DATA SHEET

NE56632-XX

Active-LOW system reset
with adjustable delay time

Philips
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Active-LOW system reset with adjustable delay time   NE56632-XX

DESCRIPTION

The NE56632-XX is a family of Active-LOW, power-on reset that offers precision threshold voltage detection within ±1.5% and super low operating supply current of typically 3.0 μA. It includes a reset delay that is user adjustable with an external capacitor.

Several detection threshold voltages are available at 1.9V , 2.0 V, 2.7 V, 2.8 V, 2.9 V, 3.0 V, 3.1 V, 4.2 V, 4.3 V, 4.4 V, 4.5 V, and 4.6 V. Other thresholds are offered upon request at 100 mV steps from 1.9 V to 4.6 V.

With its ultra low supply current and high precision voltage threshold detection capability, the NE56632-XX is well suited for various battery powered applications such as reset circuits for logic and microprocessors, voltage check, and level detecting. It is available in the 5-lead small outline package (SOP003).
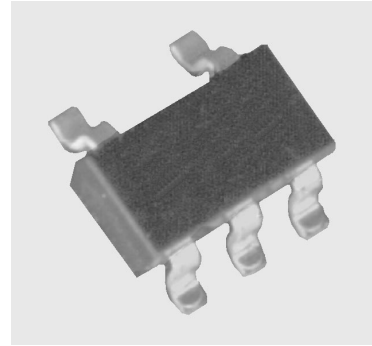
FEATURES

- High precision threshold detection voltage: V_S ±1.5%

- Super low operating supply current: 3 μA typ.

- Built-in hysteresis voltage: 50 mV typ.

- Detection threshold voltage: 1.9 V, 2.0 V, 2.7 V, 2.8 V, 2.9 V, 3.0 V, 3.1 V, 4.2 V, 4.3 V, 4.4 V, 4.5 V, and 4.6 V.

- Reset Output: Active-LOW, open collector

- Other detection threshold voltages available upon request at 100 mV steps from 1.9 V to 4.6 V.

- Large low reset output current: 30 mA typ.

- Power-on reset delay time adjustable with external capacitor: 200 μs to 200 ms

- Reset assertion with V_{CC} down to 0.65 V

APPLICATIONS

- Reset for microprocessor and logic circuits

- Voltage level detection circuit

- Battery voltage check circuit

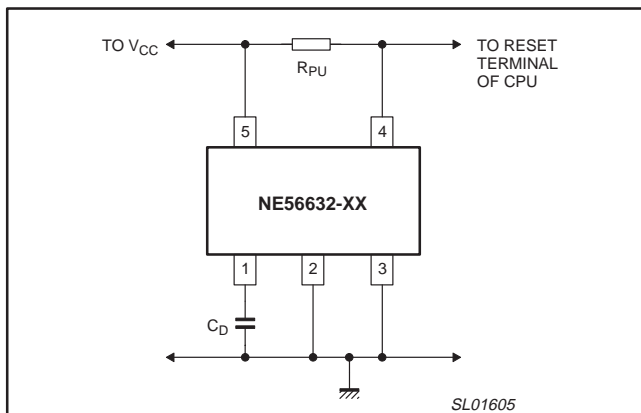- Detection circuit for battery back-up

SIMPLIFIED SYSTEM DIAGRAM

Figure 1. Simplified system diagram.

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		TEMPERATURE RANGE
	DESCRIPTION	VERSION	
NE56632-**XX**D	plastic small outline package; 5 leads (see dimensional drawing)	SOP003	–20 to +75 °C

NOTE:
The device has 12 voltage output options, indicated by the XX on the 'Type number'.

XX	VOLTAGE (Typical)
19	1.9 V
20	2.0 V
27	2.7 V
28	2.8 V
29	2.9 V
30	3.0 V
31	3.1 V
42	4.2 V
43	4.3 V
44	4.4 V
45	4.5 V
46	4.6 V

Part number marking
The package is marked with a four letter code. The first three letters designate the product. The fourth letter, represented by 'x', is a date tracking code.

Part Number	Marking
NE56632-19D	AKZx
NE56632-20D	ALAx
NE56632-27D	ALBx
NE56632-28D	ALCx
NE56632-29D	ALDx
NE56632-30D	ALEx
NE56632-31D	ALFx
NE56632-42D	ALGx
NE56632-43D	ALHx
NE56632-44D	ALJx
NE56632-45D	ALKx
NE56632-46D	ALLx

PIN CONFIGURATION
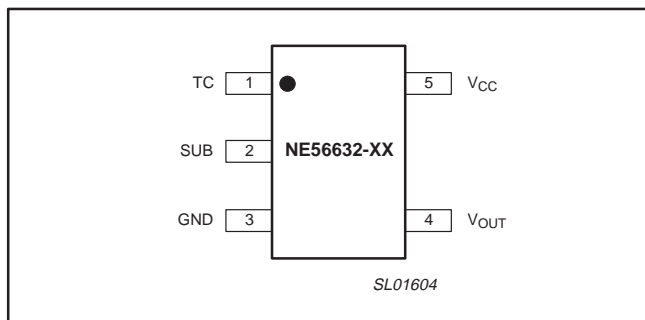
Figure 2. Pin configuration.

PIN DESCRIPTION

PIN	SYMBOL	DESCRIPTION
1	TC	Delay time control; set with external capacitor.
2	SUB	Substrate. Connect to ground (GND).
3	GND	Ground. Negative supply.
4	V_{OUT}	Reset output voltage. Active-LOW.
5	V_{CC}	Positive supply voltage; detection threshold voltage input.

MAXIMUM RATINGS

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
V_{CC}	Supply voltage	–0.3	+10	V
T_{amb}	Ambient operating temperature	–20	+75	°C
T_{stg}	Storage temperature	–40	+125	°C
P	Power dissipation	–	150	mW

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ELECTRICAL CHARACTERISTICS

T_{amb} = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	-XX	MIN.	TYP.	MAX.	UNIT
V_S	Detection threshold	V_{CC} = HIGH-to-LOW; R_L = 4.7 kΩ; S1=ON; $V_{OL} \leq 0.4$ V; Test Circuit 1 (Figure 27)	46	4.531	4.600	4.669	V
			45	4.432	4.500	4.568	V
			44	4.334	4.400	4.466	V
			43	4.235	4.300	4.365	V
			42	4.137	4.200	4.263	V
			31	3.053	3.100	3.147	V
			30	2.955	3.000	3.045	V
			29	2.856	2.900	2.944	V
			28	2.758	2.800	2.842	V
			27	2.659	2.700	2.741	V
			20	1.970	2.000	2.030	V
			19	1.871	1.900	1.929	V
V_{hys}	Hysteresis voltage	R_L = 4.7 kΩ; V_{CC} = LOW-to-HIGH-to-LOW; S1 = ON; Test Circuit 1 (Figure 27)		25	50	100	mV
$V_S/\Delta T$	Detection threshold voltage temperature coefficient	R_L = 4.7 kΩ; T_{amb} = −20 °C to +75 °C; S1 = ON; Test Circuit 1 (Figure 27)		–	±0.01	–	%/°C
V_{OL}	LOW-level output voltage	V_{CC1} = $V_{S(min)}$ − 0.05 V; R_L = 4.7 kΩ; S1 = ON; Test Circuit 1 (Figure 27)		–	0.2	0.4	V
I_{LO}	Output leakage current	V_{CC1} = V_{CC2} = 10 V; S2 = ON; Test Circuit 1 (Figure 27)		–	–	±0.1	µA
I_{CCL}	Supply current (ON time)	V_{CC1} = $V_{S(min)}$ − 0.05 V; R_L = ∞; Test Circuit 1 (Figure 27)		–	5.0	9.0	µA
I_{CCH}	Supply current (OFF time)	V_{CC1} = $V_{S(typ)}$/0.85; R_L = ∞; Test Circuit 1 (Figure 27)		–	3.0	5.0	µA
t_{PLH}	LOW-to-HIGH delay time	C_L = 100 pF; R_L = 4.7 kΩ; C_D = 10 nF (Note 1)		–	(Note 3)	–	ms
t_{PHL}	HIGH-to-LOW delay time	C_L = 100 pF; R_L = 4.7 kΩ; C_D = 10 nF (Note 2)		–	(Note 3)	–	µs
V_{OPL}	Minimum operating threshold voltage	R_L = 4.7 kΩ; $V_{OL} \leq 0.4$ V; S1 = ON; Test Circuit 1 (Figure 27)		–	0.65	0.80	V
I_{OL1}	Output current (ON Time 1)	V_O = 0.4 V; R_L = 0; V_{CC1} = $V_{S(min)}$ − 0.05 V; V_{CC2} = 0.4 V; S2 = ON; Test Circuit 1 (Figure 27)		5	–	–	mA
I_{OL2}	Output current (ON Time 2)	V_O = 0.4 V; R_L = 0; V_{CC1} = $V_{S(min)}$ − 0.05 V; T_{amb} = −20 °C to +75 °C; S2 = ON; Test Circuit 1 (Figure 27)		3	–	–	mA

NOTES:
1. t_{PLH}: V_{CC} = ($V_{S(typ)}$ − 0.4 V) to ($V_{S(typ)}$ + 0.4 V); t_{PLH} is release delay time (Test Circuit 2, Figure 28).
2. t_{PHL}: V_{CC} = ($V_{S(typ)}$ + 0.4 V) to ($V_{S(typ)}$ − 0.4 V); t_{PHL} is assertion delay time (Test Circuit 2, Figure 28).
3. See Table 1.

Table 1. NE56632-XX series typical delay time

−XX	t_{PLH}	t_{PHL}
46	195 ms	140 µs
45	190 ms	140 µs
44	185 ms	140 µs
43	180 ms	140 µs
42	175 ms	140 µs
31	120 ms	120 µs
30	115 ms	120 µs
29	110 ms	120 µs
28	105 ms	100 µs
27	100 ms	100 µs
20	65 ms	100 µs
19	60 ms	100 µs

Active-LOW system reset with adjustable delay time

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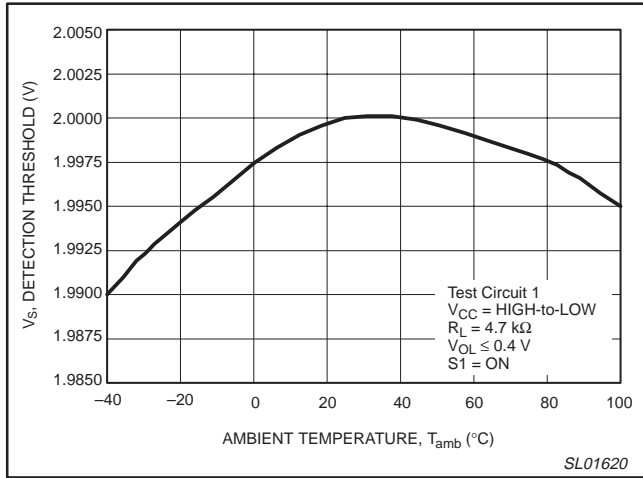## TYPICAL PERFORMANCE CURVES, NE56632-20

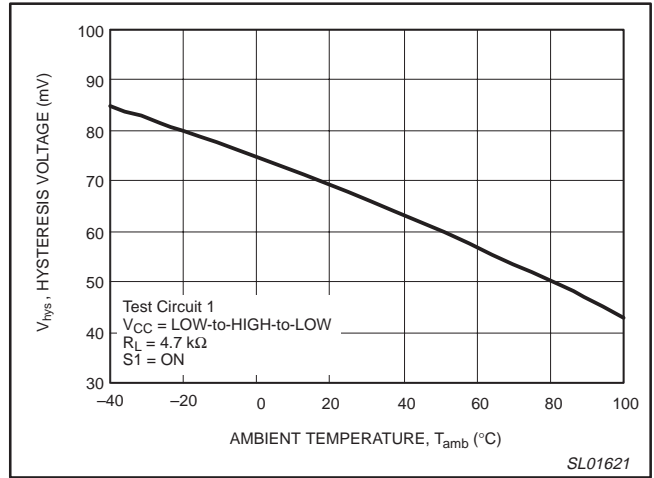Figure 3. Detection threshold versus temperature.

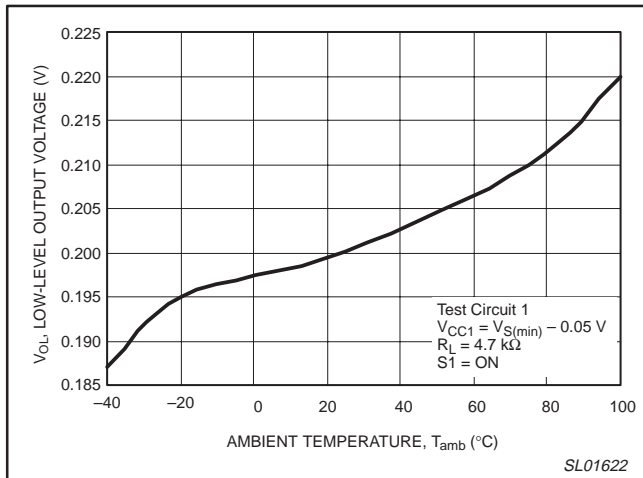Figure 4. Hysteresis voltage versus temperature.

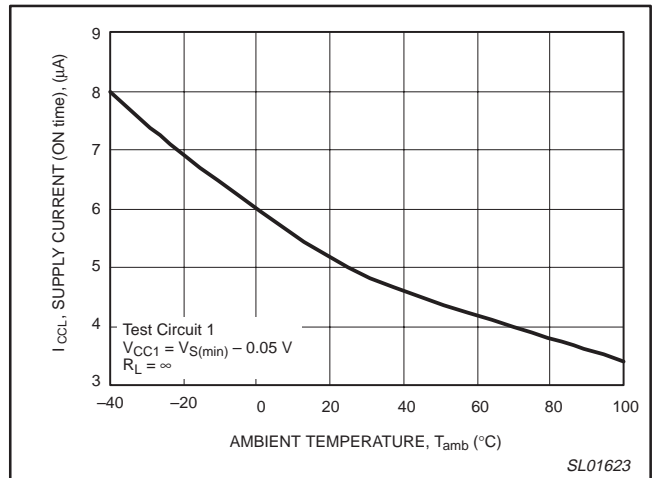Figure 5. LOW-level output voltage versus temperature.

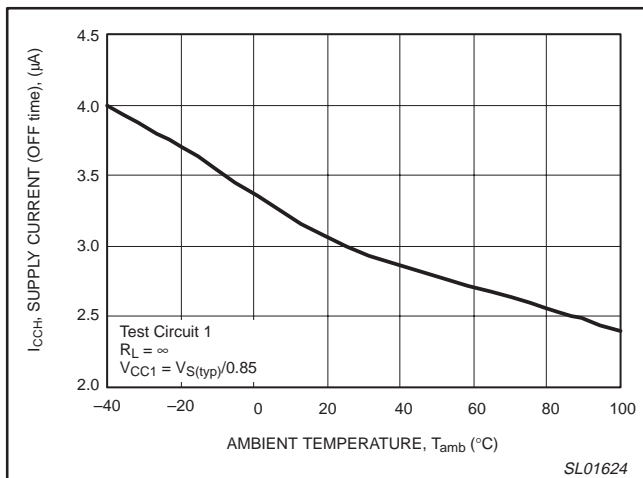Figure 6. Supply current (ON time) versus temperature.

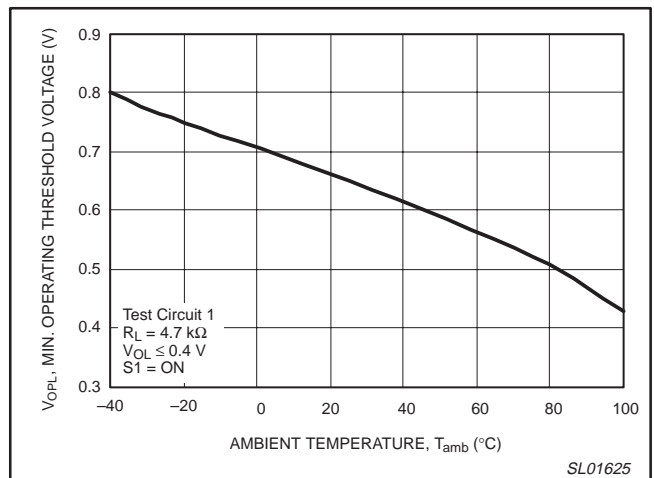Figure 7. Supply current (OFF time) versus temperature.

Figure 8. Min. operating threshold voltage versus temperature.

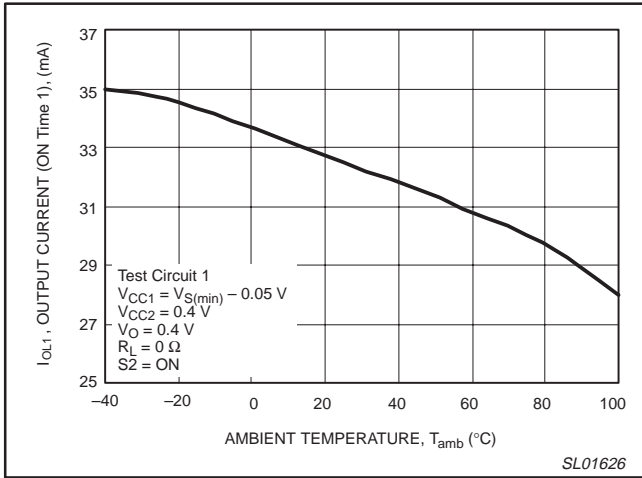## TYPICAL PERFORMANCE CURVES, NE56632-20 (continued)

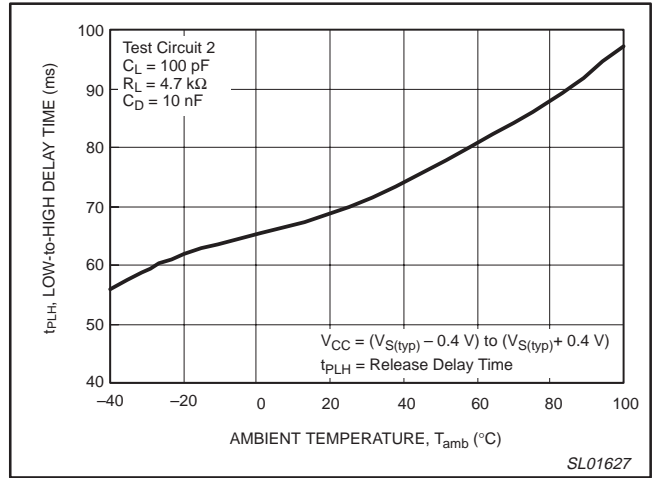Figure 9. Output current (ON time 1) versus temperature.
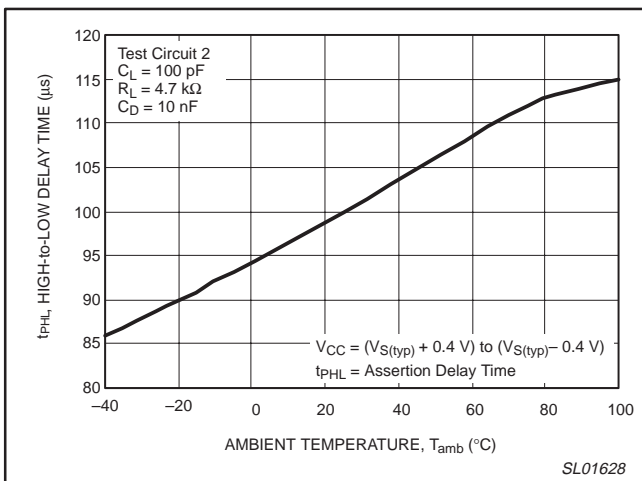

Figure 10. LOW-to-HIGH delay time versus temperature.

Figure 11. HIGH-to-LOW delay time versus temperature.

Active-LOW system reset with adjustable delay time
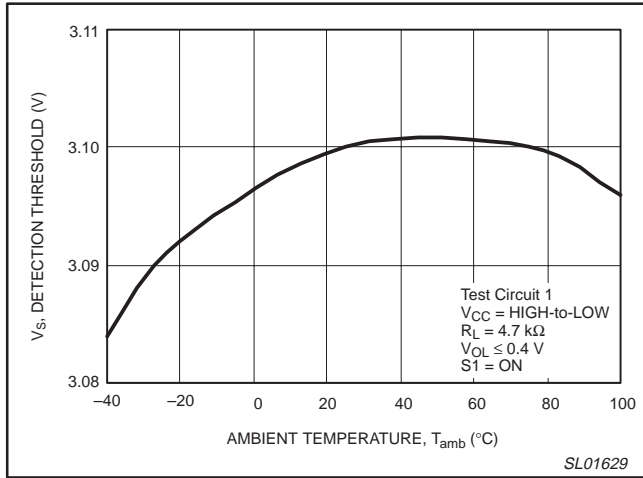
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TYPICAL PERFORMANCE CURVES, NE56632-31

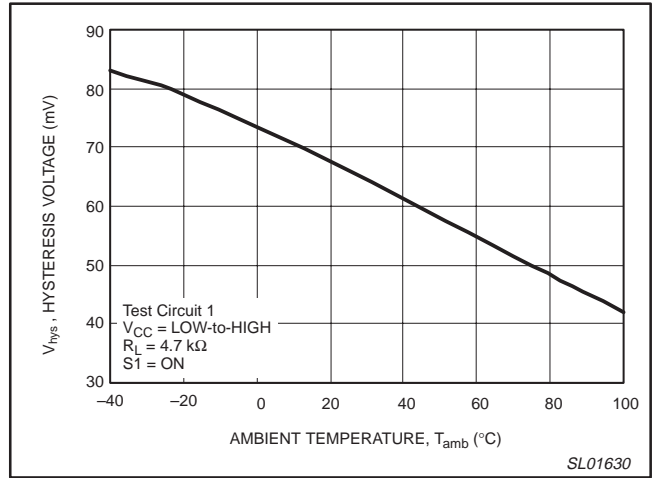**Figure 12. Detection threshold versus temperature.**

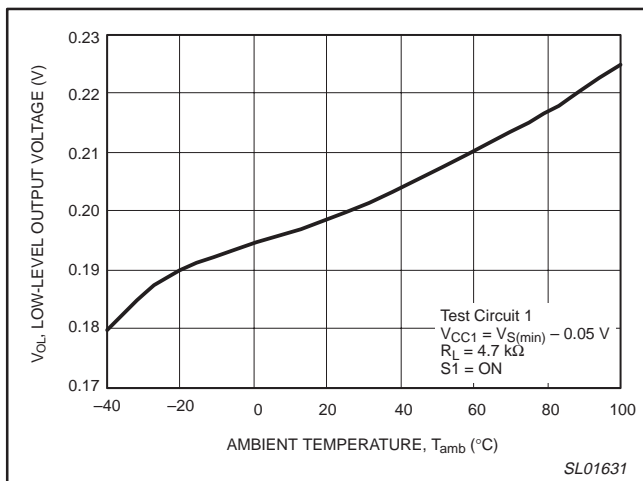**Figure 13. Hysteresis voltage versus temperature.**

Figure 14. LOW–level output voltage versus temperature.
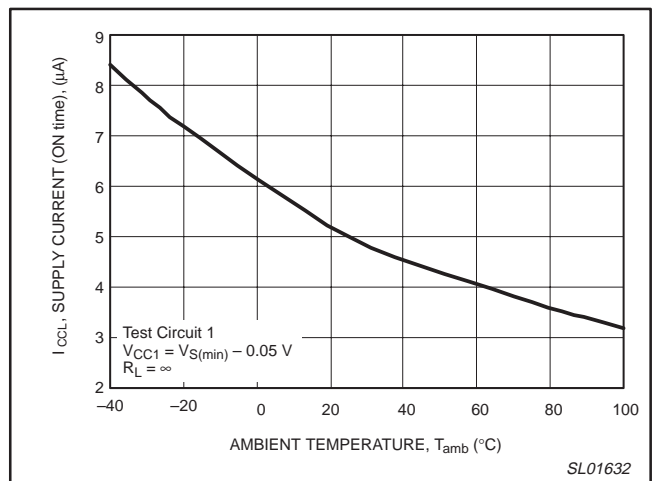

Figure 15. Supply current (ON time) versus temperature.
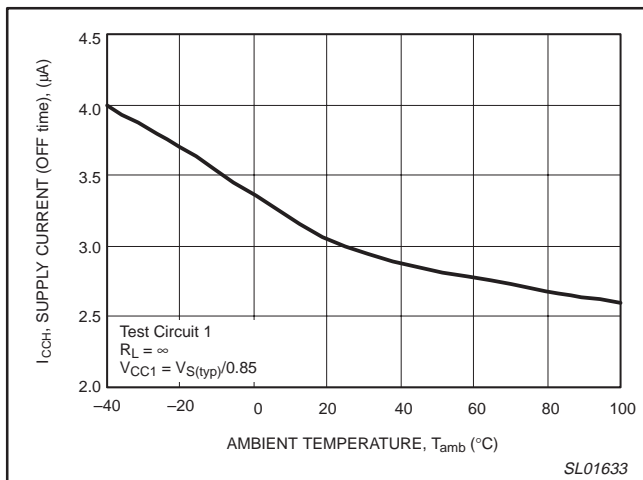
Figure 16. Supply current (OFF time) versus temperature.
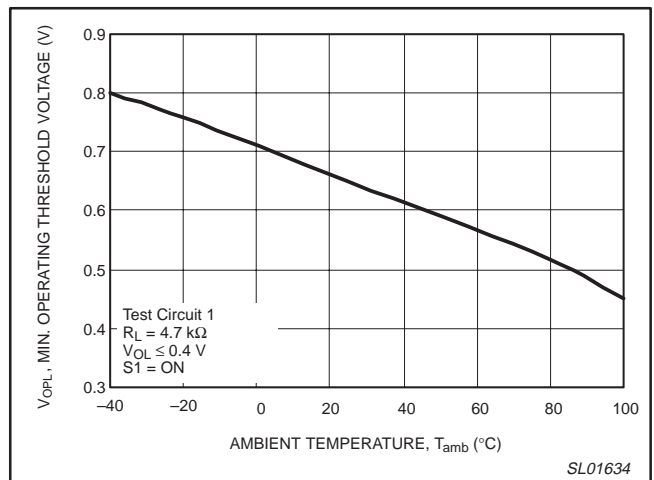
Figure 17. Min. operating threshold voltage versus temperature.

TYPICAL PERFORMANCE CURVES, NE56632-31 *(continued)*

Figure 18. Output current (ON time 1) versus temperature.

Figure 19. Output current (ON time 2) versus temperature.

Figure 20. LOW-to-HIGH delay time versus temperature.

Figure 21. HIGH-to-LOW delay time versus temperature.

TECHNICAL DISCUSSION

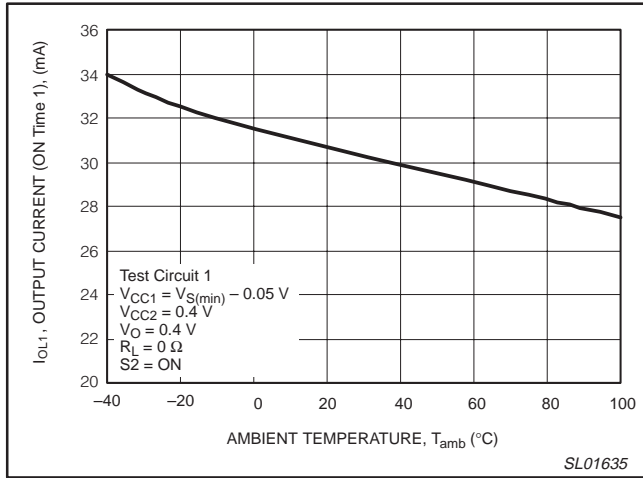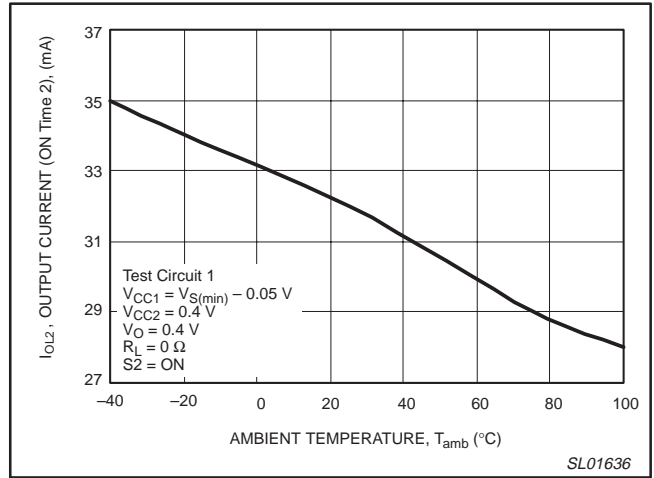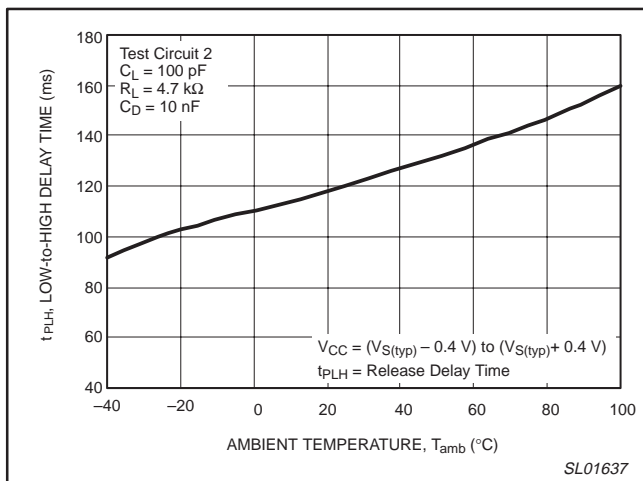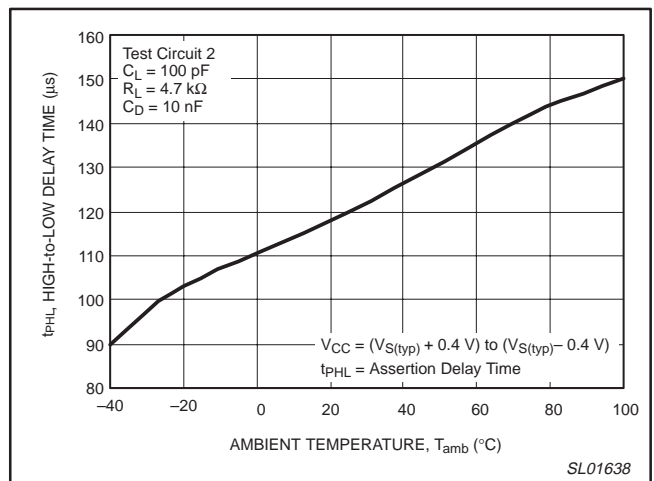The NE56632-XX is a bipolar IC designed to provide power source monitoring and a system reset function in the event the power sags below an acceptable level for the system to operate reliably. The reset threshold incorporates a typical hysteresis of 50 mV to prevent erratic reasserts from being generated. An internal delay time circuit provides a adjustable power-on reset delay of typically 200 μs to 200 ms using an external capacitor.

The output of the NE56632-XX utilizes an open collector topology, which requires an external pull-up resistor to V_{CC}. Though this may be regarded as a disadvantage, it is advantageous in many sensitive applications. Because the open collector output cannot source reset current when both are operated from a common supply, the NE56632-XX offers a safe interconnect to a wide variety of microprocessors.

The NE56632-XX operates at low supply currents, typically 3 μA, while offering precision threshold detection ($\pm$1.5%).

Figure 22 is a functional block diagram of the NE56632-XX. The internal reference source voltage, V_{REF}, is typically 0.65 V over the temperature range. The reference voltage is connected to the non-inverting inputs of the threshold Comparator 1 and Comparator 2, while the inverting input of Comparator 1 monitors the supply voltage through a voltage divider (R1 and R2). The output of the comparator drives the series base resistor, R3 of a common emitter amplifier, Q1. The collector of Q1 is connected to the inverting terminal of Comparator 2. The output of Comparator 2 is connected to the series base resistor, R4 of the output common emitter transistor, Q2. The open collector output of Q2 provides the reset output.

The Delay Time Control is outputted at the junction of the collector of Q1 and the inverting input of Comparator 2. The reset release time delay, t_{PLH} is set with an external capacitor. Figures 25 and 26 show t_{PLH} as a function of the external delay capacitor, C_D.

When the supply voltage sags to the threshold detection voltage, the resistor divider network supplies a voltage to the inverting terminal of

the threshold comparator which is less than V_{REF}, causing the output of the comparator to go to a HIGH state. This causes the common emitter amplifier, Q1 to turn ON pulling down the non-inverting terminal of Comparator 2 which causes its output to go to a HIGH state. This HIGH output level turns on the output common emitter transistor, Q2. The collector output of Q2 is pulled LOW through the external pull-up resistor, thereby asserting the Active-LOW reset.

Threshold hysteresis is established by turning on the bipolar common emitter transistor, Q1 when the input threshold Comparator 1 goes to a HIGH state. This occurs when V_{CC} sags to or below the threshold level. With the output of Q1 connected to the non-inverting terminal of Comparator 2, the non-inverting terminal has a level near ground at about 0.4 V when the reset is asserted (Active-LOW). For the Comparator 2 to reverse its output, the Comparator 1 output and Q1 must overcome the additional pull-down voltage present on the inverting input of Comparator 2. The differential voltage required to do this establishes the hysteresis voltage of the sensed threshold voltage. Typically, it is 50 mV.

When V_{CC} sags, and it is below the detection Threshold (V_{SL}), the device will assert a Reset LOW output at or near ground potential. As V_{CC} rises from ($V_{CC} < V_{SL}$) to V_{SH} or higher, the Reset is released and the output follows V_{CC}. Conversely, decreases in V_{CC} from ($V_{CC} > V_{SL}$) to V_{SL} will cause the output to be pulled to ground.

Hysteresis voltage = Release voltage – Detection Threshold voltage

$$V_{hys} = V_{SH} - V_{SL}$$

where:

$$V_{SH} = V_{SL} + V_{hys}$$
$$V_{SL} = V_{SH} - V_{hys}$$

When V_{CC} drops below the minimum operating voltage, typically 0.65 V, the output is undefined and the output reset low assertion is no longer guaranteed. At this level of V_{CC} the output will try to rise to V_{CC}. As V_{CC} drops even further to zero, V_{OUT} reset also goes to zero.
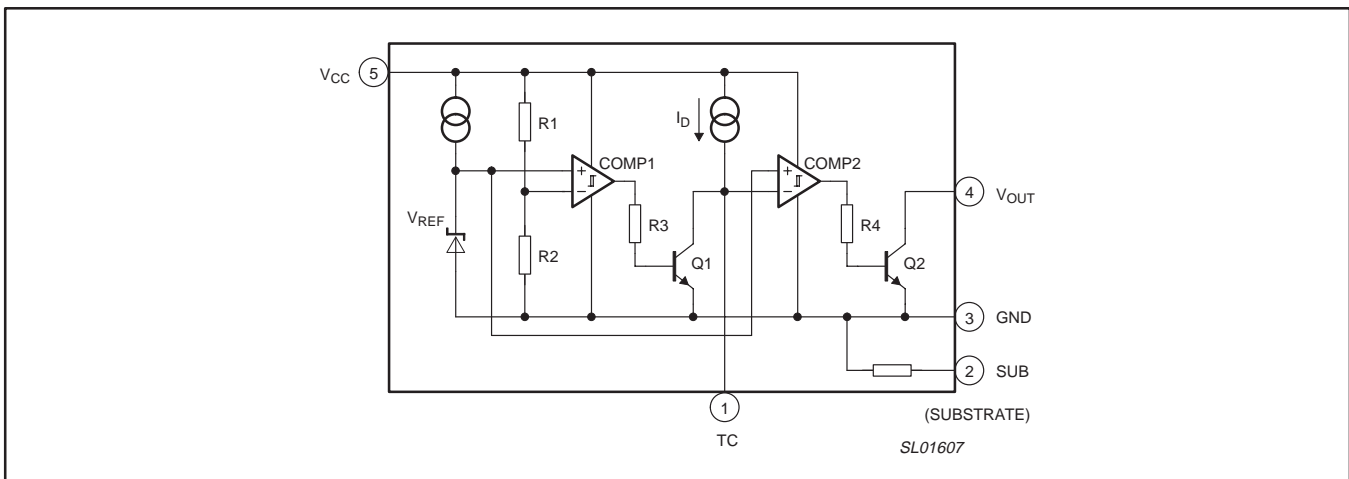

Figure 22. Functional diagram.

Active-LOW system reset with adjustable delay time

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TIMING DIAGRAM

The timing diagram in Figure 23 depicts the operation of the device. Letters A–N on the TIME axis indicates specific events.

A: At "A", V_{CC} begins to increase. Also the V_{OUT} voltage initially increases but abruptly decreases when V_{CC} reaches the level (approximately 0.65 V) that activates the internal bias circuitry and $\overline{RESET}$ is asserted.

B: At "B", V_{CC} reaches the threshold level of V_{SH}. At this point the delay time, t_{PLH} is initiated while V_{CC} rises above V_{SH} to its normal operating level. The V_{OUT} voltage remains in a low voltage state.

C: At "C", V_{CC} is above V_{SL} and the delay time elapses. At this instant, the IC releases the hold on the V_{OUT} reset. The reset output then goes HIGH (assuming the reset pull-up resistor R_{PU} is connected to V_{CC}). In a microprocessor based system these events release the reset from the microprocessor, allowing the microprocessor to function normally.

D-E: At "D", V_{CC} begins to fall, causing V_{OUT} to follow. V_{CC} continues to fall until the V_{SL} undervoltage detection threshold is reached at "E". This causes a reset signal to be generated (V_{OUT} goes LOW).

E-F: Between "E" and "F", V_{CC} continues to fall and then starts rising.

F: At "F", V_{CC} rises to the V_{SH} level. Once again, the device initiates the delay timer.

F-G: V_{CC} rises above V_{SH} and returns to normal. At "G", the delay (t_{PLH}) times out and once again, then it releases the hold on the V_{OUT} reset.

G-H: At "G", V_{CC} is above the upper threshold and begins to fall, causing V_{OUT} to follow it. As long as V_{CC} remains above the V_{SH}, no reset signal will be generated.

H: At event "H", V_{CC} falls until the V_{SL} undervoltage detection threshold is reached. At this level, a $\overline{RESET}$ signal is generated and V_{OUT} goes LOW.

H-I: Between "H" and "I", V_{CC} continues to fall and then starts to rise rising. V_{CC} rises to the V_{SH} level at "I", where the delay time is again initiated.

I-J: Between "I" and "J", V_{CC} rises above V_{SH} to V_{CC} normal and then falls back to V_{SL} level at "J". At "J", the reset signal is reasserted before the delay time has elapsed. The time between "I" and "J" is less than t_{PLH} (reset delay time). Thus, the reset is not released and the reset output remains LOW.

K–L: Between "K" and "L", V_{CC} rises again back to normal operating level causing the reset delay to be initiated at "K" and the reset to be released at "L".

M: At "M", V_{CC} falls to V_{SL} where the reset is asserted (V_{OUT} Reset goes LOW).

N: At "N", the V_{CC} voltage has decreased until normal internal circuit bias is unable to maintain a V_{OUT} reset. As a result, V_{CC} may rise to less than 0.65 V. As V_{CC} decreases further, the V_{OUT} reset also decreases to zero.
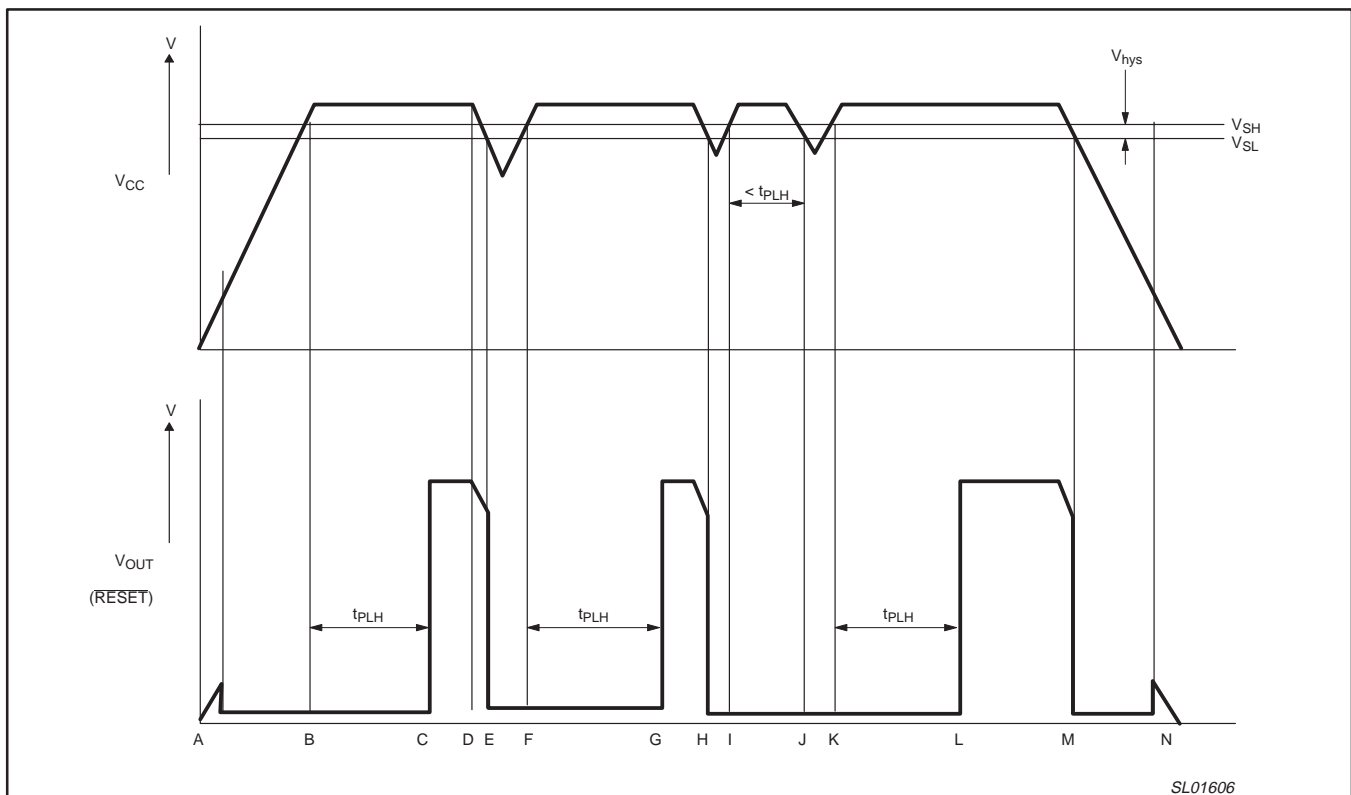

Figure 23. Timing diagram.

Active-LOW system reset with adjustable delay time

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APPLICATION INFORMATION

A typical application circuit for the NE56632-XX is shown in Figure 24. Note that a pull-up resistor, R_{PU} is necessary since the output is an open collector. The value of RPU is calculated by the following expression.

$$R_{PU} \geq (V_{CC} - V_{\overline{RESET}}) / I_{OL}$$

where:

$V_{CC} = V_{S(min)} - 0.05$ V (for a 3 V reset this is 2.905 V)

$V_{\overline{RESET}} = 0.4$ V (this is $V_{OL(max)}$)

$I_{OL} = 5$ mA; minimum output current at $T_{amb} = 25$ °C

Substituting these values into the expression and calculating, finds R_{PU} should be greater than or equal to 510 Ω. To ensure that the Active-LOW level is sufficient, a value of 4.7 kΩ is chosen in the test and application examples.
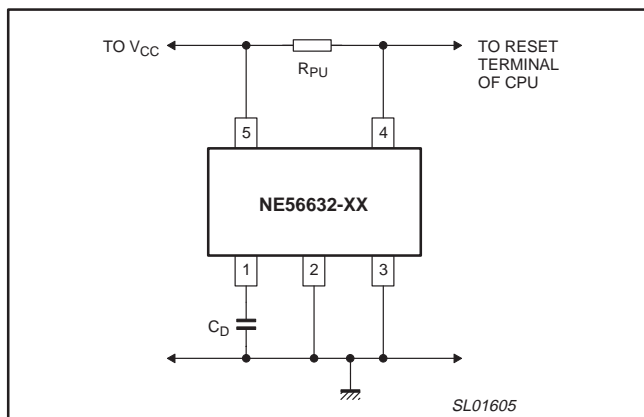

Figure 24. Typical application.

Figure 25 (NE56632-20 C_D versus t_{PLH}) and Figure 26 (NE56632-44 C_D versus t_{PLH}) show how t_{PHL}, the "H" transmission delay or reset release delay time varies as a function of the external delay capacitance, C_D. From Figure 26, typical range of the delay capacitance is 1 pF to 10 nF which yields typical delays from 200 μs to 200 ms.

The following formula can be used to find the approximate delay time based on external delay capacitance, C_D and the delay time coefficient, d shown in Table 2.

$$t_{PLH} \text{ (ms)} \approx C_D \text{ (μF)} \times d$$

For example, a NE56632-44 using an external capacitor, C_D = 1 nF = 1000 pF yields:

$$t_{PLH} \text{ (ms)} \approx (1 \times 10^{-3}) (1.85 \times 10^4) \approx 18.5 \text{ ms}$$

Compare this to the value of $t_{PLH} \approx 17$ ms for C_D = 1000 pF that is extracted from Figure 26.
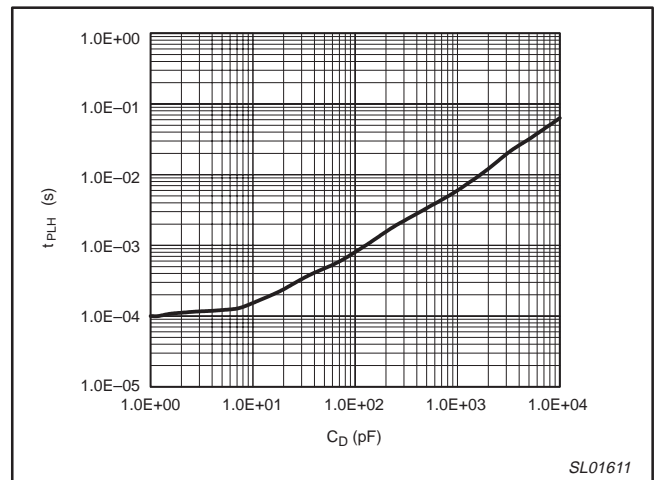

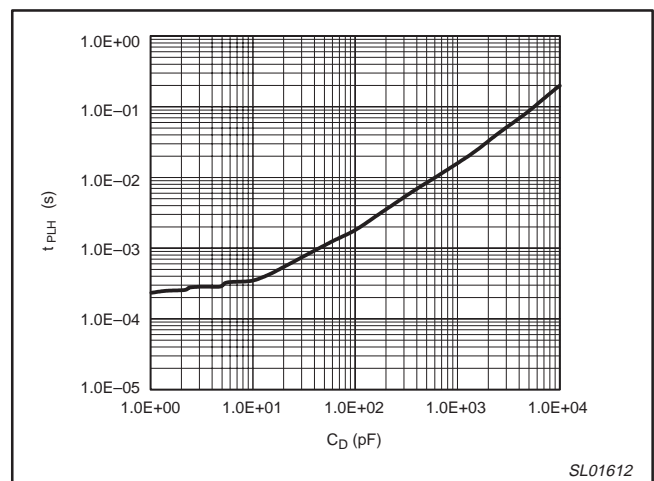**Figure 25. NE56632-20 C_D versus t_{PLH} characteristics.**

Figure 26. NE56632-44 C_D versus t_{PLH} characteristics.

Table 2. Delay time coefficient

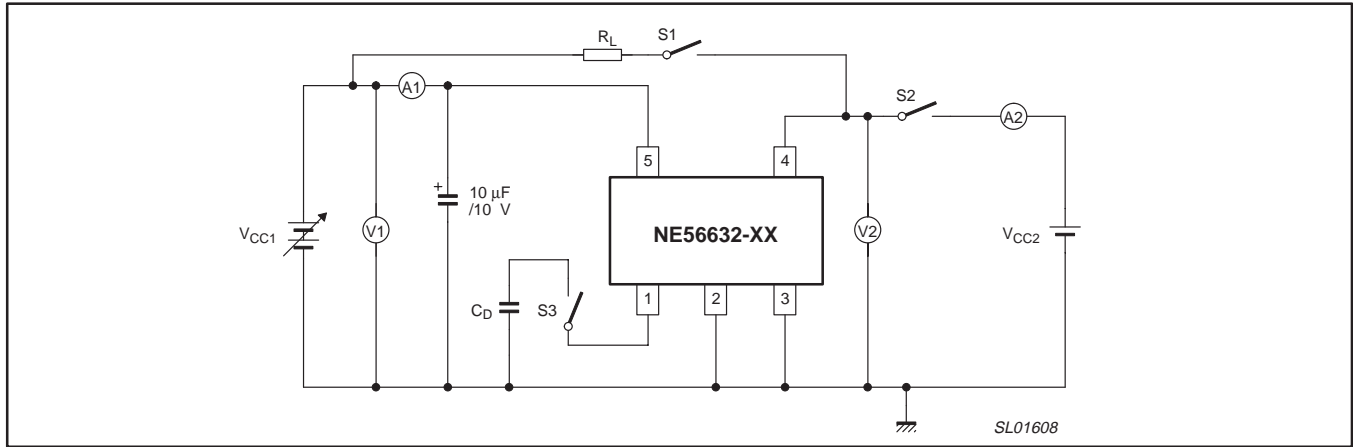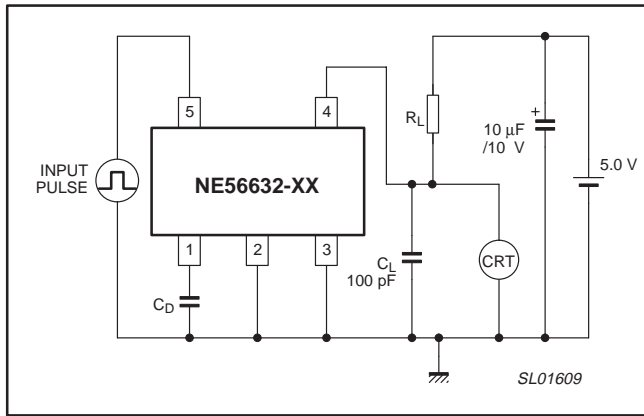| Device	d
NE56632–46	1.95×10^4
NE56632–45	1.90×10^4
NE56632–44	1.85×10^4
NE56632–43	1.80×10^4
NE56632–42	1.75×10^4
NE56632–31	1.20×10^4
NE56632–30	1.15×10^4
NE56632–29	1.10×10^4
NE56632–28	1.05×10^4
NE56632–27	1.00×10^4
NE56632–20	0.65×10^4
NE56632–19	0.60×10^4

TEST CIRCUITS

Figure 27. Test circuit 1.

Figure 28. Test circuit 2.
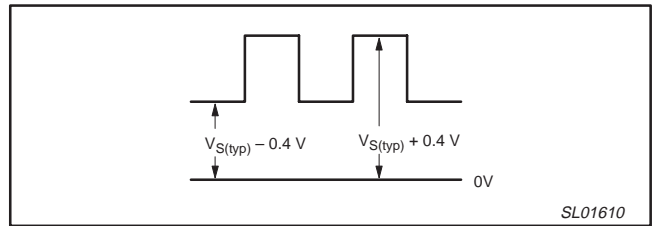
Figure 29. Input pulse.

NOTES:
A = DC amperemeter
V = DC voltmeter
CRT = oscilloscope

PACKING METHOD

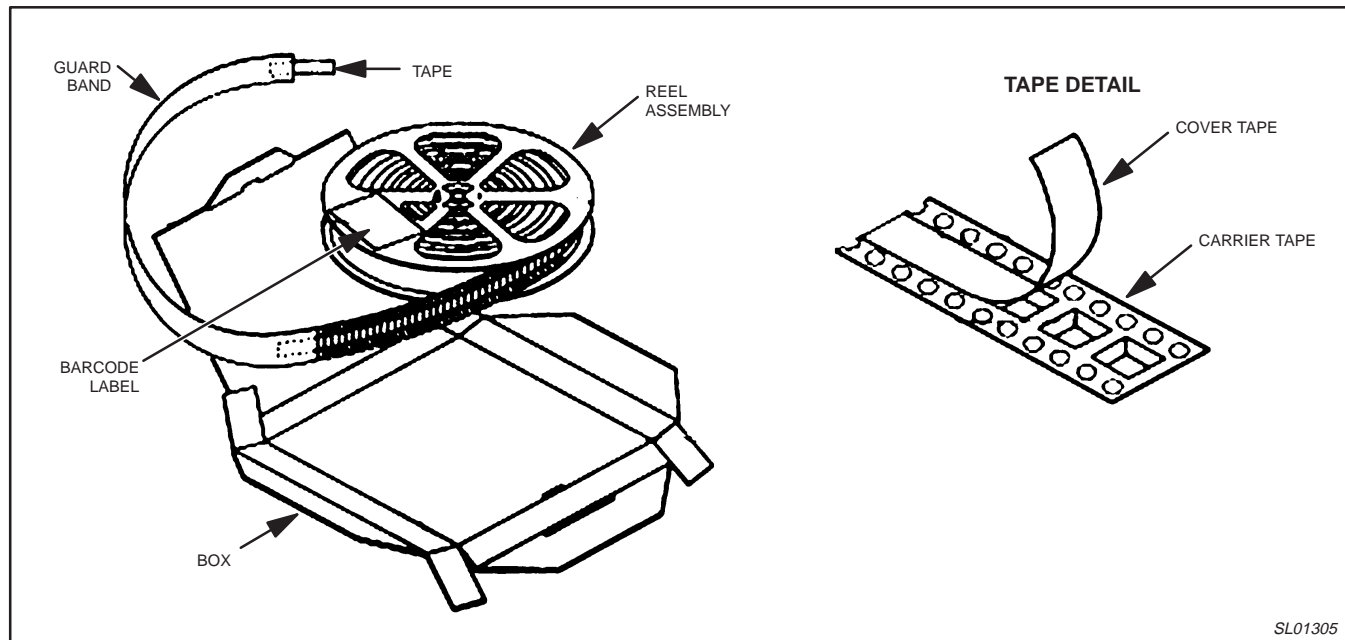The NE56632-XX is packed in reels, as shown in Figure 30.
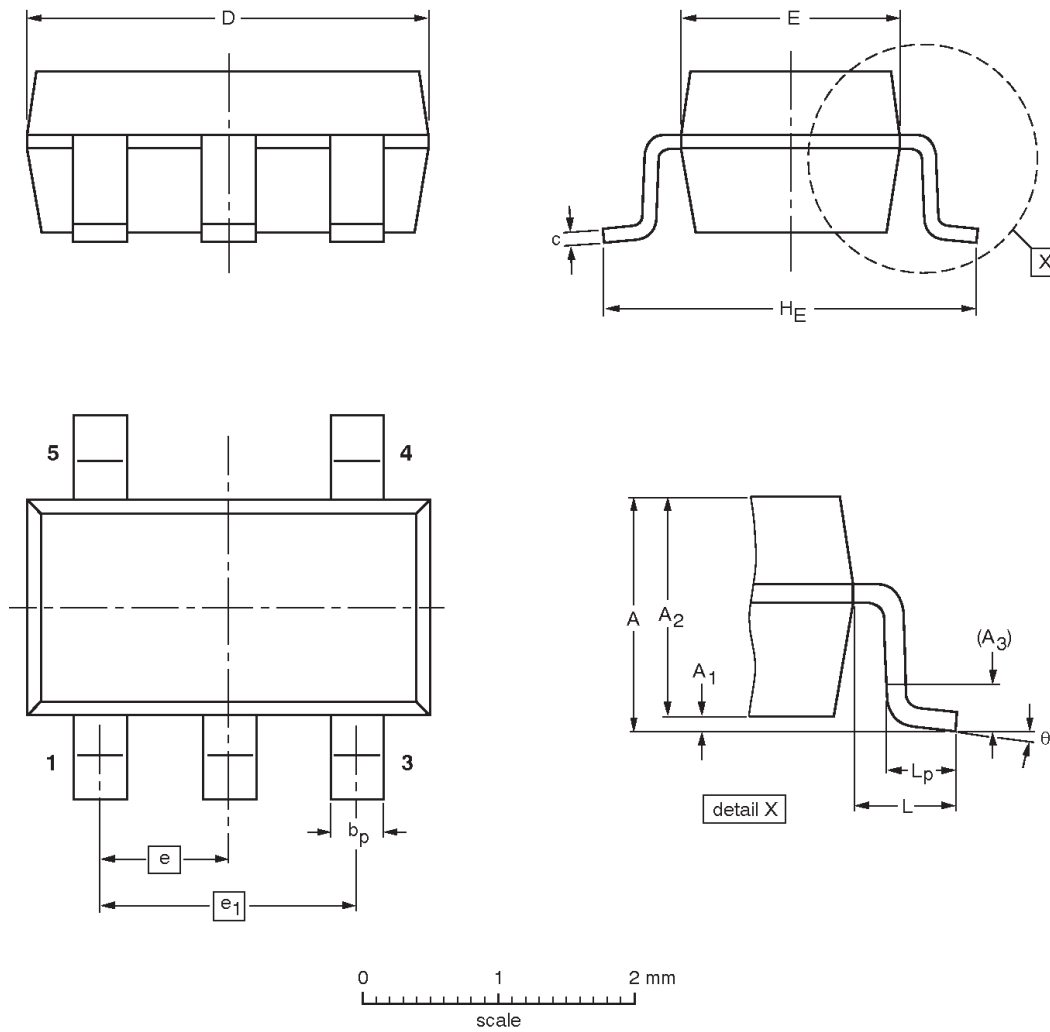

Figure 30. Tape and reel packing method.

Active-LOW system reset with adjustable delay time

NE56632-XX

Plastic small outline package; 5 leads; body width 1.6 mm

SOP003

scale

DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A₁	A₂	A₃	bₚ	c	D (1)	E (2)	e	e₁	Hₑ	L	Lₚ	θ
mm	1.35	0.15 0.05	1.2 1.0	0.25	0.50 0.25	0.22 0.08	3.0 2.7	1.7 1.5	0.95	1.9	3.0 2.6	0.6	0.55 0.35	8° 0°

Notes

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

2. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOP003		MO-178				~~03-06-25~~ 03-10-07

REVISION HISTORY

Rev	Date	Description
_2	20031014	**Product data (9397 750 12143). ECN 853-2329 30316 of 08 September 2003.** **Supersedes data of 2002 Mar 25 (9397 750 10239).** Modifications: • Change package outline version to SOP003 in Ordering information table and Package outline sections.
_1	20020325	**Product data (9397 750 10239). ECN 853-2329 27919 of 25 March 2002.**

Data sheet status

Level	Data sheet status [1]	Product status [2] [3]	Definitions
I	Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
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