LM9070 Low-Dropout System Voltage Regulator with Keep-Alive ON/OFF Control

Check for Samples: LM9070

FEATURES

- **Automotive Application Reliability**
- **3% Output Voltage Tolerance**
- **Insensitive to Radiated RFI**
- **Dropout Voltage Less than 800 mV with 250 mA Output Current**
- **Externally Programmed Reset Delay Interval**
- **Keep-Alive Feature with 2 Logic Control Inputs**
- **60V Load Dump Transient Protection**
- **Thermal Shutdown**
- **Short Circuit Protection and Disable Safety Features**
- **Reverse Battery Protection**
- **Low OFF Quiescent Current, 50 µA Maximum**
- **Wide Operating Temperature Range −40°C to +125°C**
- **TO-263 and 20-Pin Power Surface Mount Packages**
- **Lead Form Compatible with TLE4267 TO-220 Regulator**

DESCRIPTION

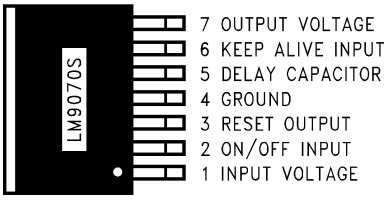
The LM9070 is a 5V, 3% accurate, 250 mA low-dropout voltage regulator. The regulator features an active low delayed reset output flag which can be used to reset a microprocessor system on turn-ON and in the event that the regulator output falls out of regulation for any reason. An external capacitor programs a delay time interval before the reset output can return high.

Designed for automotive application the LM9070 contains a variety of protection features such as reverse battery, over-voltage shutdown, thermal shutdown, input transient protection and a wide operating temperature range.

A unique two-input logic control scheme is used to enable or disable the regulator output. An ON/OFF input can be provided by an ignition switch derived signal while a second, Keep-Alive input, is generated by a system controller. This allows for a system to remain ON after ignition has been switched OFF. The system controller can then execute a power-down routine and after which command the regulator OFF to a low quiescent current state (60 µA max).

Design techniques have been employed to allow the regulator to remain operational and not generate false reset signals when subjected to high levels of RF energy (300V/m from 2 MHz to 400 MHz).

Connection Diagrams and Ordering Information



Backside metal is internally connected to ground.

Figure 1. 7 Lead TO-263 (Top View)
Package Number KTW0007B

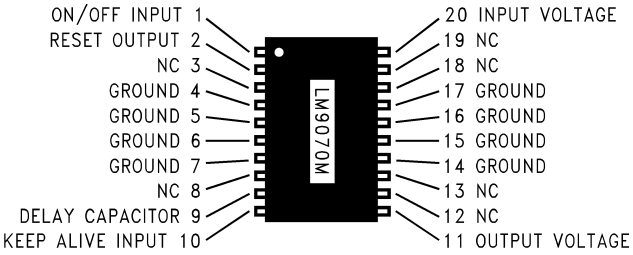


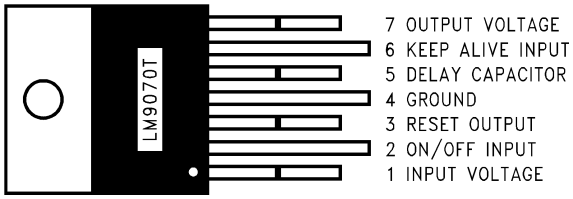
Figure 2. 20-Pin SOIC Package

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

All trademarks are the property of their respective owners.

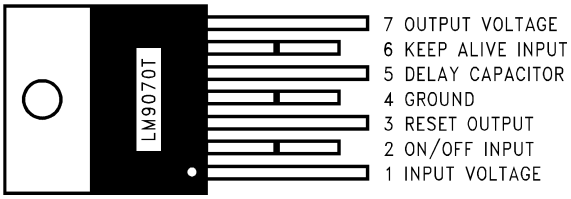
PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

Copyright © 1999–2013, Texas Instruments Incorporated



Tab is internally connected to ground.

Figure 3. 7-Lead TO-220 Package (Odd numbered pins bent forward away from package body)



Tab is internally connected to ground.

Figure 4. 7-Lead TO-220 Package (Even numbered pins bent forward away from package body)

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)

Input Voltage, DC	−26V to +40V
ON/OFF, Keep-Alive Inputs (through 1kΩ)	−26V to +26V
Positive Input Transient (t<100 ms)	60V
Negative Input Transient (t<1 ms)	−50V
Reset Output Sink Current	5 mA
Power Dissipation	Internally Limited
Junction Temperature	150°C
ESD Susceptibility (2)	12 kV, 2 kV
Lead Temperature (Soldering, 10 seconds)	260°C
Storage Temperature	−50°C to +150°C

(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 do not ensure specific performance limits. For ensured specifications and conditions, see the Electrical Characteristics.

(2) All pins will survive an ESD impulse of ±2000V using the human body model of 100 pF discharged through a 1.5 kΩ resistor. In addition, input pins V_{IN} and the ON/OFF input will withstand ten pulses of ±12 kV from a 150 pF capacitor discharged through a 560Ω resistor with each pin bypassed with a 22 nF, 100V capacitor.

Operating Ratings (1)

Input Voltage	6V to 26V
Ambient Temperature	−40°C to +125°C
TO-220 Thermal Resistance, θ_{J-C}	3°C/W
TO-220 Thermal Resistance, θ_{J-A} (2)	73°C/W
TO-263 Thermal Resistance, θ_{J-C}	3°C/W
TO-263 Thermal Resistance, θ_{J-A} (3)	80°C/W
SO20 Thermal Resistance, θ_{J-PINS}	25°C/W
SO20 Thermal Resistance, θ_{J-A}	85°C/W

(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 do not ensure specific performance limits. For ensured specifications and conditions, see the Electrical Characteristics.

(2) Exceeding the Maximum Allowable power dissipation will cause excessive die temperature, and the device will go into thermal shutdown. The θ_{J-A} value for the TO-220 package (still air, no additional heat sink) is 73°C/W. The effective θ_{J-A} value of the TO-220 package can be reduced by using conventional heat sink methods.

(3) Exceeding the Maximum Allowable power dissipation will cause excessive die temperature, and the device will go into thermal shutdown. The θ_{J-A} value for the TO-263 package (still air, no additional heat sink) is 80°C/W. The effective θ_{J-A} value of the TO-263 package can be reduced by increasing the printed circuit board area that is connected (soldered) to the package tab. Using 1 ounce (1.4 mils thick) copper clad with no solder mask, an area of 0.5 square inches will reduce θ_{J-A} to 50°C/W, an area of 1.0 square inches will reduce $\theta_{J-A}$to 37°C/W, ad an area of 1.6 square inches will reduce θ_{J-A} to 32°C/W. If the printed circuit board uses a solder mask, the copper clad area should be increased by at least 50% to maintain a similar θ_{J-A} rating.

Copyright © 1999–2013, Texas Instruments Incorporated

Electrical Characteristics (1)

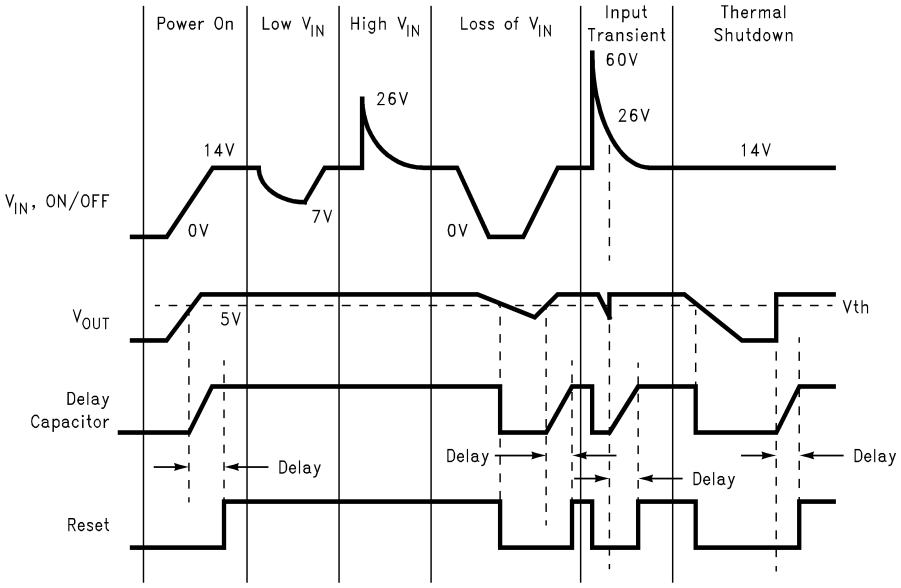
The following specifications apply for V_{CC}= 6V to 26V, −40°C ≤ T_A≤ 125°C, unless otherwise specified. C_{OUT}=47µF with an ESR < 3Ω. C_{IN}= 1µF.

Symbol	Parameter	Conditions	Min	Max	Units
REGULATOR OUTPUT					
V_{OUT}	Output Voltage	5 mA ≤ I_{OUT} ≤ 250 mA	4.85	5.15	V
ΔV_{OUT} Line	Line Regulation	I_{OUT} = 5 mA, 9V ≤ V_{IN} ≤ 16.5V I_{OUT} = 5 mA, 6V ≤ V_{IN} ≤ 26V		25 50	mV mV
ΔV_{OUT} Load	Load Regulation	V_{IN} = 14.4V, 5 mA ≤ I_{OUT} ≤ 250 mA		50	mV
Iq	Quiescent Current	$V_{ON/OFF}$ ≤ V_{IN} I_{OUT} = 5 mA I_{OUT} = 250 mA, V_{IN} ≥ 8V I_{OUT} = 5 mA, V_{IN} = 5V I_{OUT} = 250 mA, V_{IN} = 6V		 4 25 10 50	 mA mA mA mA
Ioff	OFF Quiescent Current	V_{IN} ≤ 16.5V, Regulator OFF −40°C ≤ T_J ≤ 60°C 60°C ≤ T_J ≤ 135°C		 20 60	 µA µA
Vdo	Dropout Voltage	I_{OUT} = 5 mA I_{OUT} = 250 mA		300 800	mV mV
Isc	Short Circuit Current	R_L = 1Ω	0.4	1.5	A
PSRR	Ripple Rejection	V_{IN} = ($14V_{DC}$) + $1V_{RMS}$ @ $120H_Z$)			
		I_{OUT} = 50 mA	60		dB
$Voth_{OFF}$	Safety V_{OUT} Latch-OFF Threshold	In Keep-Alive mode			
		$V_{ON/OFF}$ = 0V, V_{KA} = 0V	4	4.5	V
OVthr	Overvoltage Shutdown Threshold		27		V
Vo Transient	V_{OUT} during Transients	V_{IN} Peak ≤ 60V, R_L = 100Ω, τ = 100 ms		7	V
RESET OUTPUT					
Vth	Threshold Voltage	ΔV_{OUT} Required to Generate a Reset Output 4.85V ≤ V_{OUT} ≤ 5.15V	−300	−500	mV
Vlow	Reset Output Low Voltage	Isink = 1.6 mA, V_{OUT} > 3.2V		0.4	V
		1.4V ≤ V_{OUT} ≤ 3.2V		0.8	V
Vhigh	Reset Output High Voltage		0.9 V_{OUT}	V_{OUT}	V
t_{DELAY}	Delay Time	C_{DELAY} = 0.1µF	7	31	ms
I_{DELAY}	Charging Current for C_{DELAY}		10	30	µA
Rpu	Internal Pull-up Resistance		12	80	kΩ
CONTROL LOGIC					
V_{KA}low	Low Input Threshold Voltage, Keep-Alive Input	3.5V ≤ V_{OUT} ≤ 5.25V	0.3 V_{OUT}	0.5 V_{OUT}	V
V_{KA}high	High Input Threshold Voltage, Keep-Alive Input	3.5V ≤ V_{OUT} ≤ 5.25V	0.6 V_{OUT}	0.8 V_{OUT}	V
$V_{ON/OFF}$ low	Low Input Voltage, ON/OFF Input	Rseries = 1 kΩ	−2	2	V
$V_{ON/OFF}$ high	High Input Voltage, ON/OFF Input	Rseries = 1 kΩ	4	26	V
$I_{ON/OFF}$	Input Current, ON/OFF Input	$V_{ON/OFF}$ ≤ 4V		330	µA
		4V < $V_{ON/OFF}$ < 7V		670	µA
		$V_{ON/OFF}$ ≥ 7V		10	mA
Rpu_{KA}	Internal Pull-up Resistance, Keep-Alive Input	0V ≤ V_{IN} ≤ 26V	20	100	kΩ
$Rpd_{ON/OFF}$	Internal Pull-down Resistance ON/OFF Input	0V ≤ $V_{ON/OFF}$ ≤ 26V	50	210	kΩ

(1) Datasheet min/max specifications are ensured by design, test, and/or statistical analysis.

Copyright © 1999–2013, Texas Instruments Incorporated

Reset Operation and Protection Features



Copyright © 1999–2013, Texas Instruments Incorporated

Typical Performance Characteristics

(T_A = 25°C unless indicated otherwise)

Turn ON Characteristics

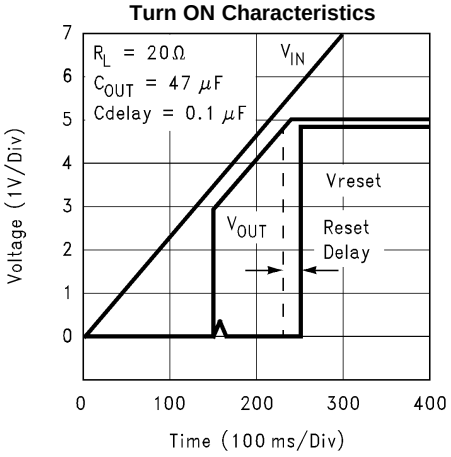


Figure 5.

Turn OFF Characteristics

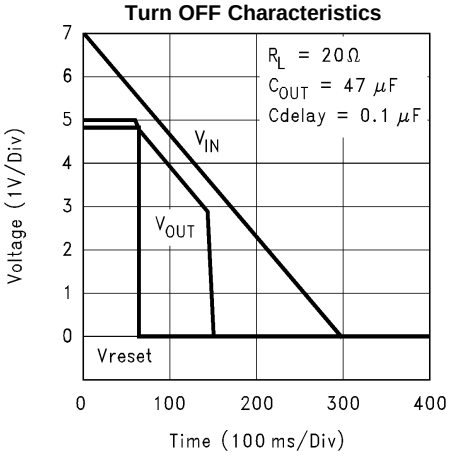


Figure 6.

Normalized Output Voltage vs Temperature

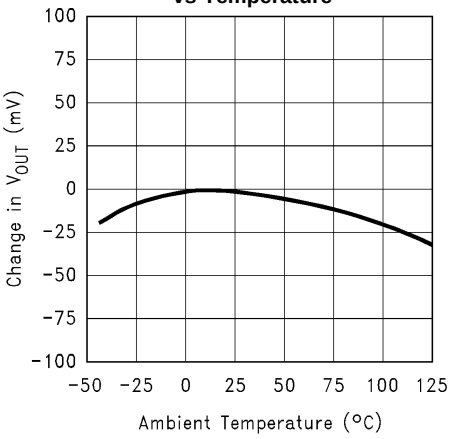


Figure 7.

Output Voltage at Input Voltage Extremes

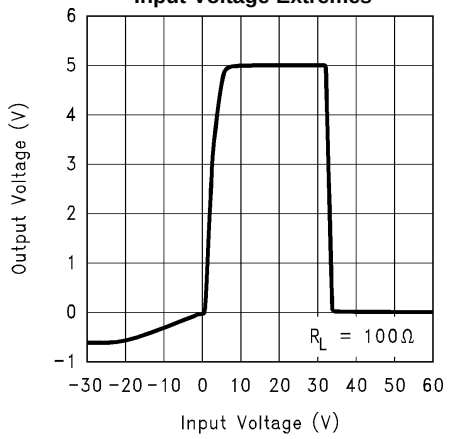


Figure 8.

Quiescent Current vs Input Voltage

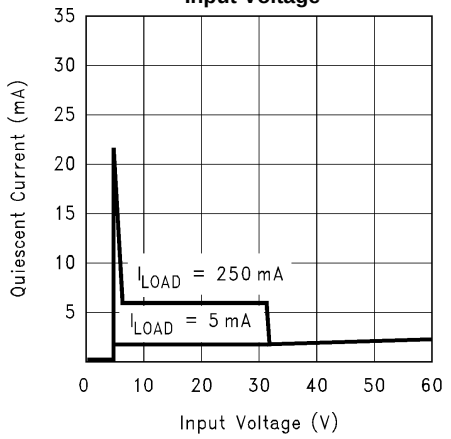


Figure 9.

Input Current vs Input Voltage Regulator Switched OFF

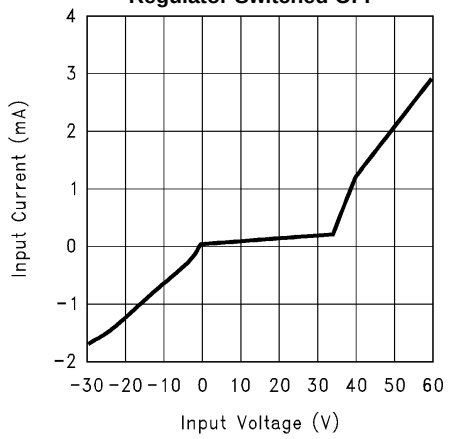


Figure 10.

Copyright © 1999–2013, Texas Instruments Incorporated

Typical Performance Characteristics (continued)

(T_A = 25°C unless indicated otherwise)

Dropout Voltage vs Temperature

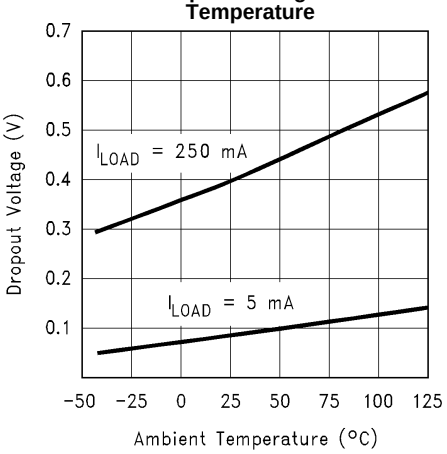


Figure 11.

Reset Delay Time vs Temperature

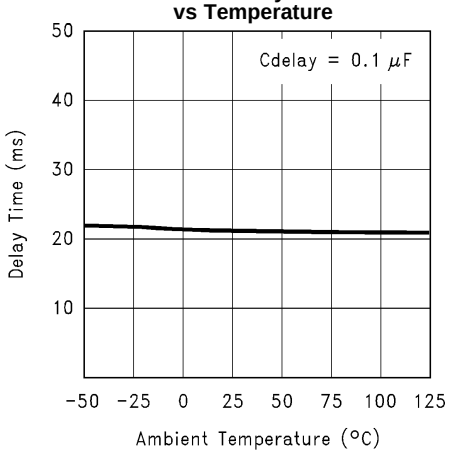


Figure 12.

Short Circuit Current vs Temperature

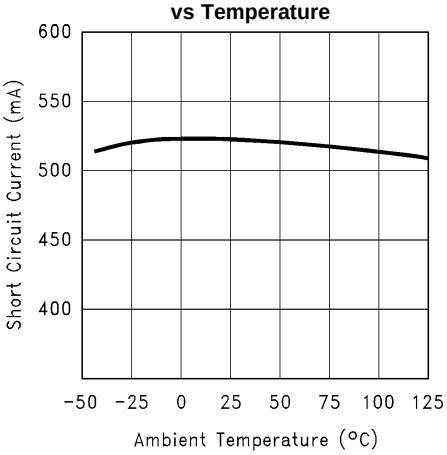


Figure 13.

Output Capacitor ESR

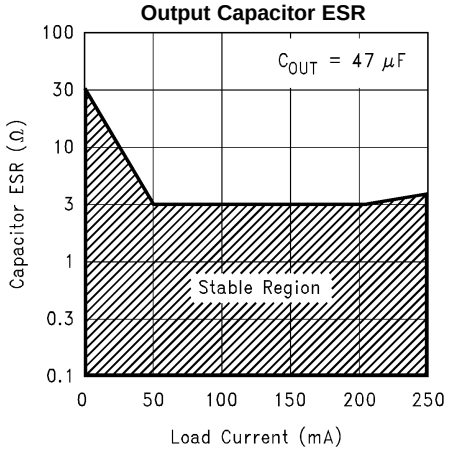


Figure 14.

Maximum Power Dissipation (TO-220 Package)

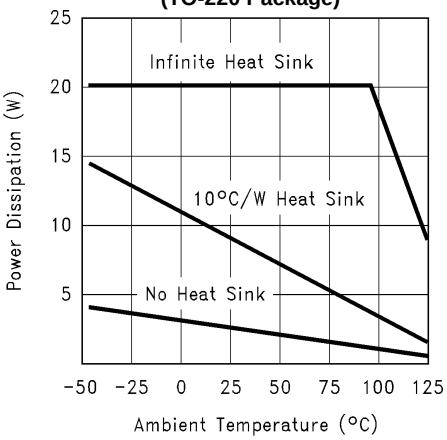


Figure 15.

Maximum Power Dissipation (TO-263 and SO-20 Packages)

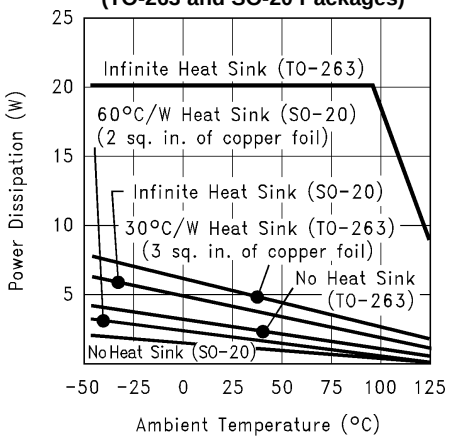
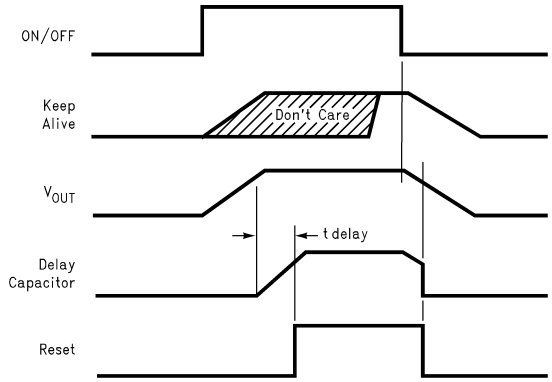


Figure 16.

Copyright © 1999–2013, Texas Instruments Incorporated

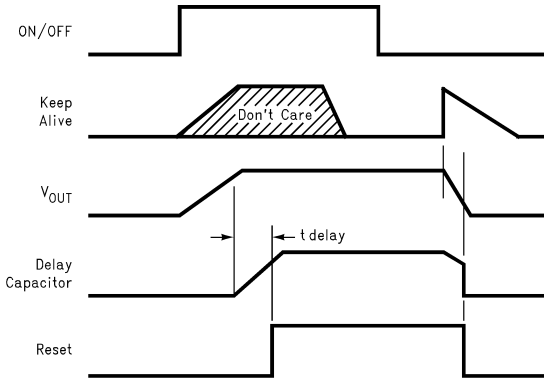
ON/OFF, KEEP-ALIVE AND SAFETY LATCH-OFF CONTROL DIAGRAMS

Note: If Keep-Alive is provided by a microprocessor powered by the output voltage of the LM9070, the logic "1" voltage level will track V_{OUT} as the regulator turns OFF.



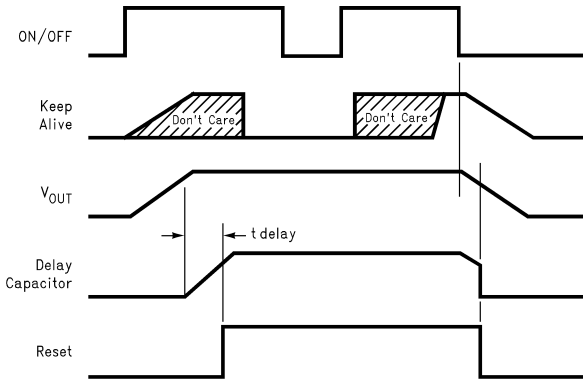
(Keep-Alive input must be high to turn OFF output)

Figure 17. Simple ON/OFF control



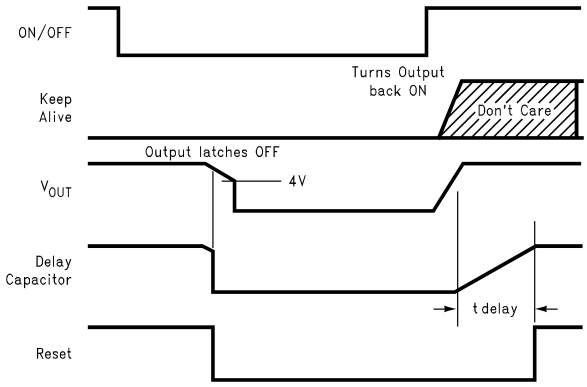
Turn ON with ON/OFF control, Keep output biased with Keep-Alive input, Turn OFF with Keep-Alive (Keep-Alive low keeps output ON, Keep-Alive going high turns output OFF)

Figure 18. Keep-Alive Mode



Keep output biased with Keep-Alive; Hold ouput ON with ON/OFF; Turn OFF with ON/OFF input. (Temporary Keep-Alive Mode)

Figure 19. Switch ON with ON/OFF input



(ON/OFF going high required to turn Output back ON)

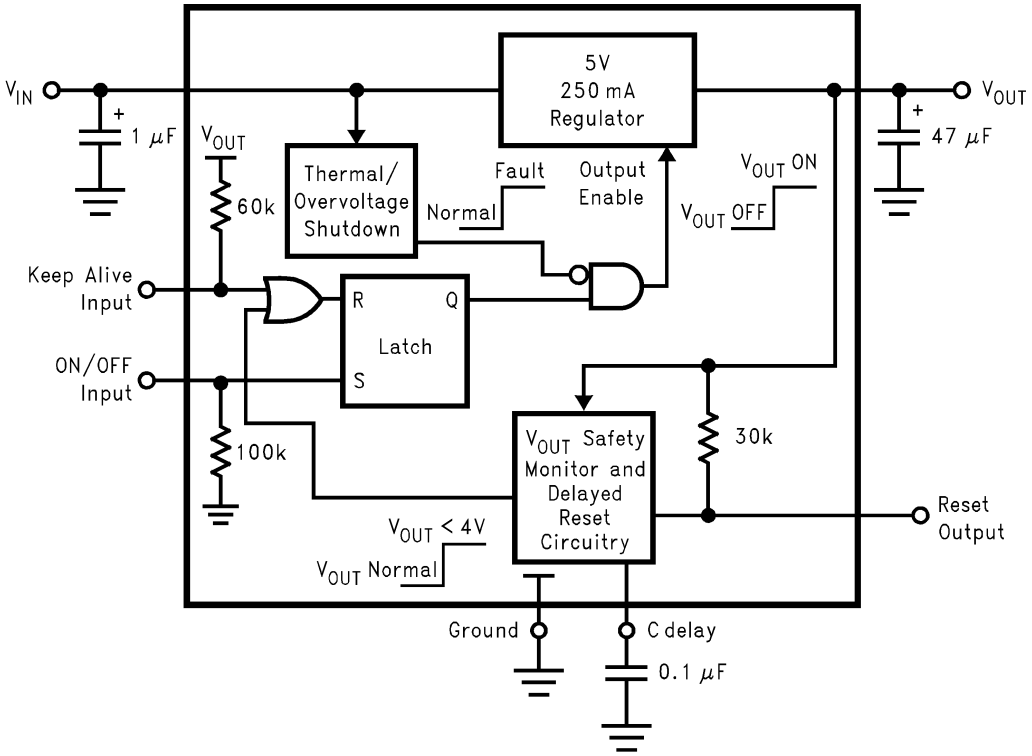
Figure 20. Safety Latch OFF of V_{OUT} when in Keep-Alive Mode

Control Logic Truth Table

ON/OFF Input	Keep-Alive Input	Output Voltage	Reset Output	Operating Condition
L	X	0V	L	Low quiescent current standby (OFF) condition
↑	X	5V	↑ after delay	Output turns ON
H	X	5V	H	Normal ON condition
↓	H	0V	L	Output turns OFF
↓	L	5V	H	Output kept ON by Keep-Alive Input
↑	L	5V	H	Output remains ON (or turns ON)
H	X	$\Delta V_{OUT} \geq -300$ mV	L	Output pulled out of regulation, reset flag generated
L	L	$V_{OUT} \leq 4V$	L	Output latches OFF

Copyright © 1999–2013, Texas Instruments Incorporated

Block Diagram



Copyright © 1999–2013, Texas Instruments Incorporated

APPLICATION INFORMATION

The LM9070 voltage regulator has been optimized for use in microprocessor based automotive systems. Several unique design features have been incorporated to address many FMEA (Failure Mode Effects Analysis) concerns for fail-safe system performance.

FAULT TOLERANT FEATURES

While not specifically ensured due to production testing limitations, the LM9070 has been tested and shown to continue to provide a regulated output and, not generate an erroneous system reset signal while subjected to high levels of RF electric field energy (up to 300 V/m signal strength over a 2 MHz to 400 MHz frequency range). This is very important in vehicle safety related applications where the system must continue to operate normally. To maintain this immunity to RFI the output bypass capacitor is important (47 µF is recommended).

This regulator is suitable for applications where continuous connection to the battery is required (Refer to the Figure 21). ON/OFF control of the regulator and system can be accomplished by switching the ON/OFF input to the battery or ignition supply V_{IN} supply through a SPST switch. If this input becomes open circuited, an internal pull-down resistor ensures that the regulator turns OFF. When the regulator is switched OFF the current load on the battery drops to less than 60 µA. With the possibility in many applications for V_{IN} and the ON/OFF input pins to be connected in a system through long lengths of wire, the ESD protection of these pins has been increased to 12 kV with the addition of small input bypass capacitors.

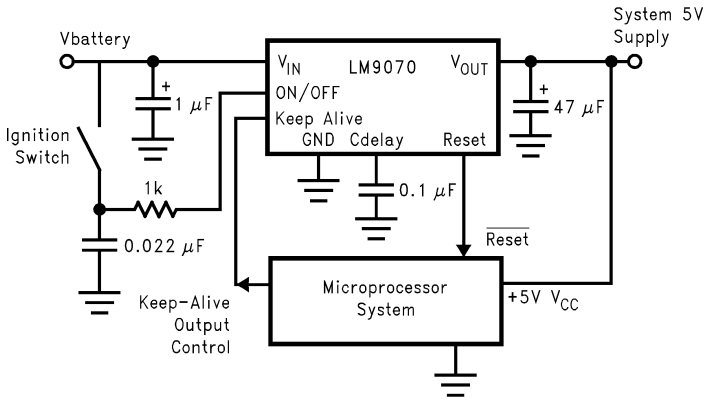


Figure 21. Typical Application Circuit

An output bypass capacitor of at least 10 µF is required for stability (47 µF is recommended). The ESR of this capacitor should be less than 3Ω. An input capacitor of 1 µF or larger is recommended to improve line transient and noise performance.

With the Keep-Alive input, a system microprocessor has the ability to keep the regulator ON (with a logic “0” on Keep-Alive) after the ON/OFF input has been commanded OFF. A power-down sequence, when system variables are typically stored in programmable memory, can be executed and take as much time as necessary. At the end of the operation the micro then pulls Keep-Alive high and the regulator and system turn OFF and revert to the low quiescent current standby mode.

For additional system reliability, consideration has been made for the possibility of a short circuited load at the output of the regulator. When the regulator is switched ON, conventional current limiting and thermal shutdown protect the regulator. When the regulator is switched OFF however, a grounded V_{CC} supply to the micro (due to the shorted regulator output) will force the Keep-Alive input to be low and thus try to maintain the Keep-Alive mode of operation. With a shorted load, the drain on the battery could be as high as 1.5A. A separate internal circuit monitors the output voltage of the regulator. If V_{OUT} is less than 4V, as would be the case with a shorted load, the Keep-Alive function is logically disabled to ensure that the regulator turns OFF and reverts to only a 50 µA load on the battery.

Copyright © 1999–2013, Texas Instruments Incorporated

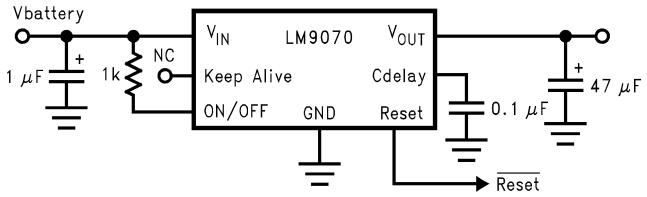


Figure 22. Control Logic Not Used

Conventional load dump protection is built in to withstand up to +60V and −50V transients. A 1 kΩ resistor in series with the ON/OFF and Keep-Alive inputs are recommended to provide the same level of transient protection for these pins if required. Protection against reverse polarity battery connections is also built in. With a reversed battery the output of the LM9070 will not go more negative than one diode drop below ground. This will prevent damage to any of the 5V load circuits.

For applications where the control logic is not required the logic pins should be configured as shown in Figure 22. A separate device, called the LM9071, can be used. The LM9071 is available in a 5-lead TO-220 package and does not provide control logic functions, but still retains all of the protection features of the LM9070.

RESET FLAG

Excessive loading of the output to the point where the output voltage drops by 300 mV to 500 mV will signal a reset flag to the micro. This will warn of a V_{CC} supply that may produce unpredictable operation of the system. On power-up and recovery from a fault condition the delay capacitor is used to hold the micro in a reset condition for a programmable time interval to allow the system operating voltages and

clock to stabilize before executing code. The typical delay time interval can be estimated using the following equation:

$$t_{DELAY} = \frac{3.8V \times C_{DELAY}}{20\ \mu A} \quad (1)$$

INPUT STABILITY

Low dropout voltage regulators which utilize a PNP power transistor usually exhibit a large increase in current when in dropout (V_{IN} < 5.5V). This increase is caused by the saturation characteristics (β reduction) of the PNP transistor. To significantly minimize this increase in current the LM9070 detects when the PNP enters saturation and reduces the operating current.

This reduction in input current can create a stability problem in applications with higher load current (> 100 mA) where the input voltage is applied through a long length of wire, which in effect adds a significant amount of inductance in series with the input. The drop in input current may create a positive input voltage transient which may take the PNP out of saturation. If the input voltage is held constant at the threshold where the PNP is going in and out of saturation, an oscillation may be created.

This is only observed where significant series inductance is present in the input supply line and when the rise and fall time of the input supply is very slow. If the application and removal of the input voltage changes at a rate greater than 500 mV/μs, the input voltage moves through the dropout region of operation (V_{IN} of 3V to 5.5V) too quickly for an oscillation to be established.

MICROPROCESSOR SYSTEM REGULATOR WITH KEEP-ALIVE INTERVAL AT TURN-OFF

Figure 23 illustrates a system application circuit utilizing both of the logic control inputs of the LM9070. Closing the ON/OFF switch powers ON the system. Once powered, the system controller sets the Keep-Alive line low. The NPN transistor is used only to signal the controller that the ON/OFF switch has been opened and the system is to be turned OFF. Upon detecting this high level at the ON/OFF Sense input line, the controller can then perform a power down routine. The system will remain fully powered until the controller commands total shut down by taking the Keep-Alive line high. The system then shuts OFF and reverts to a very low current drain standby condition until switched back on.

Copyright © 1999–2013, Texas Instruments Incorporated

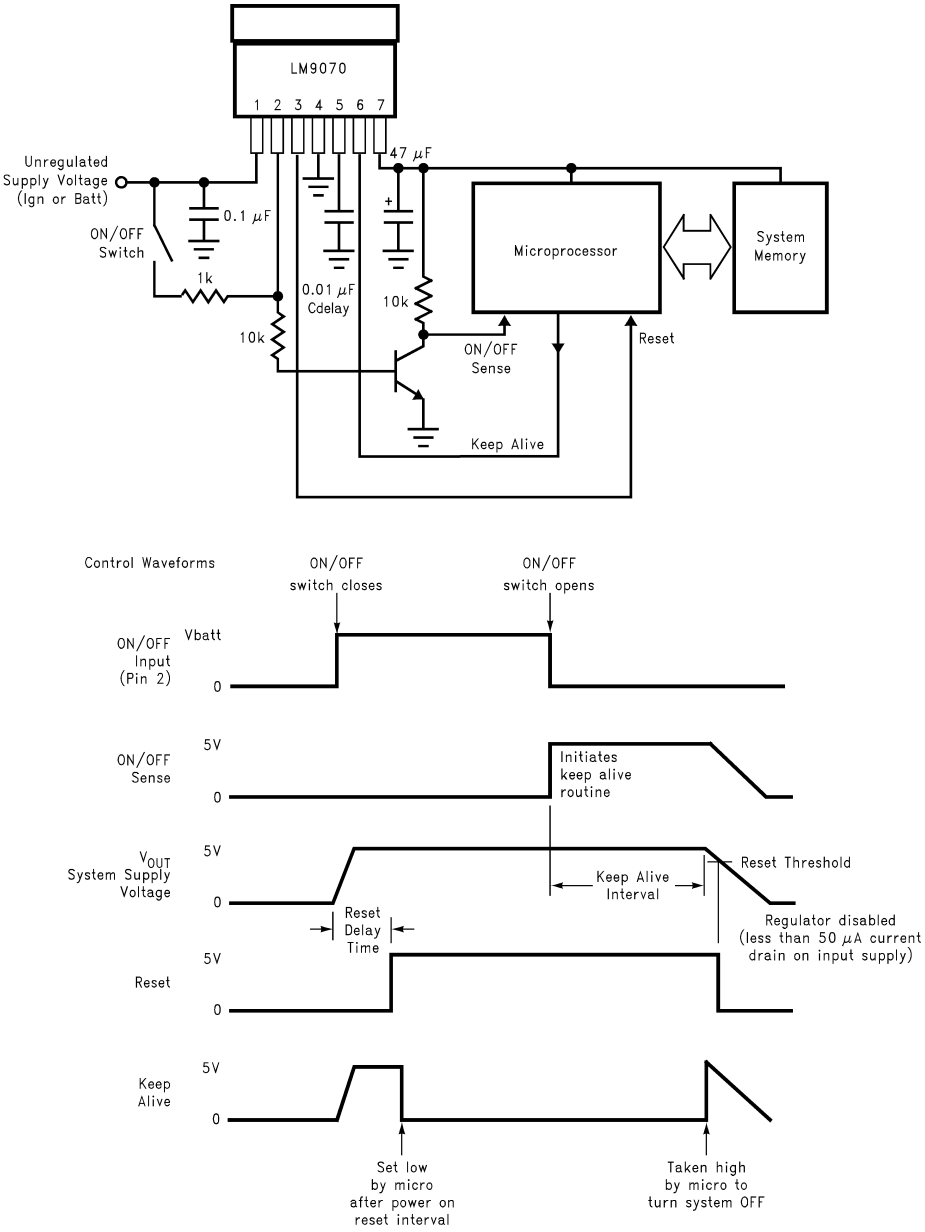


Figure 23. System Application Circuit and Control Waveforms

THERMAL MANAGEMENT

The LM9070 is packaged in both a TO-263 surface mount power package and a narrow lead-pitch TO-220 package. To obtain operation over the highest possible load current and input voltage ranges, care must be taken to control the operating temperature of the device. Thermal shutdown protection is built in, with a threshold above 150°C. Conventional heat-sinking techniques can be used with the TO-220 package. When applying the TO-263 package, on board heat-sinking is important to prevent premature thermal shutdown. More copper foil area under the tab of the device will directly improve the operating θ_{J-A} of the TO-263 package, which will reduce the junction temperature of the device.

Copyright © 1999–2013, Texas Instruments Incorporated

The θ_{J-A} value for the TO-263 package (still air, no additional heat sink) is rated at 80°C/W. The effective θ_{J-A} value of the TO-263 package can be reduced by increasing the printed circuit board area that is connected (soldered) to the package tab. Using 1 ounce (1.4 mils thick) copper clad with no solder mask, an area of 0.5 square inches will reduce θ_{J-A} to 50°C/W, an area of 1.0 square inches will reduce $\theta_{J-A}$to 37°C/W, and an area of 1.6 square inches will reduce θ_{J-A} to 32°C/W. If the printed circuit board uses a solder mask, the copper clad area under the solder mask should be increased by at least 50% to maintain a similar θ_{J-A} rating.

The use of a double sided PC board with soldered filled vias between two planes of copper, as shown in Figure 24, will improve thermal performance while optimizing the PC board surface area required. Using the double sided PC board arrangement shown in Figure 24, with 1 ounce (1.4 mils thick) copper clad with no solder mask and solder filled vias, an area of 0.5 square inches on both sides will reduce θ_{J-A} to 43°C/W.

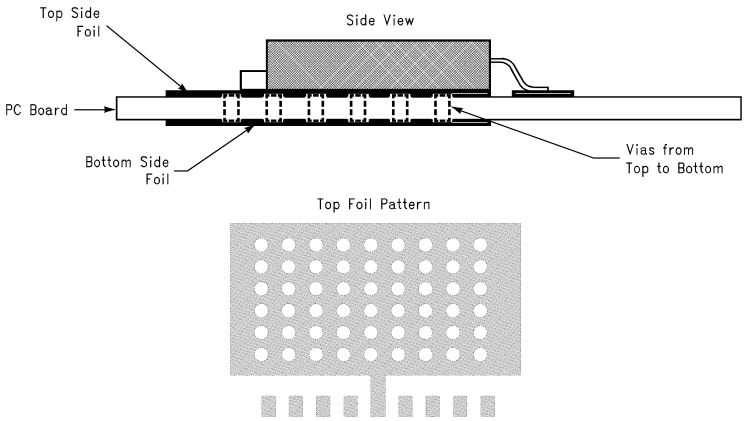


Figure 24. Typical TO-263 PC Board Heatsinking

Copyright © 1999–2013, Texas Instruments Incorporated

REVISION HISTORY

Changes from Revision D (April 2013) to Revision E	Page
• Changed layout of National Data Sheet to TI format	12

Copyright © 1999–2013, Texas Instruments Incorporated

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
LM9070SX/NOPB	ACTIVE	DDPAK/ TO-263	KTW	7	500	Green (RoHS & no Sb/Br)	SN	Level-3-245C-168 HR	-40 to 125	LM9070S	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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(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.

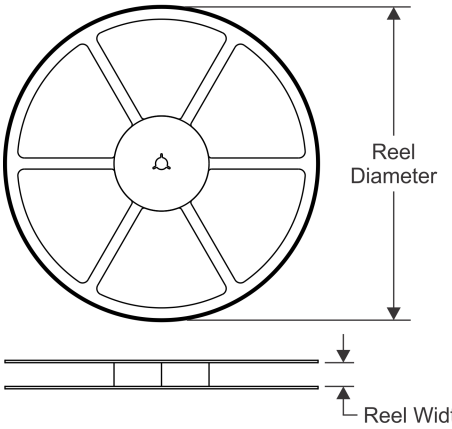
(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

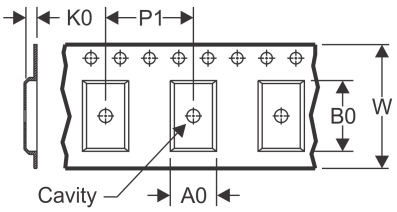
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

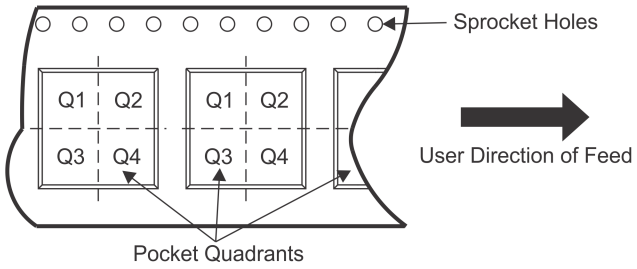


TAPE DIMENSIONS



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

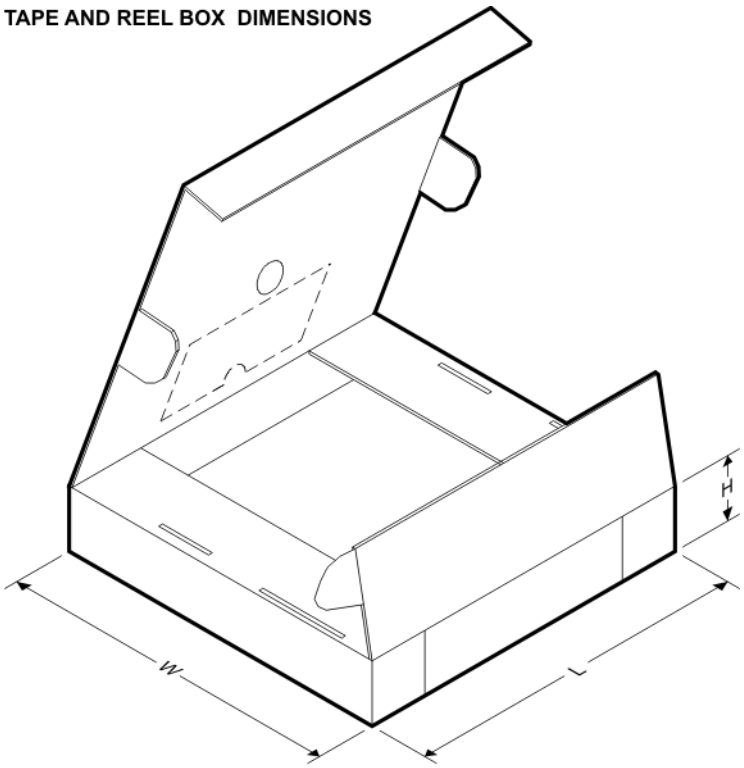
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
LM9070SX/NOPB	DDPAK/ TO-263	KTW	7	500	330.0	24.4	10.75	14.85	5.0	16.0	24.0	Q2

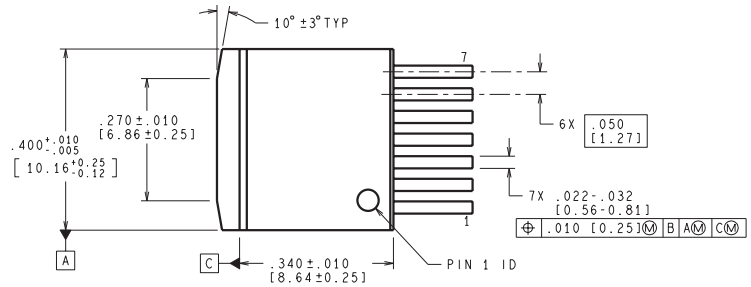
TAPE AND REEL BOX DIMENSIONS

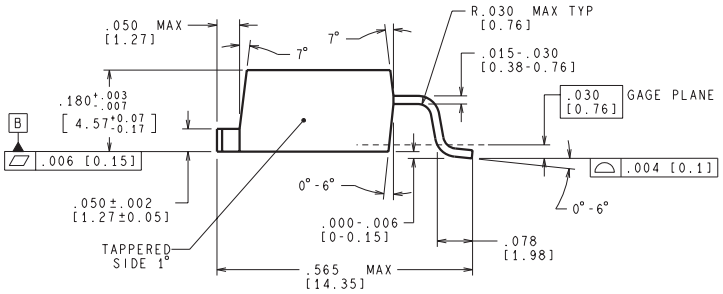


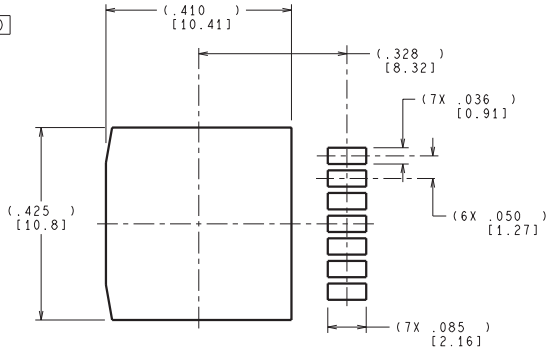
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM9070SX/NOPB	DDPAK/TO-263	KTW	7	500	367.0	367.0	45.0

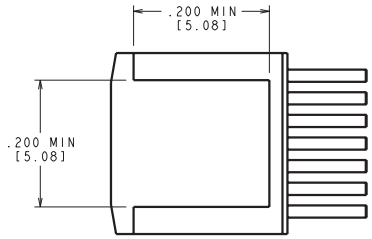
KTW0007B







LAND PATTERN RECOMMENDATION



BOTTOM SIDE OF PACKAGE

CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE MILLIMETERS
DIMENSIONS IN ( ) FOR REFERENCE ONLY

TS7B (Rev E)

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2020, Texas Instruments Incorporated