LM2941/LM2941C 1A Low Dropout Adjustable Regulator

Check for Samples: LM2941, LM2941C

FEATURES

- **WSON Space Saving Package**
- **Output Voltage Adjustable From 5V to 20V**
- **Dropout Voltage Typically 0.5V @ I_O = 1A**
- **Output Current in Excess of 1A**
- **Trimmed Reference Voltage**
- **Reverse Battery Protection**
- **Internal Short Circuit Current Limit**
- **Mirror Image Insertion Protection**
- **P^+ Product Enhancement Tested**
- **TTL, CMOS Compatible ON/OFF Switch**

DESCRIPTION

The LM2941 positive voltage regulator features the ability to source 1A of output current with a typical dropout voltage of 0.5V and a maximum of 1V over the entire temperature range. Furthermore, a quiescent current reduction circuit has been included which reduces the ground pin current when the differential between the input voltage and the output voltage exceeds approximately 3V. The quiescent current with 1A of output current and an input-output differential of 5V is therefore only 30mA. Higher quiescent currents only exist when the regulator is in the dropout mode ($V_{IN} - V_{OUT} \leq 3V$).

Designed also for vehicular applications, the LM2941 and all regulated circuitry are protected from reverse battery installations or two-battery jumps. During line transients, such as load dump when the input voltage can momentarily exceed the specified maximum operating voltage, the regulator will automatically shut down to protect both the internal circuits and the load. Familiar regulator features such as short circuit and thermal overload protection are also provided.

Connection Diagrams

TO-220 Plastic Package

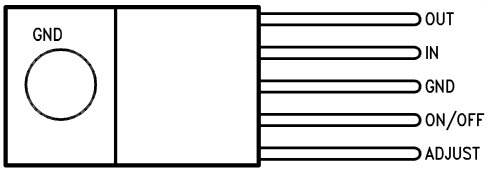


Figure 1. Top View
See Package Number KC

TO-263 Surface-Mount Package

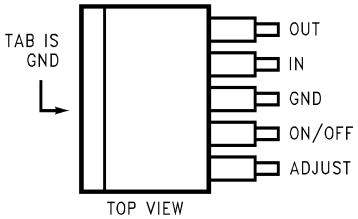


Figure 2. See Package Number KTT

8-Lead WSON Surface Mount Package

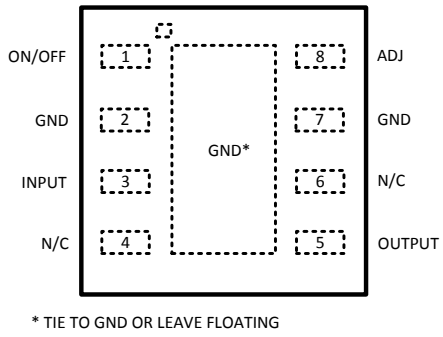


Figure 3. Top View
See Package Number NGN

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Absolute Maximum Ratings(1)(2)

Input Voltage (Survival Voltage, ≤ 100ms)	LM2941T, LM2941S, LM2941LD	60V
	LM2941CT, LM2941CS	45V
Internal Power Dissipation (3)		Internally Limited
Maximum Junction Temperature		150°C
Storage Temperature Range		−65°C ≤ T_J ≤ +150°C
Soldering Temperature(4)	TO-220 (T), Wave	260°C, 10s
	TO-263 (S)	235°C, 30s
	WSON-8 (LD)	235°C, 30s
ESD Rating (5)		±2 kV

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating ratings indicate conditions for which the device is intended to be functional, but device parameter specifications may not be ensured under these conditions. For ensured specifications and test conditions, see the Electrical Characteristics.
(2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/Distributors for availability and specifications.
(3) The maximum power dissipation is a function of T_J(max), θ_{JA}, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_J(max) - T_A)/\theta_{JA}$. If this dissipation is exceeded, the die temperature will rise above 150°C and the LM2941 will go into thermal shutdown. If the TO-263 package is used, the thermal resistance can be reduced by increasing the P.C. board copper area thermally connected to the package: Using 0.5 square inches of copper area, θ_{JA} is 50°C/W; with 1 square inch of copper area, θ_{JA} is 37°C/W; and with 1.6 or more square inches of copper area, θ_{JA} is 32°C/W. Thermal performance for the WSON package was obtained using a JESD51-7 board with six vias, using no airflow and an ambient temperature of 22°C. The value θ_{JA} for the WSON package is specifically dependent on PCB trace area, trace material, and the number of layers and thermal vias. For improved thermal resistance and power dissipation for the WSON package, refer to Application Note AN-1187 (literature number SNOA401). It is recommended that 6 vias be placed under the center pad to improve thermal performance.
(4) Refer to JEDEC J-STD-020C for surface mount device (SMD) package reflow profiles and conditions. Unless otherwise stated, the temperature and time are for Sn-Pb (STD) only.
(5) The Human Body Model (HBM) is a 100 pF capacitor discharged through a 1.5kΩ resistor into each pin. Test method is per JESD22–A114.

Operating Ratings

Maximum Input Voltage		26V
Temperature Range	LM2941T	−40°C ≤ T_J ≤ 125°C
	LM2941CT	0°C ≤ T_J ≤ 125°C
	LM2941S	−40°C ≤ T_J ≤ 125°C
	LM2941CS	0°C ≤ T_J ≤ 125°C
	LM2941LD	−40°C ≤ T_J ≤ 125°C

Electrical Characteristics—LM2941T, LM2941S, LM2941LD

5V ≤ V_O ≤ 20V, V_{IN} = V_O + 5V, C_O = 22µF, unless otherwise specified. Specifications in standard typeface apply for T_J = 25°C, while those in **boldface type** apply over the full **Operating Temperature Range.**

Parameter	Conditions	Typ	LM2941T LM2941S LM2941LD Limit	Units (Limits)
Reference Voltage	5mA ≤ I_O ≤ 1A (1)	1.275	1.237/**1.211**	V(min)
			1.313/**1.339**	V(max)
Line Regulation	V_O + 2V ≤ V_{IN} ≤ 26V, I_O = 5mA	4	10/**10**	mV/V(max)
Load Regulation	50mA ≤ I_O ≤ 1A	7	10/**10**	mV/V(max)
Output Impedance	100 mADC and 20 mArms f_O = 120Hz	7		mΩ/V
Quiescent Current	V_O + 2V ≤ V_{IN} < 26V, I_O = 5mA	10	15/**20**	mA(max)
	V_{IN} = V_O + 5V, I_O = 1A	30	45/**60**	mA(max)

(1) The output voltage range is 5V to 20V and is determined by the two external resistors, R1 and R2. See Typical Application Circuit.

Electrical Characteristics—LM2941T, LM2941S, LM2941LD (continued)

5V ≤ V_O ≤ 20V, V_{IN} = V_O + 5V, C_O = 22µF, unless otherwise specified. Specifications in standard typeface apply for T_J = 25°C, while those in **boldface type** apply over the full **Operating Temperature Range.**

Parameter	Conditions	Typ	LM2941T LM2941S LM2941LD Limit	Units (Limits)
RMS Output Noise, % of V_{OUT}	10Hz–100kHz I_O = 5mA	0.003		%
Ripple Rejection	f_O = 120Hz, 1 Vrms, I_L = 100mA	0.005	0.02/**0.04**	%/V(max)
Long Term Stability		0.4		%/1000 Hr
Dropout Voltage	I_O = 1A	0.5	0.8/**1.0**	V(max)
	I_O = 100mA	110	200/**200**	mV(max)
Short Circuit Current	V_{IN} Max = 26V (2)	1.9	1.6	A(min)
Maximum Line Transient	V_O Max 1V Above Nominal V_O R_O = 100, t ≤ 100ms	75	60/**60**	V(min)
Maximum Operational Input Voltage		31	26/**26**	V_{DC}
Reverse Polarity DC Input Voltage	R_O = 100, V_O ≥ −0.6V	−30	−15/**−15**	V(min)
Reverse Polarity Transient Input Voltage	t ≤ 100ms, R_O = 100Ω	−75	−50/**−50**	V(min)
ON/OFF Threshold Voltage ON	I_O ≤ 1A	1.30	0.80/**0.80**	V(max)
ON/OFF Threshold Voltage OFF	I_O ≤ 1A	1.30	2.00/**2.00**	V(min)
ON/OFF Threshold Current	$V_{ON/OFF}$ = 2.0V, I_O ≤ 1A	50	100/**300**	µA(max)

(2) Output current capability will decrease with increasing temperature, but will not go below 1A at the maximum specified temperatures.

Electrical Characteristics—LM2941CT, LM2941CS

5V ≤ V_O ≤ 20V, V_{IN} = V_O + 5V, C_O = 22µF, unless otherwise specified. Specifications in standard typeface apply for T_J = 25°C, while those in **boldface type** apply over the full **Operating Temperature Range**.

Parameter	Conditions	Typ	Limit (1)	Units (Limits)
Reference Voltage	5mA ≤ I_O ≤ 1A (2)	1.275	1.237/**1.211**	V(min)
			1.313/**1.339**	V(max)
Line Regulation	V_O + 2V ≤ V_{IN} ≤ 26V, I_O = 5mA	4	10	mV/V(max)
Load Regulation	50mA ≤ I_O ≤ 1A	7	10	mV/V(max)
Output Impedance	100 mADC and 20 mArms f_O = 120Hz	7		mΩ/V
Quiescent Current	V_O + 2V ≤ V_{IN} < 26V, I_O = 5mA	10	15	mA(max)
	V_{IN} = V_O + 5V, I_O = 1A	30	45/**60**	mA(max)
RMS Output Noise, % of V_{OUT}	10Hz–100kHz I_O = 5mA	0.003		%
Ripple Rejection	f_O = 120Hz, 1 Vrms, I_L = 100mA	0.005	0.02	%/V(max)
Long Term Stability		0.4		%/1000 Hr
Dropout Voltage	I_O = 1A	0.5	0.8/**1.0**	V(max)
	I_O = 100mA	110	200/**200**	mV(max)
Short Circuit Current	V_{IN} Max = 26V (3)	1.9	1.6	A(min)

(1) All limits specified at room temperature (standard typeface) and at temperature extremes (boldface type). All room temperature limits are 100% production tested. All limits at temperature extremes are ensured via correlation using standard Statistical Quality Control (SQC) methods.
(2) The output voltage range is 5V to 20V and is determined by the two external resistors, R1 and R2. See Typical Application Circuit.
(3) Output current capability will decrease with increasing temperature, but will not go below 1A at the maximum specified temperatures.

Electrical Characteristics—LM2941CT, LM2941CS (continued)

5V ≤ V_O ≤ 20V, V_{IN} = V_O + 5V, C_O = 22µF, unless otherwise specified. Specifications in standard typeface apply for T_J = 25°C, while those in **boldface type** apply over the full **Operating Temperature Range**.

Parameter	Conditions	Typ	Limit (1)	Units (Limits)
Maximum Line Transient	V_O Max 1V Above Nominal V_O R_O = 100Ω, T ≤ 100ms	55	45	V(min)
Maximum Operational Input Voltage		31	26	V_{DC}
Reverse Polarity DC Input Voltage	R_O = 100Ω, V_O ≥ −0.6V	−30	−15	V(min)
Reverse Polarity Transient Input Voltage	T ≤ 100ms, R_O = 100Ω	−55	−45	V(min)
ON/OFF Threshold Voltage ON	I_O ≤ 1A	1.30	0.80	V(max)
ON/OFF Threshold Voltage OFF	I_O ≤ 1A	1.30	2.00	V(min)
ON/OFF Threshold Current	$V_{ON/OFF}$ = 2.0V, I_O ≤ 1A	50	100	µA(max)

Thermal Performance

Thermal Resistance Junction-to-Case, θ_{JC}	5-Lead TO-220	1		°C/W
	5-Lead TO-263	1		°C/W
	8-Lead WSON	5.3		°C/W
Thermal Resistance Junction-to-Ambient, θ_{JA} (1)	5-Lead TO-220	53		°C/W
	5-Lead TO-263 (See TO-263 Mounting)	73		°C/W
	8-Lead WSON (See WSON Mounting)	35		°C/W

(1) The maximum power dissipation is a function of T_J(max), θ_{JA}, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_J(max) - T_A)/\theta_{JA}$. If this dissipation is exceeded, the die temperature will rise above 150°C and the LM2941 will go into thermal shutdown. If the TO-263 package is used, the thermal resistance can be reduced by increasing the P.C. board copper area thermally connected to the package: Using 0.5 square inches of copper area, θ_{JA} is 50°C/W; with 1 square inch of copper area, θ_{JA} is 37°C/W; and with 1.6 or more square inches of copper area, θ_{JA} is 32°C/W. Thermal performance for the WSON package was obtained using a JESD51-7 board with six vias, using no airflow and an ambient temperature of 22°C. The value θ_{JA} for the WSON package is specifically dependent on PCB trace area, trace material, and the number of layers and thermal vias. For improved thermal resistance and power dissipation for the WSON package, refer to Application Note AN-1187 (literature number SNOA401). It is recommended that 6 vias be placed under the center pad to improve thermal performance.

Typical Performance Characteristics

Dropout Voltage

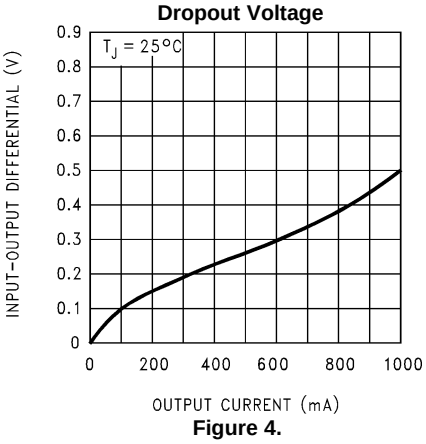


Figure 4.

Dropout Voltage vs. Temperature

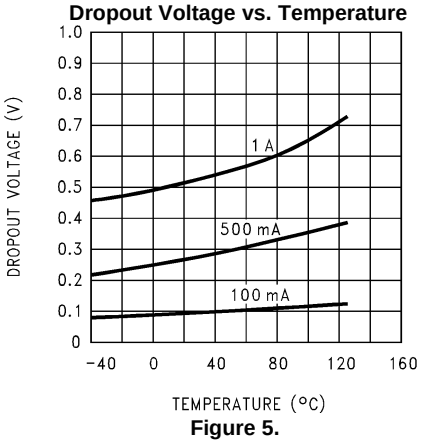


Figure 5.

Output Voltage

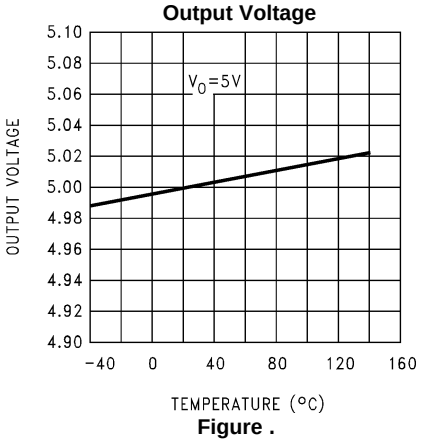


Figure .

Quiescent Current vs. Temperature

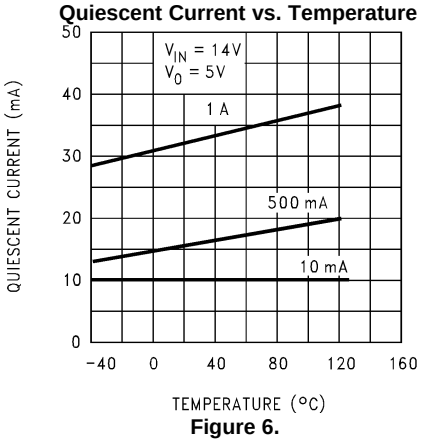


Figure 6.

Quiescent Current

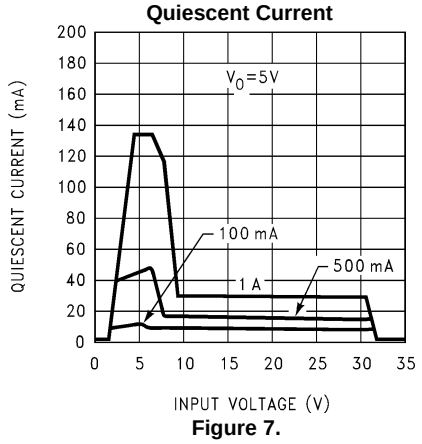


Figure 7.

Quiescent Current

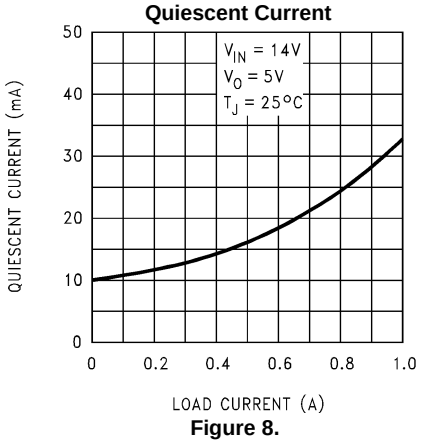


Figure 8.

Typical Performance Characteristics (continued)

Line Transient Response

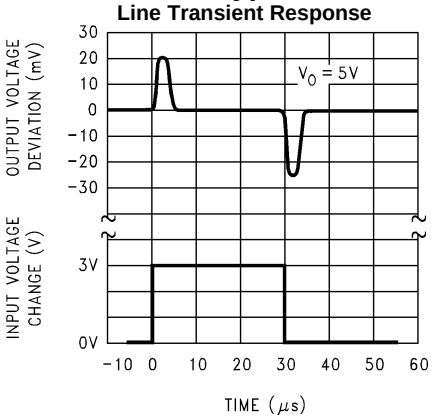


Figure 9.

Load Transient Response

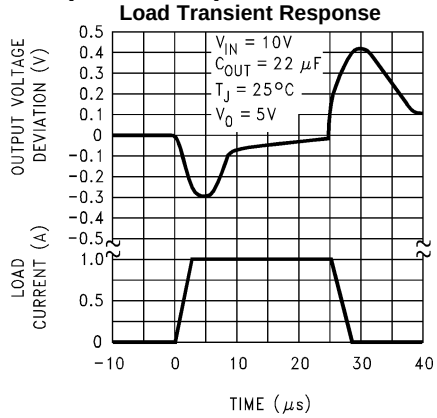


Figure 10.

Ripple Rejection

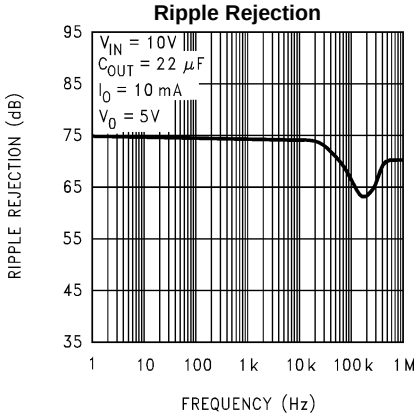


Figure 11.

Output Impedance

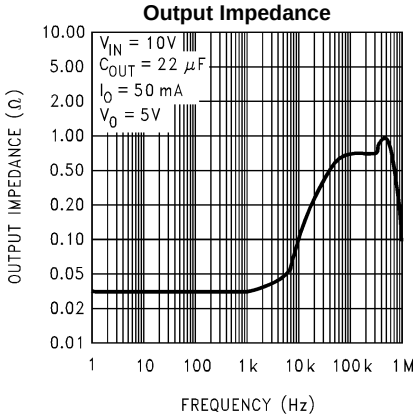


Figure 12.

Low Voltage Behavior

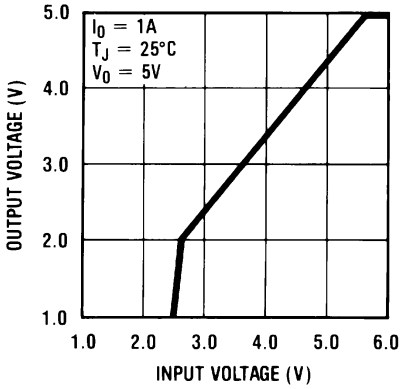


Figure 13.

Low Voltage Behavior

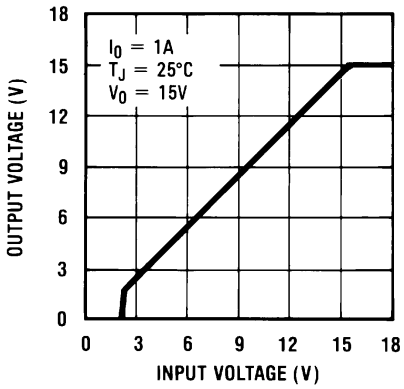


Figure 14.

Typical Performance Characteristics (continued)

Output Capacitor ESR

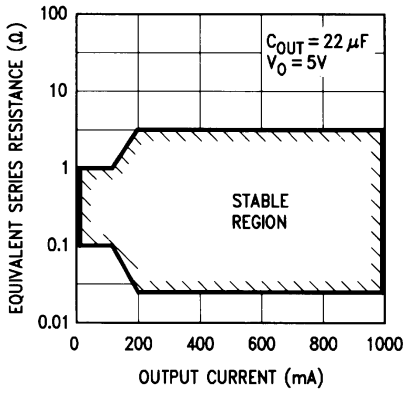


Figure 15.

Output at Voltage Extremes

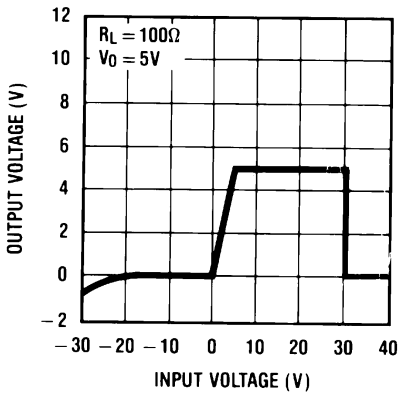


Figure 16.

Output at Voltage Extremes

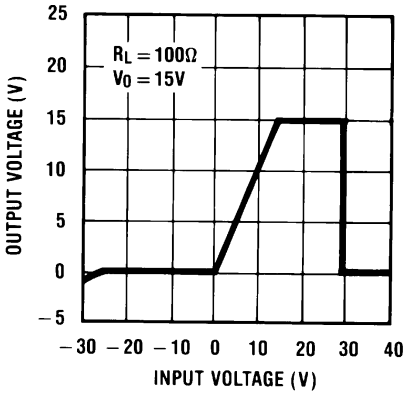


Figure 17.

Peak Output Current

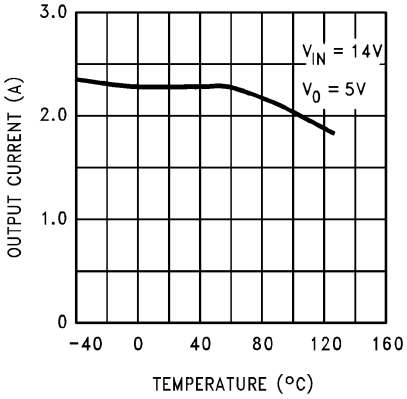


Figure 18.

Maximum Power Dissipation (TO-220)

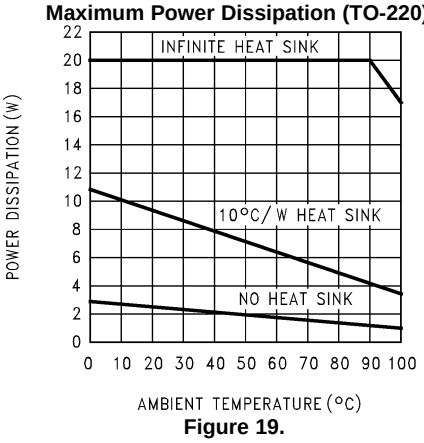


Figure 19.

Maximum Power Dissipation (TO-263)

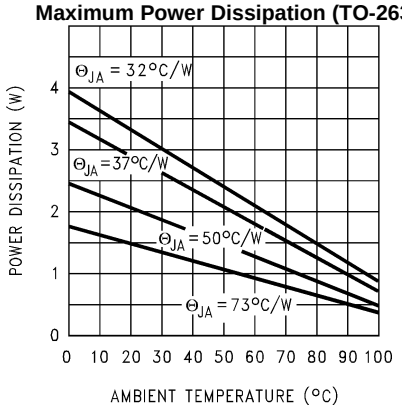


Figure 20.

Definition of Terms

Dropout Voltage: The input-voltage differential at which the circuit ceases to regulate against further reduction in input voltage. Measured when the output voltage has dropped 100mV from the nominal value obtained at (V_{OUT} + 5V) input, dropout voltage is dependent upon load current and junction temperature.

Input Voltage: The DC voltage applied to the input terminals with respect to ground.

Input-Output Differential: The voltage difference between the unregulated input voltage and the regulated output voltage for which the regulator will operate.

Line Regulation: The change in output voltage for a change in the input voltage. The measurement is made under conditions of low dissipation or by using pulse techniques such that the average chip temperature is not significantly affected.

Load Regulation: The change in output voltage for a change in load current at constant chip temperature.

Long Term Stability: Output voltage stability under accelerated life-test conditions after 1000 hours with maximum rated voltage and junction temperature.

Output Noise Voltage: The rms AC voltage at the output, with constant load and no input ripple, measured over a specified frequency range.

Quiescent Current: That part of the positive input current that does not contribute to the positive load current. The regulator ground lead current.

Ripple Rejection: The ratio of the peak-to-peak input ripple voltage to the peak-to-peak output ripple voltage.

Temperature Stability of V_O: The percentage change in output voltage for a thermal variation from room temperature to either temperature extreme.

APPLICATION HINTS

Output Capacitor

A Tantalum capacitor with a minimum capacitance value of 22 µF, and ESR in the range of 0.01Ω to 5Ω, is required at the output pin for loop stability. It must be located less than 1 cm from the device. There is no limitation on any additional capacitance.

Alternately, a high quality X5R/X7R 22 µF ceramic capacitor may be used for the output capacitor only if an appropriate value of series resistance is added to simulate the ESR requirement. The ceramic capacitor selection must include an appropriate voltage de-rating of the capacitance value due to the applied output voltage. The series resistor (for ESR simulation) should be in the range of 0.1Ω to 1.0Ω.

Setting the Output Voltage

The output voltage range is 5V to 20V and is set by the two external resistors, R1 and R2. See the Typical Applications. The output voltage is given by the formula:

$$V_{OUT} = V_{REF} \times ((R1+R2) / R1) \quad (1)$$

where V_{REF} is typically 1.275V.

Using 1.00 kΩ for R1 will ensure that the bias current error of the adjust pin will be negligible. Using a R1 value higher than 10 kΩ may cause the output voltage to shift across temperature due to variations in the adjust pin bias current.

Calculating the upper resistor (R2) value of the pair when the lower resistor (R1) value is known is accomplished with the following formula:

$$R2 = R1 \times ((V_{OUT} / V_{REF}) - 1) \quad (2)$$

The resistors used for R1 and R2 should be high quality, tight tolerance, and with matching temperature coefficients. It is important to remember that, although the value of V_{REF} is ensured, the final value of V_{OUT} is not. The use of low quality resistors for R1 and R2 can easily produce a V_{OUT} value that is unacceptable.

ON/OFF

The ON/OFF pin has no internal pull-up or pull-down to establish a default condition and, as a result, this pin must be terminated externally, either actively or passively.

The ON/OFF pin requires a low level to enable the output, and a high level to disable the output. To ensure reliable operation, the ON/OFF pin voltage must rise above the maximum $ON/OFF_{(OFF)}$ voltage threshold (2.00V) to disable the output, and must fall below the minimum $ON/OFF_{(ON)}$ voltage threshold (0.80V) to enable the output. If the ON/OFF function is not needed this pin can be connected directly to Ground.

If the ON/OFF pin is being pulled to a high state through a series resistor, an allowance must be made for the ON/OFF pin current that will cause a voltage drop across the pull-up resistor.

Thermal Overload Protection

The LM2941 incorporates a linear form of thermal protection that limits the junction temperature (T_J) to typically 155°C.

Should the LM2941 see a fault condition that results in excessive power dissipation and the junction temperature approaches 155°C, the device will respond by reducing the output current (which reduces the power dissipation) to hold the junction temperature at 155°C.

Thermal Overload protection is not an ensured operating condition. Operating at, or near to, the Thermal Overload condition for any extended period of time is not encouraged, or recommended, as this may shorten the lifetime of the device.

Power Dissipation

Consideration should be given to the maximum power dissipation ($P_{D(MAX)}$) which is limited by the maximum operating junction temperature ($T_{J(MAX)}$) of 125°C, the maximum operating ambient temperature ($T_{A(MAX}$)) of the application, and the thermal resistance (θ_{JA}) of the package. Under all possible conditions, the junction temperature (T_J) must be within the range specified in the Operating Ratings. The total power dissipation of the device is given by:

$$P_D = ((V_{IN} - V_{OUT}) \times I_{OUT}) + (V_{IN} \times I_{GND}) \quad (3)$$

where I_{GND} is the operating ground pin current of the device (specified under Electrical Characteristics).

The maximum allowable junction temperature rise (ΔT_J) depends on the maximum expected ambient temperature ($T_{A(MAX)}$) of the application, and the maximum allowable junction temperature ($T_{J(MAX)}$):

$$\Delta T_J = T_{J(MAX)} - T_{A(MAX)} \quad (4)$$

The maximum allowable value for junction to ambient Thermal Resistance, θ_{JA}, required to keep the junction temperature, T_J, from exceeding maximum allowed can be calculated using the formula:

$$\theta_{JA} = \Delta T_J / P_{D(MAX)} \quad (5)$$

The maximum allowable power dissipation, $P_{D(MAX)}$, required allowed for a specific ambient temperature can be calculated using the formula:

$$P_{D(MAX)} = \Delta T_J / \theta_{JA} \quad (6)$$

Additional information for thermal performance of surface mount packages can be found in *AN-1520: A Guide to Board Layout for Best Thermal Resistance for Exposed Packages* (literature number SNVA183), *AN-1187: Leadless Leadframe Package (LLP)* (literature number SNOA401), and *AN-2020: Thermal Design By Insight, Not Hindsight* (literature number SNVA419).

TO-263 Mounting

The thermal dissipation of the TO-263 package is directly related to the printed circuit board construction and the amount of additional copper area connected to the TAB.

The TAB on the bottom of the TO-263 package is connected to the die substrate via a conductive die attach adhesive, and to device pin 3. As such, it is strongly recommend that the TAB area be connected to copper area directly under the TAB that is extended into the ground plane via multiple thermal vias. Alternately, but not recommended, the TAB may be left floating (i.e. no direct electrical connection). The TAB must not be connected to any potential other than ground.

For the LM2941S in the KTT TO-263 package, the junction-to-case thermal rating, θ_{JC}, is 1°C/W, where the CASE is defined as the bottom of the package at the center of the TAB area. The junction-to-ambient thermal performance for the LM2941S in the TO-263 package, using the JEDEC JESD51 standards is summarized in the following table:

Board Type	Thermal Vias	θ_{JC}	θ_{JA}
JEDEC 2-Layer JESD 51-3	None	1°C/W	73°C/W
JEDEC 4-Layer JESD 51-7	1	1°C/W	35°C/W
	2	1°C/W	30°C/W
	4	1°C/W	26°C/W
	8	1°C/W	24°C/W

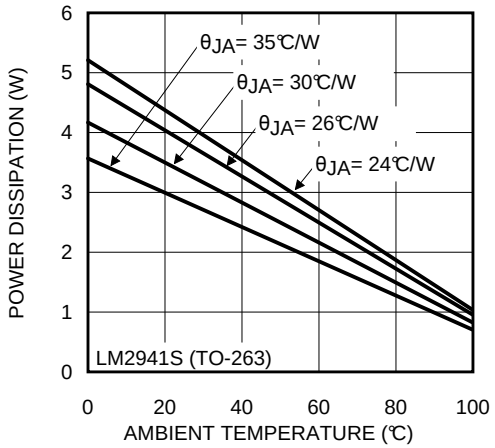


Figure 21. $P_{D(MAX)}$ vs T_A for LM2941S (TO-263)

WSON Mounting

The NGN (Pullback) 8-Lead WSON package requires specific mounting techniques which are detailed in Application Note 1187 (literature number SNOA401). Referring to the section **PCB Design Recommendations** in AN-1187 (Page 5), it should be noted that the pad style which should be used with the WSON package is the NSMD (non-solder mask defined) type.

The thermal dissipation of the WSON package is directly related to the printed circuit board construction and the amount of additional copper area connected to the DAP.

The DAP (exposed pad) on the bottom of the WSON package is connected to the die substrate via a conductive die attach adhesive, and to device pin 2 and pin 7. As such, it is strongly recommend that the DAP area be connected copper area directly under the DAP that is extended into the ground plane via multiple thermal vias. Alternately, but not recommended, the DAP area may be left floating (i.e. no direct electrical connection). The DAP area must not be connected to any potential other than ground.

For the LM2941LD in the NGN 8-Lead WSON package, the junction-to-case thermal rating, θ_{JC}, is 5.3°C/W, where the CASE is defined as the bottom of the package at the center of the DAP area. The junction-to-ambient thermal performance for the LM2941LD in the NGN 8-Lead WSON package, using the JEDEC JESD51 standards is summarized in the following table:

Board Type	Thermal Vias	θ_{JC}	θ_{JA}
JEDEC 2-Layer JESD 51-3	None	5.3°C/W	181°C/W
JEDEC 4-Layer JESD 51-7	1	5.3°C/W	58°C/W
	2	5.3°C/W	49°C/W
	4	5.3°C/W	40°C/W
	6	5.3°C/W	35°C/W

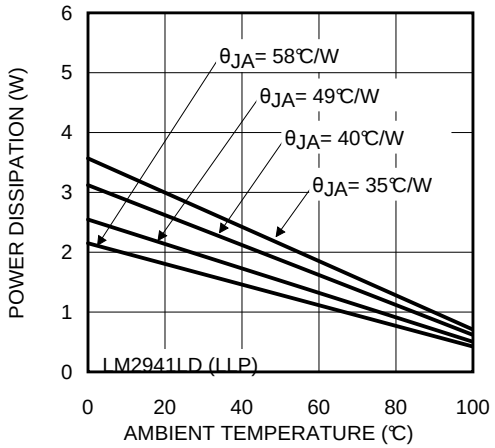
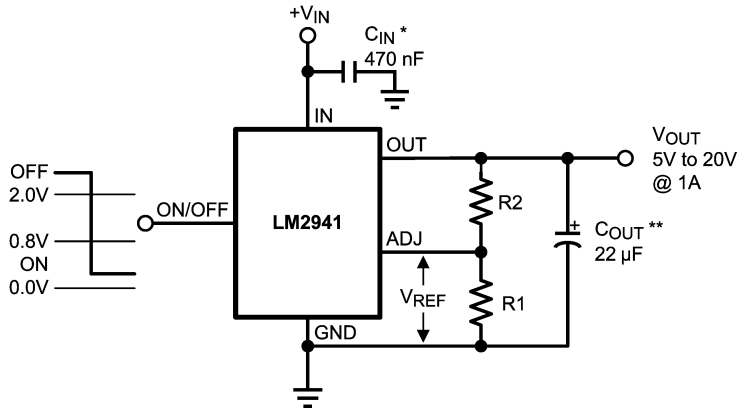


Figure 22. $PD_{(MAX)}$ vs T_A for LM2941LD (WSON)

Typical Applications



V_{OUT} = Reference voltage $\times \frac{R1 + R2}{R1}$ where V_{REF} = 1.275 typical

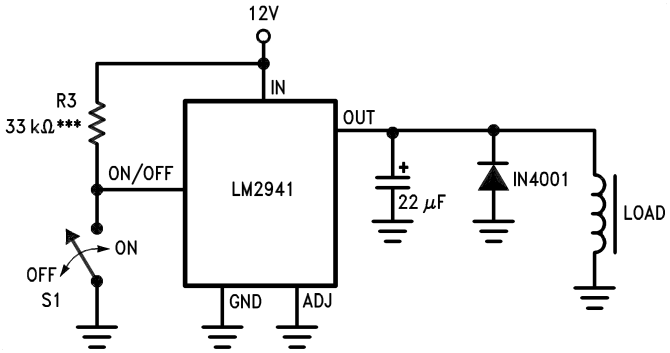
Solving for R2: $R2 = R1 \left(\frac{V_O}{V_{REF}} - 1\right)$

Note: Using 1k for R1 will ensure that the bias current error from the adjust pin will be negligible. Do not bypass R1 or R2. This will lead to instabilities.

***** Required if regulator is located far from power supply filter.

****** C_{OUT} must be at least 22µF to maintain stability. May be increased without bound to maintain regulation during transients. Locate as close as possible to the regulator. This capacitor must be rated over the same operating temperature range as the regulator and the ESR is critical; see curve.

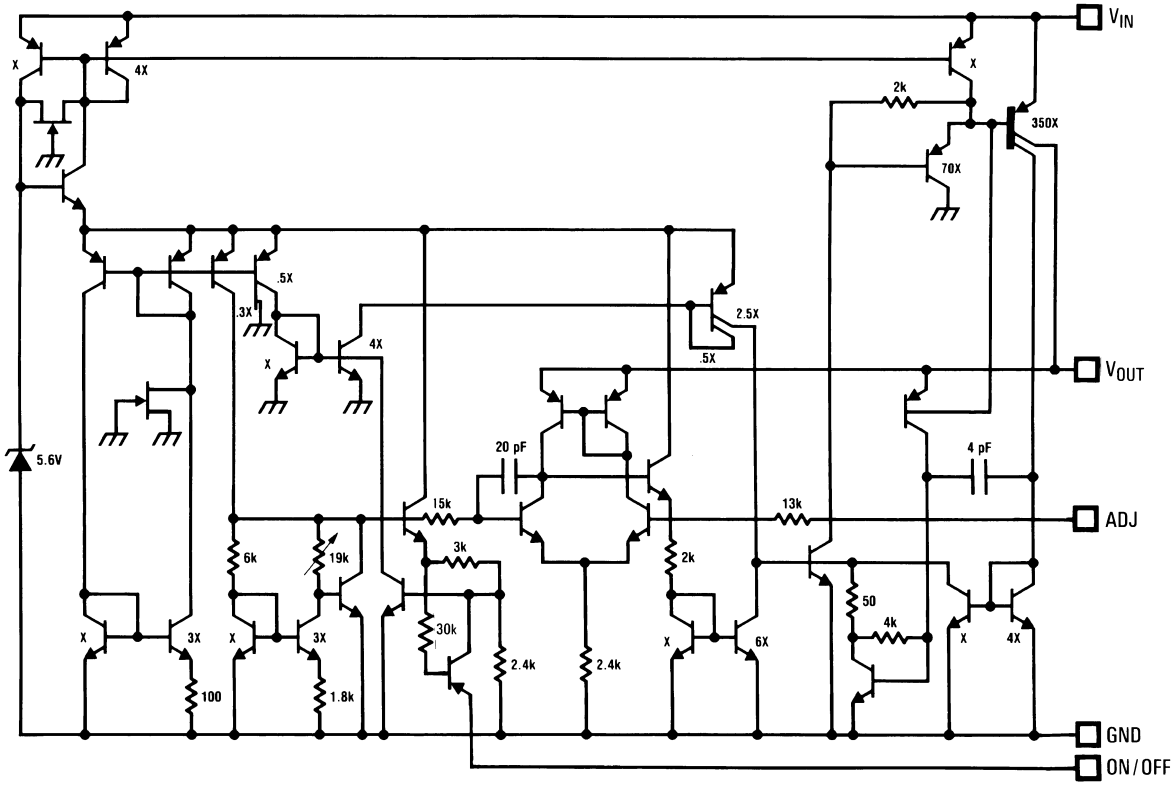
Figure 23. 5V to 20V Adjustable Regulator



******* To assure shutdown, select Resistor R3 to ensure at least 300µA of pull-up current when S1 is open. (Assume 2V at the ON/OFF pin.)

Figure 24. 1A Switch

Equivalent Schematic Diagram



REVISION HISTORY

Changes from Revision F (April 2013) to Revision G	Page
• Changed layout of National Data Sheet to TI format	13

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM2941CS	NRND	DDPAK/ TO-263	KTT	5	45	TBD	Call TI	Call TI	0 to 125	LM2941CS P+	
LM2941CS/NOPB	ACTIVE	DDPAK/ TO-263	KTT	5	45	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	0 to 125	LM2941CS P+	Samples
LM2941CSX	NRND	DDPAK/ TO-263	KTT	5	500	TBD	Call TI	Call TI	0 to 125	LM2941CS P+	
LM2941CSX/NOPB	ACTIVE	DDPAK/ TO-263	KTT	5	500	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	0 to 125	LM2941CS P+	Samples
LM2941CT	NRND	TO-220	KC	5	45	TBD	Call TI	Call TI	0 to 125	LM2941CT P+	
LM2941CT/LB03	NRND	TO-220	NDH	5	45	TBD	Call TI	Call TI		LM2941CT P+	
LM2941CT/LF03	ACTIVE	TO-220	NDH	5	45	Green (RoHS & no Sb/Br)	CU SN	Level-1-NA-UNLIM		LM2941CT P+	Samples
LM2941CT/LF04	ACTIVE	TO-220	NEB	5	45	Green (RoHS & no Sb/Br)	CU SN	Level-1-NA-UNLIM		LM2941CT P+	Samples
LM2941CT/NOPB	ACTIVE	TO-220	KC	5	45	Green (RoHS & no Sb/Br)	CU SN	Level-1-NA-UNLIM	0 to 125	LM2941CT P+	Samples
LM2941LD	NRND	WSON	NGN	8	1000	TBD	Call TI	Call TI	-40 to 125	L2941LD	
LM2941LD/NOPB	ACTIVE	WSON	NGN	8	1000	Green (RoHS & no Sb/Br)	CU NIPDAU | CU SN	Level-3-260C-168 HR	-40 to 125	L2941LD	Samples
LM2941LDX	NRND	WSON	NGN	8	4500	TBD	Call TI	Call TI	-40 to 125	L2941LD	
LM2941LDX/NOPB	ACTIVE	WSON	NGN	8	4500	Green (RoHS & no Sb/Br)	CU NIPDAU | CU SN	Level-3-260C-168 HR	-40 to 125	L2941LD	Samples
LM2941S	NRND	DDPAK/ TO-263	KTT	5	45	TBD	Call TI	Call TI	-40 to 125	LM2941S P+	
LM2941S/NOPB	ACTIVE	DDPAK/ TO-263	KTT	5	45	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	-40 to 125	LM2941S P+	Samples
LM2941SX	NRND	DDPAK/ TO-263	KTT	5	500	TBD	Call TI	Call TI	-40 to 125	LM2941S P+	
LM2941SX/NOPB	ACTIVE	DDPAK/ TO-263	KTT	5	500	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	-40 to 125	LM2941S P+	Samples
LM2941T	NRND	TO-220	KC	5	45	TBD	Call TI	Call TI	-40 to 125	LM2941T P+	

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM2941T/LB03	NRND	TO-220	NDH	5	45	TBD	Call TI	Call TI		LM2941T P+	
LM2941T/LB04	NRND	TO-220	NEB	5	45	TBD	Call TI	Call TI		LM2941T P+	
LM2941T/LB08	NRND	TO-220	NEC	5	45	TBD	Call TI	Call TI		LM2941T P+	
LM2941T/LF03	ACTIVE	TO-220	NDH	5	45	Green (RoHS & no Sb/Br)	CU SN	Level-1-NA-UNLIM		LM2941T P+	Samples
LM2941T/NOPB	ACTIVE	TO-220	KC	5	45	Green (RoHS & no Sb/Br)	CU SN	Level-1-NA-UNLIM	-40 to 125	LM2941T P+	Samples

(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.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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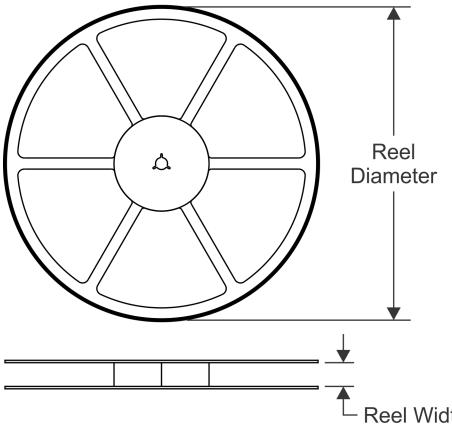
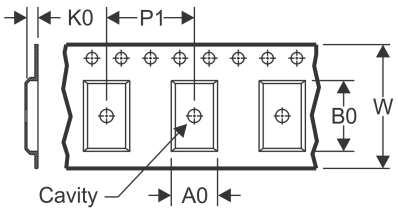
TAPE AND REEL INFORMATION

REEL DIMENSIONS

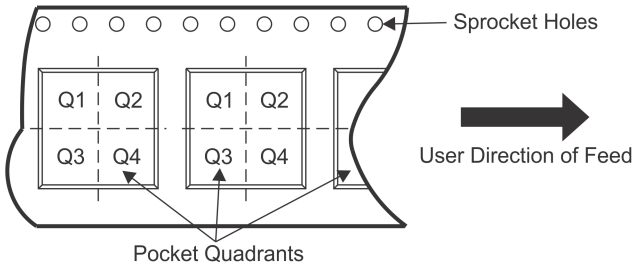


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

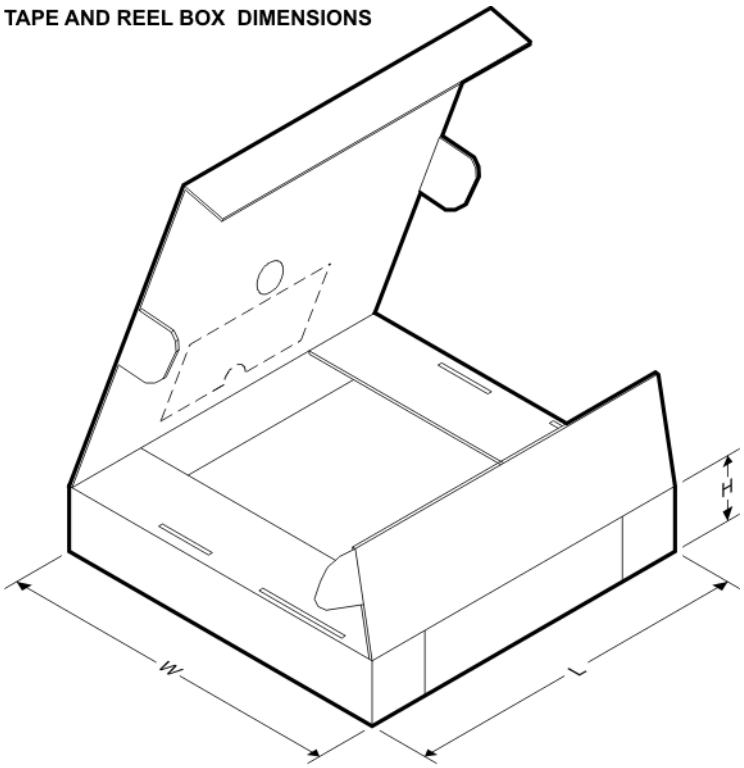
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM2941CSX	DDPAK/ TO-263	KTT	5	500	330.0	24.4	10.75	14.85	5.0	16.0	24.0	Q2
LM2941CSX/NOPB	DDPAK/ TO-263	KTT	5	500	330.0	24.4	10.75	14.85	5.0	16.0	24.0	Q2
LM2941LD	WSON	NGN	8	1000	178.0	12.4	4.3	4.3	1.3	8.0	12.0	Q1
LM2941LD/NOPB	WSON	NGN	8	1000	180.0	12.4	4.3	4.3	1.1	8.0	12.0	Q1
LM2941LDX	WSON	NGN	8	4500	330.0	12.4	4.3	4.3	1.3	8.0	12.0	Q1
LM2941LDX/NOPB	WSON	NGN	8	4500	330.0	12.4	4.3	4.3	1.1	8.0	12.0	Q1
LM2941SX	DDPAK/ TO-263	KTT	5	500	330.0	24.4	10.75	14.85	5.0	16.0	24.0	Q2
LM2941SX/NOPB	DDPAK/ TO-263	KTT	5	500	330.0	24.4	10.75	14.85	5.0	16.0	24.0	Q2

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM2941CSX	DDPAK/TO-263	KTT	5	500	367.0	367.0	45.0
LM2941CSX/NOPB	DDPAK/TO-263	KTT	5	500	367.0	367.0	45.0
LM2941LD	WSON	NGN	8	1000	210.0	185.0	35.0
LM2941LD/NOPB	WSON	NGN	8	1000	195.0	200.0	45.0
LM2941LDX	WSON	NGN	8	4500	367.0	367.0	35.0
LM2941LDX/NOPB	WSON	NGN	8	4500	370.0	355.0	55.0
LM2941SX	DDPAK/TO-263	KTT	5	500	367.0	367.0	45.0
LM2941SX/NOPB	DDPAK/TO-263	KTT	5	500	367.0	367.0	45.0

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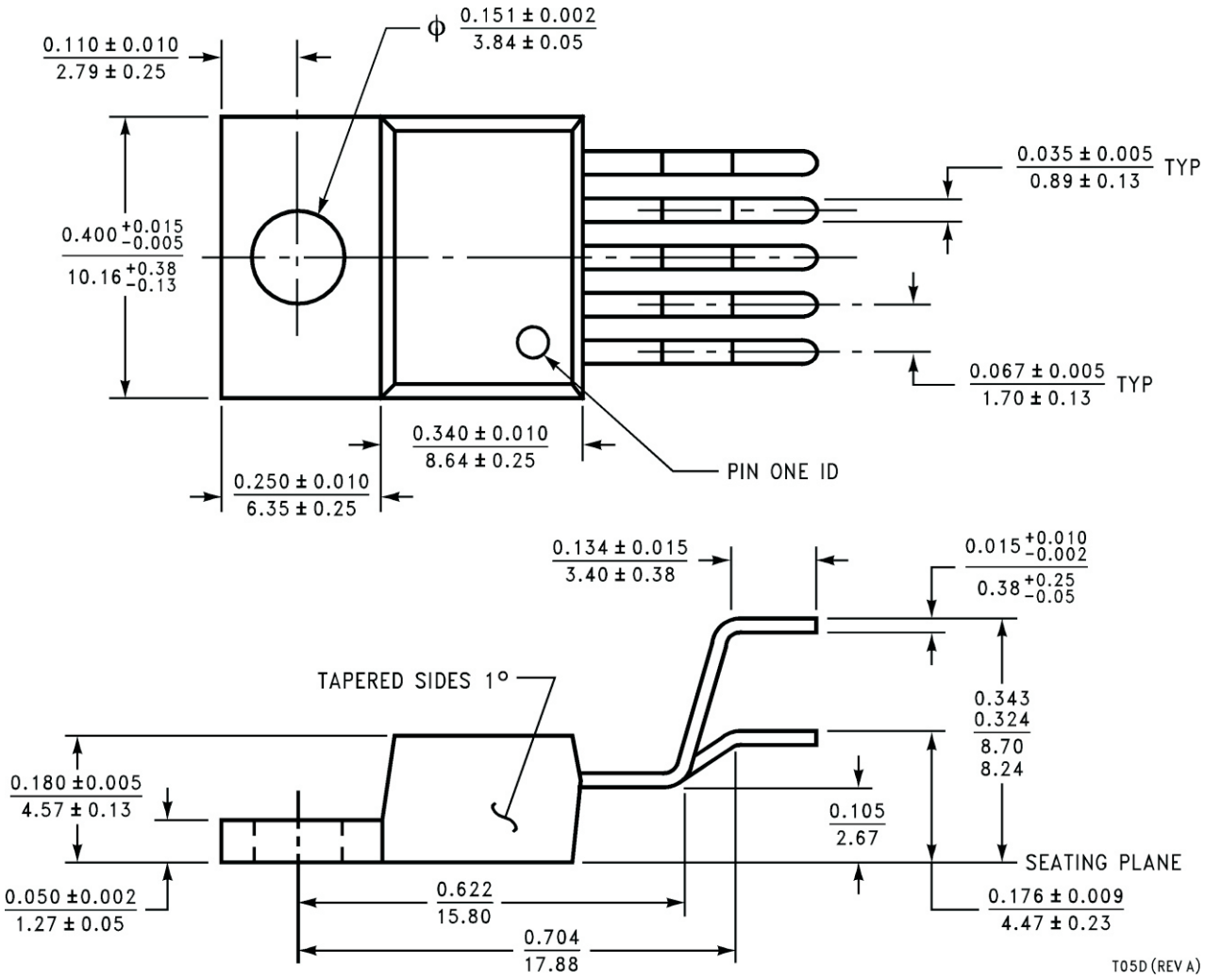
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2.79 ± 0.25
ϕ 0.151 ± 0.002
3.84 ± 0.05
0.035 ± 0.005
0.89 ± 0.13
TYP
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10.16 +0.38 −0.13
0.067 ± 0.005
1.70 ± 0.13
TYP
0.340 ± 0.010
8.64 ± 0.25
PIN ONE ID
0.250 ± 0.010
6.35 ± 0.25
0.134 ± 0.015
3.40 ± 0.38
0.015 +0.010 −0.002
0.38 +0.25 −0.05
TAPERED SIDES 1°
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0.324
8.70
8.24
0.180 ±0.005
4.57 ± 0.13
0.105
2.67
SEATING PLANE
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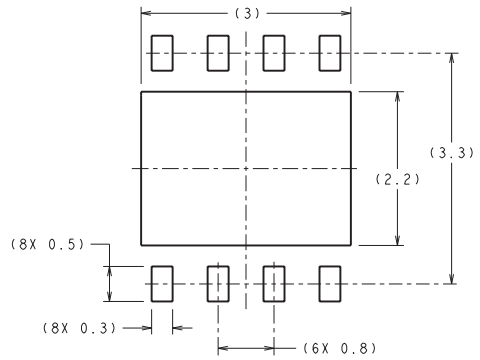

RECOMMENDED LAND PATTERN
1:1 RATION WITH PKG SOLDER PADS

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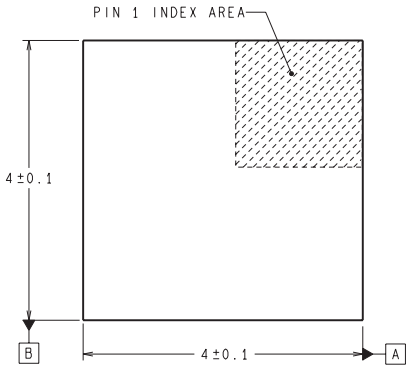

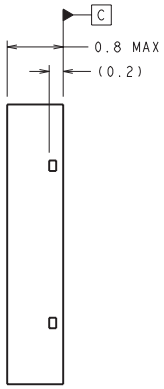

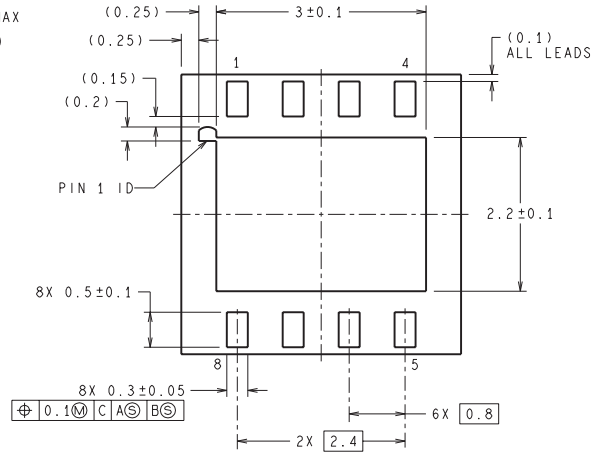

LDC08A (Rev B)

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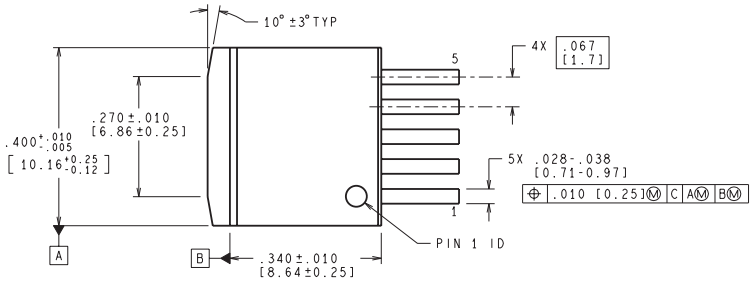

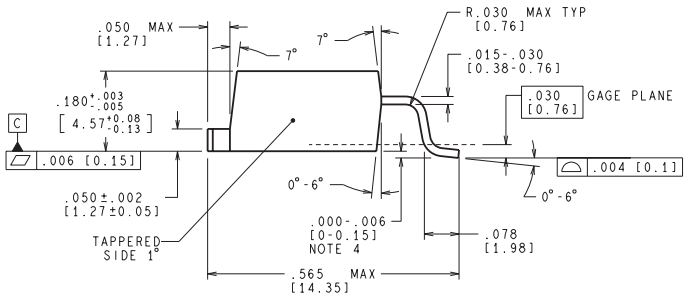

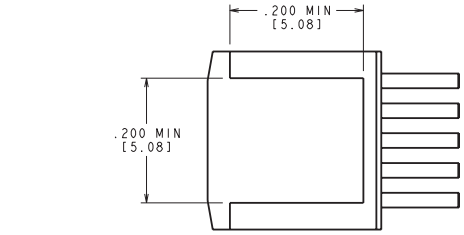

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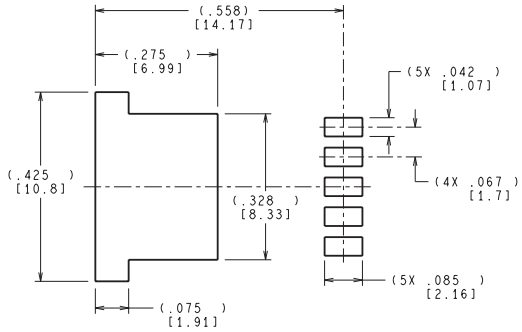

LAND PATTERN RECOMMENDATION

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TS5B (Rev D)

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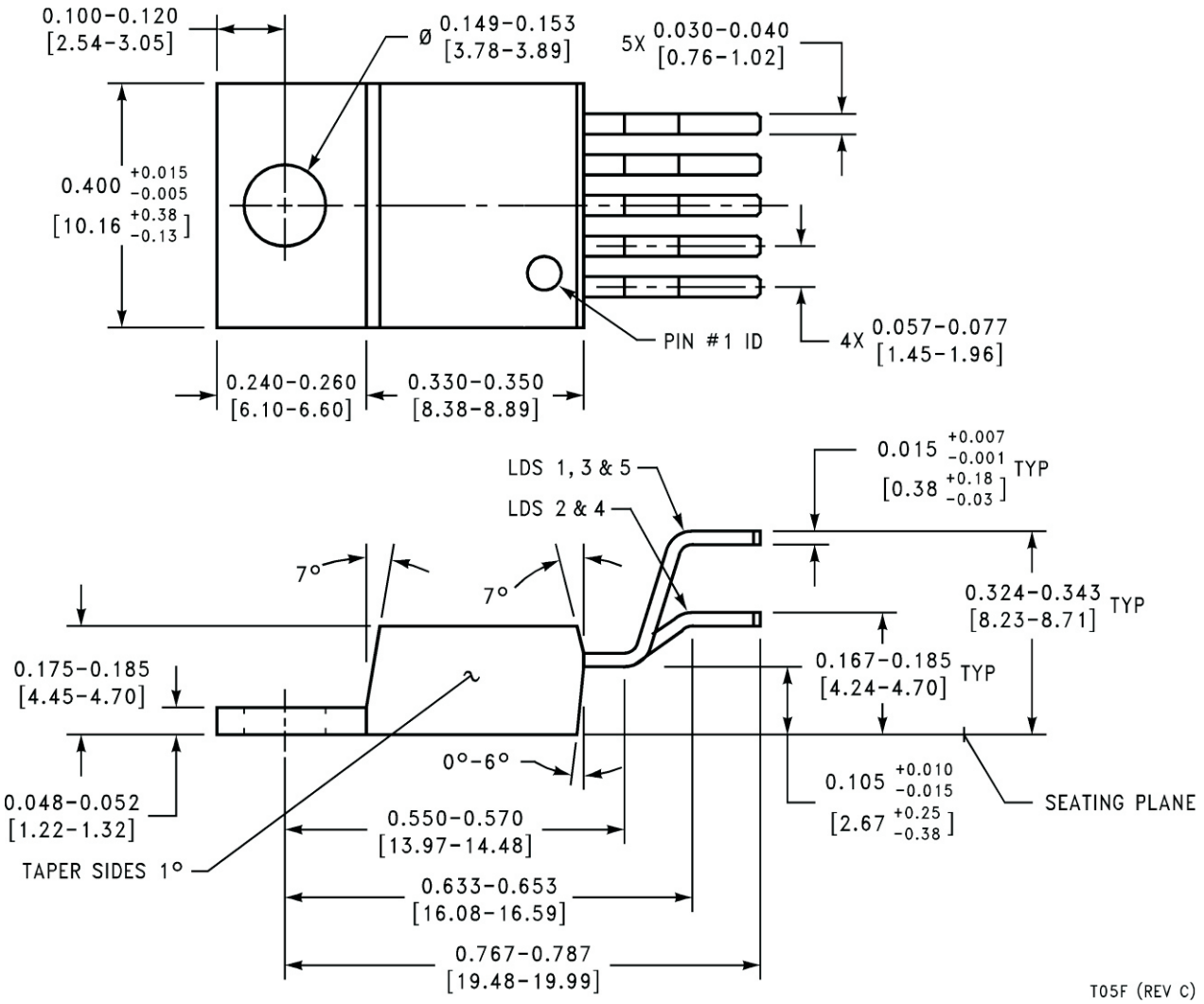
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0.400 +0.015 -0.005
[10.16 +0.38 -0.13]
PIN #1 ID
4X 0.057-0.077
[1.45-1.96]
0.240-0.260
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0.330-0.350
[8.38-8.89]
LDS 1, 3 & 5
LDS 2 & 4
0.015 +0.007 -0.001 TYP
[0.38 +0.18 -0.03]
7°
7°
0.324-0.343 TYP
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0.167-0.185 TYP
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0°-6°
0.105 +0.010 -0.015
[2.67 +0.25 -0.38]
SEATING PLANE
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TAPER SIDES 1°
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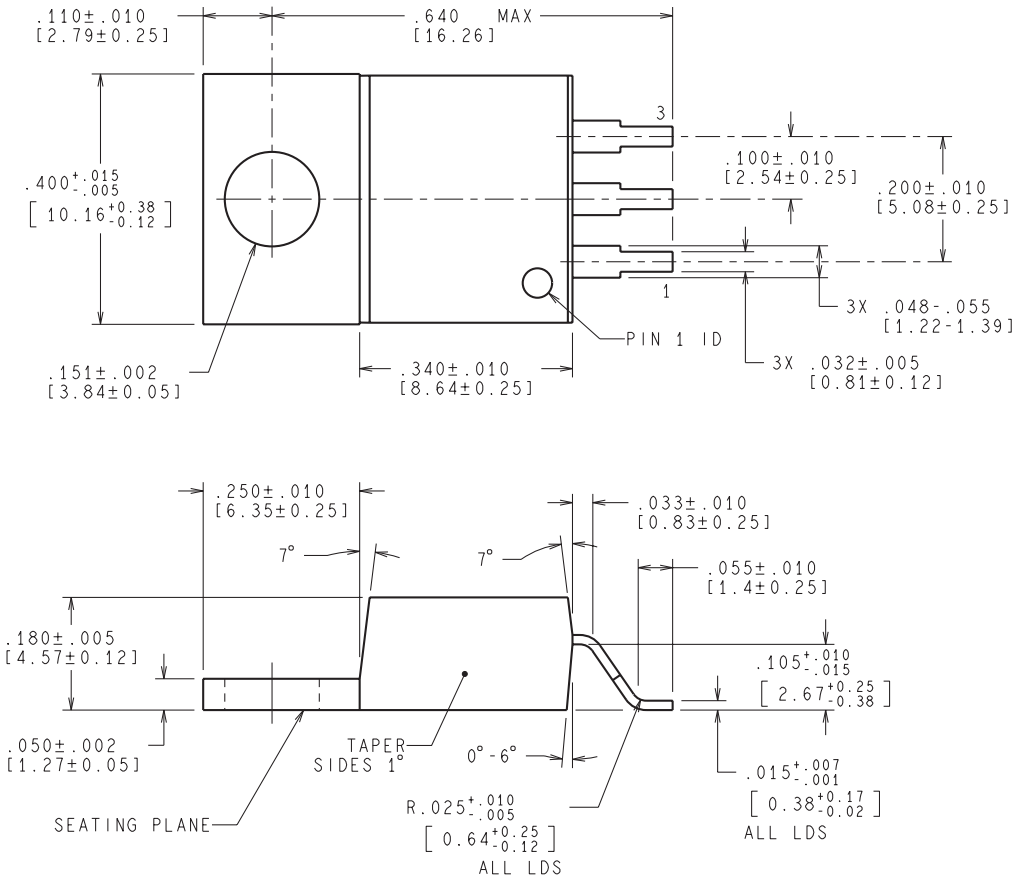

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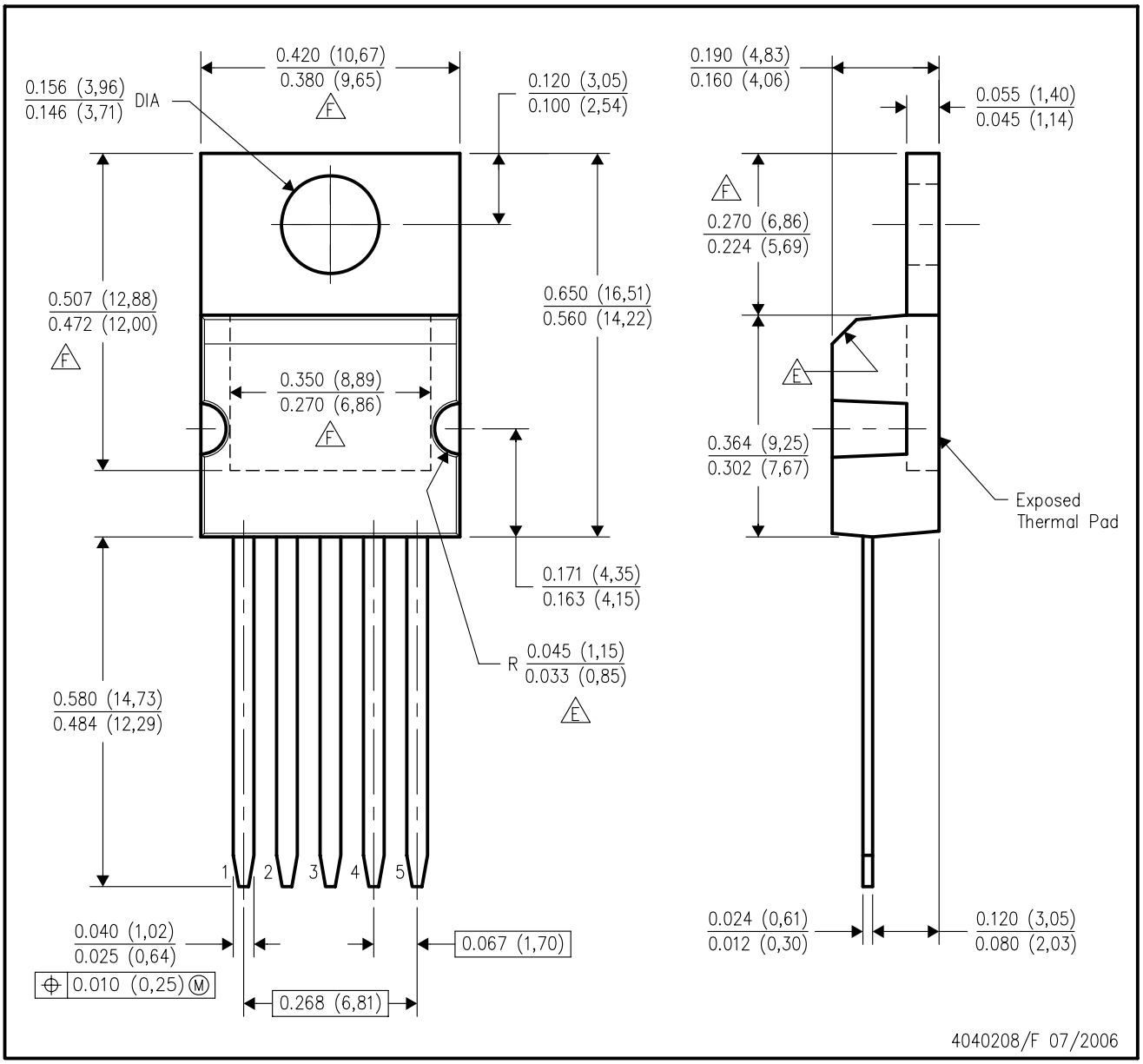
TA05D (Rev A)

KC (R–PSFM–T5) PLASTIC FLANGE–MOUNT PACKAGE



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. All lead dimensions apply before solder dip.
D. The center lead is in electrical contact with the mounting tab.
E. These features are optional.
F. Thermal pad contour optional within these dimensions.

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