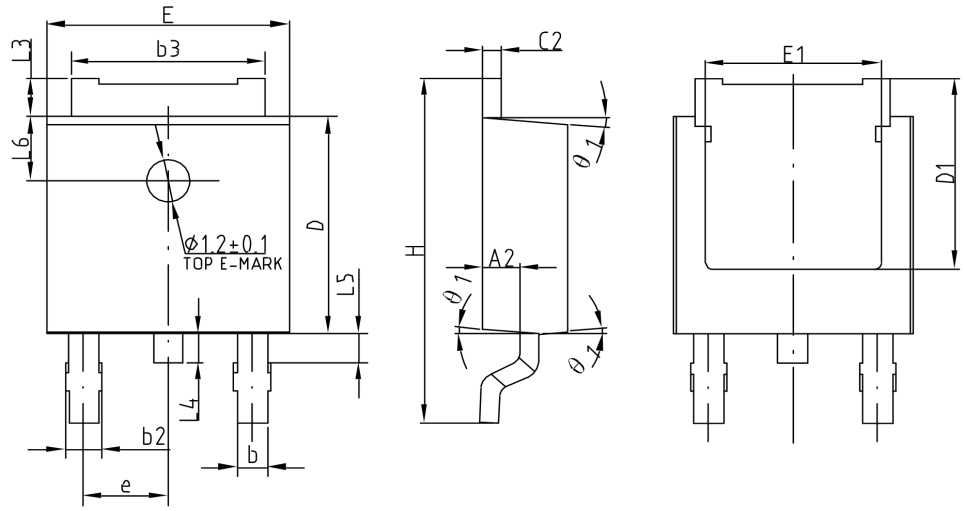
The voltage rating must be greater than the maximum input voltage. An input capacitor is not required for stability. A good analog design practice is to connect a 10 µF to 22 µF capacitor from IN to GND.

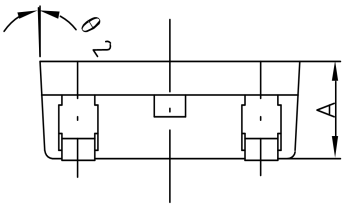
9.4. Output capacitor

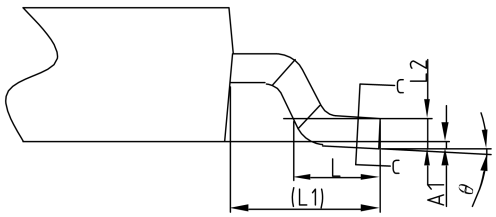
To better endure the stability of the DIA7875, an output capacitor with a value in the range from 1 µF to 200 µF and with an equivalent series resistance range between 0.001 Ω and 5 Ω is required. To improve the load transient response, select a ceramic capacitor with low equivalent series resistance.

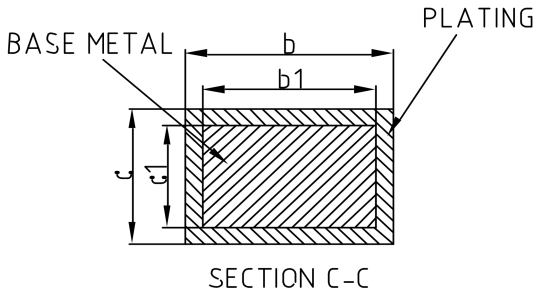
10. Physical Dimensions

10.1. TO252-3



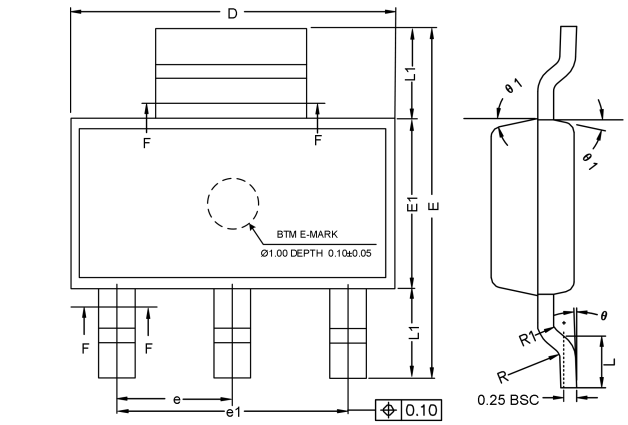


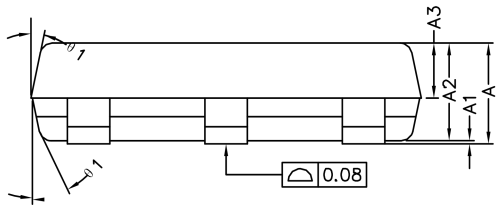


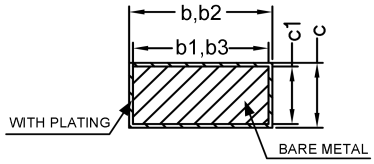


Common Dimensions (Units of measure = Millimeter)			
Symbol	**Min**	**Nom**	**Max**
A	2.20	2.30	2.38
A1	0	-	0.10
A2	0.90	1.00	1.10
b	0.77	-	0.89
b1	0.76	0.81	0.86
b2	0.77	-	1.10
b3	5.23	5.33	5.43
c	0.47	-	0.60
c1	0.46	0.51	0.56
c2	0.47	-	0.60
D	6.00	6.10	6.20
D1	5.25	-	-
E	6.50	6.60	6.70
E1	4.70	-	-
e	2.28 BSC		
H	9.80	10.10	10.40
L	1.40	1.50	1.70
L1	2.90 REF		
L2	0.51 BSC		
L3	0.90	-	1.25
L4	0.60	0.80	1.00
L5	0.90	-	1.50
L6	1.80 REF		
θ	0°	-	8°
θ1	3°	5°	7°
θ2	1°	3°	5°

10.2. SOT223







SECTION F-F&G-G

Common Dimensions (Units of measure = Millimeter)			
Symbol	**Min**	**Nom**	**Max**
A	-	-	1.80
A1	0.02	-	0.10
A2	1.50	1.60	1.70
A3	0.80	0.90	1.00
b	0.67	-	0.80
b1	0.66	0.71	0.76
b2	2.96	-	3.09
b3	2.95	3.00	3.05
c	0.24	-	0.35
c1	0.23	0.25	0.30
D	6.43	6.48	6.58
E	6.80	7.00	7.20
E1	3.30	3.38	3.53
e	2.25	2.30	2.35
e1	4.50	4.60	4.70
L	0.80	1.00	1.20
L1	1.81 REF		
R	0.10	-	-
R1	0.10	-	-
θ	0°	-	8°
θ1	10°	12°	14°

Disclaimer

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