Low Voltage Supervisory Circuits with Watchdog in 4-Lead SC70

ADM8616/ADM8617

FEATURES

- Precision 1.8 V to 5 V power supply monitoring
- 9 $\overline{\text{RESET}}$ threshold options
  - 1.58 V to 4.63 V
- 4 $\overline{\text{RESET}}$ timeout options
  - 1 ms, 20 ms, 140 ms, 1120 ms
- 3 Watchdog timeout options
  - 6.3 ms, 102 ms, 1.6 sec
- $\overline{\text{RESET}}$ output stages
  - Push-pull active-low (ADM8616)
  - Open-drain active-low (ADM8617)
- Low power consumption (5 µA)
- Guaranteed reset output valid to V_{CC} = 1 V
- Power supply glitch immunity
- Specified over −40°C to +85°C temperature range
- 4-lead SC70 package

APPLICATIONS

- Microprocessor systems
- Computers
- Controllers
- Intelligent instruments
- Portable equipment

FUNCTIONAL BLOCK DIAGRAM

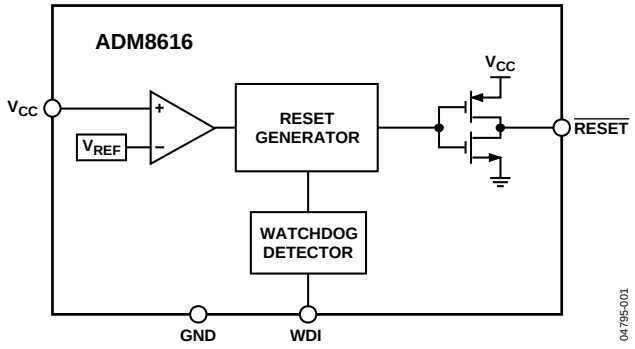

Figure 1.

GENERAL DESCRIPTION

The ADM8616/ADM8617 are supervisory circuits that monitor power supply voltage levels and code execution integrity in microprocessor-based systems. A power-on reset signal is generated when the supply voltage rises to a preset threshold level. The ADM8616/ADM8617 have an on-chip watchdog timer that can reset the microprocessor if it fails to strobe within a preset timeout period.

Each part is available in the following 9 reset threshold options: 1.58 V, 1.67 V, 2.19 V, 2.32 V, 2.63 V, 2.93 V, 3.08 V, 4.38 V, and 4.63 V. There are four reset timeout options: 1 ms, 20 ms, 140 ms, and 1120 ms. There are also three possible watchdog timeouts available: 6.3 ms, 102 ms and 1.6 sec.

The parts differ in terms of reset output configuration. The ADM8616 is active-low with a push-pull output, while the ADM8617 is active-low with an open-drain output.

The ADM8616/ADM8617 are available in 4-lead SC70 packages and typically consume only 5 µA, making them suitable for use in low power, portable applications.

Rev. 0

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REVISION HISTORY

6/05—Revision 0: Initial Version

SPECIFICATIONS

V_{CC} = full operating range; T_A = −40°C to 85°C, unless otherwise noted.

Table 1.

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
SUPPLY					
V_{CC} Operating Voltage Range	1		5.5	V	
Supply Current		10	20	µA	V_{CC} = 5.5 V
		5	12	µA	V_{CC} = 3.6 V
$\overline{\text{RESET}}$ THRESHOLD VOLTAGE					
ADM861xL	4.50	4.63	4.75	V	
ADM861xM	4.25	4.38	4.50	V	
ADM861xT	3.00	3.08	3.15	V	
ADM861xS	2.85	2.93	3.00	V	
ADM861xR	2.55	2.63	2.70	V	
ADM861xZ	2.25	2.32	2.38	V	
ADM861xY	2.12	2.19	2.25	V	
ADM861xW	1.62	1.67	1.71	V	
ADM861xV	1.52	1.58	1.62	V	
$\overline{\text{RESET}}$ THRESHOLD TEMPERATURE COEFFICIENT		40		ppm/°C	
$\overline{\text{RESET}}$ THRESHOLD HYSTERESIS		2xV_{TH}		mV	
$\overline{\text{RESET}}$ TIMEOUT PERIOD					
ADM861xxA	1	1.4	2	ms	
ADM861xxB	20	28	40	ms	
ADM861xxC	140	200	280	ms	
ADM861xxD	1120	1600	2240	ms	
V_{CC} TO $\overline{\text{RESET}}$ DELAY		40		µs	V_{CC} falling at 1 mV/µs
$\overline{\text{RESET}}$ OUTPUT VOLTAGE					
VOL (Open-Drain and Push-Pull)			0.3	V	V_{CC} > = 1.0 V, I_{SINK} = 50 µA
			0.3	V	V_{CC} > = 1.2 V, I_{SINK} = 100 µA
			0.3	V	V_{CC} > = 2.7 V, I_{SINK} = 1.2 mA
			0.4	V	V_{CC} > = 4.5 V, I_{SINK} = 3.2 mA
VOH (Push-Pull Only)	0.8 x V_{CC}			V	V_{CC} > = 2.7 V, I_{SOURCE} = 500 µA
	V_{CC} − 1.5			V	V_{CC} > = 4.5 V, I_{SOURCE} = 800 µA
$\overline{\text{RESET}}$ Rise Time		5	25	ns	From 10% to 90% V_{CC}, C_L = 5 pF, V_{CC} = 3.3 V
Open-Drain $\overline{\text{RESET}}$ Output Leakage Current			1	µA	
WATCHDOG INPUT					
Watchdog Timeout Period					
ADM861xxxW	4.3	6.3	9.3	ms	
ADM861xxxX	71	102	153	ms	
ADM861xxxY	1.12	1.6	2.4	sec	
WDI Pulse Width	50			ns	V_{IL} = 0.3 x V_{CC}, V_{IH} = 0.7 x V_{CC}
WDI Input Threshold				V	
VIL			0.3 x V_{CC}		
VIH	0.7 x V_{CC}			V	
WDI Input Current		120	160	µA	V_{WDI} = V_{CC}
	−20	−15		µA	V_{WDI} = 0

ABSOLUTE MAXIMUM RATINGS

T_A = 25°C, unless otherwise noted.

Table 2.

Parameter	Rating
V_{CC}	−0.3 V to +6 V
$\overline{RESET}$	−0.3 V to +6 V
Output Current ($\overline{RESET}$)	20 mA
Operating Temperature Range	−40°C to +85°C
Storage Temperature Range	−65°C to +150°C
θ_{JA} Thermal Impedance, SC70	146°C/W
Soldering Temperature	
Sn/Pb	240°C, 30 sec
Pb-Free	260°C, 40 sec

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although this product features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

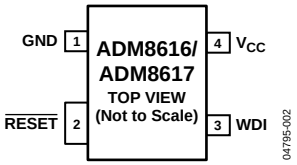

Figure 2. Pin Configuration

Table 3. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	GND	Ground.
2	$\overline{\text{RESET}}$	Active-Low $\overline{\text{RESET}}$ Output. Asserted whenever V_{CC} is below the reset threshold, V_{TH}. Push-Pull Output Stage for ADM8616. Open-Drain Output Stage for ADM8617.
3	WDI	Watchdog Input. Generates a $\overline{\text{RESET}}$ if the logic level on the pin remains low or high for the duration of the watchdog timeout. The timer is cleared if a logic transition occurs on this pin or if a reset is generated. Leave floating to disable the watchdog timer.
4	V_{CC}	Power Supply Voltage Being Monitored.

TYPICAL PERFORMANCE CHARACTERISTICS

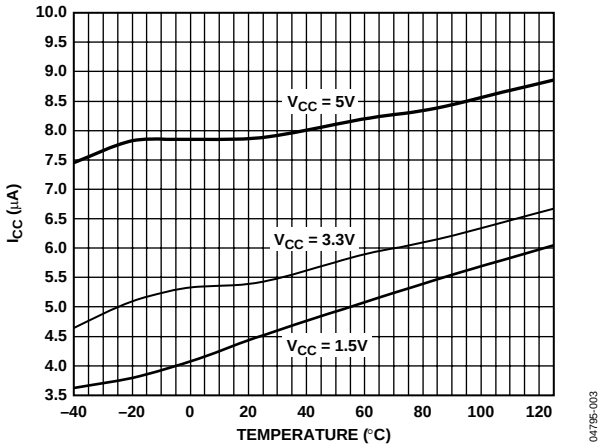

Figure 3. Supply Current vs. Temperature

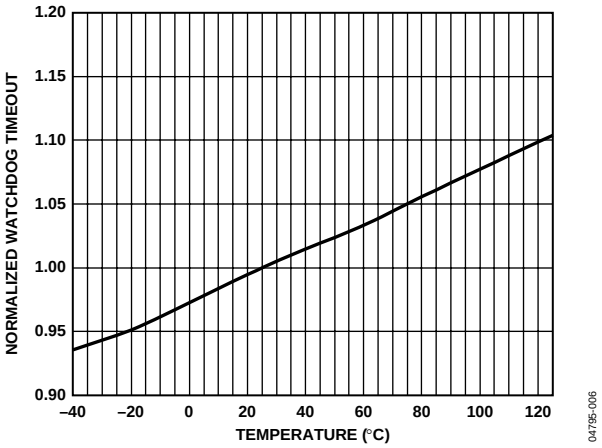

Figure 6. Normalized Watchdog Timeout Period vs. Temperature

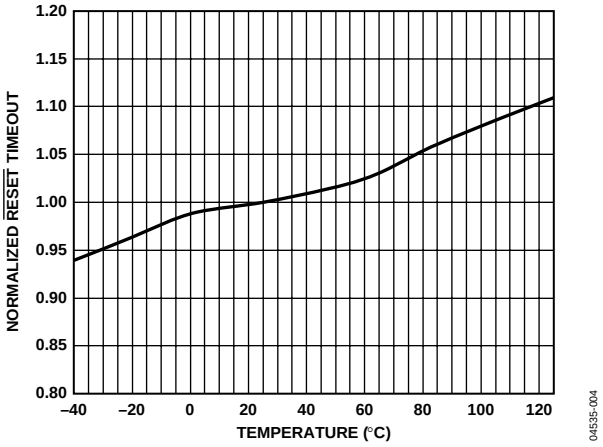

Figure 4. Normalized $\overline{RESET}$ Timeout Period vs. Temperature

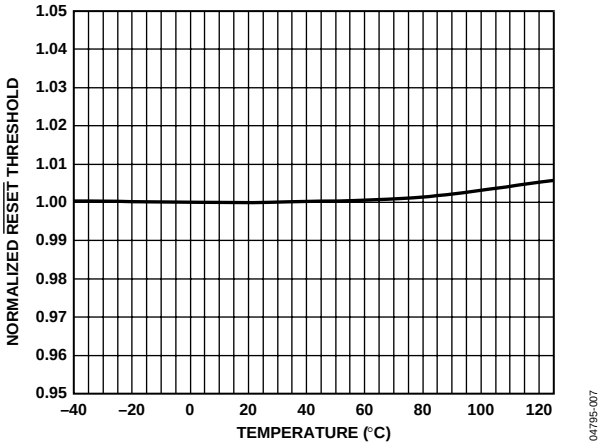

Figure 7. Normalized $\overline{RESET}$ Threshold vs. Temperature

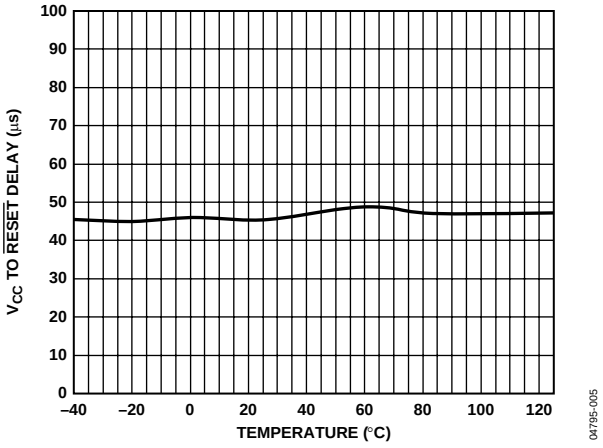

Figure 5. V_{CC} to $\overline{RESET}$ Output Delay vs. Temperature

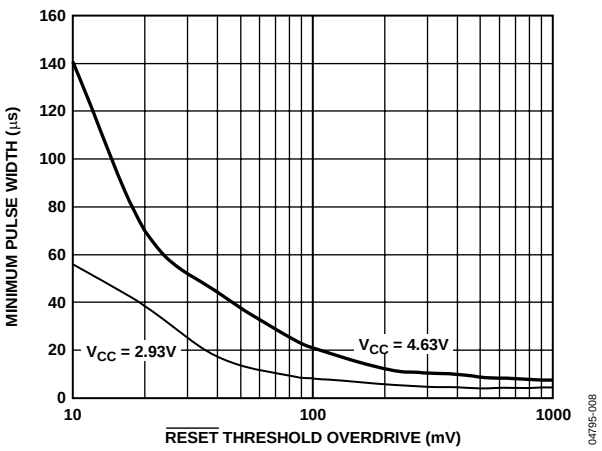

Figure 8. Maximum V_{CC} Transient Duration vs. $\overline{RESET}$ Threshold Overdrive

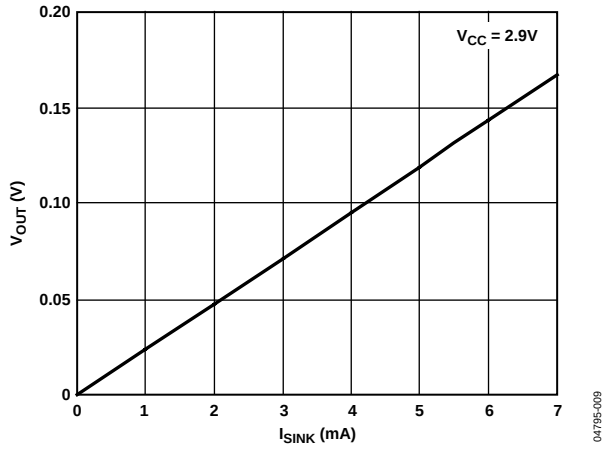

Figure 9. Voltage Output Low vs. I_{SINK}

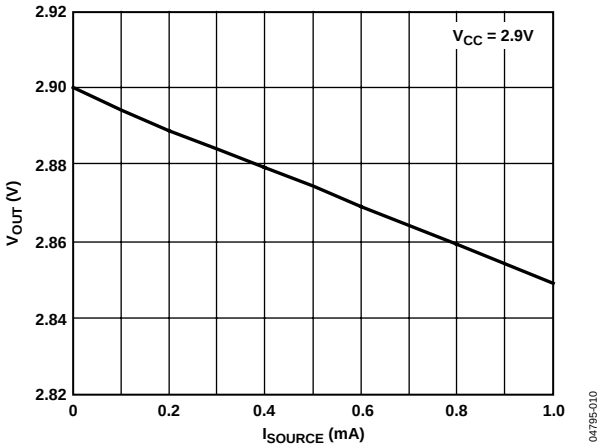

Figure 10. Voltage Output High vs. I_{SOURCE}

CIRCUIT DESCRIPTION

The ADM8616/ADM8617 provide microprocessor supply voltage supervision by controlling the microprocessor's $\overline{\text{RESET}}$ input. Code execution errors are avoided during power-up, power-down, and brownout conditions by asserting a $\overline{\text{RESET}}$ signal when the supply voltage is below a preset threshold and by allowing supply voltage stabilization with a fixed timeout $\overline{\text{RESET}}$ after the supply voltage rises above the threshold. In addition, problems with microprocessor code execution can be monitored and corrected with a watchdog timer. By including watchdog strobe instructions in microprocessor code, a watchdog timer can detect if the microprocessor code breaks down or becomes stuck in an infinite loop. If this happens, the watchdog timer asserts a $\overline{\text{RESET}}$ pulse that restarts the microprocessor in a known state.

RESET OUTPUT

The ADM8616 features an active-low, push-pull $\overline{\text{RESET}}$ output, while the ADM8617 features an active-low, open-drain $\overline{\text{RESET}}$ output. The $\overline{\text{RESET}}$ signal is guaranteed to be logic low and logic high, respectively, for V_{CC} down to 1 V.

The $\overline{\text{RESET}}$ output is asserted when V_{CC} is below the $\overline{\text{RESET}}$ threshold (V_{TH}), or when WDI is not serviced within the watchdog timeout period (t_{WD}). $\overline{\text{RESET}}$ remains asserted for the duration of the $\overline{\text{RESET}}$ active timeout period (t_{RP}) after V_{CC} rises above the $\overline{\text{RESET}}$ threshold or after the watchdog timer times out. Figure 11 illustrates the behavior of the $\overline{\text{RESET}}$ outputs.

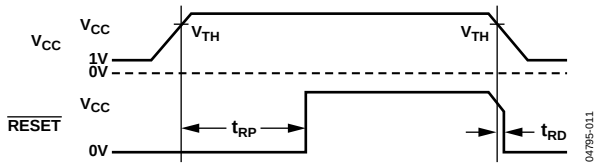

Figure 11. $\overline{\text{RESET}}$ Timing Diagram

WATCHDOG INPUT

The ADM8616/ADM8617 feature a watchdog timer that monitors microprocessor activity. A timer circuit is cleared with every low-to-high or high-to-low logic transition on the watchdog input pin (WDI), which detects pulses as short as 50 ns. If the timer counts through the preset watchdog timeout period (t_{WD}), $\overline{\text{RESET}}$ is asserted. The microprocessor is required to toggle the WDI pin to avoid being reset. Failure of the microprocessor to toggle WDI within the timeout period therefore indicates a code execution error, and the $\overline{\text{RESET}}$ pulse generated restarts the microprocessor in a known state.

In addition to logic transitions on WDI, the watchdog timer is also cleared by a $\overline{\text{RESET}}$ assertion due to an undervoltage condition on V_{CC}. When $\overline{\text{RESET}}$ is asserted, the watchdog timer is cleared and does not begin counting again until $\overline{\text{RESET}}$ deasserts. The watchdog timer can be disabled by leaving WDI floating or by three-stating the WDI driver.

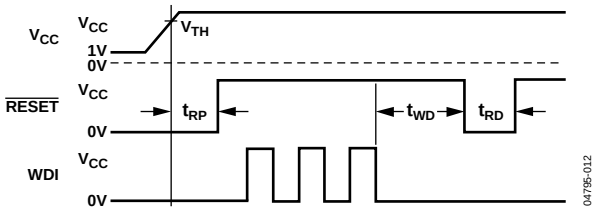

Figure 12. Watchdog Timing Diagram

APPLICATION INFORMATION

WATCHDOG INPUT CURRENT

To minimize watchdog input current (and minimize overall power consumption), leave WDI low for the majority of the watchdog timeout period. When driven high, WDI can draw as much as 160 µA. Pulsing WDI low-high-low at a low duty cycle reduces the effect of the large input current. When WDI is unconnected, a window comparator disconnects the watchdog timer from the $\overline{\text{RESET}}$ output circuitry so that $\overline{\text{RESET}}$ is not asserted when the watchdog timer times out.

NEGATIVE-GOING V_{CC} TRANSIENTS

To avoid unnecessary resets caused by fast power supply transients, the ADM8616/ADM8617 are equipped with glitch rejection circuitry. The typical performance characteristic in Figure 8 plots V_{CC} transient duration versus the transient magnitude. The curve shows combinations of transient magnitude and duration for which a $\overline{\text{RESET}}$ is not generated for 4.63 V and 2.93 V reset threshold parts. For example, with the 2.93 V threshold, a transient that goes 100 mV below the threshold and lasts 8 µs typically does not cause a $\overline{\text{RESET}}$, but if the transient is any bigger in magnitude or duration, a $\overline{\text{RESET}}$ is generated. An optional 0.1 µF bypass capacitor mounted close to V_{CC} provides additional glitch rejection.

ENSURING RESET VALID TO V_{CC} = 0 V

The active-low $\overline{\text{RESET}}$ output is guaranteed to be valid for V_{CC} as low as 1 V. However, by using an external resistor, valid outputs for V_{CC} as low as 0 V are possible. The resistor, connected between $\overline{\text{RESET}}$ and ground, pulls the output low when it is unable to sink current. A large resistance such as 100 kΩ should be used so that it does not overload the $\overline{\text{RESET}}$ output when V_{CC} is above 1 V.

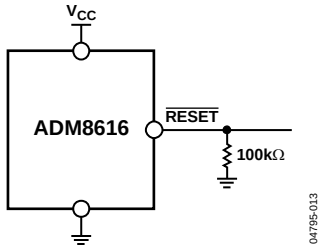

Figure 13. Ensuring $\overline{\text{RESET}}$ Valid to V_{CC} = 0 V

WATCHDOG SOFTWARE CONSIDERATIONS

In implementing the microprocessor's watchdog strobe code, quickly switching WDI low-high and then high-low (minimizing WDI high time) is desirable for current consumption reasons. However, a more effective way of using the watchdog function can be considered.

A low-high-low WDI pulse within a given subroutine prevents the watchdog timing out. However, if the subroutine becomes stuck in an infinite loop, the watchdog does not detect this because the subroutine continues to toggle WDI. A more effective coding scheme for detecting this error involves using a slightly longer watchdog timeout. In the program that calls the subroutine, WDI is set high. The subroutine sets WDI low when it is called. If the program executes without error, WDI is toggled high and low with every loop of the program. If the subroutine enters an infinite loop, WDI is kept low, the watchdog times out, and the microprocessor is reset.

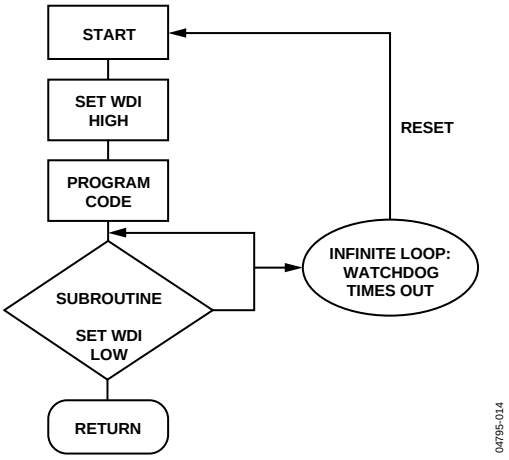

Figure 14. Watchdog Flow Diagram

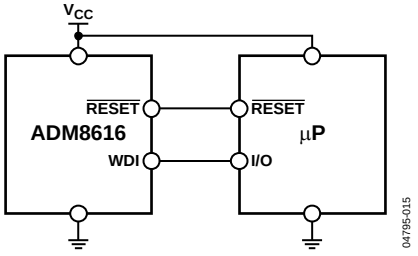

Figure 15. Typical Application Circuit

OUTLINE DIMENSIONS

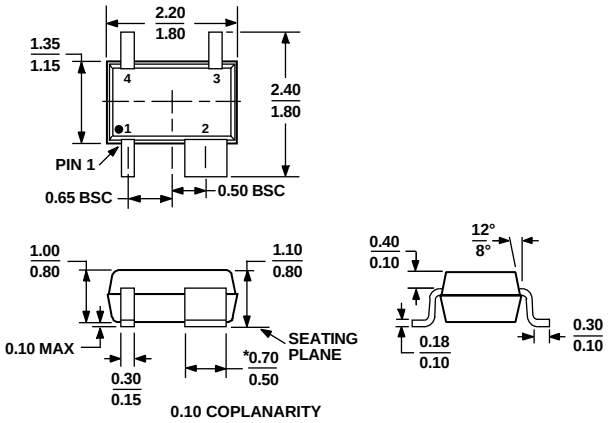

Figure 16. 4-Lead Thin Shrink Small Outline Transistor Package [SC70]
(KS-4)
Dimensions shown in millimeters

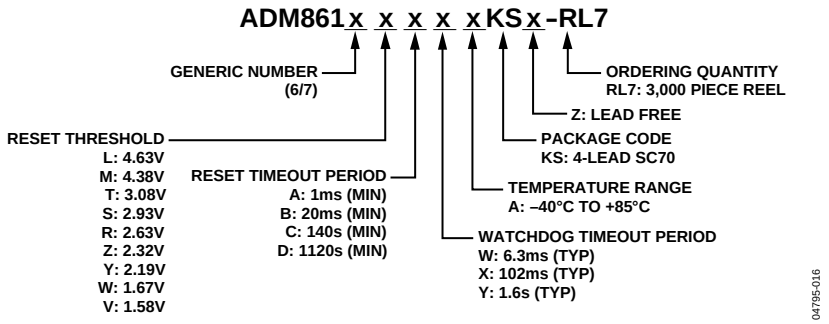

Figure 17. Ordering Code Structure

ORDERING GUIDE

Standard Models[1]	Reset Threshold (V)	Temperature Range	Quantity	Package Type	Branding
ADM8616LCYAKSZ-RL7[2]	4.63	–40°C to +85°C	3k	SC70-4	N0F
ADM8616MCYAKSZ-RL7[2]	4.38	–40°C to +85°C	3k	SC70-4	N0F
ADM8616TCYAKSZ-RL7[2]	3.08	–40°C to +85°C	3k	SC70-4	N0F
ADM8616SCYAKSZ-RL7[2]	2.93	–40°C to +85°C	3k	SC70-4	N0F
ADM8616RCYAKSZ-RL7[2]	2.63	–40°C to +85°C	3k	SC70-4	N0F
ADM8616ZCYAKSZ-RL7[2]	2.32	–40°C to +85°C	3k	SC70-4	N0F
ADM8616YCYAKSZ-RL7[2]	2.19	–40°C to +85°C	3k	SC70-4	N0F
ADM8616WCYAKSZ-RL7[2]	1.67	–40°C to +85°C	3k	SC70-4	N0F
ADM8616VCYAKSZ-RL7[2]	1.58	–40°C to +85°C	3k	SC70-4	N0F
ADM8617SAYAKSZ-RL7[2]	2.93	–40°C to +85°C	3k	SC70-4	N0G

[1] If ordering nonstandard models, complete the ordering code shown in Figure 17 by inserting reset threshold, reset timeout, and watchdog timeout suffixes. Contact Sales for availability of nonstandard models.
[2] Z = Pb-free part.

NOTES

D04795–0–6/05(0)