

DATA SHEET

74LVC169

Presettable synchronous 4-bit up/down
binary counter

specification
Supersedes data of 1996 Aug 23
IC24 Data Handbook

1998 May 20

Pre-settable synchronous 4-bit up/down binary counter

74LVC169

FEATURES

- Wide supply voltage range of 1.2 V to 3.6 V
- In accordance with JEDEC standard no. 8-1A
- Inputs accept voltages up to 5.5 V
- CMOS low power consumption
- Direct interface with TTL levels
- Synchronous counting and loading
- Up/down counting
- Modular 16 binary counter
- Two count enable inputs for n-bit cascading
- Built-in lookahead carry capability
- Pre-settable for programmable operation
- Positive-edge triggered clock

DESCRIPTION

The 74LVC169 is a high-performance, low-power, low-voltage, Si-gate CMOS device and superior to most advanced CMOS compatible TTL families.

The 74LVC169 is a synchronous pre-settable binary counter which features an internal lookahead carry and can be used for high-speed counting. Synchronous operation is provided by having all flip-flops clocked simultaneously on the positive-going edge of the clock (CP). The outputs (Q₀ to Q₃) of the counters may be preset to a HIGH or LOW level. A LOW level at the parallel enable input (PE) disables the counting action and causes the data at the data inputs (D₀ to D₃) to be loaded into the counter on the positive-going edge of the clock (provided that the set-up and hold time requirements for PE are met). Preset takes place regardless of the levels at count enable inputs (CEP and CET). A low level at the master reset input (MR) sets all four outputs of the flip-flops (Q₀ to Q₃) to LOW level after the next positive-going transition on the clock (CP) input (provided that the set-up and hold time requirements for PE are met).

This action occurs regardless of the levels at CP, PE, CET and CEP inputs. This synchronous reset feature enables the designer to modify the maximum count with only one external NAND gate.

The lookahead carry simplifies serial cascading of the counters. Both count enable inputs (CEP and CET) must be HIGH to count. The CET input is fed forward to enable the terminal count output (TC). The TC output thus enabled will produce a HIGH output pulse of a duration approximately equal to a HIGH level output of Q₀. This pulse can be used to enable the next cascaded stage. The maximum clock frequency for the cascaded counters is determined by the CP to TC propagation delay and CEP to CP set-up time, according to the following formula:

$$f_{\max} = \frac{1}{t_{p(\max)}(\text{CP to TC}) + t_{\text{SU}}(\text{CEP to CP})}$$

QUICK REFERENCE DATA

GND = 0V; T_{amb} = 25°C; T_R = T_F ≤ 2.5ns

| SYMBOL | PARAMETER | CONDITIONS | TYPICAL | UNIT |
|------------------------------------|--|--|-------------------|------|
| t _{PHL} /t _{PLH} | Propagation delay CP to Q _n CP to TC CET to TC | C _L = 50 pF V _{CC} = 3.3V | 5.0 6.5 5.3 | ns |
| f _{MAX} | maximum clock frequency | | 200 | MHz |
| C _I | input capacitance | | 5.0 | pF |
| C _{PD} | power dissipation capacitance per gate | notes 1 and 2 | 42 | pF |

NOTES:

1. C_{PD} is used to determine the dynamic power dissipation (P_D in μW)
 $P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum (C_L \times V_{CC}^2 \times f_o)$ where:
 f_i = input frequency in MHz; C_L = output load capacity in pF;
 f_o = output frequency in MHz; V_{CC} = supply voltage in V;
 Σ (C_L × V_{CC}² × f_o) = sum of the outputs
2. The condition is V₁ = GND to V_{CC}

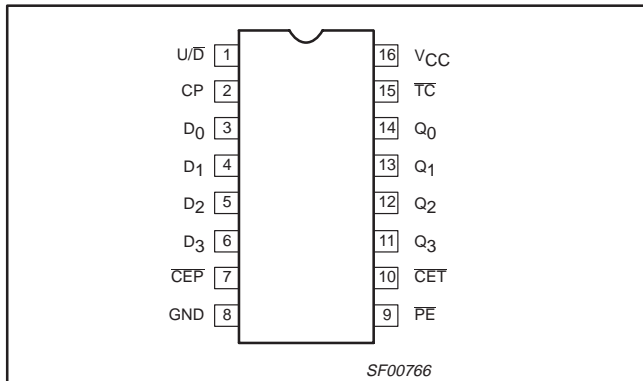
ORDERING INFORMATION

| PACKAGES | TEMPERATURE RANGE | OUTSIDE NORTH AMERICA | NORTH AMERICA | DWG NUMBER |
|-----------------------------|-------------------|-----------------------|---------------|------------|
| 16-Pin Plastic SO | −40°C to +85°C | 74LVC169 D | 74LVC169 D | SOT109-1 |
| 16-Pin Plastic SSOP Type II | −40°C to +85°C | 74LVC169 DB | 74LVC169 DB | SOT338-1 |
| 16-Pin Plastic TSSOP Type I | −40°C to +85°C | 74LVC169 PW | 74LVC169PW DH | SOT403-1 |

Pre-settable synchronous 4-bit up/down binary counter

74LVC169

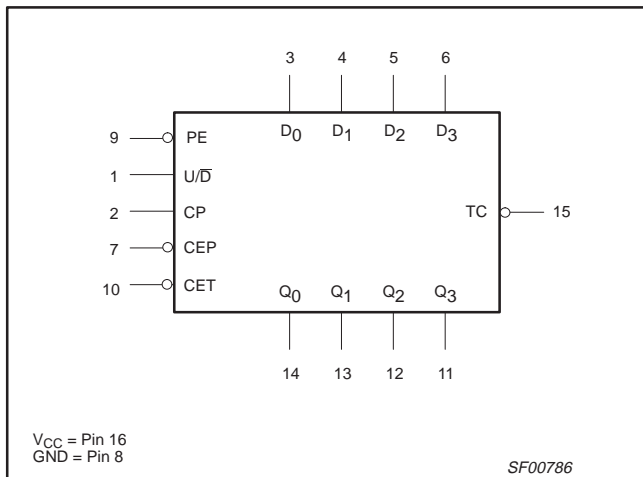
PIN CONFIGURATION



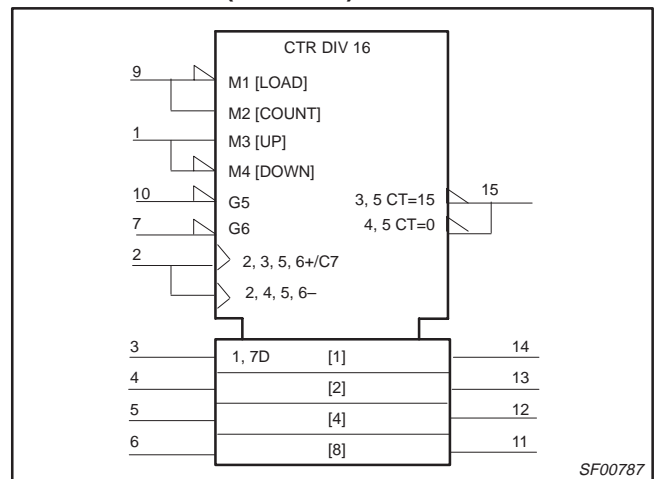
PIN DESCRIPTION

| PIN NUMBER | SYMBOL | FUNCTION |
|-------------|----------------------------------|---|
| 1 | U/D | up/down control input |
| 2 | CP | clock input (LOW-to-HIGH, edge-triggered) |
| 3,4,5,6 | D ₀ to D ₃ | data inputs |
| 7 | CEP | count enable inputs (active LOW) |
| 8 | GND | ground (0V) |
| 9 | PE | parallel enable input (active LOW) |
| 10 | CET | count enable carry input (active LOW) |
| 14,13,12,11 | Q ₀ to Q ₃ | flip-flop outputs |
| 15 | TC | terminal count output (active LOW) |
| 16 | V _{CC} | positive supply voltage |

LOGIC SYMBOL



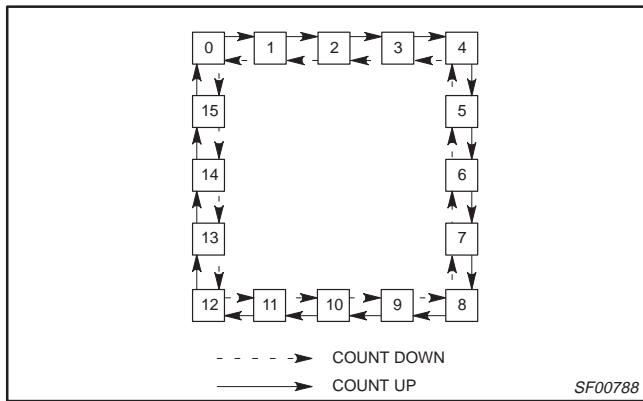
LOGIC SYMBOL (IEEE/IEC)



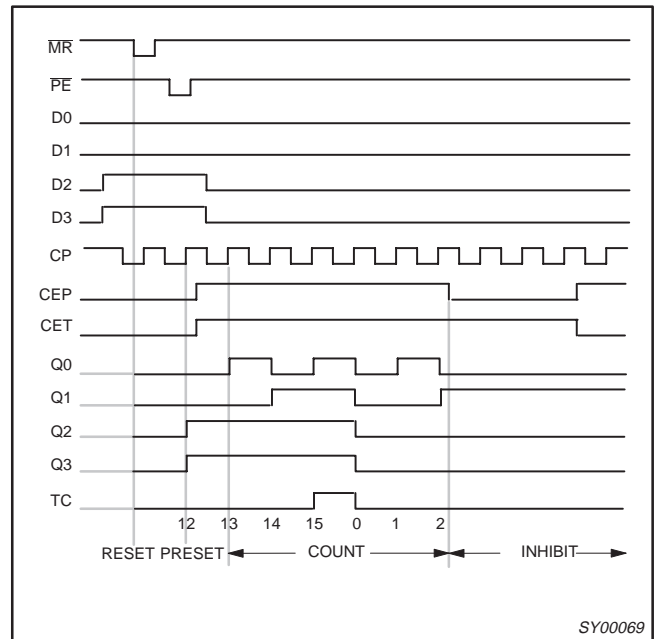
Pre-settable synchronous 4-bit up/down binary counter

74LVC169

STATE DIAGRAM



TYPICAL TIMING SEQUENCE



FUNCTION TABLE

| OPERATING MODES | INPUTS | | | | | | OUTPUTS | | |
|---|--------|-----|-----|-----|----|----------------|----------------|----|--|
| | CP | U/D | CEP | CET | PE | D _n | Q _n | TC | |
| Parallel load (D _n →Q _n) | ↑ | X | X | X | l | l | L | * | |
| | ↑ | X | X | X | X | X | H | * | |
| Count Up (increment) | ↑ | h | l | l | h | X | Count Up | * | |
| Count Down (decrement) | ↑ | l | l | l | h | X | Count Down | * | |
| Hold (do nothing) | ↑ | X | h | X | h | X | q _n | * | |
| | ↑ | X | X | X | h | X | q _n | H | |

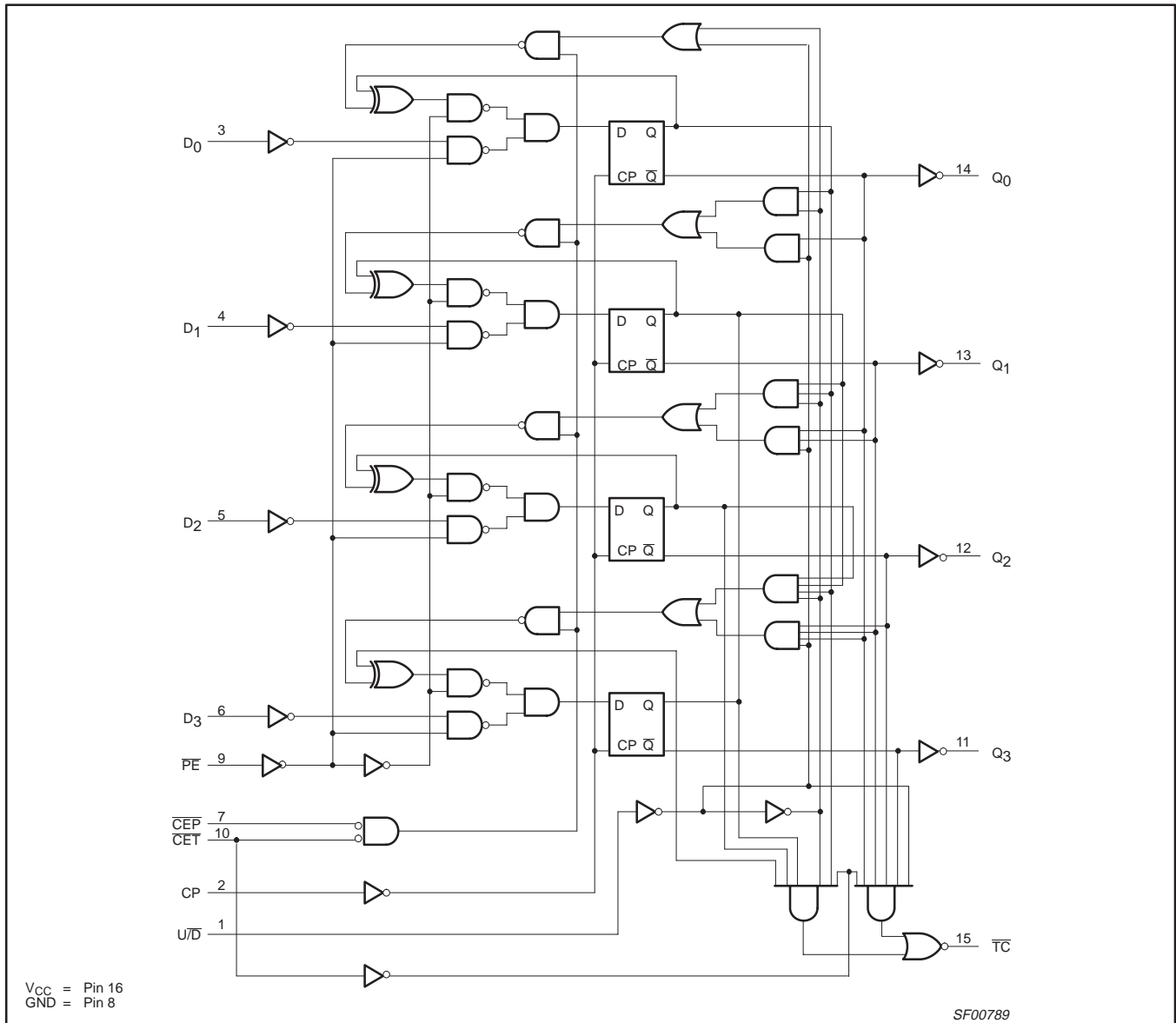
- H = High voltage level steady state
- h = High voltage level one setup time prior to the Low-to-High clock transition
- L = Low voltage level steady state
- l = Low voltage level one setup time prior to the Low-to-High clock transition
- q = Lower case letters indicate the state of the referenced output prior to the Low-to-High clock transition
- X = Don't care
- ↑ = Low-to-High clock transition
- * = The TC is Low when CET is Low and the counter is at Terminal Count.
Terminal Count Up is (HHHH) and Terminal Count Down is (LLLL).

Typical timing sequence: reset outputs to zero; preset to binary twelve; count to thirteen, fourteen, fifteen, zero, one, and two; inhibit

Pre-settable synchronous 4-bit up/down binary counter

74LVC169

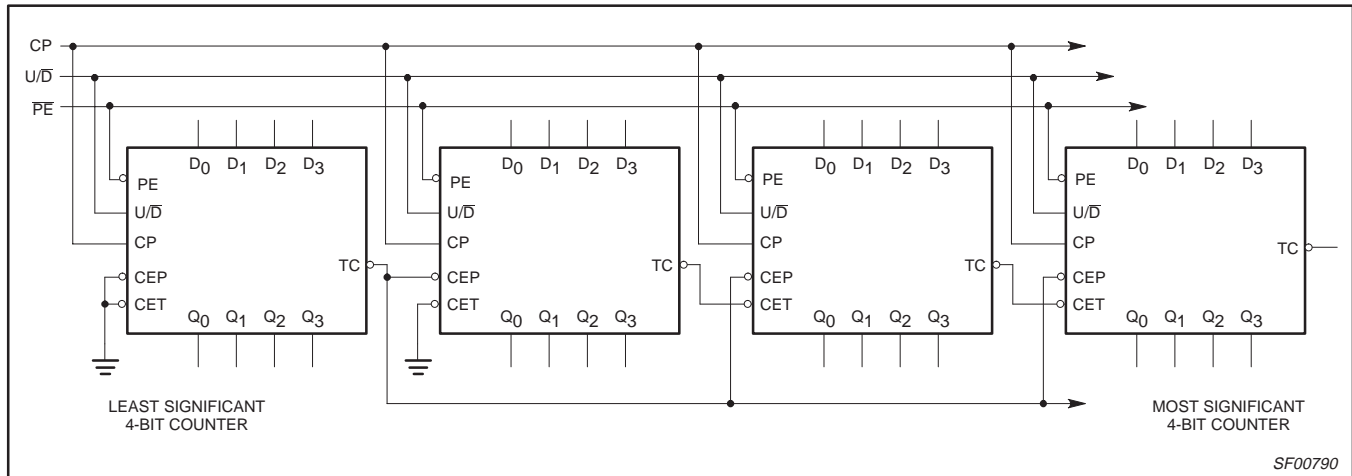
LOGIC DIAGRAM



Pre-settable synchronous 4-bit up/down binary counter

74LVC169

APPLICATION



Synchronous multistage counting scheme

RECOMMENDED OPERATING CONDITIONS

| SYMBOL | PARAMETER | CONDITIONS | LIMITS | | UNIT |
|---------------------------------|--|-------------------------------|--------|-----------------|------|
| | | | MIN | MAX | |
| V _{CC} | DC supply voltage (for max. speed performance) | | 2.7 | 3.6 | V |
| | DC supply voltage (for low-voltage applications) | | 1.2 | 3.6 | |
| V _I | DC input voltage range | | 0 | 5.5 | V |
| V _O | DC output voltage range | | 0 | V _{CC} | V |
| T _{amb} | Operating free-air temperature range | | -40 | +85 | °C |
| t _p , t _f | Input rise and fall times | V _{CC} = 1.2 to 2.7V | 0 | 20 | ns/V |
| | | V _{CC} = 2.7 to 3.6V | 0 | 10 | |

ABSOLUTE MAXIMUM RATINGS¹

In accordance with the Absolute Maximum Rating System (IEC 134)
 Voltages are referenced to GND (ground = 0V)

| SYMBOL | PARAMETER | CONDITIONS | RATING | UNIT |
|------------------------------------|--|--|-------------------------------|------|
| V _{CC} | DC supply voltage | | -0.5 to +6.5 | V |
| I _{IK} | DC input diode current | V _I < 0 | -50 | mA |
| V _I | DC input voltage | Note 2 | -0.5 to +5.5 | V |
| I _{OK} | DC output diode current | V _O > V _{CC} or V _O < 0 | ± 50 | mA |
| V _O | DC output voltage | Note 2 | -0.5 to V _{CC} + 0.5 | V |
| I _O | DC output source or sink current | V _O = 0 to V _{CC} | ± 50 | mA |
| I _{GND} , I _{CC} | DC V _{CC} or GND current | | ± 100 | mA |
| T _{stg} | Storage temperature range | | -65 to +150 | °C |
| P _{TOT} | Power dissipation per package – plastic mini-pack (SO) – plastic shrink mini-pack (SSOP and TSSOP) | above +70°C derate linearly with 8 mW/K | 500 | mW |
| | | above +60°C derate linearly with 5.5 mW/K | 500 | |

NOTES:

- Stresses beyond those listed 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 under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

Pre-settable synchronous 4-bit up/down binary counter

74LVC169

DC ELECTRICAL CHARACTERISTICS

Over recommended operating conditions voltages are referenced to GND (ground = 0V)

| SYMBOL | PARAMETER | TEST CONDITIONS | LIMITS | | | UNIT |
|------------------|---|---|-----------------------|------------------|------|------|
| | | | Temp = -40°C to +85°C | | | |
| | | | MIN | TYP ¹ | MAX | |
| V _{IH} | HIGH level Input voltage | V _{CC} = 1.2V | V _{CC} | | | V |
| | | V _{CC} = 2.7 to 3.6V | 2.0 | | | |
| V _{IL} | LOW level Input voltage | V _{CC} = 1.2V | | | GND | V |
| | | V _{CC} = 2.7 to 3.6V | | | 0.8 | |
| V _{OH} | HIGH level output voltage | V _{CC} = 2.7V; V _I = V _{IH} or V _{IL} ; I _O = -12mA | V _{CC} - 0.5 | | | V |
| | | V _{CC} = 3.0V; V _I = V _{IH} or V _{IL} ; I _O = -100µA | V _{CC} - 0.2 | V _{CC} | | |
| | | V _{CC} = 3.0V; V _I = V _{IH} or V _{IL} ; I _O = -12mA | V _{CC} - 0.6 | | | |
| | | V _{CC} = 3.0V; V _I = V _{IH} or V _{IL} ; I _O = -24mA | V _{CC} - 1.0 | | | |
| V _{OL} | LOW level output voltage | V _{CC} = 2.7V; V _I = V _{IH} or V _{IL} ; I _O = 12mA | | | 0.40 | V |
| | | V _{CC} = 3.0V; V _I = V _{IH} or V _{IL} ; I _O = 100µA | | GND | 0.20 | |
| | | V _{CC} = 3.0V; V _I = V _{IH} or V _{IL} ; I _O = 24mA | | | 0.55 | |
| I _I | Input leakage current | V _{CC} = 3.6V; V _I = 5.5V or GND | | ±0.1 | ±5 | µA |
| I _{CC} | Quiescent supply current | V _{CC} = 3.6V; V _I = V _{CC} or GND; I _O = 0 | | 0.1 | 10 | µA |
| ΔI _{CC} | Additional quiescent supply current per input pin | V _{CC} = 2.7V to 3.6V; V _I = V _{CC} - 0.6V; I _O = 0 | | 5 | 500 | µA |

NOTES:

- All typical values are at V_{CC} = 3.3V and T_{amb} = 25°C.

Pre-settable synchronous 4-bit up/down binary counter

74LVC169

AC CHARACTERISTICS

GND = 0 V; $t_r = t_f \leq 2.5$ ns; $C_L = 50$ pF; $R_L = 500\Omega$; $T_{amb} = -40^\circ\text{C}$ to $+85^\circ\text{C}$

| SYMBOL | PARAMETER | WAVEFORM | LIMITS | | | | | | UNIT |
|-------------------|--|----------|--------------------------|------------------|------|-----------------|------|-----------------|------|
| | | | $V_{CC} = 3.3V \pm 0.3V$ | | | $V_{CC} = 2.7V$ | | $V_{CC} = 1.2V$ | |
| | | | MIN. | TYP ¹ | MAX. | MIN. | MAX. | TYP | |
| t_{PHL}/t_{PLH} | propagation delay CP to Q_n | 1 | - | 5.0 | 8.5 | - | 9.5 | 24 | ns |
| t_{PHL}/t_{PLH} | propagation delay CP to \overline{TC} | 1 | - | 6.5 | 10.8 | - | 12.8 | 30 | ns |
| t_{PHL}/t_{PLH} | propagation delay \overline{CEP} to \overline{TC} | 2 | - | 5.3 | 8.7 | - | 9.7 | 19 | ns |
| t_{PHL}/t_{PLH} | propagation delay U/\overline{D} to \overline{TC} | 4 | - | 5.7 | 9.5 | - | 10.5 | 24 | ns |
| t_W | clock pulse width HIGH or LOW | 1 | 4.0 | 1.2 | - | 5.0 | - | - | ns |
| t_{su} | set-up time D_n to CP | 3 | 2.5 | 1.0 | - | 3.0 | - | - | ns |
| t_{su} | set-up time \overline{PE} to CP | 3 | 3.0 | 1.2 | - | 3.5 | - | - | ns |
| t_{su} | set-up time U/\overline{D} to CP | 5 | 5.5 | 2.8 | - | 6.5 | - | - | ns |
| t_{su} | set-up time \overline{CEP} , \overline{CET} to CP | 5 | 4.5 | 2.1 | - | 5.5 | - | - | ns |
| t_h | hold time D_n , \overline{PE} , \overline{CEP} , \overline{CET} , U/\overline{D} to CP | 3 and 5 | 0 | -2.5 | - | 0 | - | - | ns |
| f_{max} | maximum clock pulse frequency | 1 | 125 | 200 | - | 110 | - | - | MHz |

NOTE:

1. These typical values are measured at $V_{CC} = 3.3V$ and $T_{amb} = 25^\circ\text{C}$.

Pre-settable synchronous 4-bit up/down binary counter

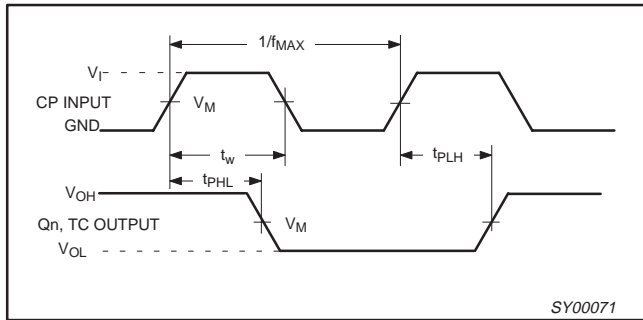
74LVC169

AC WAVEFORMS

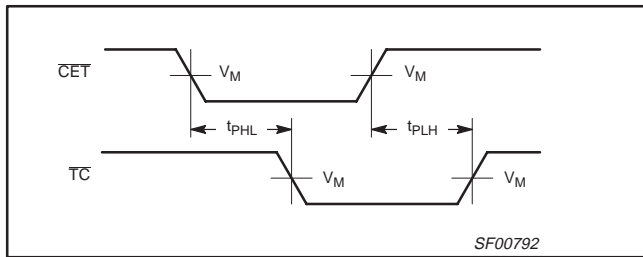
$V_M = 1.5\text{ V}$ at $V_{CC} \geq 2.7\text{ V}$

$V_M = 0.5 \cdot V_{CC}$ at $V_{CC} < 2.7\text{ V}$

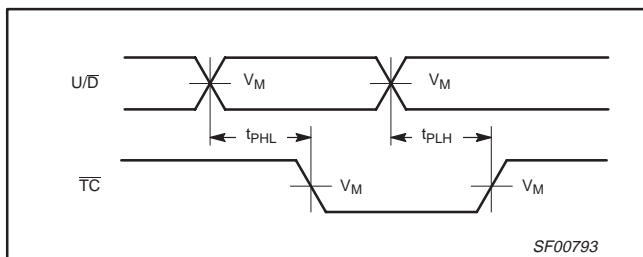
V_{OL} and V_{OH} are the typical output voltage drop that occur with the output load.



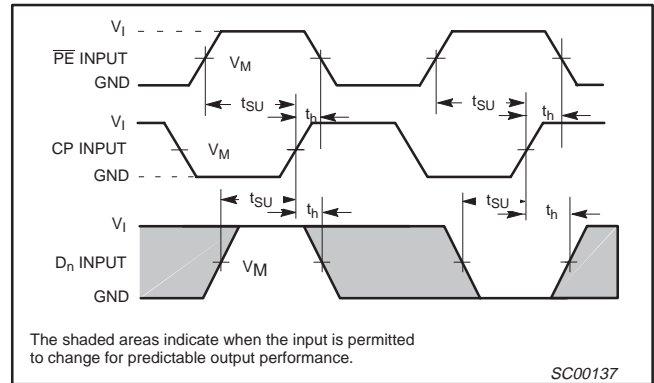
Waveform 1. Clock (CP) to outputs (Q_n , TC) propagation delays, the clock pulse width and the maximum clock frequency.



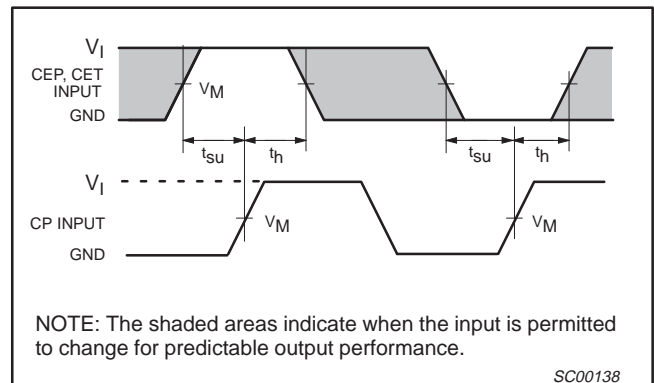
Waveform 2. Input (CET) to output (TC) propagation delays and output transition times.



Waveform 3. Master reset (\overline{MR}) pulse width, the master reset to output (Q_n , TC) propagation delays and the master reset to clock (CP) removal times.

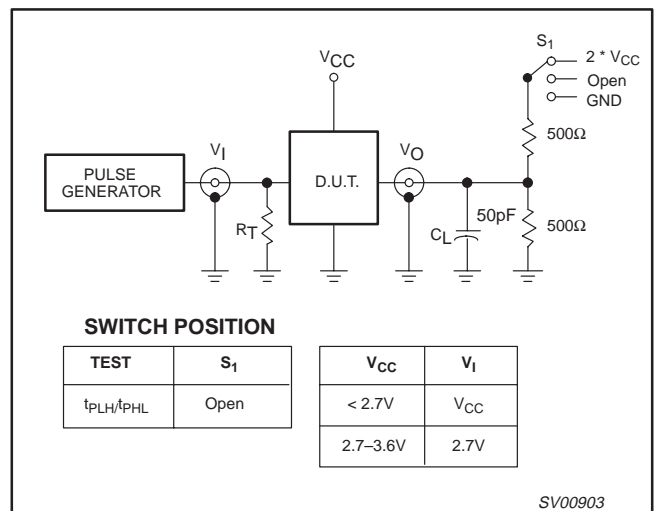


Waveform 4. Setup and hold times for the input (D_n) and parallel enable input (PE).



Waveform 5. CEP and CET setup and hold times.

TEST CIRCUIT



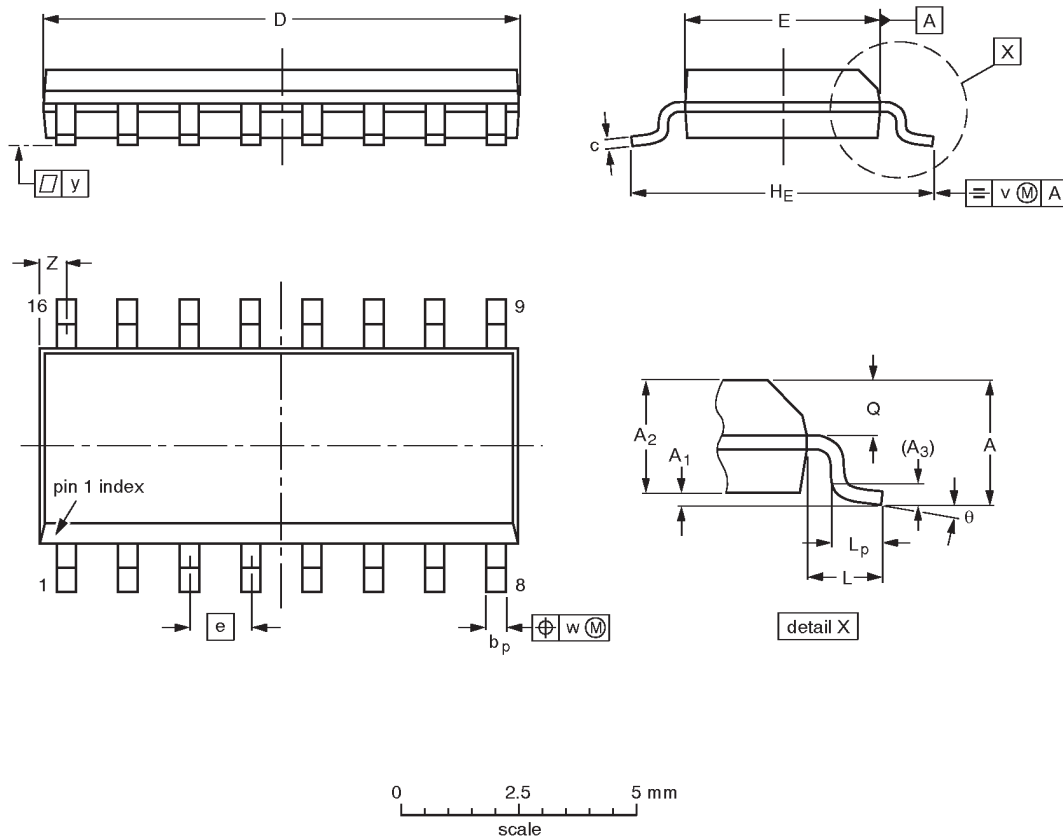
Waveform 6. Load circuitry for switching times.

Presettable synchronous 4-bit up/down binary counter

74LVC169

SO16: plastic small outline package; 16 leads; body width 3.9 mm

SOT109-1



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

| UNIT | A max. | A ₁ | A ₂ | A ₃ | b _p | c | D ⁽¹⁾ | E ⁽¹⁾ | e | H _E | L | L _p | Q | v | w | y | z ⁽¹⁾ | θ |
|--------|--------|------------------|----------------|----------------|----------------|------------------|------------------|------------------|-------|----------------|-------|----------------|----------------|------|------|-------|------------------|----------|
| mm | 1.75 | 0.25 0.10 | 1.45 1.25 | 0.25 | 0.49 0.36 | 0.25 0.19 | 10.0 9.8 | 4.0 3.8 | 1.27 | 6.2 5.8 | 1.05 | 1.0 0.4 | 0.7 0.6 | 0.25 | 0.25 | 0.1 | 0.7 0.3 | 8° 0° |
| inches | 0.069 | 0.0098 0.0039 | 0.057 0.049 | 0.01 | 0.019 0.014 | 0.0098 0.0075 | 0.39 0.38 | 0.16 0.15 | 0.050 | 0.24 0.23 | 0.041 | 0.039 0.016 | 0.028 0.020 | 0.01 | 0.01 | 0.004 | 0.028 0.012 | |

Note

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

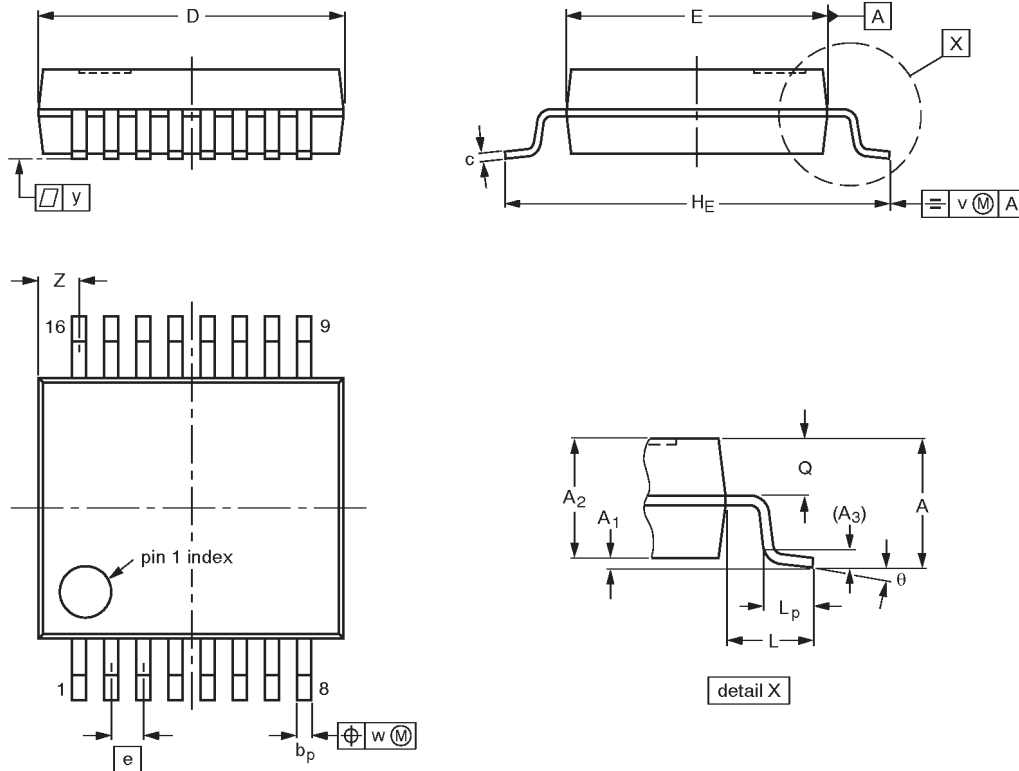
| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|------------|----------|------|--|---------------------|----------------------|
| | IEC | JEDEC | EIAJ | | | |
| SOT109-1 | 076E07S | MS-012AC | | | | 91-08-13 95-01-23 |

Presettable synchronous 4-bit up/down binary counter

74LVC169

SSOP16: plastic shrink small outline package; 16 leads; body width 5.3 mm

SOT338-1



DIMENSIONS (mm are the original dimensions)

| UNIT | A max. | A ₁ | A ₂ | A ₃ | b _p | c | D ⁽¹⁾ | E ⁽¹⁾ | e | H _E | L | L _p | Q | v | w | y | Z ⁽¹⁾ | θ |
|------|--------|----------------|----------------|----------------|----------------|--------------|------------------|------------------|------|----------------|------|----------------|------------|-----|------|-----|------------------|----------|
| mm | 2.0 | 0.21 0.05 | 1.80 1.65 | 0.25 | 0.38 0.25 | 0.20 0.09 | 6.4 6.0 | 5.4 5.2 | 0.65 | 7.9 7.6 | 1.25 | 1.03 0.63 | 0.9 0.7 | 0.2 | 0.13 | 0.1 | 1.00 0.55 | 8° 0° |

Note

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

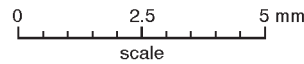
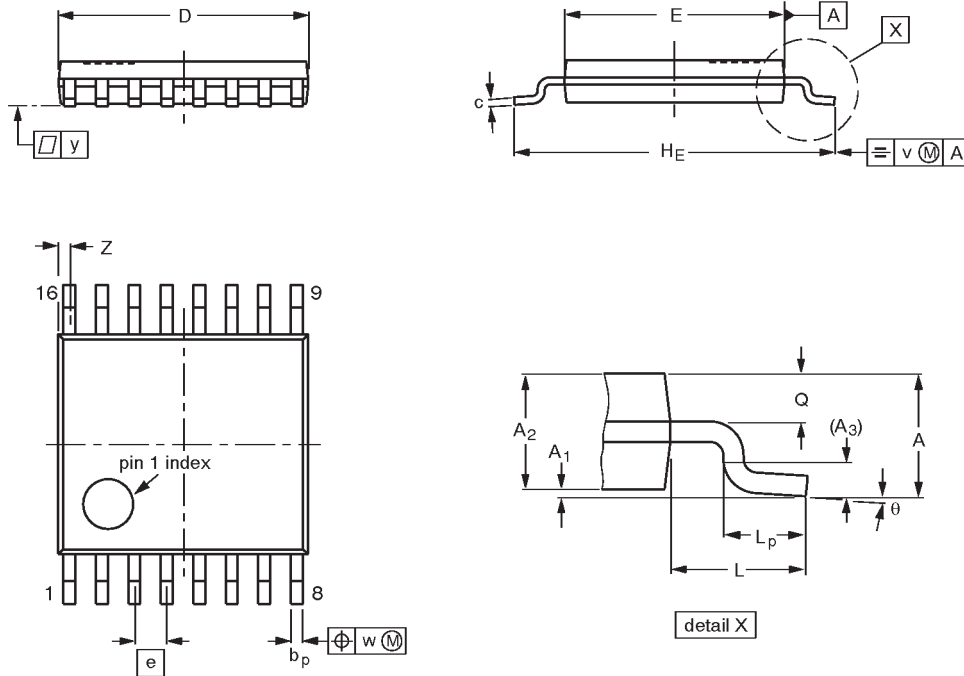
| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|------------|----------|------|--|---------------------|-----------------------|
| | IEC | JEDEC | EIAJ | | | |
| SOT338-1 | | MO-150AC | | | | 94-01-14- 95-02-04 |

Pre-settable synchronous 4-bit up/down binary counter

74LVC169

TSSOP16: plastic thin shrink small outline package; 16 leads; body width 4.4 mm

SOT403-1



DIMENSIONS (mm are the original dimensions)

| UNIT | A max. | A ₁ | A ₂ | A ₃ | b _p | c | D ⁽¹⁾ | E ⁽²⁾ | e | H _E | L | L _p | Q | v | w | y | Z ⁽¹⁾ | θ |
|------|--------|----------------|----------------|----------------|----------------|------------|------------------|------------------|------|----------------|-----|----------------|------------|-----|------|-----|------------------|----------|
| mm | 1.10 | 0.15 0.05 | 0.95 0.80 | 0.25 | 0.30 0.19 | 0.2 0.1 | 5.1 4.9 | 4.5 4.3 | 0.65 | 6.6 6.2 | 1.0 | 0.75 0.50 | 0.4 0.3 | 0.2 | 0.13 | 0.1 | 0.40 0.06 | 8° 0° |

Notes

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|------------|--------|------|--|---------------------|----------------------|
| | IEC | JEDEC | EIAJ | | | |
| SOT403-1 | | MO-153 | | | | 94-07-12 95-04-04 |

**Presettable synchronous 4-bit up/down
binary counter**

74LVC169

NOTES

Presetable synchronous 4-bit up/down binary counter

74LVC169

DEFINITIONS

| Data Sheet Identification | Product Status | Definition |
|----------------------------------|-------------------------------|--|
| <i>Objective Specification</i> | Formative or in Design | This data sheet contains the design target or goal specifications for product development. Specifications may change in any manner without notice. |
| <i>Preliminary Specification</i> | Preproduction Product | This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product. |
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