NCP304, NCP305

Voltage Detector Series

The NCP304 and NCP305 series are second generation ultra–low current voltage detectors. These devices are specifically designed for use as reset controllers in portable microprocessor based systems where extended battery life is paramount.

Each series features a highly accurate under voltage detector with hysteresis which prevents erratic system reset operation as the comparator threshold is crossed.

The NCP304 series consists of complementary output devices that are available with either an active high or active low reset output. The NCP305 series has an open drain N–channel output with an active low reset output.

The NCP304 and NCP305 device series are available in the SC–82AB package with seven standard under voltage thresholds. Additional thresholds that range from 0.9 V to 4.9 V in 100 mV steps can be manufactured.

Features

- Quiescent Current of 1.0 μA Typical
- High Accuracy Under Voltage Threshold of 2.0%
- Wide Operating Voltage Range of 0.8 V to 10 V
- Complementary or Open Drain Reset Output
- Active Low or Active High Reset Output

Typical Applications

- Microprocessor Reset Controller
- Low Battery Detection
- Power Fail Indicator
- Battery Backup Detection

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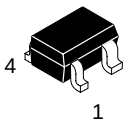
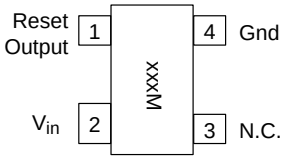


SC–82AB
SQ SUFFIX
CASE 419C

PIN CONNECTIONS AND MARKING DIAGRAM

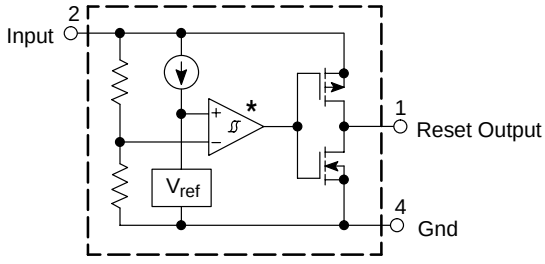


xxx = 304 or 305
M = Date Code
(Top View)

ORDERING INFORMATION

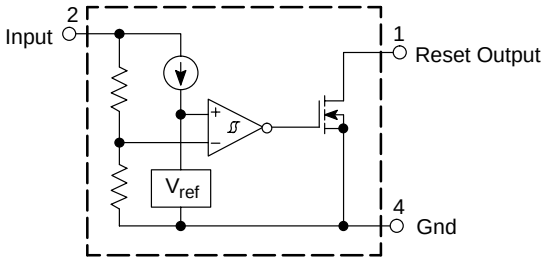
See detailed ordering and shipping information in the ordering information section on page 22 of this data sheet.

NCP304xSQxxT1
Complementary Output Configuration



This device contains 38 active transistors.

NCP305LSQxxT1
Open Drain Output Configuration



This device contains 37 active transistors.

* The representative block diagram depicts active low reset output ‘L’ suffix devices. The comparator input is interchanged for the active high output ‘H’ suffix devices.

Figure 1. Representative Block Diagrams

MAXIMUM RATINGS (Note 1)

Rating	Symbol	Value	Unit
Input Power Supply Voltage (Pin 2)	V_{in}	12	V
Output Voltage (Pin 1) Complementary, NCP304 N–Channel Open Drain, NCP305	V_{OUT}	 –0.3 to V_{in}+0.3 –0.3 to 12	V
Output Current (Pin 1) (Note 2)	I_{OUT}	70	mA
Thermal Resistance Junction to Air	$R_{\theta JA}$	285	°C/W
Operating Junction Temperature Range	T_J	–40 to +125	°C
Storage Temperature Range	T_{stg}	–55 to +150	°C
Latch–up Performance Positive Negative	$I_{LATCH–UP}$	 500 170	mA

1. This device series contains ESD protection and exceeds the following tests:
   Human Body Model 2000 V per MIL–STD–883, Method 3015.
   Machine Model Method 200 V.
2. The maximum package power dissipation limit must not be exceeded.

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

ELECTRICAL CHARACTERISTICS (For all values T_A = 25°C, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
NCP304/5 – 0.9					
Detector Threshold (Pin 2, V_{in} Decreasing)	$V_{DET–}$	0.882	0.900	0.918	V
Detector Threshold Hysteresis (Pin 2, V_{in} Increasing)	V_{HYS}	0.027	0.045	0.063	V
Supply Current (Pin 2) (V_{in} = 0.8 V) (V_{in} = 2.9 V)	I_{in}	 – –	 0.8 –	 2.4 3.0	µA
Maximum Operating Voltage (Pin 2)	$V_{in(max)}$	–	–	10	V
Minimum Operating Voltage (Pin 2) (T_A = –40°C to 85°C)	$V_{in(min)}$	– –	0.55 0.65	0.70 0.80	V
Reset Output Current (Pin 1, Active Low ‘L’ Suffix Devices) Nch Sink Current, NCP304, NCP305 (V_{OUT} = 0.05V, V_{in} = 0.70V) (V_{OUT} = 0.50V, V_{in} = 0.85V) Pch Source Current, NCP304 (V_{OUT} = 2.4V, V_{in} = 4.5V)	I_{OUT}	 0.01 0.05 1.0	 0.05 0.50 2.0	 – – –	mA
Reset Output Current (Pin 1, Active High ‘H’ Suffix Devices) Nch Sink Current, NCP304, NCP305 (V_{OUT} = 0.5 V, V_{in} = 1.5 V) Pch Source Current, NCP304 (V_{OUT} = 0.4 V, V_{in} = 0.7 V) (V_{OUT} = GND, V_{in} = 0.8 V)	I_{OUT}	 1.05 0.011 0.014	 2.5 0.04 0.08	 – – –	mA
Propagation Delay Input to Output (Figure 2) Complementary Output NCP304 Series Output Transition, High to Low (Note 3) Output Transition, Low to High (Note 3) N–Channel Open Drain NCP305 Series Output Transition, High to Low (Note 3) Output Transition, Low to High (Note 3)	 t_{pHL} t_{pLH} t_{pHL} t_{pLH}	 – – – –	 18 6.0 18 –	 – 100 – 100	µs

3. In the case of CMOS Output Type: The time interval between the rising edge of V_{DD} input pulse from 0.7 V to ($+V_{DET}$) +2.0 V and output voltage level becoming to V_{DD}/2. In the case of N_{CH} Open Drain Output Type: Output pin is pulled up with a resistance of 470 kΩ to 5.0 V, the time interval between the rising edge of V_{DD} input pulse from 0.7 V to ($+V_{DET}$) +2.0 V and output voltage level becoming to 2.5.

ELECTRICAL CHARACTERISTICS (For all values T_A = 25°C, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
NCP304/5 – 1.8					
Detector Threshold (Pin 2, V_{in} Decreasing)	V_{DET-}	1.764	1.80	1.836	V
Detector Threshold Hysteresis (Pin 2, V_{in} Increasing)	V_{HYS}	0.054	0.090	0.126	V
Supply Current (Pin 2) (V_{in} = 1.7 V) (V_{in} = 3.8 V)	I_{in}	 – –	 0.8 1.0	 2.4 3.0	µA
Maximum Operating Voltage (Pin 2)	$V_{in(max)}$	–	–	10	V
Minimum Operating Voltage (Pin 2) (T_A = –40°C to 85°C)	$V_{in(min)}$	– –	0.55 0.65	0.70 0.80	V
Reset Output Current (Pin 1, Active Low ‘L’ Suffix Devices) Nch Sink Current, NCP304, NCP305 (V_{OUT} = 0.05V, V_{in} = 0.70V) (V_{OUT} = 0.50V, V_{in} = 1.5V) Pch Source Current, NCP304 (V_{OUT} = 2.4V, V_{in} = 4.5V)	I_{OUT}	 0.01 1.0 1.0	 0.05 2.0 2.0	 – – –	mA
Reset Output Current (Pin 1, Active High ‘H’ Suffix Devices) Nch Sink Current, NCP304, NCP305 (V_{OUT} = 0.5 V, V_{in} = 5.0 V) Pch Source Current, NCP304 (V_{OUT} = 0.4 V, V_{in} = 0.7 V) (V_{OUT} = GND, V_{in} = 1.5 V)	I_{OUT}	 6.3 0.011 0.525	 11 0.04 0.6	 – – –	mA
Propagation Delay Input to Output (Figure 2) Complementary Output NCP304 Series Output Transition, High to Low (Note 4) Output Transition, Low to High (Note 4) N–Channel Open Drain NCP305 Series Output Transition, High to Low (Note 4) Output Transition, Low to High (Note 4)	 t_{pHL} t_{pLH} t_{pHL} t_{pLH}	 – – – –	 14 15 14 –	 – 100 – 100	µs

ELECTRICAL CHARACTERISTICS (For all values T_A = 25°C, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
NCP304/5 – 2.0					
Detector Threshold (Pin 2, V_{in} Decreasing)	V_{DET-}	1.960	2.00	2.040	V
Detector Threshold Hysteresis (Pin 2, V_{in} Increasing)	V_{HYS}	0.06	0.10	0.14	V
Supply Current (Pin 2)	I_{in}				μA
(V_{in} = 1.9 V)		–	0.9	2.7	
(V_{in} = 4.0 V)		–	1.1	3.3	
Maximum Operating Voltage (Pin 2)	$V_{in(max)}$	–	–	10	V
Minimum Operating Voltage (Pin 2)	$V_{in(min)}$	–	0.55	0.70	V
(T_A = –40°C to 85°C)		–	0.65	0.80	
Reset Output Current (Pin 1, Active Low 'L' Suffix Devices)	I_{OUT}				mA
Nch Sink Current, NCP304, NCP305					
(V_{OUT} = 0.05V, V_{in} = 0.70V)		0.01	0.05	–	
(V_{OUT} = 0.50V, V_{in} = 1.5V)		1.0	2.0	–	
Pch Source Current, NCP304					
(V_{OUT} = 2.4V, V_{in} = 4.5V)		1.0	2.0	–	
Reset Output Current (Pin 1, Active High 'H' Suffix Devices)	I_{OUT}				mA
Nch Sink Current, NCP304, NCP305					
(V_{OUT} = 0.5 V, V_{in} = 5.0 V)		6.3	11	–	
Pch Source Current, NCP304					
(V_{OUT} = 0.4 V, V_{in} = 0.7 V)		0.011	0.04	–	
(V_{OUT} = GND, V_{in} = 1.5 V)		0.525	0.6	–	
Propagation Delay Input to Output (Figure 2)					μs
Complementary Output NCP304 Series					
Output Transition, High to Low (Note 4)	t_{pHL}	–	13	–	
Output Transition, Low to High (Note 4)	t_{pLH}	–	15	100	
N–Channel Open Drain NCP305 Series					
Output Transition, High to Low (Note 4)	t_{pHL}	–	13	–	
Output Transition, Low to High (Note 4)	t_{pLH}	–	–	100	

4. In the case of CMOS Output Type: The time interval between the rising edge of V_{DD} input pulse from 0.7 V to ($+V_{DET}$) +2.0 V and output voltage level becoming to V_{DD}/2. In the case of N_{CH} Open Drain Output Type: Output pin is pulled up with a resistance of 470 kΩ to 5.0 V, the time interval between the rising edge of V_{DD} input pulse from 0.7 V to ($+V_{DET}$) +2.0 V and output voltage level becoming to 2.5.

ELECTRICAL CHARACTERISTICS (For all values T_A = 25°C, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
NCP304/5 – 2.7					
Detector Threshold (Pin 2, V_{in} Decreasing)	V_{DET-}	2.646	2.700	2.754	V
Detector Threshold Hysteresis (Pin 2, V_{in} Increasing)	V_{HYS}	0.081	0.135	0.189	V
Supply Current (Pin 2) (V_{in} = 2.6 V) (V_{in} = 4.7 V)	I_{in}	 – –	 0.9 1.1	 2.7 3.3	μA
Maximum Operating Voltage (Pin 2)	$V_{in(max)}$	–	–	10	V
Minimum Operating Voltage (Pin 2) (T_A = –40°C to 85°C)	$V_{in(min)}$	– –	0.55 0.65	0.70 0.80	V
Reset Output Current (Pin 1, Active Low 'L' Suffix Devices) Nch Sink Current, NCP304, NCP305 (V_{OUT} = 0.05V, V_{in} = 0.70V) (V_{OUT} = 0.50V, V_{in} = 1.5V) Pch Source Current, NCP304 (V_{OUT} = 2.4V, V_{in} = 4.5V)	I_{OUT}	 0.01 1.0 1.0	 0.05 2.0 2.0	 – – –	mA
Reset Output Current (Pin 1, Active High 'H' Suffix Devices) Nch Sink Current, NCP304, NCP305 (V_{OUT} = 0.5 V, V_{in} = 5.0 V) Pch Source Current, NCP304 (V_{OUT} = 0.4 V, V_{in} = 0.7 V) (V_{OUT} = GND, V_{in} = 1.5 V)	I_{OUT}	 6.3 0.011 0.525	 11 0.04 0.6	 – – –	mA
Propagation Delay Input to Output (Figure 2) Complementary Output NCP304 Series Output Transition, High to Low (Note 5) Output Transition, Low to High (Note 5) N–Channel Open Drain NCP305 Series Output Transition, High to Low (Note 5) Output Transition, Low to High (Note 5)	 t_{pHL} t_{pLH} t_{pHL} t_{pLH}	 – – – –	 12 19 12 –	 – 100 – 100	μs

ELECTRICAL CHARACTERISTICS (For all values T_A = 25°C, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
NCP304/5 – 3.0					
Detector Threshold (Pin 2, V_{in} Decreasing)	V_{DET-}	2.94	3.00	3.06	V
Detector Threshold Hysteresis (Pin 2, V_{in} Increasing)	V_{HYS}	0.09	0.15	0.21	V
Supply Current (Pin 2)	I_{in}				μA
(V_{in} = 2.87 V)		–	1.0	3.0	
(V_{in} = 5.0 V)		–	1.2	3.6	
Maximum Operating Voltage (Pin 2)	$V_{in(max)}$	–	–	10	V
Minimum Operating Voltage (Pin 2)	$V_{in(min)}$	–	0.55	0.70	V
(T_A = –40°C to 85°C)		–	0.65	0.80	
Reset Output Current (Pin 1, Active Low 'L' Suffix Devices)	I_{OUT}				mA
Nch Sink Current, NCP304, NCP305					
(V_{OUT} = 0.05V, V_{in} = 0.70V)		0.01	0.05	–	
(V_{OUT} = 0.50V, V_{in} = 1.5V)		1.0	2.0	–	
Pch Source Current, NCP304					
(V_{OUT} = 2.4V, V_{in} = 4.5V)		1.0	2.0	–	
Reset Output Current (Pin 1, Active High 'H' Suffix Devices)	I_{OUT}				mA
Nch Sink Current, NCP304, NCP305					
(V_{OUT} = 0.5 V, V_{in} = 5.0 V)		6.3	11	–	
Pch Source Current, NCP304					
(V_{OUT} = 0.4 V, V_{in} = 0.7 V)		0.011	0.04	–	
(V_{OUT} = GND, V_{in} = 1.5 V)		0.525	0.6	–	
Propagation Delay Input to Output (Figure 2)					μs
Complementary Output NCP304 Series					
Output Transition, High to Low (Note 5)	t_{pHL}	–	12	–	
Output Transition, Low to High (Note 5)	t_{pLH}	–	19	100	
N–Channel Open Drain NCP305 Series					
Output Transition, High to Low (Note 5)	t_{pHL}	–	12	–	
Output Transition, Low to High (Note 5)	t_{pLH}	–	–	100	

5. In the case of CMOS Output Type: The time interval between the rising edge of V_{DD} input pulse from 0.7 V to ($+V_{DET}$) +2.0 V and output voltage level becoming to V_{DD}/2. In the case of N_{CH} Open Drain Output Type: Output pin is pulled up with a resistance of 470 kΩ to 5.0 V, the time interval between the rising edge of V_{DD} input pulse from 0.7 V to ($+V_{DET}$) +2.0 V and output voltage level becoming to 2.5.

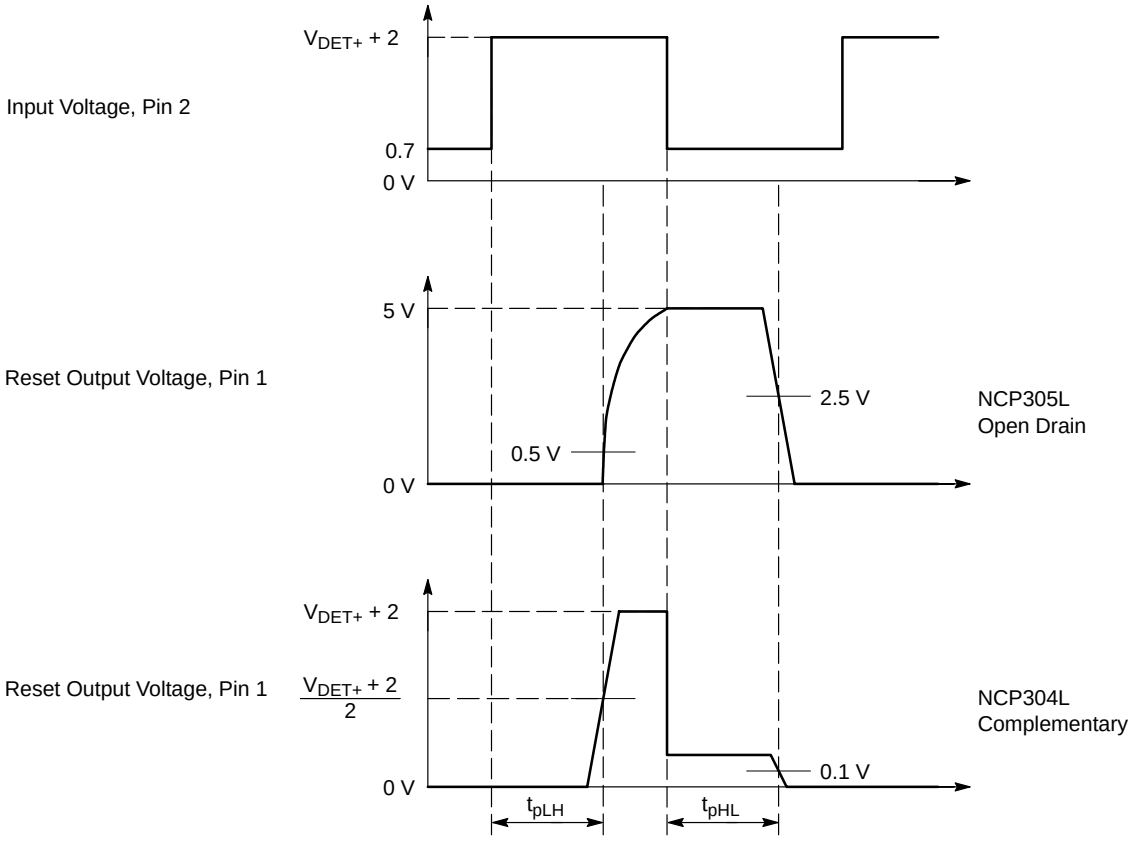
ELECTRICAL CHARACTERISTICS (For all values T_A = 25°C, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
NCP304/5 – 4.5					
Detector Threshold (Pin 2, V_{in} Decreasing)	V_{DET-}	4.410	4.500	4.590	V
Detector Threshold Hysteresis (Pin 2, V_{in} Increasing)	V_{HYS}	0.135	0.225	0.315	V
Supply Current (Pin 2) (V_{in} = 4.34 V) (V_{in} = 6.5 V)	I_{in}	 – –	 – –	 3.0 3.9	μA
Maximum Operating Voltage (Pin 2)	$V_{in(max)}$	–	–	10	V
Minimum Operating Voltage (Pin 2) (T_A = –40°C to 85°C)	$V_{in(min)}$	– –	0.55 0.65	0.70 0.80	V
Reset Output Current (Pin 1, Active Low 'L' Suffix Devices) Nch Sink Current, NCP304, NCP305 (V_{OUT} = 0.05V, V_{in} = 0.70V) (V_{OUT} = 0.50V, V_{in} = 1.5V) Pch Source Current, NCP304 (V_{OUT} = 5.9V, V_{in} = 8.0V)	I_{OUT}	 0.01 1.0 1.5	 0.05 2.0 3.0	 – – –	mA
Reset Output Current (Pin 1, Active High 'H' Suffix Devices) Nch Sink Current, NCP304, NCP305 (V_{OUT} = 0.5 V, V_{in} = 5.0 V) Pch Source Current, NCP304 (V_{OUT} = 0.4 V, V_{in} = 0.7 V) (V_{OUT} = GND, V_{in} = 1.5 V)	I_{OUT}	 6.3 0.011 0.525	 11 0.04 0.6	 – – –	mA
Propagation Delay Input to Output (Figure 2) Complementary Output NCP304 Series Output Transition, High to Low (Note 6) Output Transition, Low to High (Note 6) N–Channel Open Drain NCP305 Series Output Transition, High to Low (Note 6) Output Transition, Low to High (Note 6)	 t_{pHL} t_{pLH} t_{pHL} t_{pLH}	 – – – –	 10 21 10 –	 – 100 – 100	μs

ELECTRICAL CHARACTERISTICS (For all values T_A = 25°C, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
NCP304/5 – 4.7					
Detector Threshold (Pin 2, V_{in} Decreasing)	V_{DET-}	4.606	4.70	4.794	V
Detector Threshold Hysteresis (Pin 2, V_{in} Increasing)	V_{HYS}	0.141	0.235	0.329	V
Supply Current (Pin 2)	I_{in}				μA
(V_{in} = 4.54 V)		–	1.1	3.0	
(V_{in} = 6.7 V)		–	1.3	3.9	
Maximum Operating Voltage (Pin 2)	$V_{in(max)}$	–	–	10	V
Minimum Operating Voltage (Pin 2)	$V_{in(min)}$	–	0.55	0.70	V
(T_A = –40°C to 85°C)		–	0.65	0.80	
Reset Output Current (Pin 1, Active Low 'L' Suffix Devices)	I_{OUT}				mA
Nch Sink Current, NCP304, NCP305					
(V_{OUT} = 0.05V, V_{in} = 0.70V)		0.01	0.05	–	
(V_{OUT} = 0.50V, V_{in} = 1.5V)		1.0	2.0	–	
Pch Source Current, NCP304					
(V_{OUT} = 5.9V, V_{in} = 8.0V)		1.5	3.0	–	
Reset Output Current (Pin 1, Active High 'H' Suffix Devices)	I_{OUT}				mA
Nch Sink Current, NCP304, NCP305					
(V_{OUT} = 0.5 V, V_{in} = 5.0 V)		6.3	11	–	
Pch Source Current, NCP304					
(V_{OUT} = 0.4 V, V_{in} = 0.7 V)		0.011	0.04	–	
(V_{OUT} = GND, V_{in} = 1.5 V)		0.525	0.6	–	
Propagation Delay Input to Output (Figure 2)					μs
Complementary Output NCP304 Series					
Output Transition, High to Low (Note 6)	t_{pHL}	–	10	–	
Output Transition, Low to High (Note 6)	t_{pLH}	–	21	100	
N–Channel Open Drain NCP305 Series					
Output Transition, High to Low (Note 6)	t_{pHL}	–	10	–	
Output Transition, Low to High (Note 6)	t_{pLH}	–	–	100	

6. In the case of CMOS Output Type: The time interval between the rising edge of V_{DD} input pulse from 0.7 V to ($+V_{DET}$) +2.0 V and output voltage level becoming to V_{DD}/2. In the case of N_{CH} Open Drain Output Type: Output pin is pulled up with a resistance of 470 kΩ to 5.0 V, the time interval between the rising edge of V_{DD} input pulse from 0.7 V to ($+V_{DET}$) +2.0 V and output voltage level becoming to 2.5.



NCP304 and NCP305 series are measured with a 10 pF capacitive load. NCP305 has an additional 470 k pullup resistor connected from the reset output to +5.0 V. The reset output voltage waveforms are shown for the active low ‘L’ devices. The upper detector threshold, V_{DET+} is the sum of the lower detector threshold, V_{DET-} plus the input hysteresis, V_{HYS}.

Figure 2. Propagation Delay Measurement Conditions

Table 1. ELECTRICAL CHARACTERISTIC TABLE FOR 0.9 – 4.9 V

NCP304 Series	Detector Threshold			Detector Threshold Hysteresis			Supply Current		Nch Sink Current		Pch Source Current
							V_{in} Low	V_{in} High	V_{in} Low	V_{in} High	
	V_{DET-} (V)			V_{HYS} (V)			I_{in} (μA) (1)	I_{in} (μA) (2)	I_{OUT} (mA) (3)	I_{OUT} (mA) (4)	I_{OUT} (mA) (5)
Part Number	Min	Typ	Max	Min	Typ	Max	Typ	Typ	Typ	Typ	Typ
NCP304LSQ09T1	0.882	0.9	0.918	0.027	0.045	0.063	0.8	0.9	0.05	0.5	2.0
NCP304LSQ10T1	0.980	1.0	1.020	0.030	0.050	0.070		1.0			
NCP304LSQ11T1	1.078	1.1	1.122	0.033	0.055	0.077				1.0	
NCP304LSQ12T1	1.176	1.2	1.224	0.036	0.060	0.084					
NCP304LSQ13T1	1.274	1.3	1.326	0.039	0.065	0.091					
NCP304LSQ14T1	1.372	1.4	1.428	0.042	0.070	0.098					
NCP304LSQ15T1	1.470	1.5	1.530	0.045	0.075	0.105					
NCP304LSQ16T1	1.568	1.6	1.632	0.048	0.080	0.112				2.0	
NCP304LSQ17T1	1.666	1.7	1.734	0.051	0.085	0.119					
NCP304LSQ18T1	1.764	1.8	1.836	0.054	0.090	0.126					
NCP304LSQ19T1	1.862	1.9	1.938	0.057	0.095	0.133					
NCP304LSQ20T1	1.960	2.0	2.040	0.060	0.100	0.140	0.9	1.1			
NCP304LSQ21T1	2.058	2.1	2.142	0.063	0.105	0.147					
NCP304LSQ22T1	2.156	2.2	2.244	0.066	0.110	0.154					
NCP304LSQ23T1	2.254	2.3	2.346	0.069	0.115	0.161					
NCP304LSQ24T1	2.352	2.4	2.448	0.072	0.120	0.168					
NCP304LSQ25T1	2.450	2.5	2.550	0.075	0.125	0.175					
NCP304LSQ26T1	2.548	2.6	2.652	0.078	0.130	0.182					
NCP304LSQ27T1	2.646	2.7	2.754	0.081	0.135	0.189					
NCP304LSQ28T1	2.744	2.8	2.856	0.084	0.140	0.196					
NCP304LSQ29T1	2.842	2.9	2.958	0.087	0.145	0.203					
NCP304LSQ30T1	2.940	3.0	3.060	0.090	0.150	0.210	1.0	1.2			
NCP304LSQ31T1	3.038	3.1	3.162	0.093	0.155	0.217					
NCP304LSQ32T1	3.136	3.2	3.264	0.096	0.160	0.224					
NCP304LSQ33T1	3.234	3.3	3.366	0.099	0.165	0.231					
NCP304LSQ34T1	3.332	3.4	3.468	0.102	0.170	0.238					
NCP304LSQ35T1	3.430	3.5	3.570	0.105	0.175	0.245					
NCP304LSQ36T1	3.528	3.6	3.672	0.108	0.180	0.252					
NCP304LSQ37T1	3.626	3.7	3.774	0.111	0.185	0.259					
NCP304LSQ38T1	3.724	3.8	3.876	0.114	0.190	0.266					
NCP304LSQ39T1	3.822	3.9	3.978	0.117	0.195	0.273					
NCP304LSQ40T1	3.920	4.0	4.080	0.120	0.200	0.280	1.1	1.3			3.0
NCP304LSQ41T1	4.018	4.1	4.182	0.123	0.205	0.287					
NCP304LSQ42T1	4.116	4.2	4.284	0.126	0.210	0.294					
NCP304LSQ43T1	4.214	4.3	4.386	0.129	0.215	0.301					
NCP304LSQ44T1	4.312	4.4	4.488	0.132	0.220	0.308					
NCP304LSQ45T1	4.410	4.5	4.590	0.135	0.225	0.315					
NCP304LSQ46T1	4.508	4.6	4.692	0.138	0.230	0.322					
NCP304LSQ47T1	4.606	4.7	4.794	0.141	0.235	0.329					
NCP304LSQ48T1	4.704	4.8	4.896	0.144	0.240	0.336					
NCP304LSQ49T1	4.802	4.9	4.998	0.147	0.245	0.343					

(1) Condition 1: 0.9 — 2.9 V, $V_{in} = V_{DET-} – 0.10$ V; 3.0 — 3.9 V, $V_{in} = V_{DET-} – 0.13$ V; 4.0 — 4.9 V, $V_{in} = V_{DET-} – 0.16$ V
(2) Condition 2: 0.9 — 4.9 V, $V_{in} = V_{DET-} + 2.0$ V
(3) Condition 3: 0.9 — 4.9 V, $V_{in} = 0.7$ V, $V_{OUT} = 0.05$ V, Active Low ‘L’ Suffix Devices
(4) Condition 4: 0.9 — 1.0 V, $V_{in} = 0.85$ V, $V_{OUT} = 0.5$ V; 1.1 — 1.5 V, $V_{in} = 1.0$ V, $V_{OUT} = 0.5$ V; 1.6 — 4.9 V, $V_{in} = 1.5$ V, $V_{OUT} = 0.5$ V, Active Low ‘L’ Suffix Devices
(5) Condition 5: 0.9 — 3.9 V, $V_{in} = 4.5$ V, $V_{OUT} = 2.4$ V; 4.0 — 4.9 V, $V_{in} = 8.0$ V, $V_{OUT} = 5.9$ V, Active Low ‘L’ Suffix Devices

Table 2. ELECTRICAL CHARACTERISTIC TABLE FOR 0.9 – 4.9 V

NCP304 Series	Detector Threshold			Detector Threshold Hysteresis			Supply Current		Nch Sink Current	Pch Source Current	
							V_{in} Low	V_{in} High		V_{in} Low	V_{in} High
	V_{DET-} (V)			V_{HYS} (V)			I_{in} (μA) (1)	I_{in} (μA) (2)	I_{OUT} (mA) (3)	I_{OUT} (mA) (4)	I_{OUT} (mA) (5)
Part Number	Min	Typ	Max	Min	Typ	Max	Typ	Typ	Typ	Typ	Typ
NCP304HSQ09T1	0.882	0.9	0.918	0.027	0.045	0.063	0.8	0.9	2.5	0.04	0.08
NCP304HSQ10T1	0.980	1.0	1.020	0.030	0.050	0.070		1.0			
NCP304HSQ11T1	1.078	1.1	1.122	0.033	0.055	0.077					0.18
NCP304HSQ12T1	1.176	1.2	1.224	0.036	0.060	0.084					
NCP304HSQ13T1	1.274	1.3	1.326	0.039	0.065	0.091					
NCP304HSQ14T1	1.372	1.4	1.428	0.042	0.070	0.098					
NCP304HSQ15T1	1.470	1.5	1.530	0.045	0.075	0.105			11		
NCP304HSQ16T1	1.568	1.6	1.632	0.048	0.080	0.112					0.6
NCP304HSQ17T1	1.666	1.7	1.734	0.051	0.085	0.119					
NCP304HSQ18T1	1.764	1.8	1.836	0.054	0.090	0.126					
NCP304HSQ19T1	1.862	1.9	1.938	0.057	0.095	0.133					
NCP304HSQ20T1	1.960	2.0	2.040	0.060	0.100	0.140	0.9	1.1			
NCP304HSQ21T1	2.058	2.1	2.142	0.063	0.105	0.147					
NCP304HSQ22T1	2.156	2.2	2.244	0.066	0.110	0.154					
NCP304HSQ23T1	2.254	2.3	2.346	0.069	0.115	0.161					
NCP304HSQ24T1	2.352	2.4	2.448	0.072	0.120	0.168					
NCP304HSQ25T1	2.450	2.5	2.550	0.075	0.125	0.175					
NCP304HSQ26T1	2.548	2.6	2.652	0.078	0.130	0.182					
NCP304HSQ27T1	2.646	2.7	2.754	0.081	0.135	0.189					
NCP304HSQ28T1	2.744	2.8	2.856	0.084	0.140	0.196					
NCP304HSQ29T1	2.842	2.9	2.958	0.087	0.145	0.203					
NCP304HSQ30T1	2.940	3.0	3.060	0.090	0.150	0.210	1.0	1.2			
NCP304HSQ31T1	3.038	3.1	3.162	0.093	0.155	0.217					
NCP304HSQ32T1	3.136	3.2	3.264	0.096	0.160	0.224					
NCP304HSQ33T1	3.234	3.3	3.366	0.099	0.165	0.231					
NCP304HSQ34T1	3.332	3.4	3.468	0.102	0.170	0.238					
NCP304HSQ35T1	3.430	3.5	3.570	0.105	0.175	0.245					
NCP304HSQ36T1	3.528	3.6	3.672	0.108	0.180	0.252					
NCP304HSQ37T1	3.626	3.7	3.774	0.111	0.185	0.259					
NCP304HSQ38T1	3.724	3.8	3.876	0.114	0.190	0.266					
NCP304HSQ39T1	3.822	3.9	3.978	0.117	0.195	0.273					
NCP304HSQ40T1	3.920	4.0	4.080	0.120	0.200	0.280	1.1	1.3			
NCP304HSQ41T1	4.018	4.1	4.182	0.123	0.205	0.287					
NCP304HSQ42T1	4.116	4.2	4.284	0.126	0.210	0.294					
NCP304HSQ43T1	4.214	4.3	4.386	0.129	0.215	0.301					
NCP304HSQ44T1	4.312	4.4	4.488	0.132	0.220	0.308					
NCP304HSQ45T1	4.410	4.5	4.590	0.135	0.225	0.315					
NCP304HSQ46T1	4.508	4.6	4.692	0.138	0.230	0.322					
NCP304HSQ47T1	4.606	4.7	4.794	0.141	0.235	0.329					
NCP304HSQ48T1	4.704	4.8	4.896	0.144	0.240	0.336					
NCP304HSQ49T1	4.802	4.9	4.998	0.147	0.245	0.343					

(1) Condition 1: 0.9 — 2.9 V, $V_{in} = V_{DET-} - 0.10$ V; 3.0 — 3.9 V, $V_{in} = V_{DET-} - 0.13$ V; 4.0 — 4.9 V, $V_{in} = V_{DET-} - 0.16$ V
(2) Condition 2: 0.9 — 4.9 V, $V_{in} = V_{DET-} + 2.0$ V
(3) Condition 3: 0.9 — 1.4 V, V_{in} = 1.5 V, V_{OUT} = 0.5 V; 1.5 — 4.9 V, V_{in} = 5.0 V, V_{OUT} = 0.5 V, Active High ‘H’ Suffix Devices
(4) Condition 4: 0.9 — 4.9 V, V_{in} = 0.7 V, V_{OUT} = 0.4 V, Active High ‘H’ Suffix Devices
(5) Condition 5: 0.9 — 1.0 V, V_{in} = 0.8 V, V_{OUT} = GND; 1.1 — 1.5 V, V_{in} = 1.0 V, V_{OUT} = GND; 1.6 — 4.9 V, V_{in} = 1.5 V, V_{OUT} = GND, Active High ‘H’ Suffix Devices

Table 3. ELECTRICAL CHARACTERISTIC TABLE FOR 0.9 – 4.9 V

NCP305 Series	Detector Threshold			Detector Threshold Hysteresis			Supply Current		Nch Sink Current	
							V_{in} Low	V_{in} High	V_{in} Low	V_{in} High
	V_{DET-} (V)			V_{HYS} (V)			I_{in} (μA) (1)	I_{in} (μA) (2)	I_{OUT} (mA) (3)	I_{OUT} (mA) (4)
Part Number	Min	Typ	Max	Min	Typ	Max	Typ	Typ	Typ	Typ
NCP305LSQ09T1	0.882	0.9	0.918	0.027	0.045	0.063	0.8	0.9	0.05	0.5
NCP305LSQ10T1	0.980	1.0	1.020	0.030	0.050	0.070		1.0		
NCP305LSQ11T1	1.078	1.1	1.122	0.033	0.055	0.077				1.0
NCP305LSQ12T1	1.176	1.2	1.224	0.036	0.060	0.084				
NCP305LSQ13T1	1.274	1.3	1.326	0.039	0.065	0.091				
NCP305LSQ14T1	1.372	1.4	1.428	0.042	0.070	0.098				
NCP305LSQ15T1	1.470	1.5	1.530	0.045	0.075	0.105				
NCP305LSQ16T1	1.568	1.6	1.632	0.048	0.080	0.112				2.0
NCP305LSQ17T1	1.666	1.7	1.734	0.051	0.085	0.119				
NCP305LSQ18T1	1.764	1.8	1.836	0.054	0.090	0.126				
NCP305LSQ19T1	1.862	1.9	1.938	0.057	0.095	0.133				
NCP305LSQ20T1	1.960	2.0	2.040	0.060	0.100	0.140	0.9	1.1		
NCP305LSQ21T1	2.058	2.1	2.142	0.063	0.105	0.147				
NCP305LSQ22T1	2.156	2.2	2.244	0.066	0.110	0.154				
NCP305LSQ23T1	2.254	2.3	2.346	0.069	0.115	0.161				
NCP305LSQ24T1	2.352	2.4	2.448	0.072	0.120	0.168				
NCP305LSQ25T1	2.450	2.5	2.550	0.075	0.125	0.175				
NCP305LSQ26T1	2.548	2.6	2.652	0.078	0.130	0.182				
NCP305LSQ27T1	2.646	2.7	2.754	0.081	0.135	0.189				
NCP305LSQ28T1	2.744	2.8	2.856	0.084	0.140	0.196				
NCP305LSQ29T1	2.842	2.9	2.958	0.087	0.145	0.203				
NCP305LSQ30T1	2.940	3.0	3.060	0.090	0.150	0.210	1.0	1.2		
NCP305LSQ31T1	3.038	3.1	3.162	0.093	0.155	0.217				
NCP305LSQ32T1	3.136	3.2	3.264	0.096	0.160	0.224				
NCP305LSQ33T1	3.234	3.3	3.366	0.099	0.165	0.231				
NCP305LSQ34T1	3.332	3.4	3.468	0.102	0.170	0.238				
NCP305LSQ35T1	3.430	3.5	3.570	0.105	0.175	0.245				
NCP305LSQ36T1	3.528	3.6	3.672	0.108	0.180	0.252				
NCP305LSQ37T1	3.626	3.7	3.774	0.111	0.185	0.259				
NCP305LSQ38T1	3.724	3.8	3.876	0.114	0.190	0.266				
NCP305LSQ39T1	3.822	3.9	3.978	0.117	0.195	0.273				
NCP305LSQ40T1	3.920	4.0	4.080	0.120	0.200	0.280	1.1	1.3		
NCP305LSQ41T1	4.018	4.1	4.182	0.123	0.205	0.287				
NCP305LSQ42T1	4.116	4.2	4.284	0.126	0.210	0.294				
NCP305LSQ43T1	4.214	4.3	4.386	0.129	0.215	0.301				
NCP305LSQ44T1	4.312	4.4	4.488	0.132	0.220	0.308				
NCP305LSQ45T1	4.410	4.5	4.590	0.135	0.225	0.315				
NCP305LSQ46T1	4.508	4.6	4.692	0.138	0.230	0.322				
NCP305LSQ47T1	4.606	4.7	4.794	0.141	0.235	0.329				
NCP305LSQ48T1	4.704	4.8	4.896	0.144	0.240	0.336				
NCP305LSQ49T1	4.802	4.9	4.998	0.147	0.245	0.343				

(1) Condition 1: 0.9 — 2.9 V, $V_{in} = V_{DET-} – 0.10$ V; 3.0 — 3.9 V, $V_{in} = V_{DET-} – 0.13$ V; 4.0 — 4.9 V, $V_{in} = V_{DET-} – 0.16$ V
(2) Condition 2: 0.9 — 4.9 V, $V_{in} = V_{DET-} + 2.0$ V
(3) Condition 3: 0.9 — 4.9 V, $V_{in} = 0.7$ V, $V_{OUT} = 0.05$ V, Active Low ‘L’ Suffix Devices
(4) Condition 4: 0.9 — 1.0 V, $V_{in} = 0.85$ V, $V_{OUT} = 0.5$ V; 1.1 — 1.5 V, $V_{in} = 1.0$ V, $V_{OUT} = 0.5$ V; 1.6 — 4.9 V, $V_{in} = 1.5$ V, $V_{OUT} = 0.5$ V, Active Low ‘L’ Suffix Devices

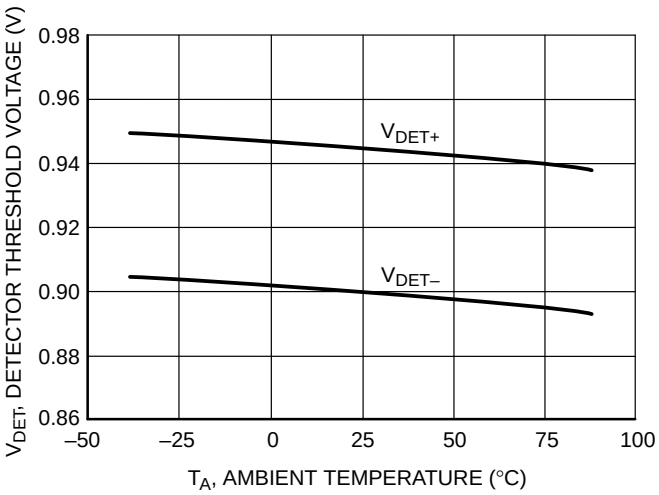


Figure 3. NCP304/5 Series 0.9 V Detector Threshold Voltage vs. Temperature

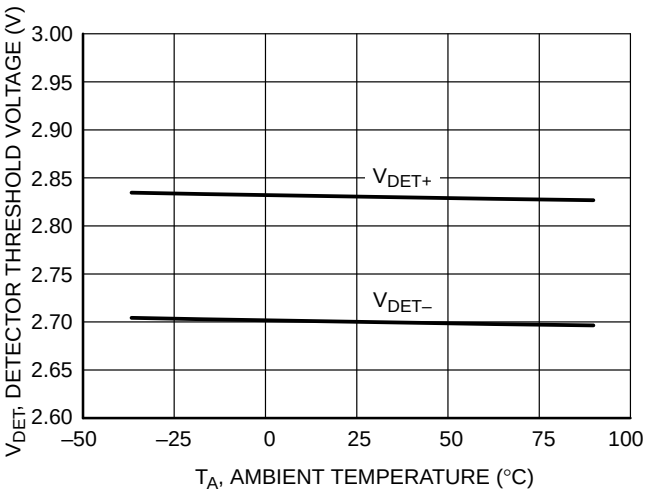


Figure 4. NCP304/5 Series 2.7 V Detector Threshold Voltage vs. Temperature

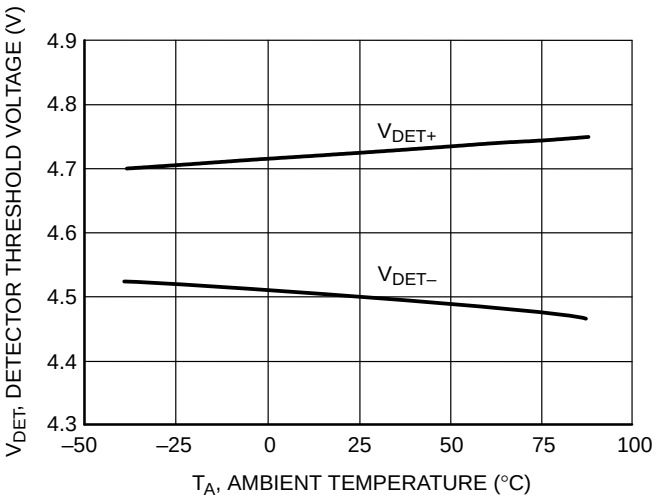


Figure 5. NCP304/5 Series 4.5 V Detector Threshold Voltage vs. Temperature

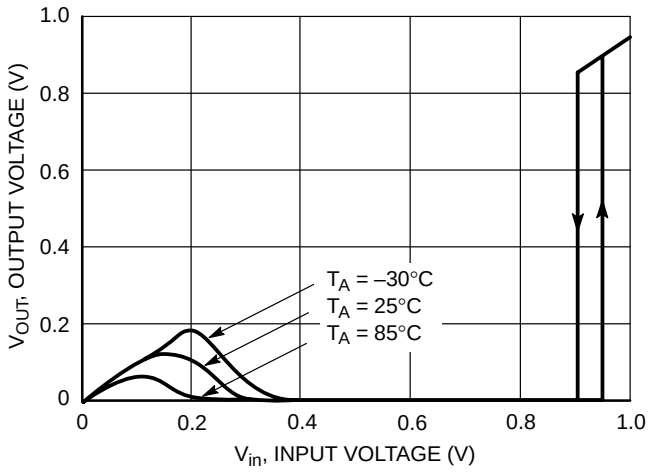


Figure 6. NCP304H/5L Series 0.9 V Reset Output Voltage vs. Input Voltage

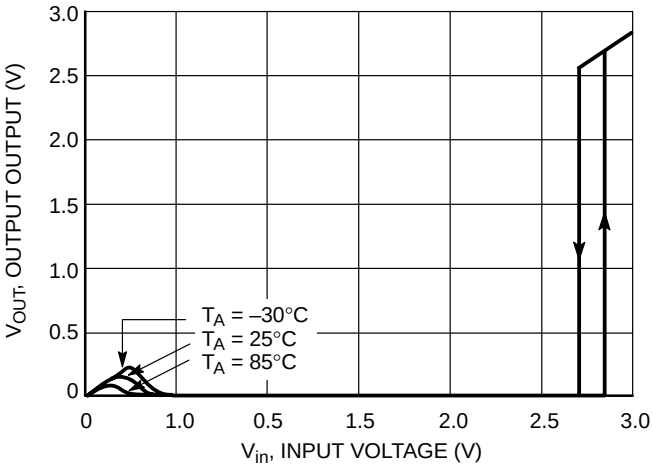


Figure 7. NCP304H/5L Series 2.7 V Reset Output Voltage vs. Input Voltage

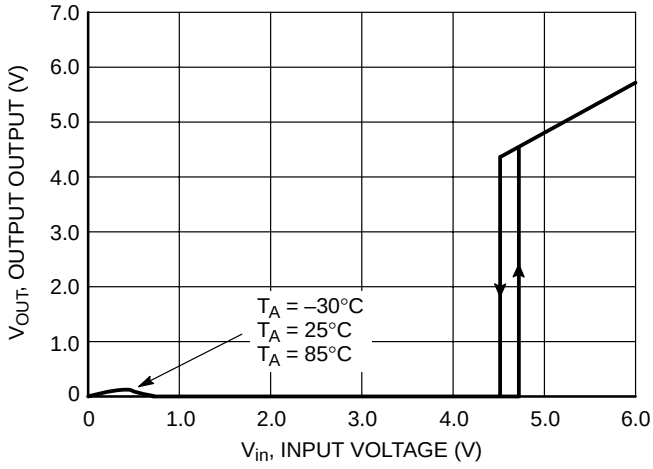


Figure 8. NCP304H/5L Series 4.5 V Reset Output Voltage vs. Input Voltage

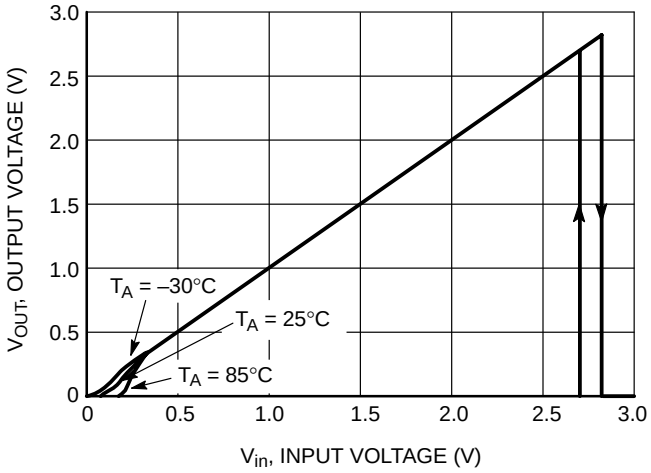


Figure 9. NCP304H/5H Series 2.7 V Reset Output Voltage vs. Input Voltage

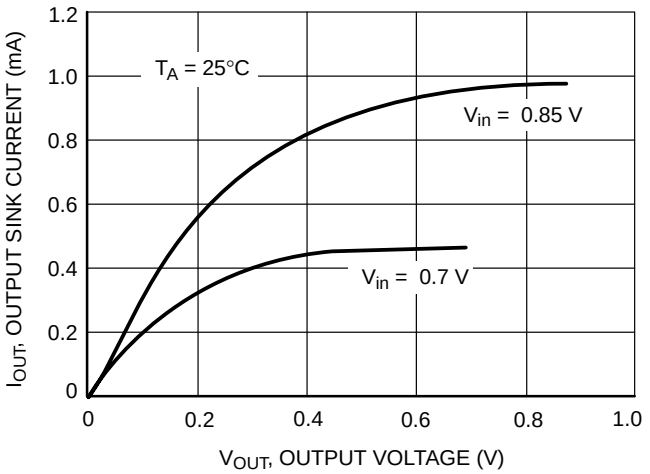


Figure 10. NCP304H/5L Series 0.9 V Reset Output Sink Current vs. Output Voltage

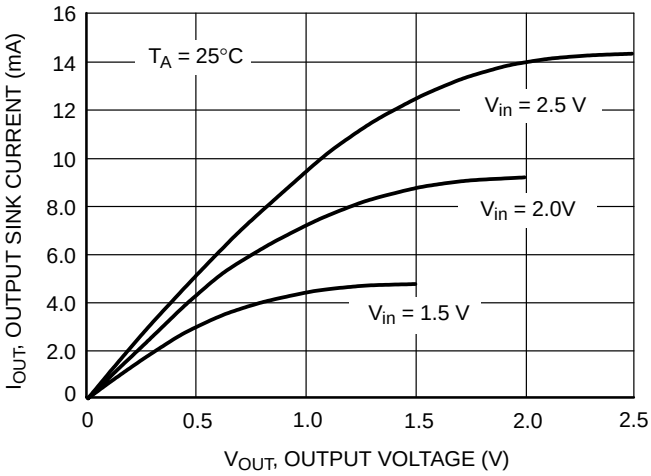


Figure 11. NCP304H/5L Series 2.7 V Reset Output Sink Current vs. Output Voltage

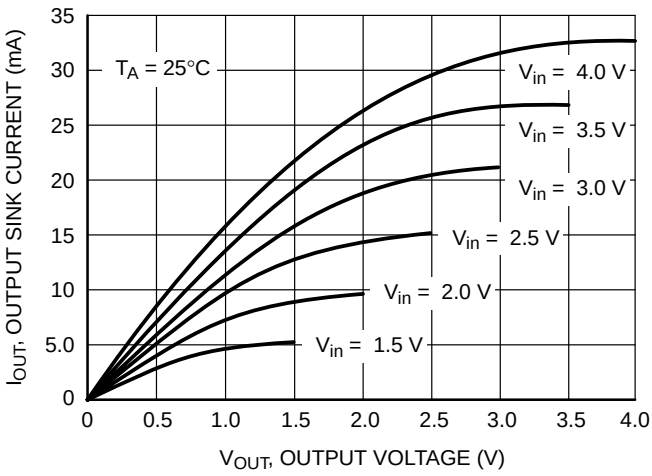


Figure 12. NCP304H/5L Series 4.5 V Reset Output Sink Current vs. Output Voltage

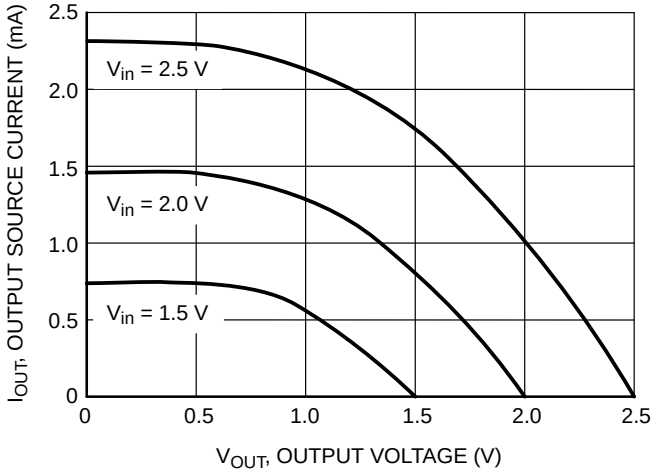


Figure 13. NCP304H Series 2.7 V Reset Output Source Current vs. Output Voltage

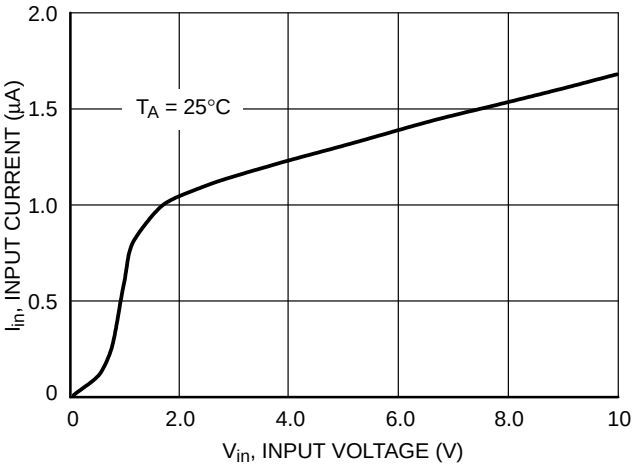


Figure 14. NCP304/5 Series 0.9 V Input Current vs. Input Voltage

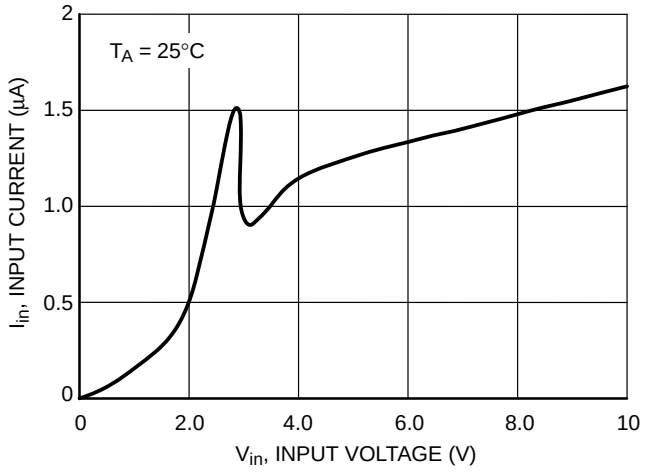


Figure 15. NCP304/5 Series 2.7 V Input Current vs. Input Voltage

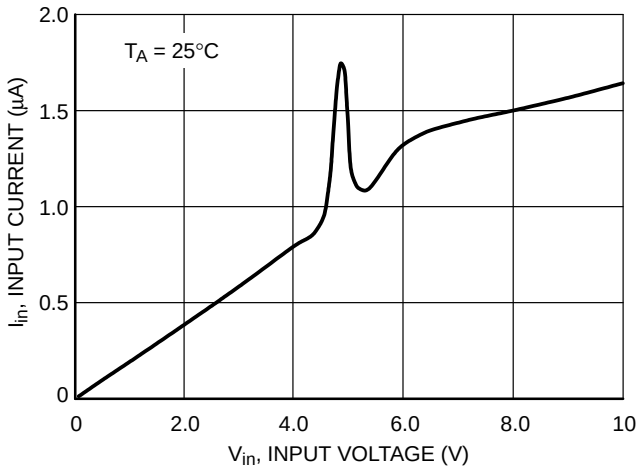


Figure 16. NCP304/5 Series 4.5 V Input Current vs. Input Voltage

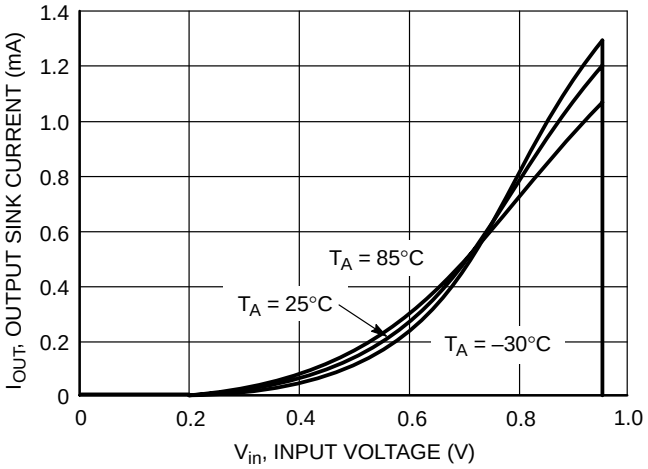


Figure 17. NCP304H/5L Series 0.9 V Reset Output Sink Current vs. Input Voltage

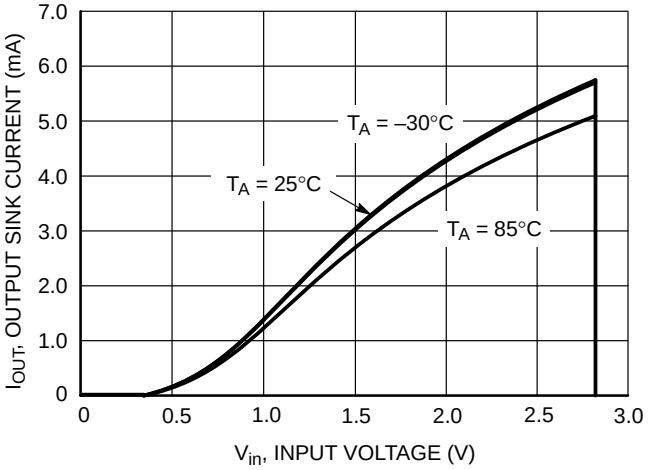


Figure 18. NCP304H/5L Series 2.7 V Reset Output Sink Current vs. Input Voltage

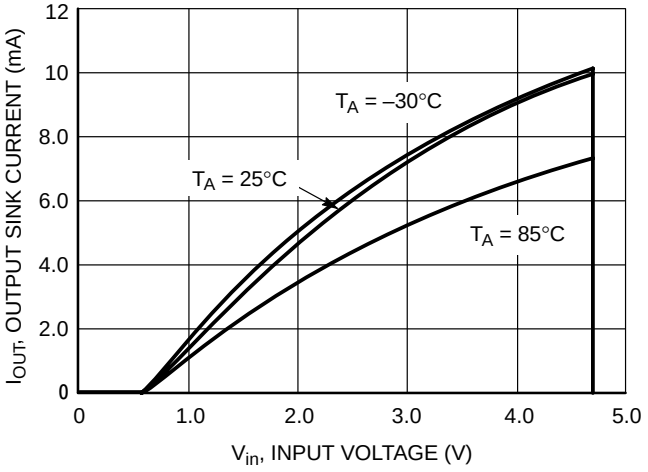


Figure 19. NCP304H/5L Series 4.5 V Reset Output Sink Current vs. Input Voltage

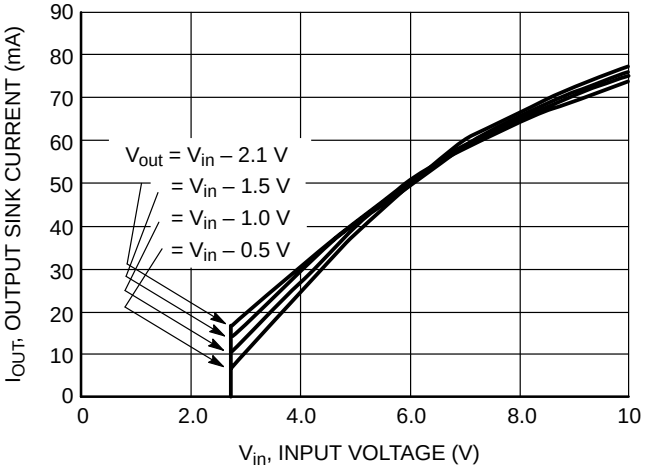


Figure 20. NCP304H/5H Series 2.7 V Reset Output Sink Current vs. Input Voltage

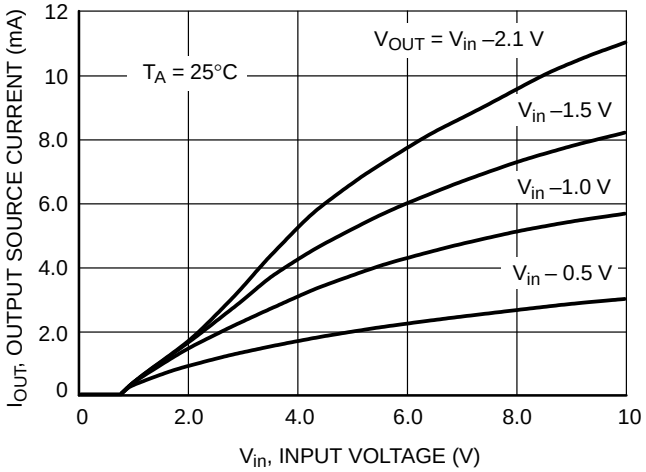


Figure 21. NCP304H Series 0.9 V Reset Output Source Current vs. Input Voltage

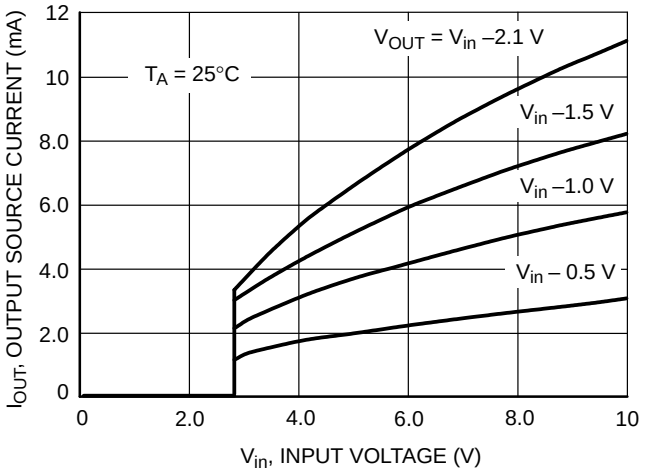


Figure 22. NCP304H Series 2.7 V Reset Output Source Current vs. Input Voltage

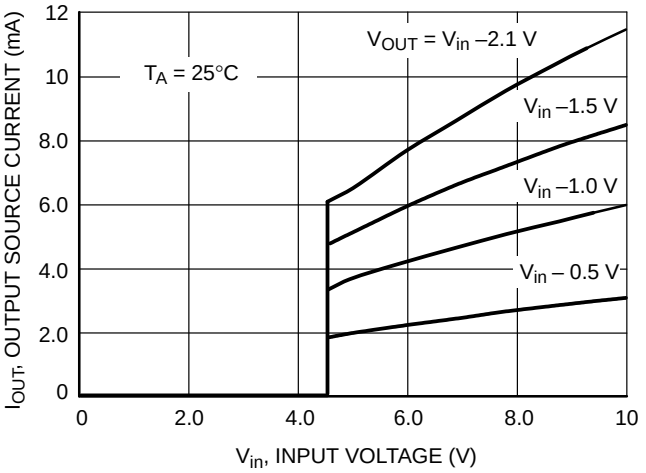


Figure 23. NCP304H Series 4.5 V Reset Output Source Current vs. Input Voltage

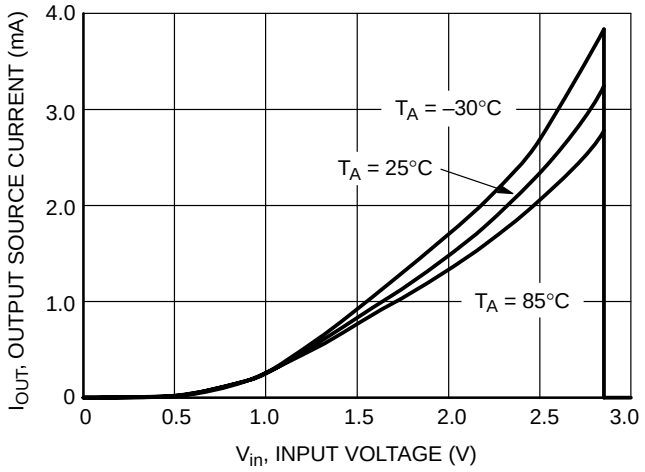


Figure 24. NCP304H Series 2.7 V Reset Output Source Current vs. Input Voltage

OPERATING DESCRIPTION

The NCP304 and NCP305 series devices are second generation ultra–low current voltage detectors. Figures 25 and 26 show a timing diagram and a typical application. Initially consider that input voltage V_{in} is at a nominal level and it is greater than the voltage detector upper threshold (V_{DET+}), and the reset output (Pin 1) will be in the high state for active low devices, or in the low state for active high devices. If there is a power interruption and V_{in} becomes significantly deficient, it will fall below the lower detector threshold ($V_{DET–}$). This sequence of events causes the Reset output to be in the low state for active low devices, or in the high state for active high devices. After completion of the power interruption, V_{in} will again return to its nominal level and become greater than the V_{DET+}. The voltage detector has built–in hysteresis to prevent erratic reset operation as the comparator threshold is crossed.

Although these device series are specifically designed for use as reset controllers in portable microprocessor based systems, they offer a cost–effective solution in numerous applications where precise voltage monitoring is required. Figure 26 through Figure 32 shows various application examples.

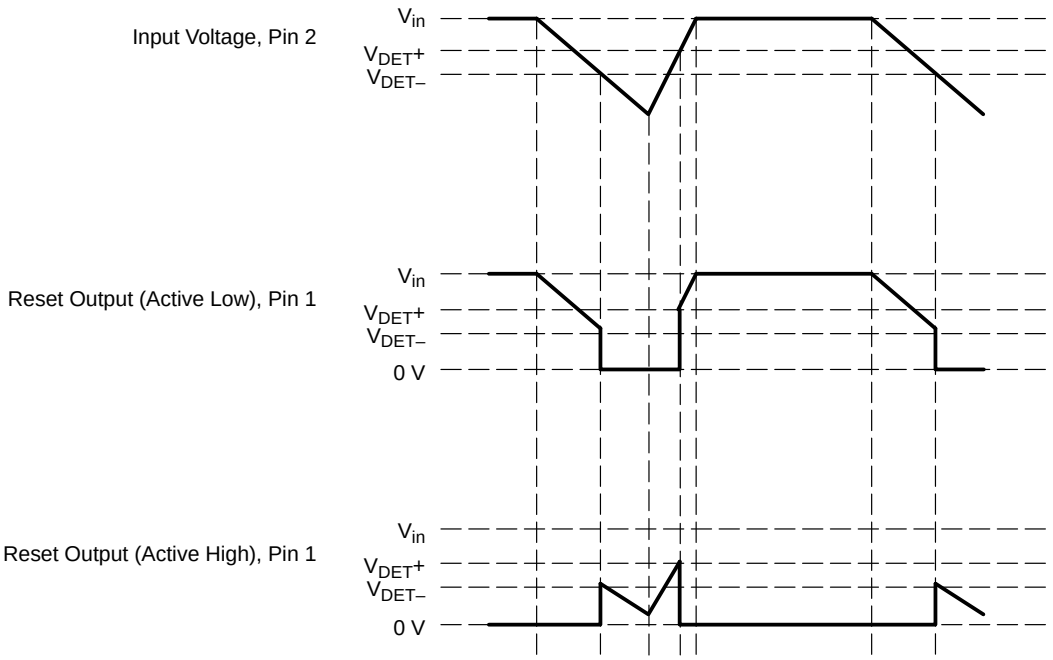


Figure 25. Timing Waveforms

APPLICATION CIRCUIT INFORMATION

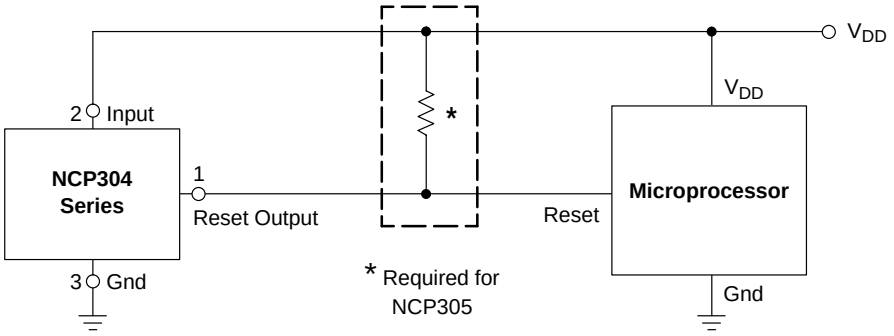


Figure 26. Microprocessor Reset Circuit

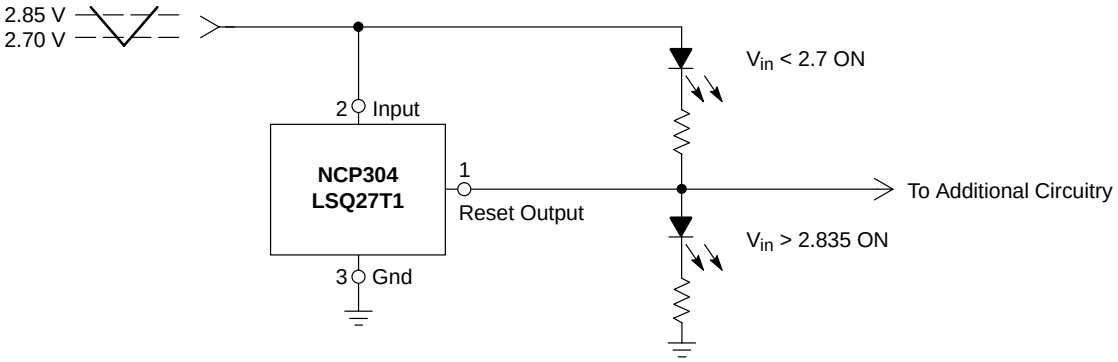


Figure 27. Battery Charge Indicator

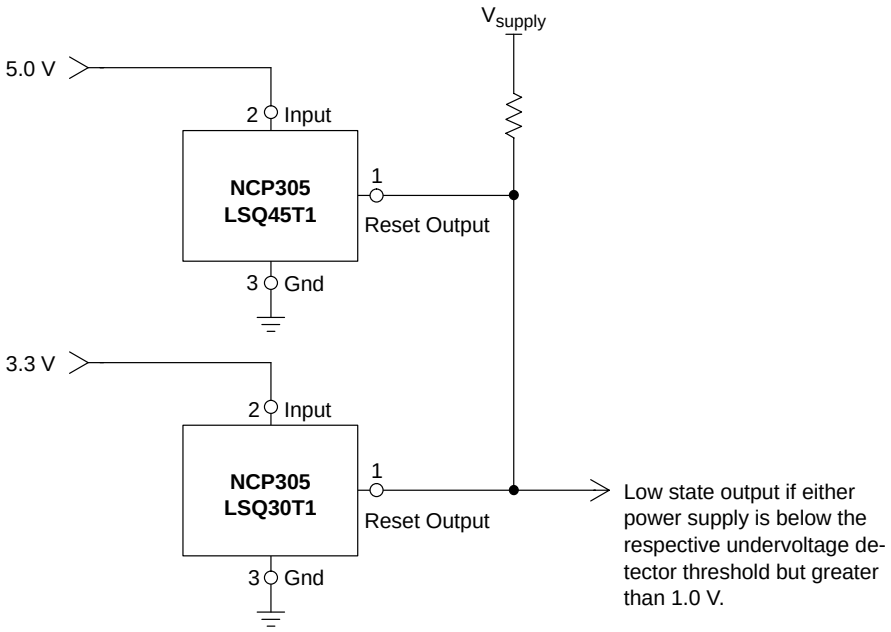


Figure 28. Dual Power Supply Undervoltage Supervision

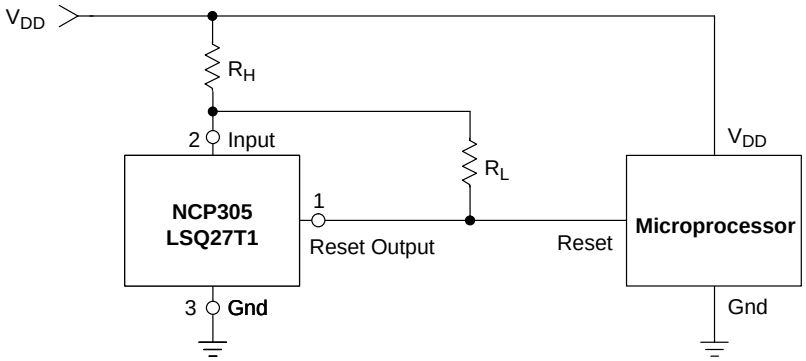


Figure 29. Microprocessor Reset Circuit with Additional Hysteresis

Comparator hysteresis can be increased with the addition of resistor R_H. The hysteresis equations have been simplified and do not account for the change of input current I_{in} as V_{in} crosses the comparator threshold. The internal resistance, R_{in} is simply calculated using I_{in} = 0.26 μA at 2.6 V.

V_{in} Decreasing:

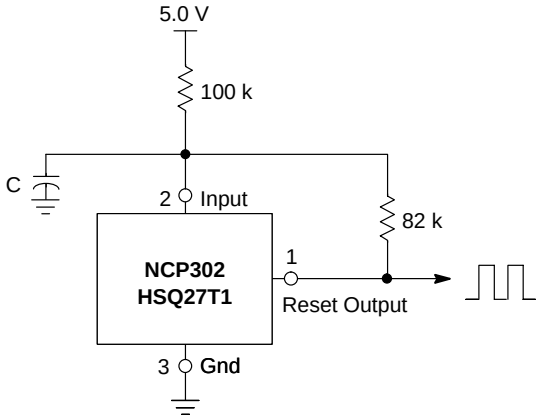
$$V_{th} = \left(\frac{R_H}{R_{in}} + 1\right)(V_{DET-})$$

V_{in} Increasing:

$$V_{th} = \left(\frac{R_H}{R_{in} \parallel R_L} + 1\right)(V_{DET-} + V_{HYS})$$

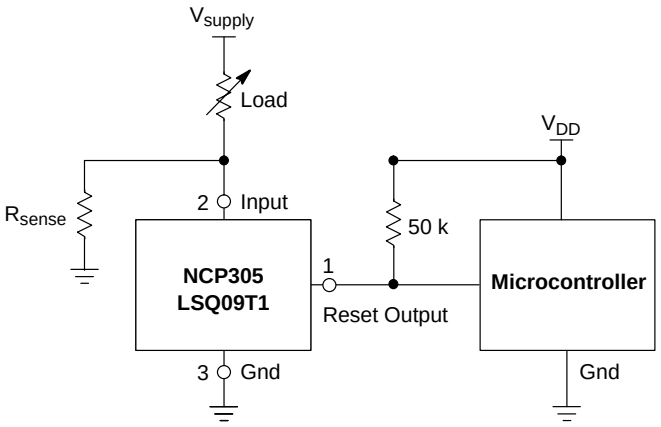
$V_{HYS} = V_{in}$ Increasing – V_{in} Decreasing

Test Data				
V_{th} Decreasing (mV)	**V_{th} Increasing (mV)**	**V_{HYS} (mV)**	**R_H (Ω)**	**R_L (kΩ)**
2.70	2.84	0.135	0	–
2.70	2.87	0.17	100	10
2.70	2.88	0.19	100	6.8
2.70	2.91	0.21	100	4.3
2.70	2.90	0.20	220	10
2.70	2.94	0.24	220	6.8
2.70	2.98	0.28	220	4.3
2.70	2.70	0.27	470	10
2.70	3.04	0.34	470	6.8
2.70	3.15	0.35	470	4.3



Test Data		
C (μF)	**f_{OSC} (kHz)**	**I_Q (μA)**
0.01	2590	21.77
0.1	490	21.97
1.0	52	22.07

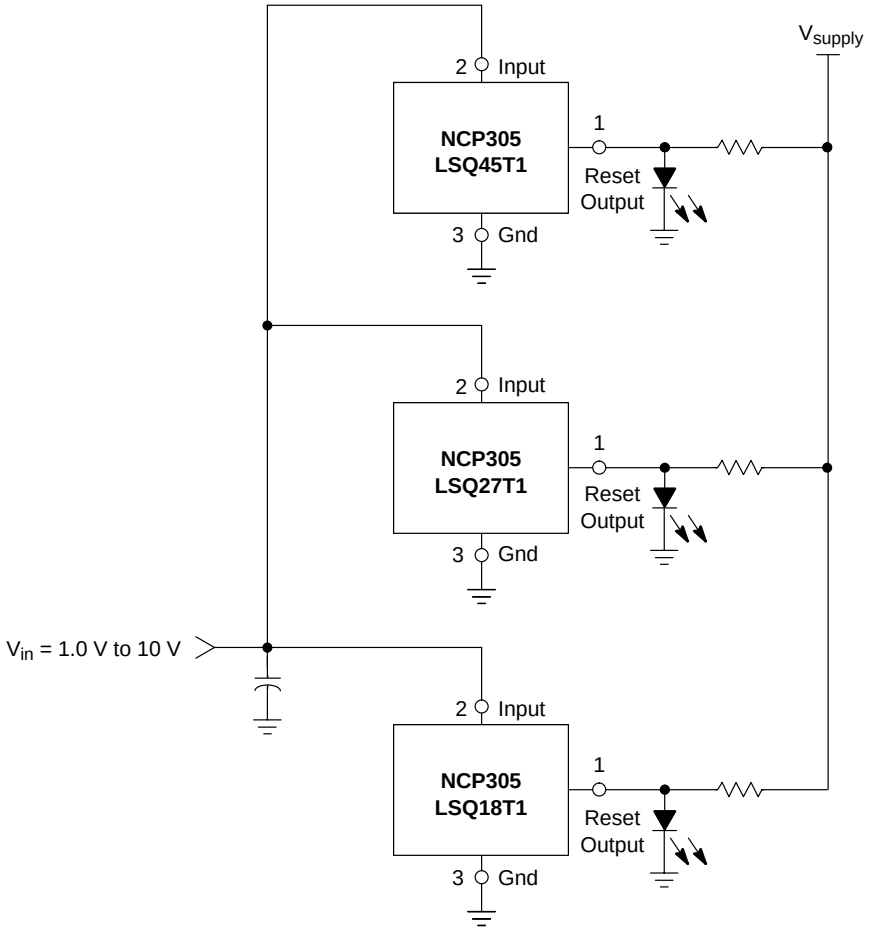
Figure 30. Simple Clock Oscillator



This circuit monitors the current at the load. As current flows through the load, a voltage drop with respect to ground appears across R_{sense} where $V_{sense} = I_{load} * R_{sense}$. The following conditions apply:

If:	Then:
$I_{Load} < V_{DET-}/R_{sense}$	Reset Output = 0 V
$I_{Load} \geq (V_{DET-}+V_{HYS})/R_{sense}$	Reset Output = V_{DD}

Figure 31. Microcontroller Systems Load Sensing



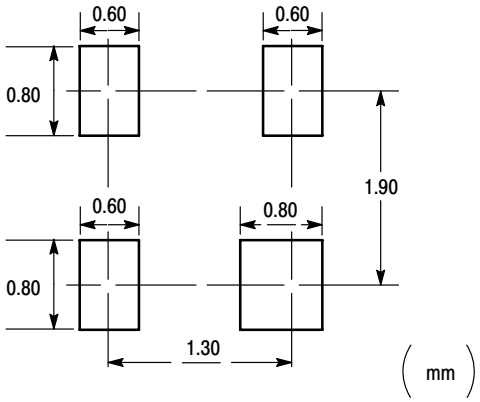
A simple voltage monitor can be constructed by connecting several voltage detectors as shown above. Each LED will sequentially turn on when the respective voltage detector threshold (V_{DET-} +V_{HYS}) is exceeded. Note that detector thresholds (V_{DET-}) that range from 0.9 V to 4.9 V in 100 mV steps can be manufactured.

Figure 32. LED Bar Graph

INFORMATION FOR USING THE SC−82AB SURFACE MOUNT PACKAGE

MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to insure proper solder connection interface between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.



SC−82AB

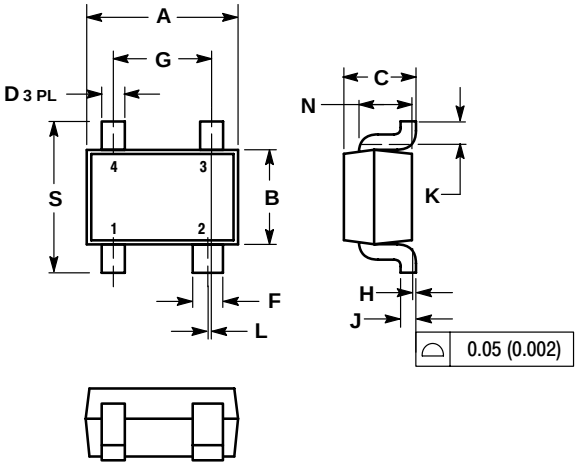
ORDERING INFORMATION

Device	Threshold Voltage	Output Type	Reset	Marking	Package (Qty/Reel)
NCP304LSQ09T1	0.9	CMOS	Active Low	SHG	3000 Units on 7 inch Reel
NCP304LSQ18T1	1.8			SGX	
NCP304LSQ20T1	2.0			SGV	
NCP304LSQ27T1	2.7			SGN	
NCP304LSQ30T1	3.0			SGJ	
NCP304LSQ33T1	3.3			SGG	
NCP304LSQ40T1	4.0			SFY	
NCP304LSQ42T1	4.2			SFU	
NCP304LSQ45T1	4.5			SFS	
NCP304LSQ47T1	4.7			SFQ	
NCP304HSQ09T1	0.9		Active High	SNQ	
NCP304HSQ18T1	1.8			SNZ	
NCP304HSQ20T1	2.0			SOB	
NCP304HSQ27T1	2.7			SOI	
NCP304HSQ29T1	2.9			SOK	
NCP304HSQ30T1	3.0			SOL	
NCP304HSQ45T1	4.5			SPA	
NCP304HSQ47T1	4.7			SPC	
NCP305LSQ09T1	0.9	Open Drain	Active Low	SIZ	3000 Units on 7 inch Reel
NCP305LSQ16T1	1.6			SIR	
NCP305LSQ18T1	1.8			SIP	
NCP305LSQ20T1	2.0			SIN	
NCP305LSQ22T1	2.2			SIK	
NCP305LSQ23T1	2.3			SIJ	
NCP305LSQ24T1	2.4			SII	
NCP305LSQ25T1	2.5			SIH	
NCP305LSQ27T1	2.7			SIF	
NCP305LSQ28T1	2.8			SIE	
NCP305LSQ29T1	2.9			SID	
NCP305LSQ30T1	3.0			SIC	
NCP305LSQ32T1	3.2			SIA	
NCP305LSQ33T1	3.3			SHZ	
NCP305LSQ40T1	4.0			SHR	
NCP305LSQ45T1	4.5			SHL	
NCP305LSQ47T1	4.7			SHJ	
NCP305LSQ49T1	4.9			SHH	

NOTE: The ordering information lists seven standard under voltage thresholds with active low outputs. Additional active low threshold devices, ranging from 0.9 V to 4.9 V in 100 mV increments and NCP304 active high output devices, ranging from 0.9 V to 4.9 V in 100 mV increments can be manufactured. Contact your ON Semiconductor representative for availability. The electrical characteristics of these additional devices are shown in Tables 1 and 2.

PACKAGE DIMENSIONS

(SC−82AB)
SQ SUFFIX
PLASTIC PACKAGE
CASE 419C−01
ISSUE A



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	1.8	2.2	0.071	0.087
B	1.15	1.45	0.045	0.057
C	0.8	1.1	0.031	0.043
D	0.2	0.4	0.008	0.016
F	0.3	0.5	0.012	0.020
G	1.1	1.5	0.043	0.059
H	0.0	0.1	0.000	0.004
J	0.10	0.26	0.004	0.010
K	0.1	---	0.004	---
L	0.05 BSC		0.002 BSC	
N	0.7 REF		0.028 REF	
S	1.8	2.4	0.07	0.09

PUBLICATION ORDERING INFORMATION

Literature Fulfillment:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303–675–2175 or 800–344–3860 Toll Free USA/Canada
Fax: 303–675–2176 or 800–344–3867 Toll Free USA/Canada
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JAPAN: ON Semiconductor, Japan Customer Focus Center
4–32–1 Nishi–Gotanda, Shinagawa–ku, Tokyo, Japan 141–0031
Phone: 81–3–5740–2700
Email: r14525@onsemi.com

ON Semiconductor Website: http://onsemi.com

For additional information, please contact your local Sales Representative.