AUTOMOTIVE LOW-DROPOUT VOLTAGE REGULATORS

FEATURES

- **Qualified for Automotive Applications**
- **Low Dropout Voltage, Less Than 0.6 V at 750 mA**
- **Low Quiescent Current**
- **TTL- and CMOS-Compatible Enable on TL751M Series**
- **Load-Dump Protection**
- **Overvoltage Protection**
- **Internal Thermal Overload Protection**
- **Internal Overcurrent-Limiting Circuitry**

DESCRIPTION

The TL750M and TL751M series are low-dropout positive voltage regulators specifically designed for automotive applications. The TL750M and TL751M series incorporate onboard overvoltage and current-limiting protection circuitry to protect the devices and the regulated system. Both series are fully protected against load-dump and reverse-battery conditions. Load-dump protection is up to a maximum of 60 V at the input of the device. Low quiescent current, even during full-load conditions, makes the TL750M and TL751M series ideal for use in applications that are permanently connected to the vehicle battery.

The TL750M and TL751M series offers 5-V and 8-V options. The TL751M series has the addition of an enable ($\overline{\text{ENABLE}}$) input. The $\overline{\text{ENABLE}}$ input gives complete control over power up, allowing sequential power up or shutdown. When $\overline{\text{ENABLE}}$ is high, the regulator output is placed in the high-impedance state. The $\overline{\text{ENABLE}}$ input is TTL and CMOS compatible.

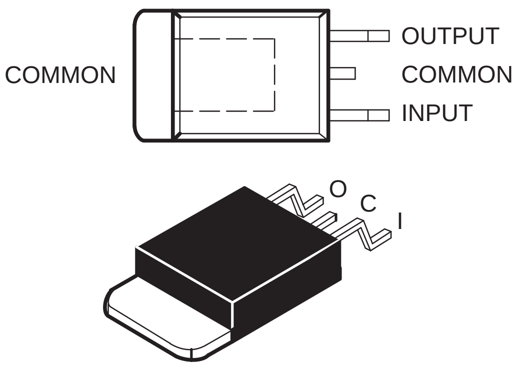
The TL750Mxx and TL751Mxx are characterized for operation over the virtual junction temperature range –40°C to 125°C.

AVAILABLE OPTIONS(1)

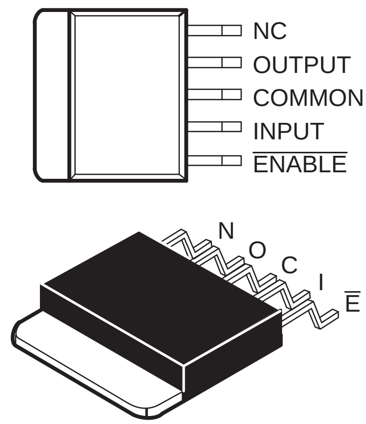
T_J	V_O NOM (V)	PACKAGE(2)	ORDERABLE PART NUMBER	TOP SIDE MARKING
–40°C to 125°C	5	TO-263-3/KTT, Reel of 500	TL750M05QKTTRQ1	TL750M05Q1
	8	TO-263-3/KTT, Reel of 500	TL750M08QKTTRQ1	TL750M08Q1
	5	TO-263-5/KTT, Reel of 500	TL751M05QKTTRQ1	TL751M05Q1
	8	TO-263-5/KTT, Reel of 500	TL751M08QKTTRQ1	TL751M08Q1

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.

TL750M . . . KTT (3 Pin Shown)
(TOP VIEW)

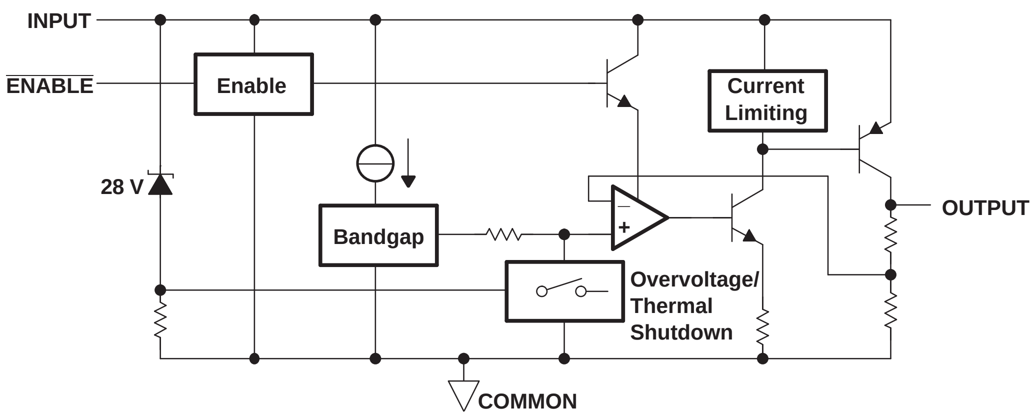


TL751M . . . KTT (5 Pin Shown)
(TOP VIEW)



A. The COMMON terminal is in electrical contact with the mounting base.
NC – No internal connection

TL751Mxx FUNCTIONAL BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted)(1)

			VALUE / UNIT
	Continuous input voltage		26 V
	Transient input voltage (see Figure 4)		60 V
	Continuous reverse input voltage		–15 V
	Transient reverse input voltage	t = 100 ms	–50 V
θ_{JA}	Package thermal impedance(2) (3)	KTT package (3 pin)	26.9°C/W
		KTT package (5 pin)	26.5°C/W
T_J	Virtual junction temperature range		–40°C to 150°C
T_{stg}	Storage temperature range		–65°C to 150°C

(1) Stresses beyond those listed under *absolute maximum ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *recommended operating conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) Maximum power dissipation is a function of T_J(max), θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) – T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can impact reliability. Due to variation in individual device electrical characteristics and thermal resistance, the built-in thermal overload protection may be activated at power levels slightly above or below the rated dissipation.
(3) The package thermal impedance is calculated in accordance with JESD 51.

RECOMMENDED OPERATING CONDITIONS

			MIN	MAX	UNIT
V_I	Input voltage	TL75xM05	6	26	V
		TL75xM08	9	26	
V_{IH}	High-level $\overline{\text{ENABLE}}$ input voltage	TL751Mxx	2	15	V
V_{IL}	Low-level $\overline{\text{ENABLE}}$ input voltage	TL751Mxx	0	0.8	V
I_O	Output current	TL75xMxx		750	mA
T_J	Operating virtual junction temperature	TL75xMxx	–40	125	°C

TL751Mxx ELECTRICAL CHARACTERISTICS

V_I = 14 V, I_O = 300 mA, T_J = 25°C

PARAMETER	TL751Mxx	UNIT
	TYP	
Response time, $\overline{\text{ENABLE}}$ to output (start-up)	50	µs

TL750M05/TL751M05 ELECTRICAL CHARACTERISTICS

V_I = 14 V, I_O = 300 mA, $\overline{ENABLE}$ at 0 V for TL751M05, T_J = –40°C to 125°C (unless otherwise noted)(1)

PARAMETER	TEST CONDITIONS		TL750M05 TL751M05 MIN	TYP	MAX	UNIT
Output voltage	V_I = 6 V to 26 V		4.85	5	5.15	V
Line regulation	V_I = 9 V to 16 V,	I_O = 250 mA		10	25	mV
	V_I = 6 V to 26 V,	I_O = 250 mA		12	50	
Power-supply ripple rejection	V_I = 8 V to 18 V,	f = 120 Hz		55		dB
Load regulation	I_O = 5 mA to 750 mA			20	50	mV
Dropout voltage(2)	I_O = 500 mA, T_J = 25°C				0.5	V
	I_O = 750 mA, T_J = 25°C				0.65	
Current consumption $I_q = I_I - I_O$	I_O = 750 mA			60	75	mA
	I_O = 10 mA				5	
Shutdown current (TL751M05 only)	$\overline{ENABLE}$ V_{IH} ≥ 2 V				200	µA

(1) Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.1-µF capacitor across the input and a 10-µF tantalum capacitor on the output, with equivalent series resistance within the guidelines shown in Figure 4.
(2) Measured when the output voltage, V_O, has dropped 100 mV from the nominal value obtained at V_I = 14 V

TL750M08/TL751M08 ELECTRICAL CHARACTERISTICS

V_I = 14 V, I_O = 300 mA, $\overline{ENABLE}$ at 0 V for TL751M08, T_J = –40°C to 125°C (unless otherwise noted)(1)

PARAMETER	TEST CONDITIONS		TL750M08 TL751M08 MIN	TYP	MAX	UNIT
Output voltage	V_I = 6 V to 26 V		7.76	8	8.24	V
Line regulation	V_I = 10 V to 17 V,	I_O = 250 mA		12	40	mV
	V_I = 9 V to 26 V,	I_O = 250 mA		15	68	
Power-supply ripple rejection	V_I = 11 V to 21 V,	f = 120 Hz		55		dB
Load regulation	I_O = 5 mA to 750 mA			24	80	mV
Dropout voltage(2)	I_O = 500 mA, T_J = 25°C				0.5	V
	I_O = 750 mA, T_J = 25°C				0.65	
Current consumption $I_q = I_I - I_O$	I_O = 750 mA, T_J = 25°C			60	75	mA
	I_O = 10 mA				5	
Shutdown current (TL751M08 only)	$\overline{ENABLE}$ V_{IH} ≥ 2 V				200	µA

(1) Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.1-µF capacitor across the input and a 10-µF tantalum capacitor on the output, with equivalent series resistance within the guidelines shown in Figure 4.
(2) Measured when the output voltage, V_O, has dropped 100 mV from the nominal value obtained at V_I = 14 V

PARAMETER MEASUREMENT INFORMATION

The TL750Mxx and TL751Mxx are low-dropout regulators. The output capacitor value and the parasitic equivalent series resistance (ESR) affect the bandwidth and stability of the control loop for these devices. For this reason, the capacitor and ESR must be carefully selected for a given operating temperature and load range. Figure 2 and Figure 3 can be used to establish the appropriate capacitance value and ESR for the best regulator transient response.

Figure 2 shows the recommended range of ESR for a given load with a 10-µF capacitor on the output. Figure 2 also shows a maximum ESR limit of 2 Ω and a load-dependent minimum ESR limit.

For applications with varying loads, the lightest load condition should be chosen because it is the worst case. Figure 3 shows the relationship of the reciprocal of ESR to the square root of the capacitance, with a minimum capacitance limit of 10 µF and a maximum ESR limit of 2 Ω. This figure establishes the amount that the minimum ESR limit shown in Figure 2 can be adjusted for different capacitor values. For example, where the minimum load needed is 200 mA, Figure 2 suggests an ESR range of 0.8 Ω to 2 Ω for 10 µF. Figure 3 shows that changing the capacitor from 10 µF to 400 µF can change the ESR minimum by greater than 3/0.5 (or 6). Therefore, the new minimum ESR value is 0.8/6 (or 0.13 Ω). This allows an ESR range of 0.13 Ω to 2 Ω, achieving an expanded ESR range by using a larger capacitor at the output. For better stability in low-current applications, a small resistance placed in series with the capacitor (see Table 1) is recommended, so that ESRs better approximate those shown in Figure 2 and Figure 3.

Table 1. Compensation for Increased Stability at Low Currents

MANUFACTURER	CAPACITANCE	ESR TYP	PART NUMBER	ADDITIONAL RESISTANCE
AVX	15 µF	0.9 Ω	TAJB156M010S	1 Ω
KEMET	33 µF	0.6 Ω	T491D336M010AS	0.5 Ω

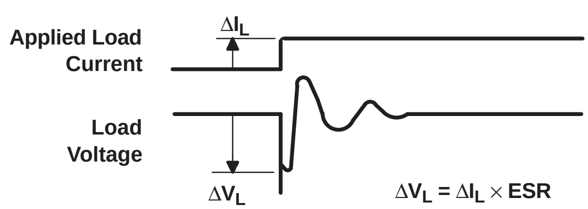


Figure 1.

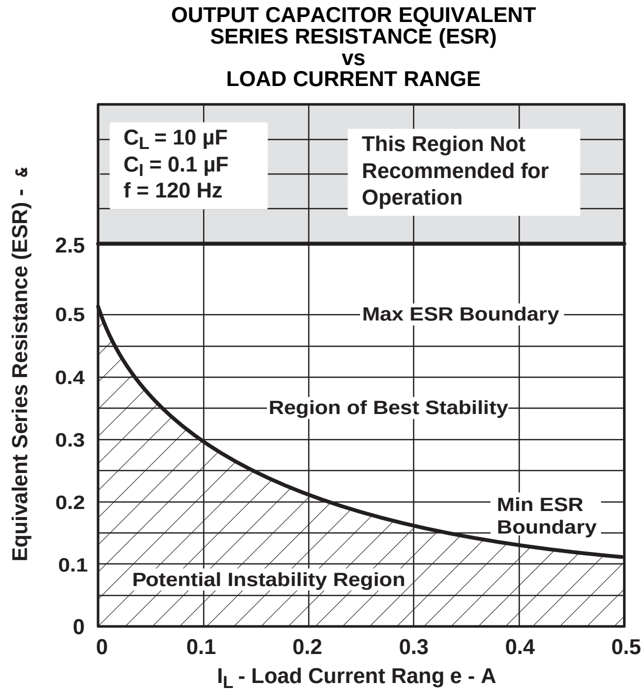


Figure 2.

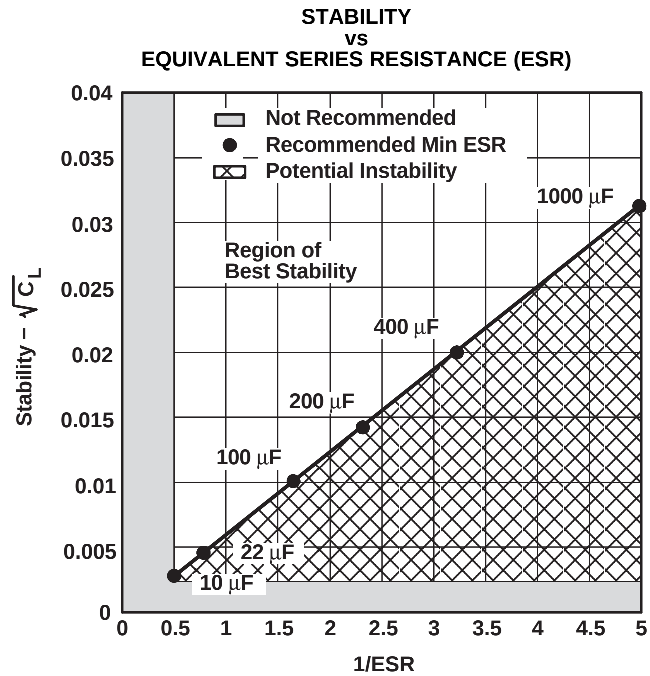


Figure 3.

TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
Transient input voltage	vs Time		4
Output voltage	vs Input voltage		5
Input current	vs Input voltage	I_O = 10 mA	6
		I_O = 100 mA	7
Dropout voltage	vs Output current		8
Quiescent current	vs Output current		9
Load transient response			10
Line transient response			11

TRANSIENT INPUT VOLTAGE vs TIME

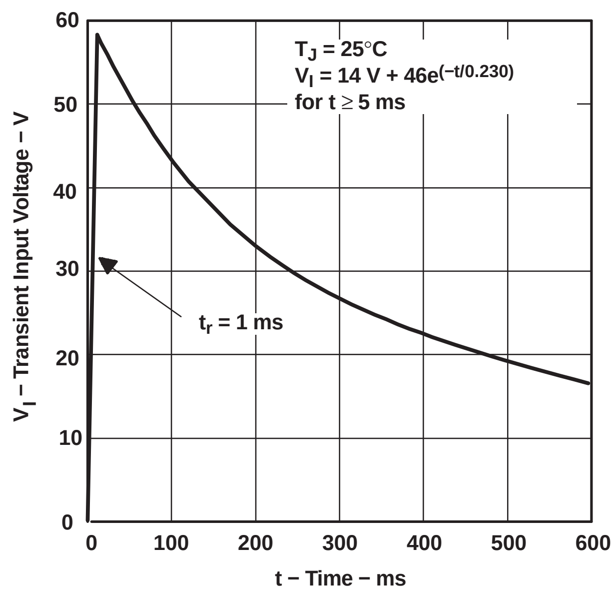


Figure 4.

OUTPUT VOLTAGE vs INPUT VOLTAGE

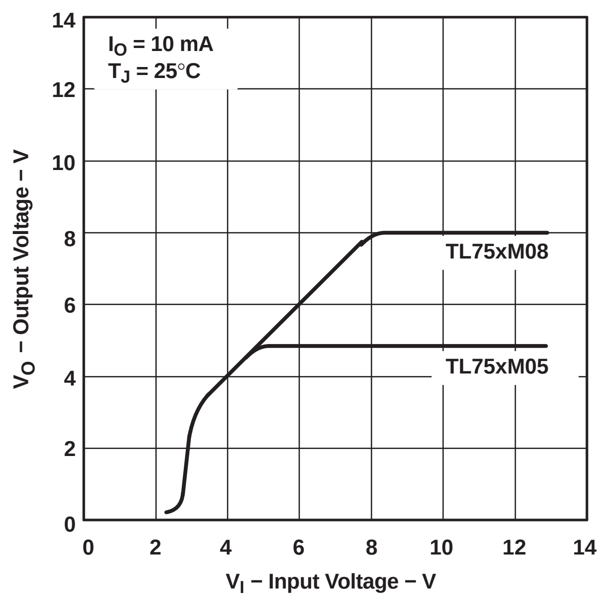


Figure 5.

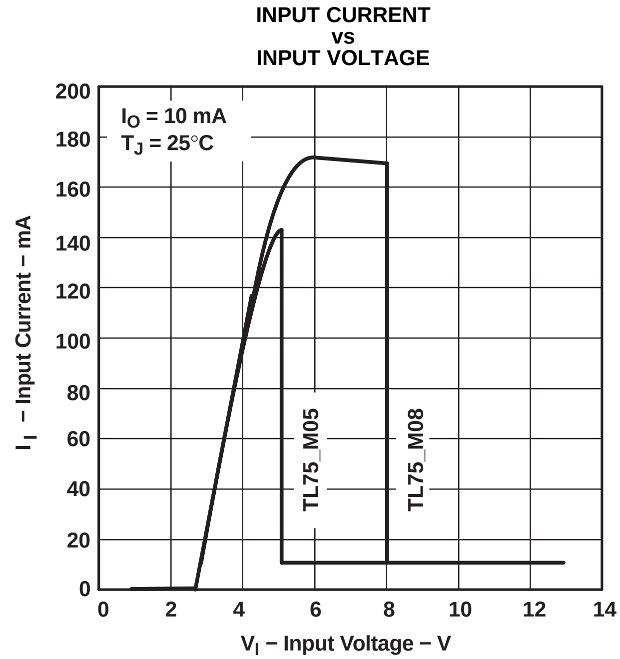


Figure 6.

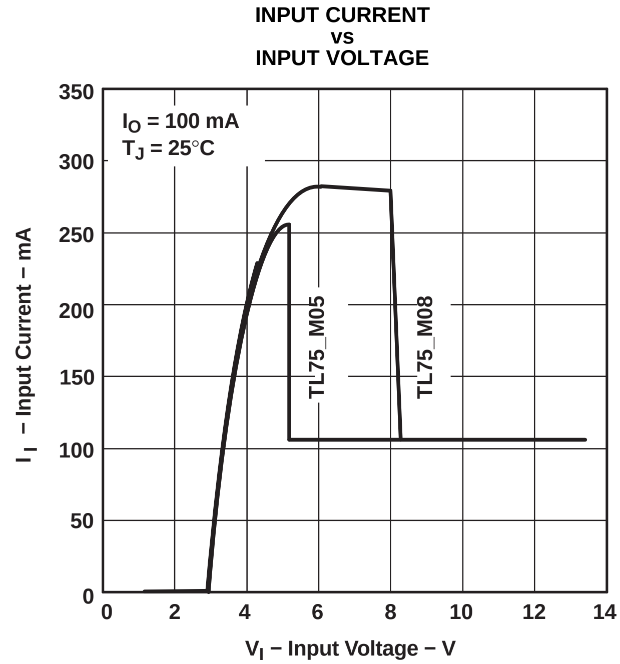


Figure 7.

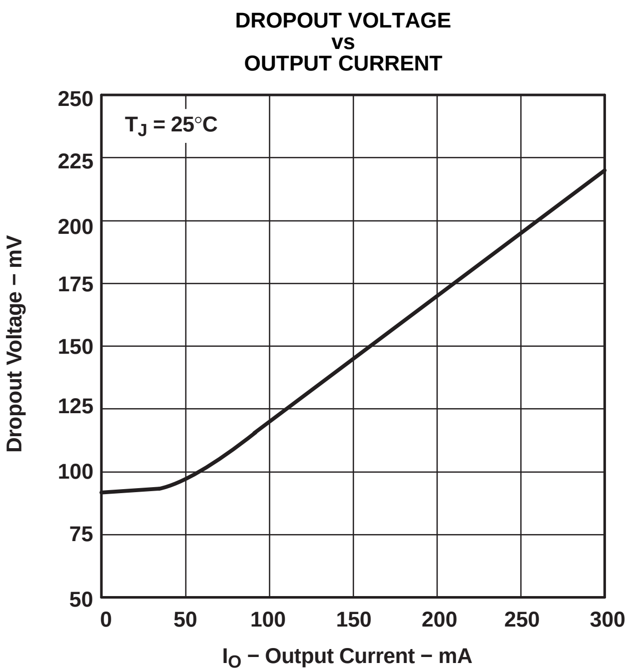


Figure 8.

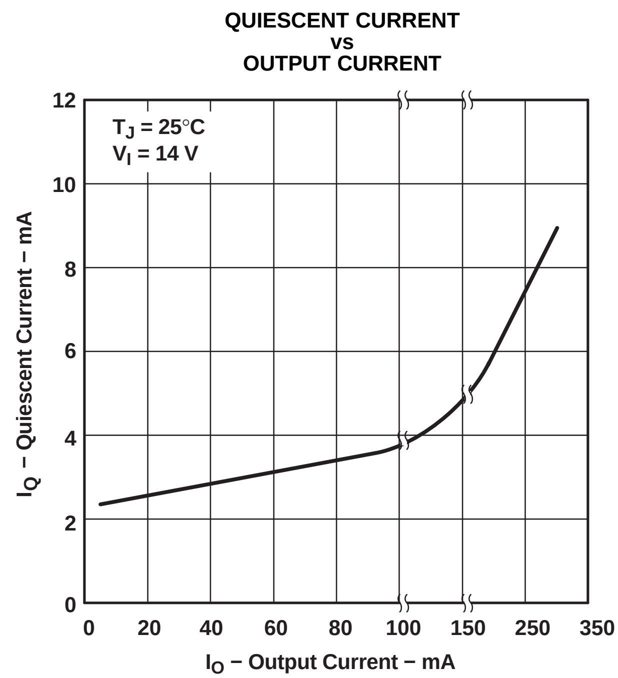


Figure 9.

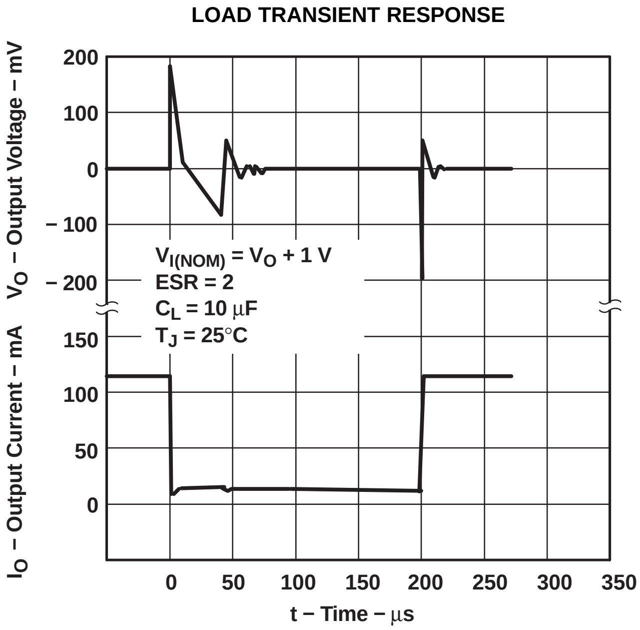


Figure 10.

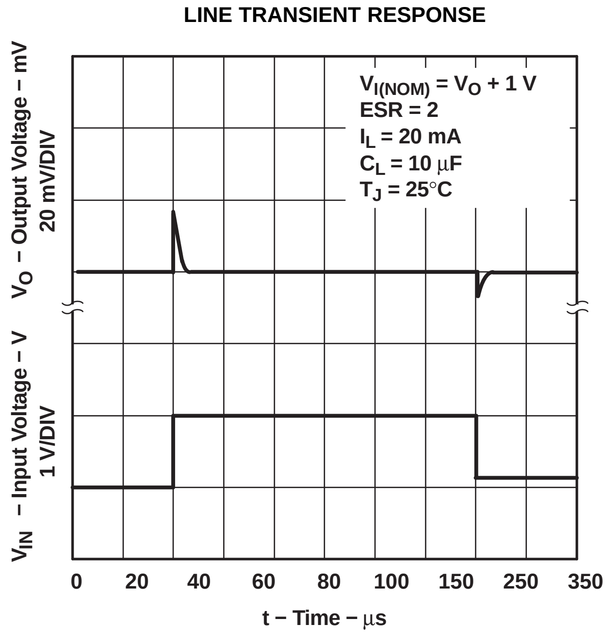


Figure 11.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
TL750M05QKTTRQ1	ACTIVE	DDPAK/ TO-263	KTT	3	500	Green (RoHS & no Sb/Br)	CU SN	Level-3-245C-168 HR
TL750M08QKTTRQ1	ACTIVE	DDPAK/ TO-263	KTT	3		TBD	Call TI	Call TI
TL751M05QKTTRQ1	ACTIVE	DDPAK/ TO-263	KTT	5		TBD	Call TI	Call TI
TL751M08QKTTRQ1	ACTIVE	DDPAK/ TO-263	KTT	5		TBD	Call TI	Call TI

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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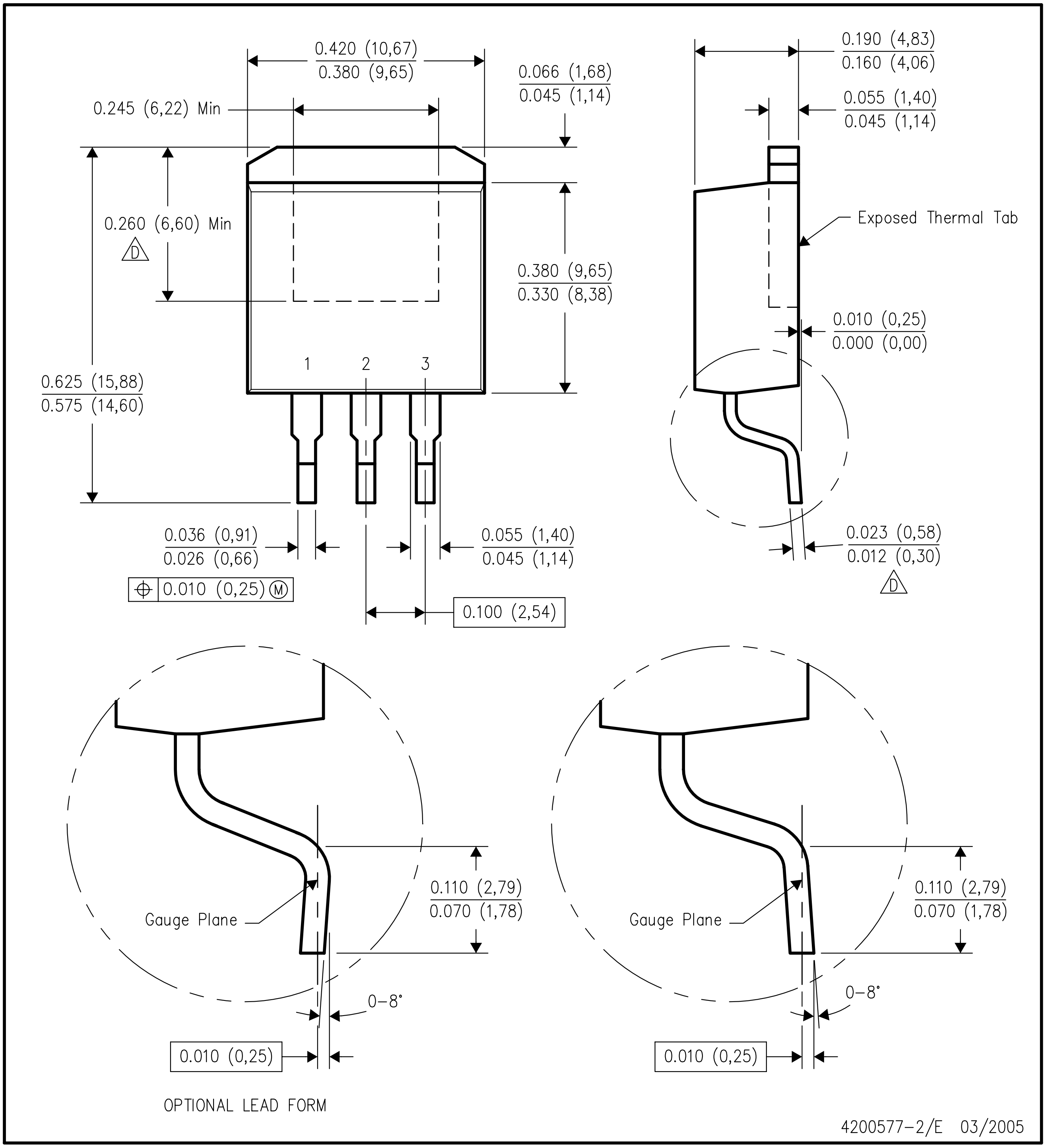
OTHER QUALIFIED VERSIONS OF TL750M05-Q1, TL750M08-Q1, TL751M05-Q1 :

- Catalog: TL750M05, TL750M08, TL751M05

NOTE: Qualified Version Definitions:

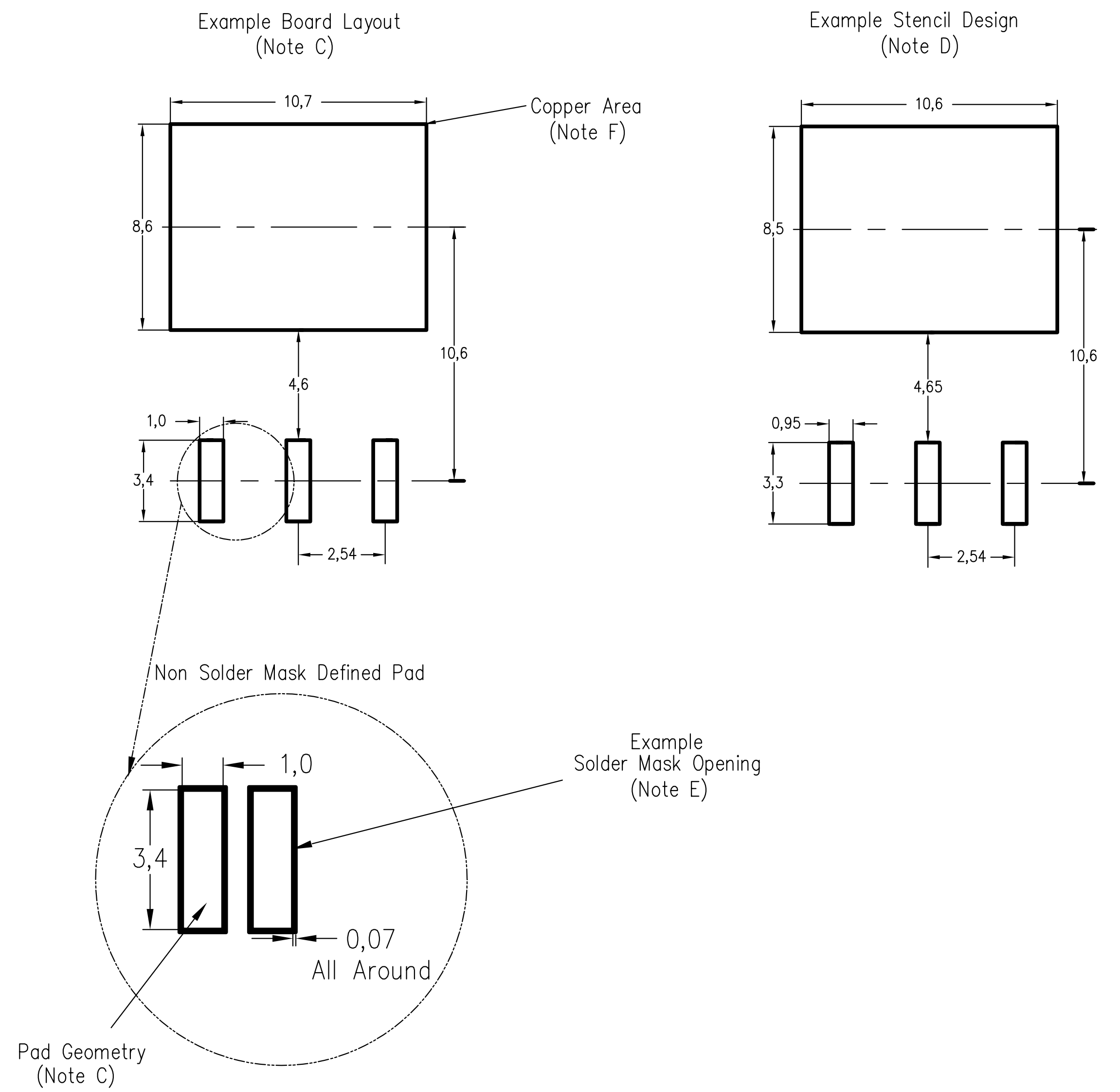
- Catalog - TI's standard catalog product

KTT (R–PSFM–G3) PLASTIC FLANGE–MOUNT PACKAGE



NOTES:
- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusion. Mold flash or protrusion not to exceed 0.005 (0,13) per side.
- D. Falls within JEDEC TO–263 variation AA, except minimum lead thickness and minimum exposed pad length.

KTT (R–PSFM–G3)



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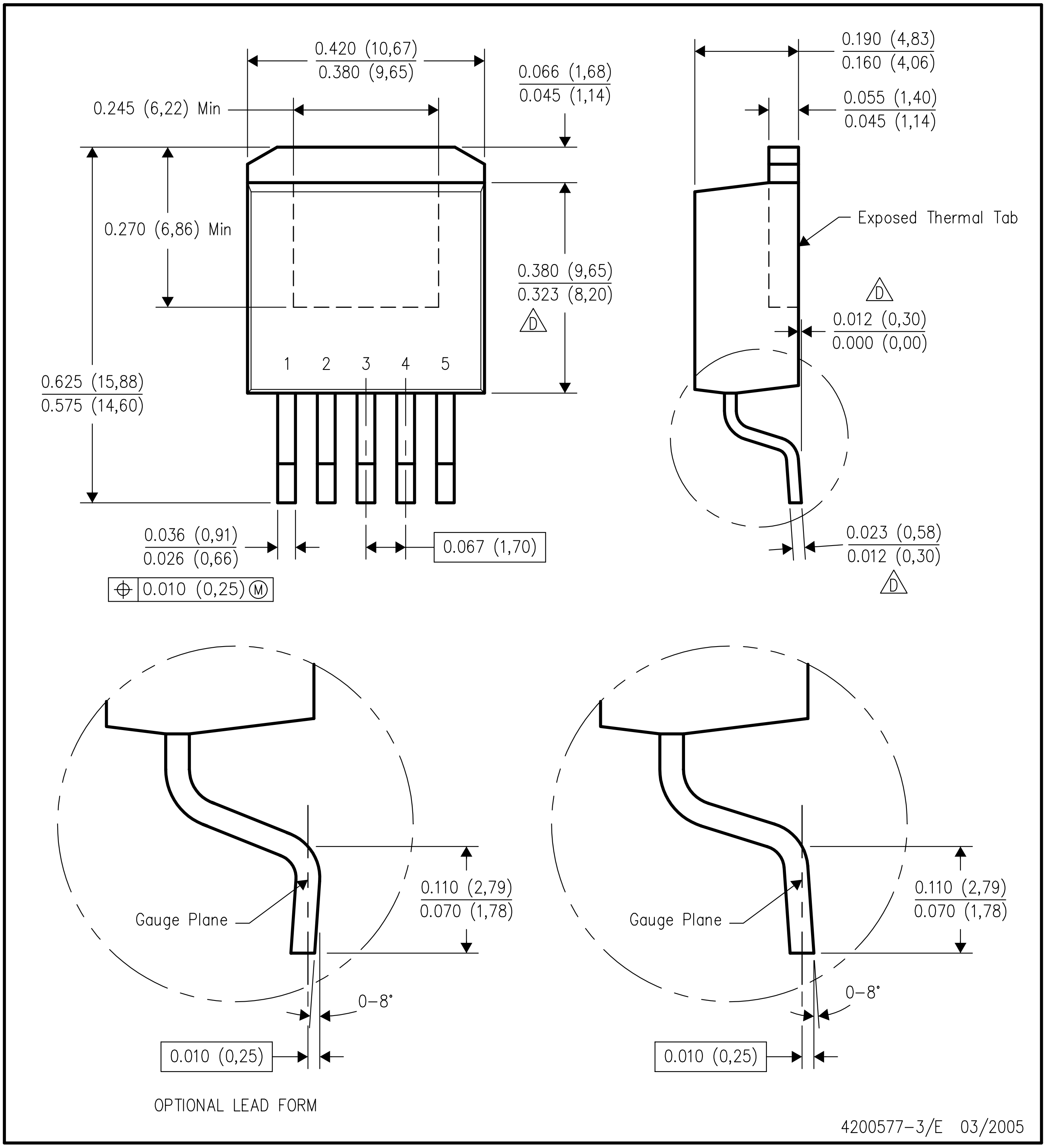
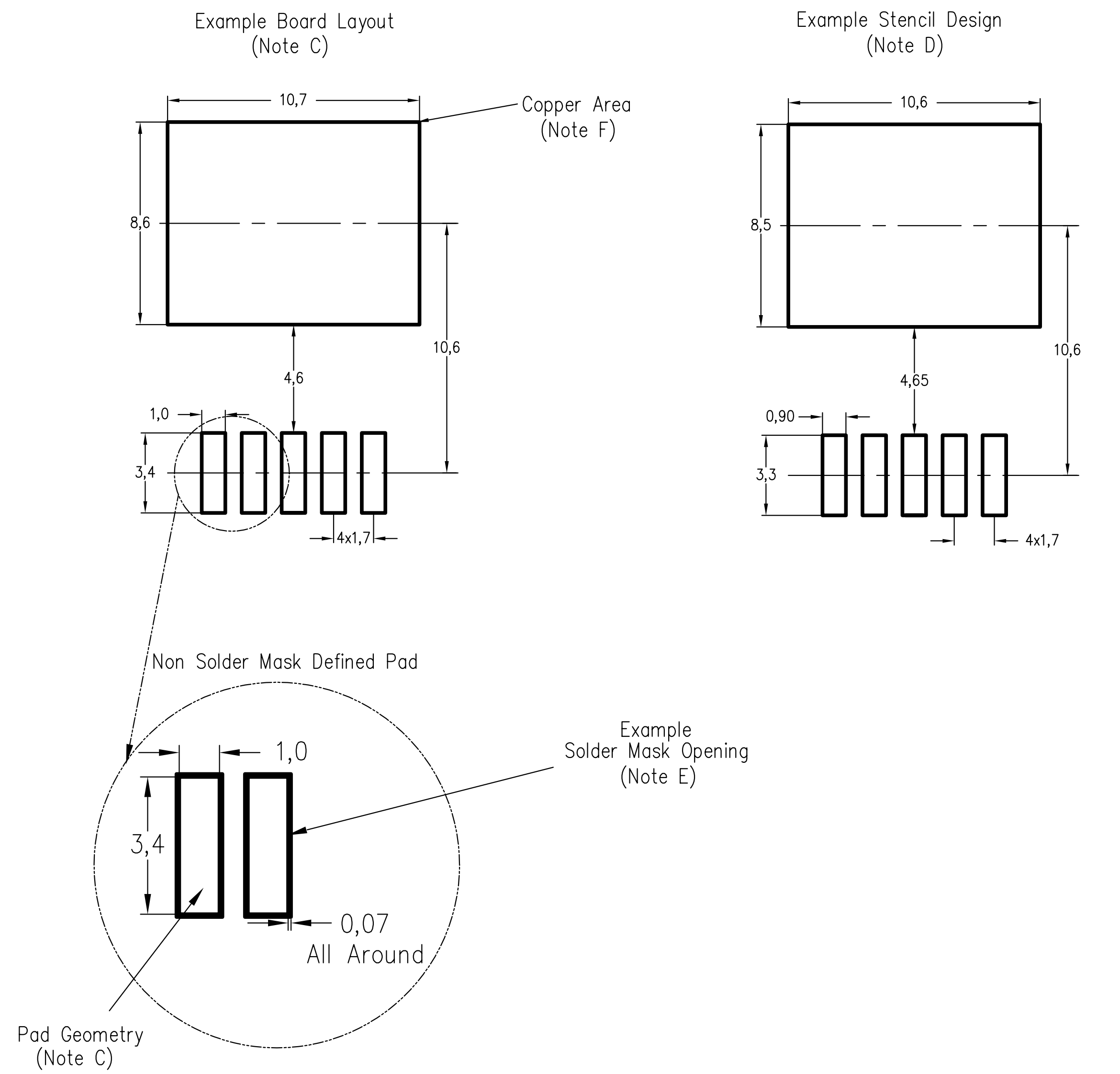
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–SM–782 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC–7525.
E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.
F. This package is designed to be soldered to a thermal pad on the board. Refer to the Product Datasheet for specific thermal information, via requirements, and recommended thermal pad size. For thermal pad sizes larger than shown a solder mask defined pad is recommended in order to maintain the solderable pad geometry while increasing copper area.

KTT (R–PSFM–G5) PLASTIC FLANGE–MOUNT PACKAGE



NOTES:
- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusion. Mold flash or protrusion not to exceed 0.005 (0,13) per side.
- D. Falls within JEDEC TO–263 variation BA, except minimum lead thickness, maximum seating height, and minimum body length.

KTT (R–PSFM–G5)



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NOTES:
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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265