AS1927

Nanopower µP Supervisory Circuits with Manual Reset and Watchdog Timer

1 General Description

The AS1927 microprocessor supervisory circuits were designed to generate a reset when the monitored supply voltage falls below a factory-trimmed threshold. The reset remains asserted for a minimum timeout period after the supply voltage stabilizes.

Guaranteed to be in the correct state for VCC higher than +1.0V, these devices are ideal for portable and battery-powered systems with strict monitoring requirements.

The devices feature factory-trimmed thresholds to monitor a supply voltage between 1.575V and 4.625V.

The devices are available with the reset output types listed in Table 1.

Table 1. Standard Products

Model	Reset Output Type
AS1927L	Active-Low Push/Pull
AS1927H	Active-High Push/Pull
AS1927D	Active-Low Open-Drain

The AS1927 include a manual-reset input for systems that never fully power down the microprocessor.

Additionally, these devices feature a watchdog timer to ensure that the processor is operating within proper code boundaries. A watchdog disable feature allows to turn off the watchdog if not required or unwanted, as in boot up conditions of microcontrollers.

The AS1927 are available in a 6-pin TDFN (2x2mm) package.

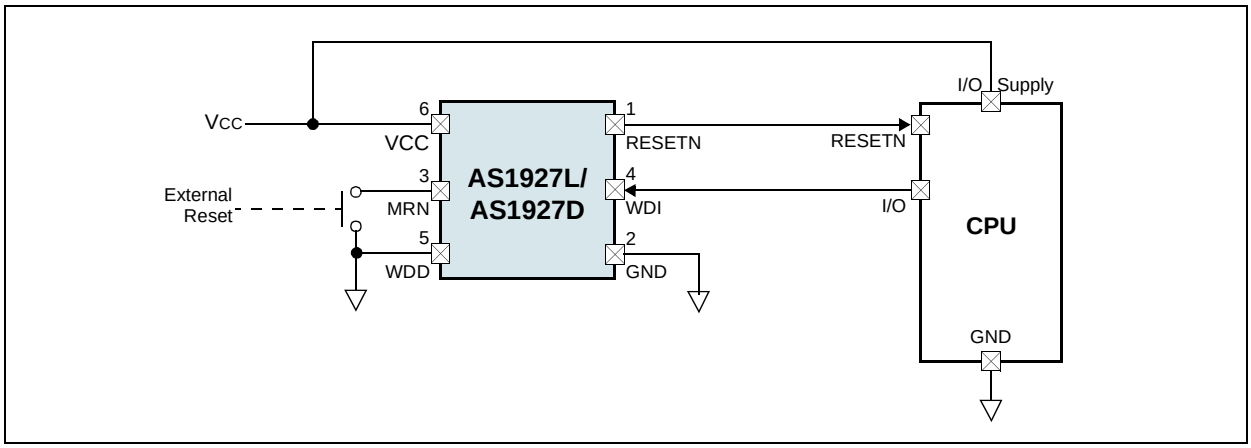
2 Key Features

- 170nA Ultra-Low Supply Current
- VCC Supervisory Range: +1.575V to +4.625V
  (for further information see Ordering Information on page 11)
- Guaranteed Reset Valid Down to VCC = +1.0V
- Six Minimum Reset Timeout Period Options from: 10ms to 1.2s
- Manual Reset Input
- Four Watchdog Timeout Periods available: 3.3, 6, 12 or 24s
- Three Reset Output Types
  - Active-Low Push/Pull (AS1927L)
  - Active-High Push/Pull (AS1927H)
  - Active-Low Open-Drain (AS1927D)
- Immune to Fast Negative VCC Transients
- External Components Not Required
- Operating Temperature Range: -40 to +85°C
- 6-pin TDFN (2x2mm) Package

3 Applications

The devices are ideal for low-power portable and battery-powered systems, embedded controllers, intelligent instruments, automotive systems, and critical CPU monitoring applications.

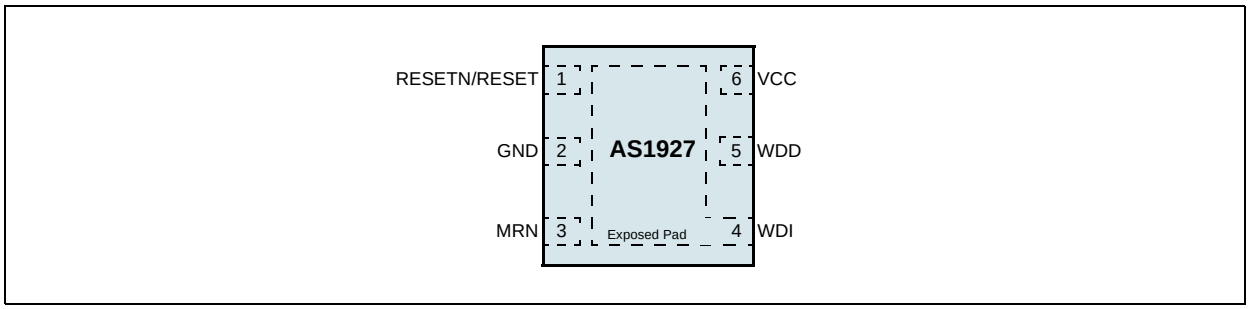
Figure 1. AS1927 - Typical Application Diagram



4 Pinout

Pin Assignments

Figure 2. Pin Assignments (Top View)



Pin Descriptions

Table 2. Pin Descriptions

Pin Number	Pin Name	Description
1	RESETN	**Active-Low Reset Output** (AS1927L, AS1927D). The RESETN signal toggles from high to low when V_{CC} crosses the threshold (falling), or MRN is pulled low, or the watchdog triggers a reset. This output signal remains low for the reset timeout period (see t_{RP} on page 4) after the supervised voltage exceeds its reset threshold, or MRN goes low to high.
	RESET	**Active-High Reset Output** (AS1927H). The RESET signal toggles from low to high when V_{CC} crosses the threshold (falling), or MRN is pulled low, or the watchdog triggers a reset. This output signal remains high for the reset timeout period (see t_{RP} on page 4) after the supervised voltage exceeds its reset threshold, or MRN goes low to high.
2	GND	**Ground**
3	MRN	**Active-Low Manual Reset Input**. Pulling this pin low asserts a reset. This pin is connected to the internal 20kΩ pullup to V_{CC}. This reset remains active as long as MRN is low and for the reset timeout period (see t_{RP} on page 4) after MRN goes high. **Note:** If the manual reset feature is not used, this pin should be unconnected or connected to V_{CC}.
4	WDI	**Watchdog Input**. If WDI remains high or low for longer than the watchdog timeout period (see t_{WD} on page 5), the internal watchdog timer period expires and a reset is triggered for the reset timeout period (see t_{RP} on page 4). The internal watchdog timer clears whenever a reset is asserted or when WDI senses a rising or falling edge.
5	WDD	**Watchdog Disable**. This pin allows to turn on or off the watchdog feature. Pin to GND: Watchdog enabled. Pin to V_{CC}: Watchdog disabled.
6	VCC	**Supervised Voltage Input**. This pin serves as the supervised supply voltage input.
Exposed Pad		**Exposed Pad**. This pin is connected to pin 4 WDI.

5 Absolute Maximum Ratings

Stresses beyond those listed in Table 3 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 in Electrical Characteristics on page 4 is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 3. Absolute Maximum Ratings

Parameter	Min	Max	Units	Comments
Electrical Parameters				
VCC to GND	-0.3	+7.0	V	
Open-Drain RESETN	-0.3	+7.0	V	
Push/Pull RESET, RESETN	-0.3	VCC + 0.3	V	
MRN, WDI to GND	-0.3	VCC + 0.3	V	
Input and Output Current (all pins)		20	mA	
Electrostatic Discharge				
ESD	1		kV	Norm: MIL 883 E method 3015
Temperature Ranges and Storage Conditions				
Continuous Power Dissipation (TAMB = +70ºC)		696	mW	Derate 8.7mW/ºC above +70ºC
Junction Temperature		+150	ºC	
Storage Temperature Range	-55	+150	ºC	
Package Body Temperature		+260	ºC	The reflow peak soldering temperature (body temperature) specified is in accordance with *IPC/JEDEC J-STD-020 "Moisture/Reflow Sensitivity Classification for Non-Hermetic Solid State Surface Mount Devices".* The lead finish for Pb-free leaded packages is matte tin (100% Sn).
Humidity non-condensing	5	85	%	
Moisture Sensitive Level	1			Represents a max. floor life time of unlimited

6 Electrical Characteristics

VCC = +1.2V to +5.5V; Typ values are @ TAMB = +25°C (unless otherwise specified). All limits are guaranteed. The parameters with min and max values are guaranteed with production tests or SQC (Statistical Quality Control) methods.

Table 4. Electrical Characteristics

Symbol	Parameter [1]	Conditions		Min	Typ	Max	Units
TAMB	Operating Temperature Range			-40		+85	°C
VCC	Operating Voltage Range	TAMB = 0 to +85ºC		1.0		5.5	V
		TAMB = -40 to +85ºC		1.2		5.5	
ICC	VCC Supply Current	No Load, VCC = +5.0V			210	400	nA
		No Load, VCC = +3.3V			190	380	
		No Load, VCC = +1.8V			170	370	
VTH	VCC Reset Threshold	VCC falling		-2		2	%
	Reset Threshold Temperature Coefficient[2]					170	ppm/ºC
	Reset Threshold Hysteresis				0.5		%/VTH
tRD	VCC to Reset Output Delay	VCC = (VTH + 100mV) to (VTH - 100mV) @ 10mV/µs			40		µs
tRP	Reset Timeout Period	VCC = (VTH-2%) to (VTH + 150mV)	D1	10	15	25	ms
			D2	40	60	80	
			D3	150	225	300	
			D4	300	450	600	
			D5	600	900	1200	
			D6	1200	1800	2400	
VOL	RESETN Output Low (Push/Pull or Open-Drain)	VCC ≥ 1.0V, ISINK = 50µA, Reset Asserted, TAMB = 0 to +85ºC				0.3	V
		VCC ≥ 1.2V, ISINK = 100µA, Reset Asserted				0.3	
		VCC ≥ 2.12V, ISINK = 1.2mA, Reset Asserted				0.3	
		VCC ≥ 3.3V, ISINK = 3.2mA, Reset Asserted				0.3	
VOH	RESETN Output High (Push/Pull Only)	VCC ≥ 1.71V, ISOURCE = 200µA, Reset Not Asserted		0.8 x VCC			V
		VCC ≥ 2.38V, ISOURCE = 500µA, Reset Not Asserted		0.8 x VCC			
		VCC ≥ 3.3V, ISOURCE = 800µA, Reset Not Asserted		0.8 x VCC			
ILKG	Open-Drain RESETN Output Leakage Current	RESETN Not Asserted				25	nA
VOH	RESET Output High (Push/Pull Only)	VCC ≥ 1.0V, ISOURCE = 10µA, Reset Asserted, TAMB = 0 to +85ºC		0.8 x VCC			V
		VCC ≥ 1.50V, ISOURCE = 200µA, Reset Asserted		0.8 x VCC			
		VCC ≥ 2.12V, ISOURCE = 500µA, Reset Asserted		0.8 x VCC			
		VCC ≥ 3.3V, ISOURCE = 800µA, Reset Asserted		0.8 x VCC			

Table 4. Electrical Characteristics (Continued)

Symbol	Parameter [1]	Conditions	Min	Typ	Max	Units
V_{OL}	RESET Output Low (Push/Pull Only)	$V_{CC} \geq 1.71V$, I_{SINK} = 500µA, Reset Asserted			0.3	V
		$V_{CC} \geq 2.38V$, I_{SINK} = 1.2mA, Reset Asserted			0.3	
		$V_{CC} \geq 3.3V$, I_{SINK} = 3.2mA, Reset Asserted			0.3	
Manual Reset Input						
V_{IH}	MRN Input voltage		0.7 x V_{CC}			V
V_{IL}					0.3 x V_{CC}	
	MRN Minimum Input Pulse		1			µs
	MRN Transient Rejection			200		ns
	MRN to Reset Delay			250		ns
	MRN Pullup Resistance			20		kΩ
Watchdog Input						
V_{IH}	WDI Input Voltage [2]		0.7 x V_{CC}			V
V_{IL}					0.3 x V_{CC}	
V_{IHE}	WDD Input Voltage [2]		0.7 x V_{CC}			V
V_{ILE}					0.3 x V_{CC}	
t_{WD}	Watchdog Timeout Period	S		3.3		s
		M		6		
		L		12		
		X		24		
t_{WDI}	WDI Pulse Width [2]		150			ns
I_{WDI}	WDI Input Current	WDI = V_{CC}, Time Average			20	nA

1. Over-temperature limits are guaranteed by design and not production tested. Devices tested at +25ºC.
2. Guaranteed by design and not production tested.

7 Detailed Description

The AS1927 supervisory circuits were designed to generate a reset when the monitored supply voltage falls below its factory-trimmed trip threshold (see Threshold Voltage Suffix Guide (x) on page 11), and to maintain the reset for a minimum timeout period (see tRP on page 4) after the supply has stabilized.

The integrated watchdog timer (see Watchdog Input on page 7) helps mitigate against bad programming code or clock signals, and/or poor peripheral response.

The active-low manual reset input (see Manual Reset Input on page 7) allows for an externally activated system reset.

RESET/RESETN

Whenever the monitored supply voltage falls below its reset threshold, the RESET output asserts high or the RESETN output asserts low. Once the monitored voltage has stabilized, an internal timer keeps the reset asserted for the reset timeout period (tRP). After the tRP period, the RESET/RESETN output returns to its original state (see Figure 4).

Figure 3. Functional Diagram of VCC Supervisory Application

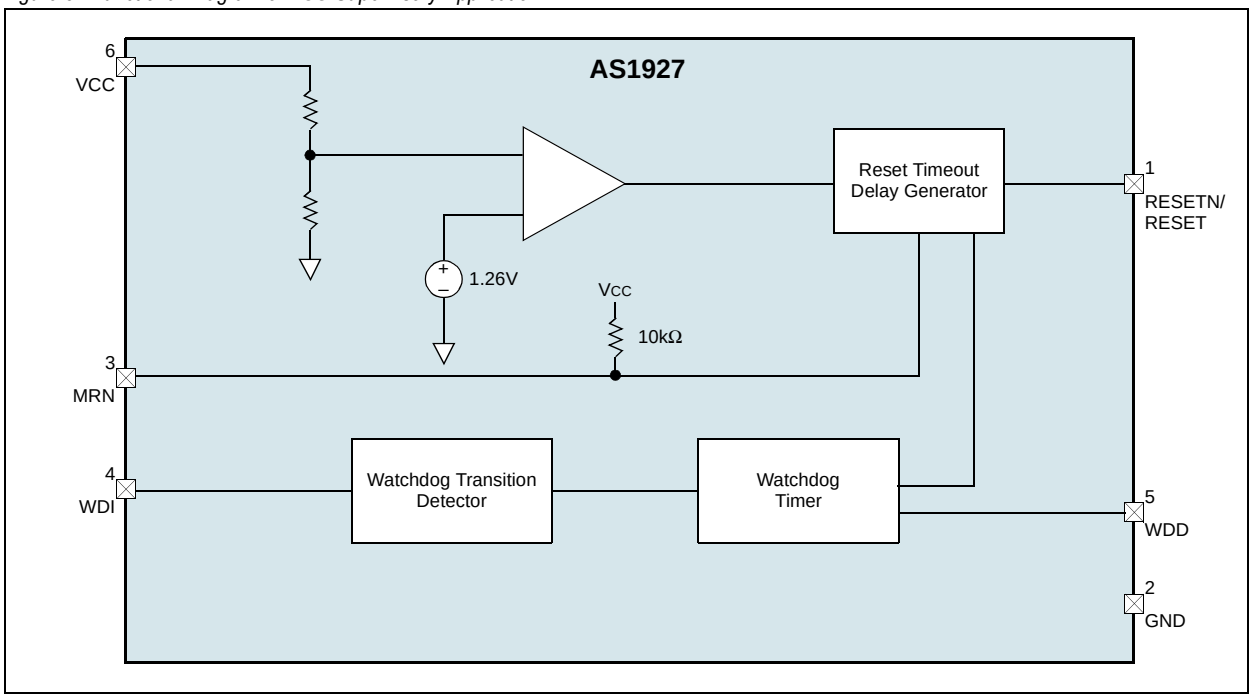
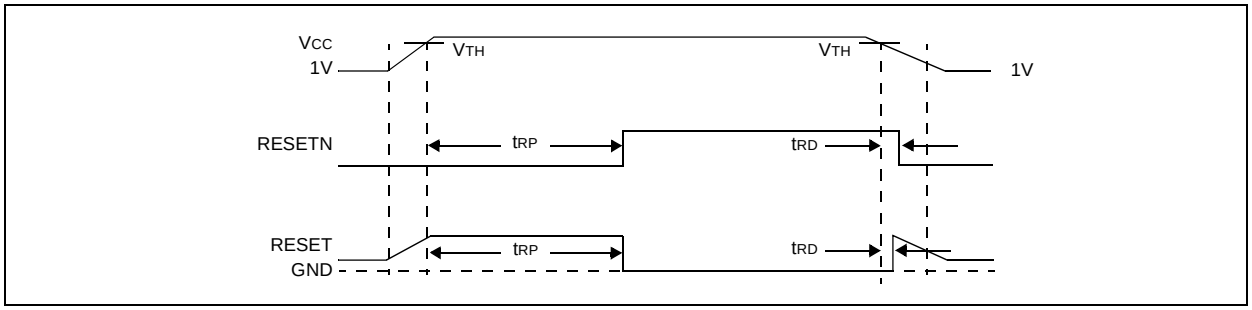


Figure 4. Reset Timing Diagram

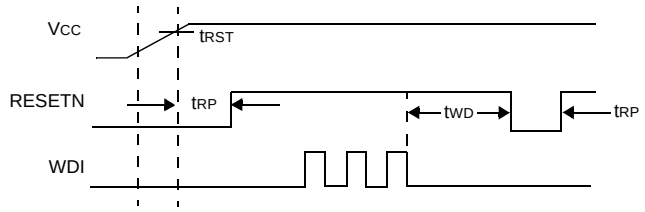


Watchdog Input

The integrated watchdog feature can be used to monitor processor activity via pin WDI, and can detect pulses as short as 150ns. The watchdog requires that the processor toggle the watchdog logic input at regular intervals, within a specified minimum watchdog timeout period (see Table 8 on page 12). A reset is asserted for the reset timeout period. As long as reset is asserted, the timer remains cleared and is not incremented. When reset is de asserted, the watchdog timer starts counting (Figure 5).

Note: The watchdog timer can be cleared with a reset pulse or by toggling WDI.

Figure 5. Watchdog Timing Relationship



The RESET signal is the inverse of the RESETN signal.

Watchdog Enable Input

The active-low pin WDD is used to enable or disable the watchdog timer. As long as this pin is pulled to VCC the watchdog timer stops and is reset. When WDD is pulled to GND the watchdog works as normal. This feature can be used if the watchdog is not in use or during the boot phase of the µC to prevent unintended resets.

Manual Reset Input

The active-low pin MRN is used to force a manual reset. This input can be driven by CMOS logic levels or with open-drain collector outputs.

Pulling MRN low asserts a reset which will remain asserted as long as MRN is kept low, and for the timeout period (see tRP on page 4) after MRN goes high. The manual reset circuitry has an internal 20kΩ pull-up resistor, thus it can be left open if not used.

To create a manual-reset circuit, connect a normally open momentary switch from pin MRN to GND (see Figure 1 on page 1); external debounce circuitry is not required in this configuration.

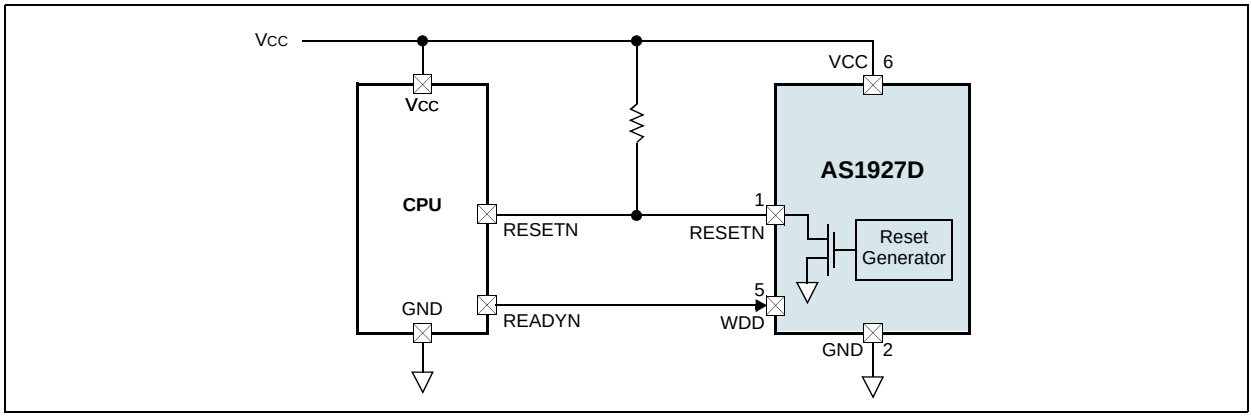
If MRN is driven via long cables or the device is used in a noisy environment, a 0.1µF capacitor between pin MRN and GND will provide additional noise immunity.

8 Application Information

Interfacing to Bi-Directional CPU Reset Pins

Since the reset output of the AS1927D is open drain, this device interfaces easily with processors that have bi-directional reset pins. Connecting the processor reset output directly to the AS1927D RESETN pin with a single pullup resistor (see Figure 6) allows the AS1927D to assert a reset.

Figure 6. AS1927D RESETN-to-CPU Bi-Directional Reset Pin



Fast Negative-Going Transients

Fast, negative-going VCC transients normally do not require the CPU to be shutdown. The AS1927 are virtually immune to such transients. Resets are issued to the CPU during power-up, powerdown, and brownout conditions.

Note: VCC transients that go 100mV below the reset threshold and last ≤ 55µs typically will not assert a reset pulse.

Valid Reset to V_{CC} = 0

The AS1927 are guaranteed to operate properly down to VCC = 1V.

For AS1927L and AS1927H applications requiring valid reset levels down to VCC = 0, a pulldown resistor to active-low outputs and a pullup resistor to active-high outputs will ensure that the reset line is valid during the interval where the reset output can no longer sink or source current.

9 Package Drawings and Markings

Figure 7. 6-pin TDFN (2x2mm) Marking

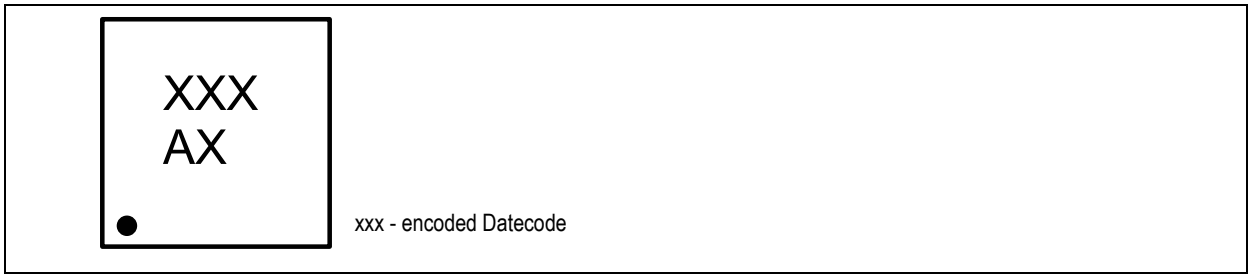
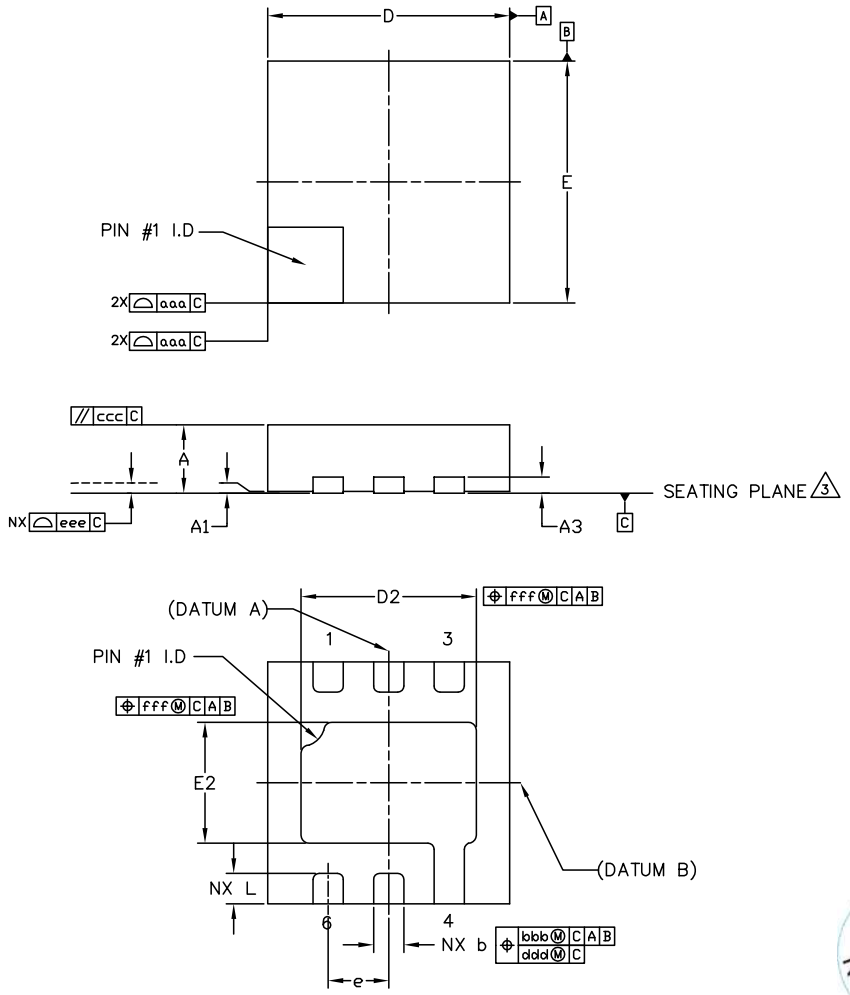


Figure 8. 6-pin TDFN (2x2mm) Package



REF.	MIN	NOM	MAX
A	0.51	0.55	0.60
A1	0	0.02	0.05
A3		0.15 REF	
L	0.15	0.25	0.35
b	0.18	0.25	0.30
D		2.00 BSC	
E		2.00 BSC	
e		0.50 BSC	
D2	1.30	1.45	1.10
E2	0.85	1.00	
aaa	–	0.15	–
bbb	–	0.10	–
ccc	–	0.10	–
ddd	–	0.05	–
eee	–	0.08	–
fff	–	0.10	–
N		6	

NOTE:

1. DIMENSIONS & TOLERANCEING CONFIRM TO ASME Y14.5M–1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS. ANGELS ARE IN DEGREES.
3. COPLANARITY APPLIES TO THE EXPOSED HEAT SLUG AS WELL AS THE TERMINAL.
4. RADIUS ON TERMINAL IS OPTIONAL.
5. N IS THE TOTAL NUMBER OF TERMINALS.

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CHECKED GBO	DATE 2011.02.02		DRAWING NO. QEF	UNIT
APPROVED MKR	DATE 2011.02.02	SHEET 1 OF 1	DIMENSION AND TOLERANCE	SCALE NOT IN SCALE

10 Ordering Information

The devices are available as the standard products shown in Table 5.

Table 5. Ordering Information

Ordering Code	Marking	Description	Delivery Form	Package
AS1927L-BTDT-33s	AX	Low Power Supervisory Circuit with 1.9V threshold, 225ms Time out and 3.3s Watchdog	Tape and Reel	6-pin TDFN (2x2mm)
AS1927L-BTDT-xyz*	___	Low Power Supervisory Circuit with **x** threshold, **y** Time out and **z** Watchdog	Tape and Reel	6-pin TDFN (2x2mm)

*) on request

Note: All products are RoHS compliant.
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These devices are available in factory-set VCC thresholds from 1.575V to 4.625V in ~100mV increments. Choose the desired reset threshold suffix from Table 6 and insert it instead of “x” in the part number.
Factory-programmed reset time out periods are also available. Insert the code corresponding to the desired nominal reset time out period from Table 7 instead of “y” in the part number.
For the desired watchdog time out period insert the suffix from Table 8 as “z” into the ordering code.
All devices are available in tape-and-reel only.

Table 6. Threshold Voltage Suffix Guide (x)

Suffix	Min	Typ	Max		Suffix	Min	Typ	Max		Suffix	Min	Typ	Max
a	4.509	4.625	4.741		l		3.500			w		2.400	
b	4.338	4.500	4.613		m		3.400			x		2.313	
c	4.266	4.375	4.484		n		3.300			y		2.235	
d	4.193	4.300	4.408		o		3.200			z		2.188	
e	4.095	4.200	4.305		p		3.075			1		2.100	
f	3.998	4.100	4.203		q		3.000			2		2.000	
g		4.000			r		2.925			3		1.900	
h		3.900			s		2.800			4		1.800	
i		3.800			t		2.700			5		1.665	
j		3.700			u		2.625			6		1.575	
k		3.600			v		2.500						

Table 7. Timeout Option Suffix Guide (y)

Suffix	Reset Timeout Periods			
	Min	Typ	Max	UNITS
1	10	15	25	ms
2	40	60	80	
3	150	225	300	
4	300	450	600	
5	600	900	1200	
6	1200	1800	2400	

Table 8. Watchdog Timeout (z)

Suffix	Watchdog Timeout Periods			
	Min	Typ	Max	UNITS
s		3.3		s
m		6		
l		12		
x		24		

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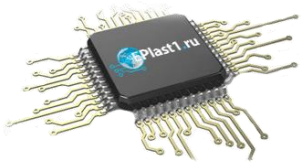
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