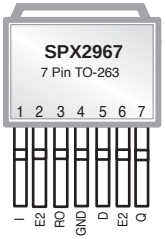
400mA Low Dropout Voltage Regulator

FEATURES

- Output voltage tolerance ≤ 2%
- 400mA current capability
- Low Dropout Voltage
- Very low standby current consumption
- Input voltage up to 40V
- Overvoltage protection up to 60V (≤ 400ms)
- Reset function down to 1V output voltage
- ESD protection up to 2000V
- Adjustable reset time
- On/Off logic
- Over temperature protection
- Reverse polarity protection
- Short-circuit protection
- Wide temperature range





Now Available in Lead Free Packaging

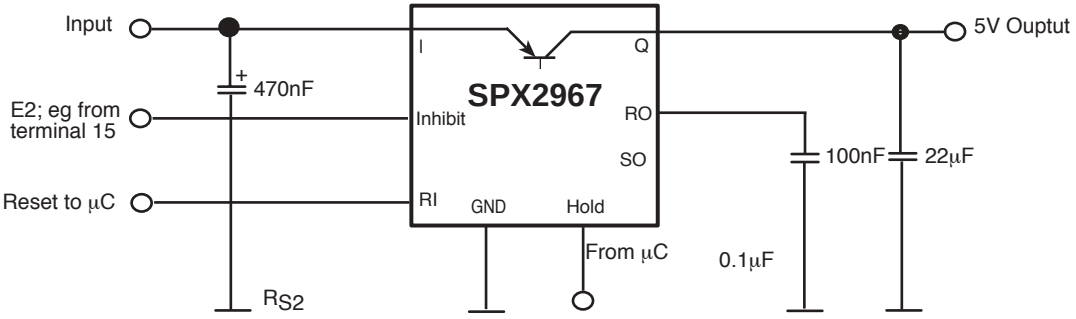
APPLICATIONS

- Automotive
- Industrial
- Wireless Base Station

DESCRIPTION

Sipex's SPX2967 is a 5 volt low dropout voltage regulator for automotive applications. It supplies output current at 400mA. The IC has short-circuit protection and has an overtemperature protection circuit. The part is available in 7 pin TO-220 and TO-263 packages.

TYPICAL APPLICATION CIRCUIT



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APPLICATIONS INFORMATION

The IC regulates an input voltage V_I in the range of 5.5 V < V_I<40 V to a nominal output voltage of V_Q= 5.0V. A reset signal is generated for an output voltage of $V_Q < V_{RT}$ (typ. 4.5V). The reset delay can be set with an external capacitor. The device has two logic inputs. A voltage of V_{E2}>4.0V given to the E2-pin (e.g. by ignition) turns the device on. Depending on the voltage on pin E6 the IC may be hold in active-state even if V_{E2} goes down to low level. This makes it simple to implement a self-holding circuit without external components. When the device is turned off, the output voltage drops to 0V and current consumption tends towards 0 μA.

DESIGN NOTES FOR EXTERNAL COMPONENTS

The input capacitor C_I is necessary for compensation of line influences. The resonant circuit consisting of lead inductance and input capacitance can be damped by a resistor of approximately 1Ω in series with C_I . The output capacitor is necessary for the stability of the regulating circuit. Stability is guaranteed at values of ≥ 22μF and an ESR of less than 3Ω within the operating temperature range.

CIRCUIT DESCRIPTION

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

The reset output RO is in high state if the voltage on the delay capacitor C_D greater than or equal to $V_{UD.}$ The delay capacitance C_D is charged with the current I_D for output voltages greater than the reset threshold $V_{RT.}$ If the output voltage gets lower than V_{RT} a fast discharge of the delay capacitor C_D sets in and as soon as V_{CD} gets lower than V_{LD} the reset output RO is set to low-level. The reset delay can be set within wide range by dimensioning the capacitance of the external capacitor.

PIN DESCRIPTION

PIN NUMBER	PIN NAME	DESCRIPTION
1	I	**Input;** Block to GND directly at the IC with a ceramic capacitor.
2	E2	**Inhibit;** Device is turned on by High signal on this pin; internal pulldown resistor of 100kΩ
3	RO	**Reset Output;** The open-collector output is internally linked to Q via a 30k Ω resistor. Keep it open if not needed.
4	GND	**Ground;** connected to rear of chip
5	D	**Reset Delay;** connect via capacitor to GND for setting delay
6	E6	**Hold;** see truth table for function; this input is connected to output voltage via a pull up resistor of 50kΩ
7	Q	**5V Output;** block to GND with 22μF capacitor, ESR < 3Ω

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TRUTH TABLE FOR TURN-ON/TURN -OFF LOGIC

Pin 2, Inhibit	Pin 6, Hold	V_Q	Comments
L	X	OFF	Initial state, Inhibit internally pulled up
H	X	ON	Regulator switched on via Inhibit, by ignition for example
H	L	ON	Hold clamped active to ground by controller while Inhibit is still high.
X	L	ON	Previous state remains, even ignition is shut off: self-holding state
L	L	ON	Ignition shut off while regulator is in self-holding state
L	H	OFF	Regulator shut down by releasing of Hold while Inhibit remains Low, final state. No active clamping required by external self-holding circuit (μC) to keep regulator in off-state

Pin 2, Inhibit: E2 Enable function, active High

Pin 6, Hold: E6 Hold and release function, active Low

ABSOLUTE MAXIMUM RATINGS

These are stress ratings only and functional operation of the device at these ratings or any other above those indicated in the operation sections of the specifications below is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

Parameter	Symbol	Limit Values		Unit	Notes
		min.	max.		
Input					
Voltage	V_I	-42	42	V	-
Voltage	V_I	-	60	V	T≤ 400ms
Current	I_I	-	-	-	Internally Limited
Reset Output					
Voltage	V_{RO}	-0.3	7	V`	-
Current	I_{RO}	-	-	-	Internally Limited
Reset Delay					
Voltage	V_D	-0.3	42	V	-
Current	V_D	-	-	-	-
Output					
Voltage	V_Q	-0.3	7	V	-
Current	I_Q	-	-	-	Internally Limited
Inhibit					
Voltage	V_{E2}	-42	42	V	-
Current	I_{E2}	-5	5	mA	t≤ 400ms

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ABSOLUTE MAXIMUM RATINGS

These are stress ratings only and functional operation of the device at these ratings or any other above those indicated in the operation sections of the specifications below is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

Parameter	Symbol	Limit Values		Unit	Notes
Hold					
Voltage	V_{E6}	-0.3	7	V	-
Current	I_{E6}	-	-	mA	Internally Limited
GND					
Current	I_{GND}	-0.5	-	A	-
Temperatures					
Junction Temperature	T_J	-40	150	ºC	-
Storage Temperature	T_{stg}	-50	150	ºC	-
Operating Range					
Input Voltage	V_I	5.5	40	V	-
Thermal Resistance					
Junction Ambient	R_{thja}	-	65	K/W	7 Pin TO220 package
Junction-case	R_{thjc}	-	6	K/W	7 Pin TO220 package
Junction-case	Z_{thjc}	-	2	K/W	7 Pin TO220 package
Junction Ambient	R_{thja}	-	70	K/W	7 Pin TO263 package
Junction-case	R_{thjc}	-	6	K/W	7 Pin TO263 package
Junction-case	Z_{thjc}	-	2	K/W	7 Pin TO263 package

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ELECTRICAL CHARACTERISTICS

V_{IN} = 13.5V; -40°C < T_J < 125°C. The ♦ denotes the specifications which apply over the full operating temperature range, unless otherwise specified.

Parameter	Sym	Min	Typ	Max	Units	Conditions
Output Volatage	V_Q	4.9	5.0	5.1	V	5mA ≤ I_Q ≤ 400mA 6V ≤ V_I ≤ 26V
Output Volatage	V_Q	4.9	5.0	5.1	V	5mA ≤ I_Q ≤ 150mA 6V ≤ V_I ≤ 40V
Output Current Limiting	I_Q	500	-	-	mA	Tj = 25° C
Current Consumption $I_q = I_I - I_Q$	I_q	-	-	50	µA	IC turned off
Current Consumption $I_q = I_I - I_Q$	I_q	-	1.0	10	µA	Tj = 25° C IC turned off
Current Consumption $I_q = I_I - I_Q$	I_q	-	1.3	4	mA	I_Q =5mA IC turned on
Current Consumption $I_q = I_I - I_Q$	I_q	-	-	60	mA	I_Q = 400mA
Current Consumption $I_q = I_I - I_Q$	I_q	-	-	80	mA	I_Q = 400mA V_r = 5V
Drop Voltage	V_{DR}	-	0.3	0.6	V	I_Q = 400mA (note 1)
Load Regulation	Δ V_Q	-	-	50	mV	5mA ≤ I_Q ≤ 400mA
Supply-voltage regulation	Δ V_Q	-	15	25	mV	V_I = 6 to 36V I_Q = 5mA
Supply-voltage rejection	Δ V_Q	-	54	-	dB	f_r = 100Hz V_r = 0.5V
Longterm stability	Δ V_Q	-	0	-	mV	1000 h

Note 1: Drop voltage = V_I - V_Q measured when the output voltage has dropped 100mV from the nominal value obtained at 13.5V input.

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ELECTRICAL CHARACTERISTICS

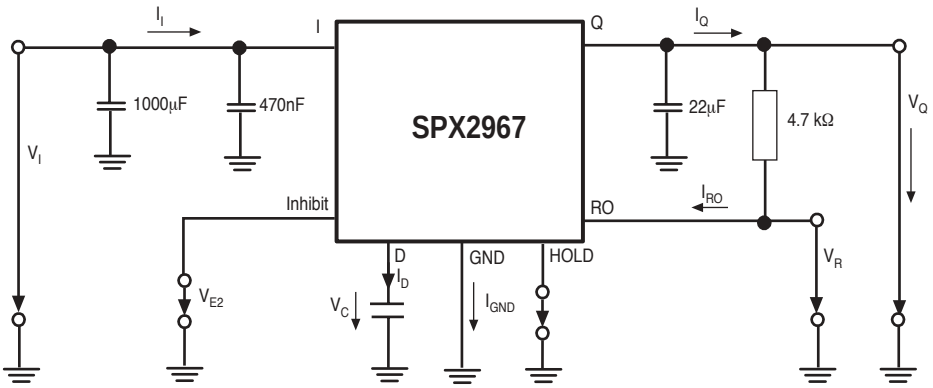
V_{IN} = 13.5V; -40°C < T_J < 125°C. The ♦ denotes the specifications which apply over the full operating temperature range, unless otherwise specified.

Parameter	Sym	Min	Typ	Max	Units	Conditions
Reset Generator						
Switching Threshold	V_{RT}	4.2	4.5	4.8	V	-
Reset High Level	-	4.5	-	-	V	$R_{ext} = \infty$
Saturation Voltage	$V_{RO, SAT}$	-	0.1	0.4	V	R_R = 4.7kΩ (note 2)
Internal Pull up resistor	V_{RO}	-	30	-	kΩ	-
Saturation Voltage	$V_{D, SAT}$	-	50	100	mV	$V_Q < V_{RT}$
Charge Current	I_D	8	15	25	µA	V_D = 1.5 V
Upper delay switching threshold	V_{UD}	2.6	3	3.3	V	-
Delay Time	t_D	-	20	-	ms	C_d = 100nF
Lower delay switching threshold	V_{LD}	-	0.43	-	V	-
Reset reaction time	t_{RR}	-	2	-	µS	C = 100nF
Inhibit						
Turn on voltage	$V_{U, INH}$	-	3	4	V	IC turned on
Turn off voltage	$V_{L, INH}$	2	-	-	V	IC turned off
Pull down Resistor	R_{INH}	50	100	200	kΩ	-
Hysteresis	ΔV_{INH}	0.2	0.5	0.8	V	-
Input Current	I_{INH}	-	35	100	µA	V_{INH} = 4V
Hold Voltage	$V_{U, HOLD}$	30	35	40	%	Referred to V_Q
Turn off Voltage	$V_{L, HOLD}$	60	70	80	%	Referred to V_Q
Pull up Resistor	R_{HOLD}	20	50	100	kΩ	-
Overvoltage Protection						
Turn off Voltage	$V_{L, OV}$	42	44	46	V	-
Turn on Hysteresis	$\Delta V_{L, OV}$	2	-	6	V	-

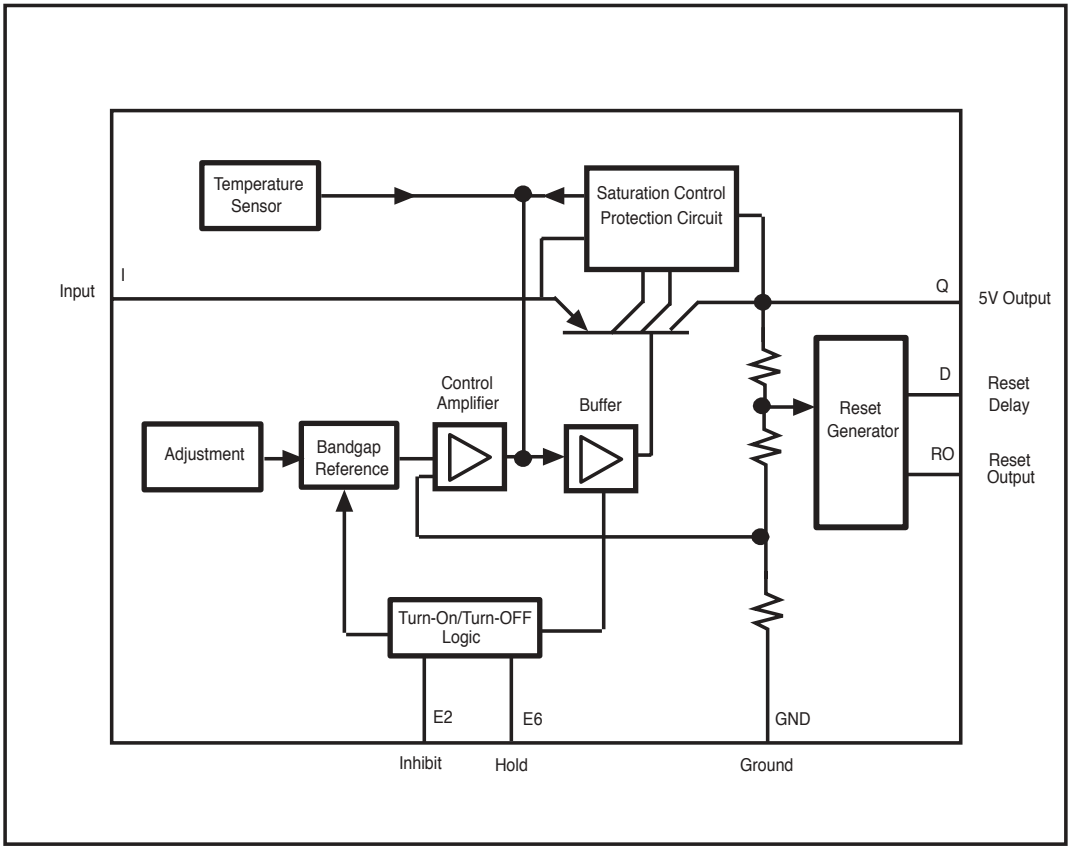
Note 2: The reset output is low for 1V < V_Q < V_{RT}

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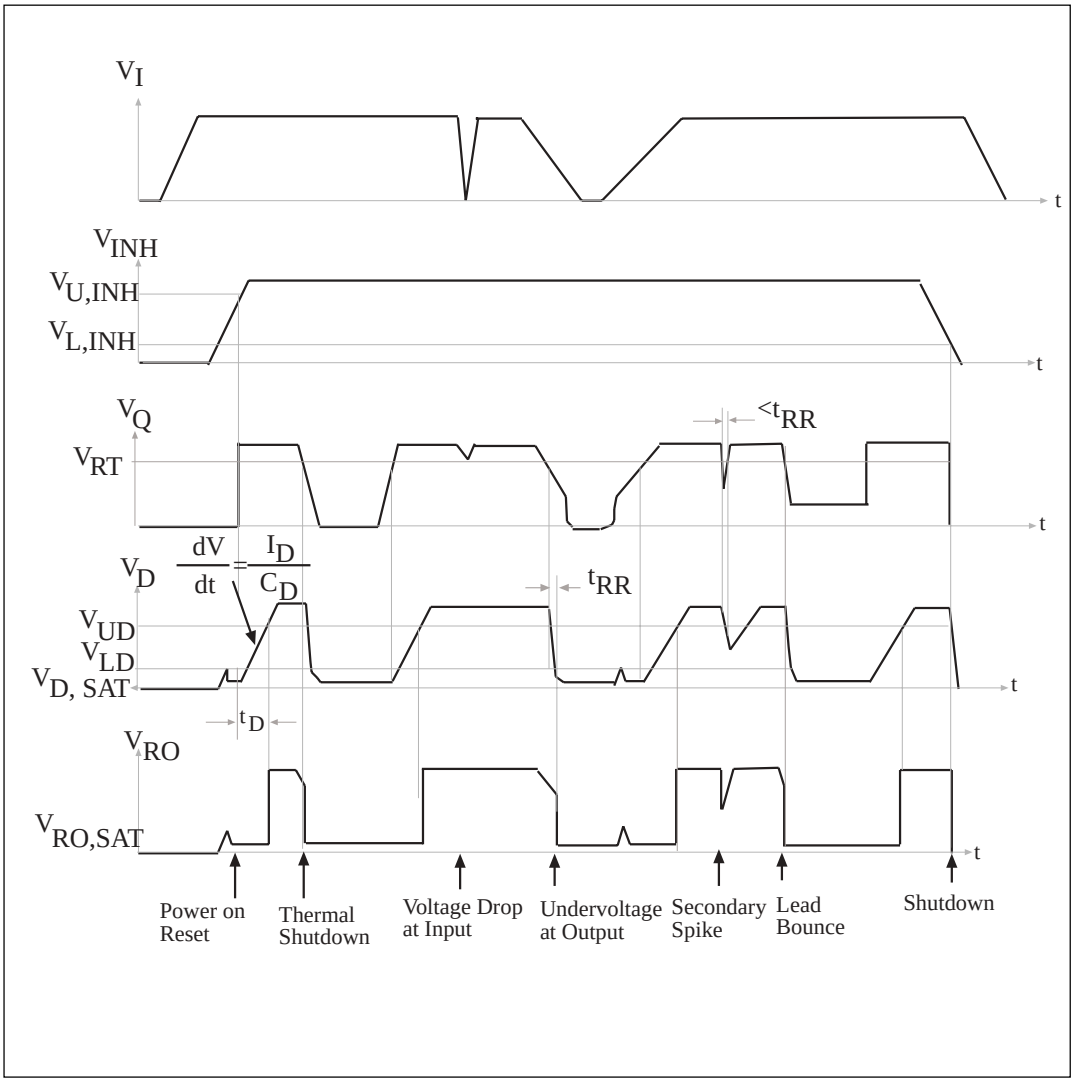
TEST CIRCUIT



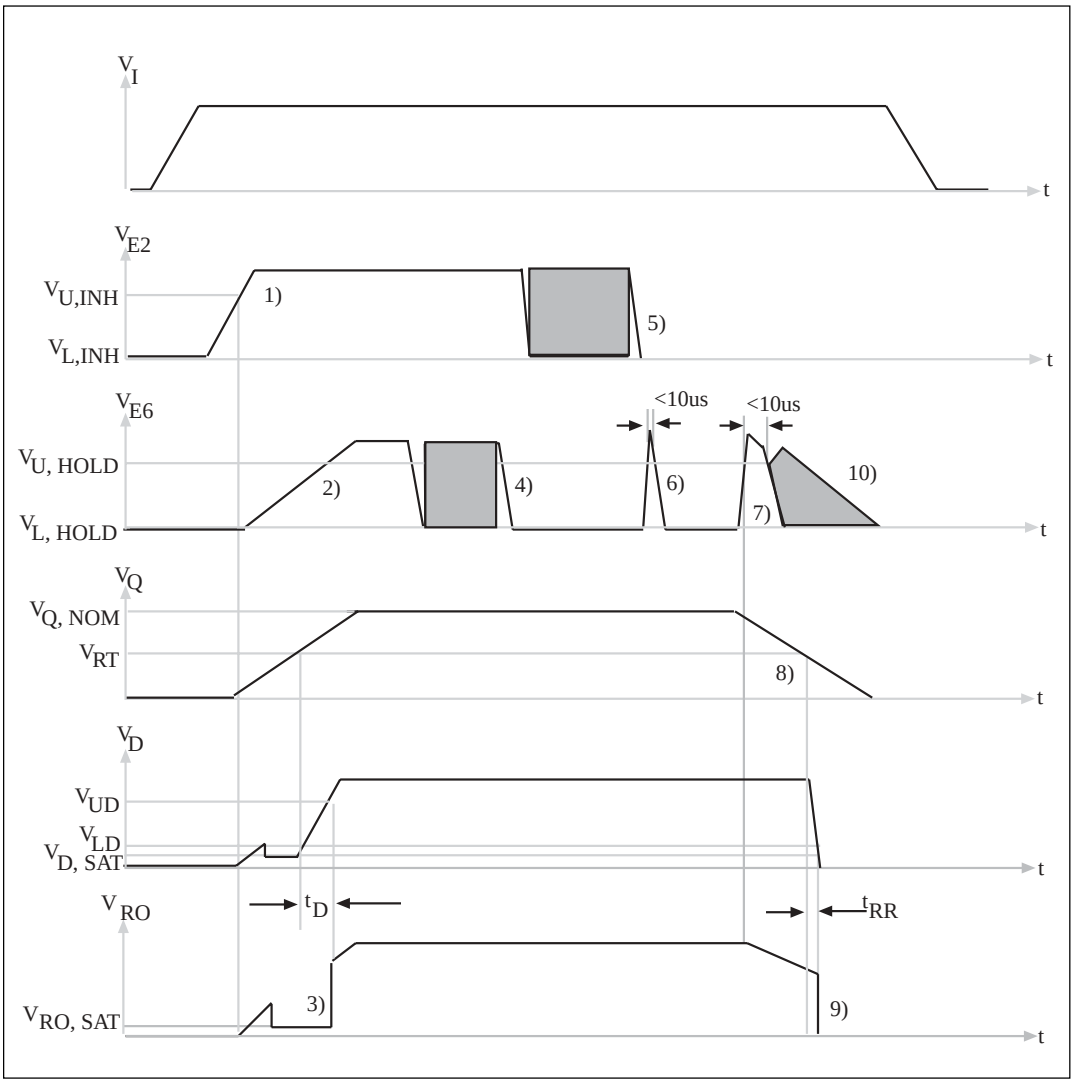
BLOCK DIAGRAM



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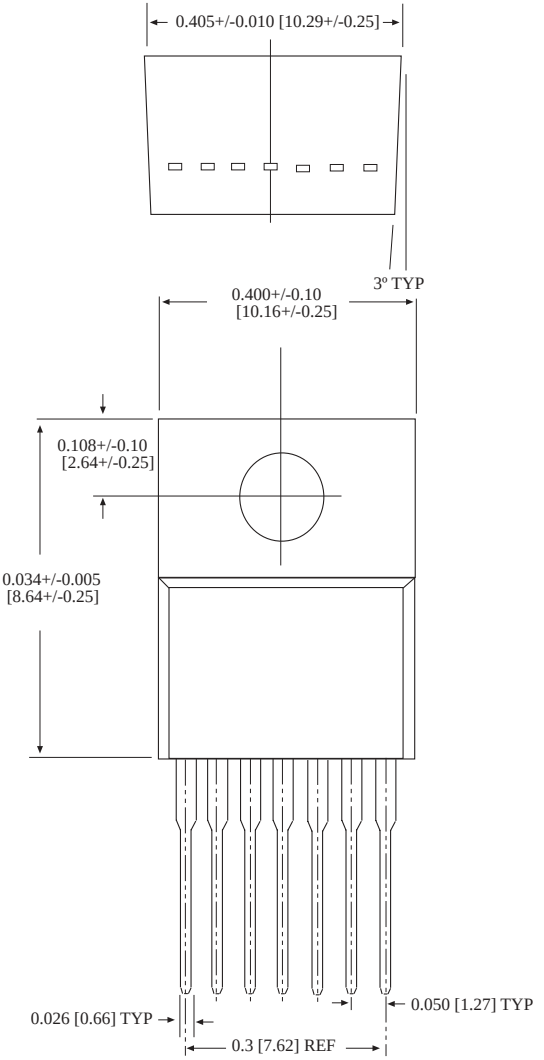


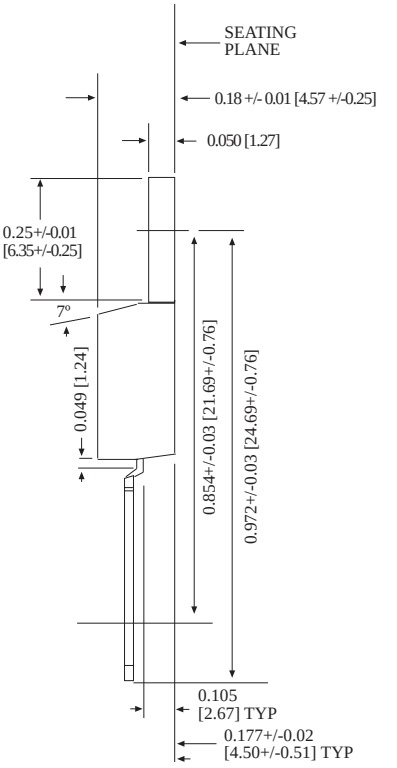
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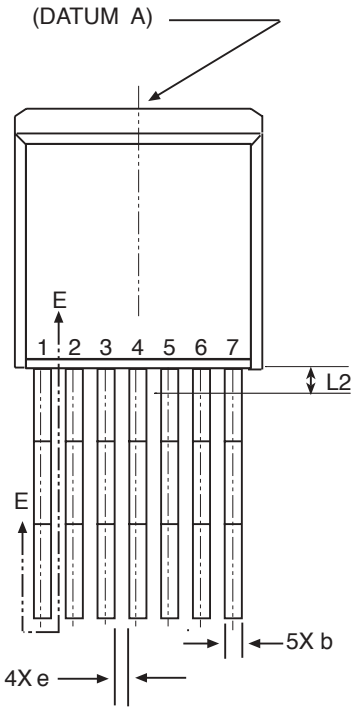
1) Enable Device
2) Hold Inactive
3) Power-on reset
4) Hold active, clamped to GND by external uC
5) Enable inactive, clamped by int. pull down resistor.
6) Pulse width smaller than 1us.
7) Hold inactive, released by uC.
8) Voltage controller shutdown.
9) Output-low reset
10) No switch via V_{E6} possible after E6 was released to $V_{E6} > V_{E6, REL}$ for more than 4 us.

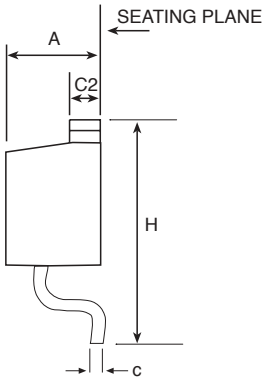
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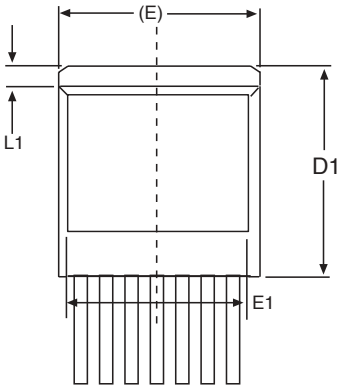


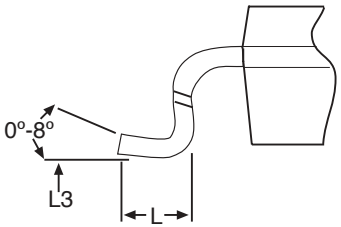


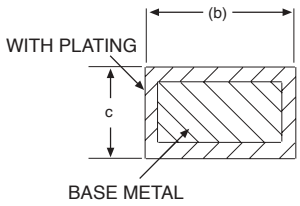
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7 PIN TO-263 JEDEC TO-263 (BB) Variation	Dimensions in (mm)		
	MIN	NOM	MAX
A	.160	-	.190
A1	0	-	.010
b	.020	-	.039
c	.015	-	.029
c2	.045	-	.023
D1	.270	-	-
E	.380	-	.420
E1	.245	-	-
e	.067 BSC		
H	.575	-	.625
L	.070	-	.110
L1	-	-	.066
L2	-	-	.070
L3	.010 BSC		

7 PIN TO-263

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ORDERING INFORMATION

Part number	Output Voltage	Package Type
SPX2967U	5.0V	7 Pin TO-220
SPX2967T	5.0V	7 Pin TO-263

Available in lead free packaging. To order add “-L” suffix to part number.

Example: SPX2967U = standard; SPX2967U-L = lead free

ANALOG EXCELLENCE

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