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| Document No. | 853-1508 |
| ECN No. | 00730 |
| Date of Issue | October 17, 1990 |
| Status | Product Specification |
| ACL Products | |

74AC/ACT11160

Synchronous presettable synchronous BCD decade counter, asynchronous reset

FEATURES

- Synchronous counting and loading
- Two count enable inputs for n-bit cascading
- Positive edge-triggered clock
- Asynchronous reset
- Output capability: $\pm 24\text{mA}$
- CMOS (AC) and TTL (ACT) voltage level inputs
- 50 Ω incident wave switching
- Center-pin V_{CC} and ground configuration to minimize high-speed switching noise
- I_{CC} category: MSI

DESCRIPTION

The 74AC/ACT11160 high-performance CMOS devices combine very high speed and high output drive comparable to the most advanced TTL families.

The 74AC/ACT11160 4-bit synchronous presettable decade counters feature an internal carry look-ahead 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.

QUICK REFERENCE DATA

| SYMBOL | PARAMETER | CONDITIONS $T_{amb} = 25^\circ\text{C}; \text{GND} = 0\text{V};$ $V_{CC} = 5.0\text{V}$ | TYPICAL | | UNIT |
|-------------------|--|---|---------|-----|------|
| | | | AC | ACT | |
| t_{PLH}/t_{PHL} | Propagation delay CP_n to Q_n ($\overline{PE} = \text{High}$) | $C_L = 50\text{pF}$ | 6.9 | 6.4 | ns |
| C_{PD} | Power dissipation capacitance ¹ | $f = 1\text{MHz}; C_L = 50\text{pF}$ | 48 | 60 | pF |
| C_{IN} | Input capacitance | $V_I = 0\text{V}$ or V_{CC} | 4.0 | 4.0 | pF |
| I_{LATCH} | Latch-up current | Per JEDEC JC40.2 Standard 17 | 500 | 500 | mA |
| f_{MAX} | Maximum clock frequency | $C_L = 50\text{pF}$ | 140 | 125 | MHz |

Note:

1. C_{PD} is used to determine the dynamic power dissipation (P_D in μW):

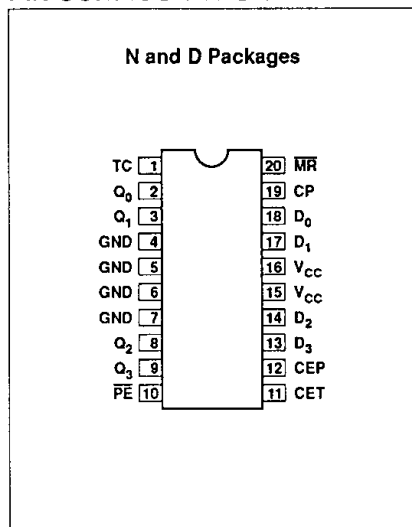
$$P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum (C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

f_i = input frequency in MHz, C_L = output load capacitance in pF,
 f_o = output frequency in MHz, V_{CC} = supply voltage in V,
 $\sum (C_L \times V_{CC}^2 \times f_o)$ = sum of outputs

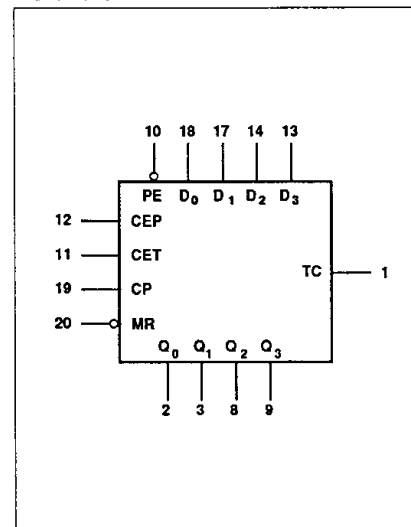
ORDERING INFORMATION

| PACKAGES | TEMPERATURE RANGE | ORDER CODE |
|-------------------------------------|-------------------|---------------------------|
| 20-pin plastic DIP (300mil-wide) | -40°C to +85°C | 74AC11160N 74ACT11160N |
| 20-pin plastic SOL (300mil-wide) | -40°C to +85°C | 74AC11160D 74ACT11160D |

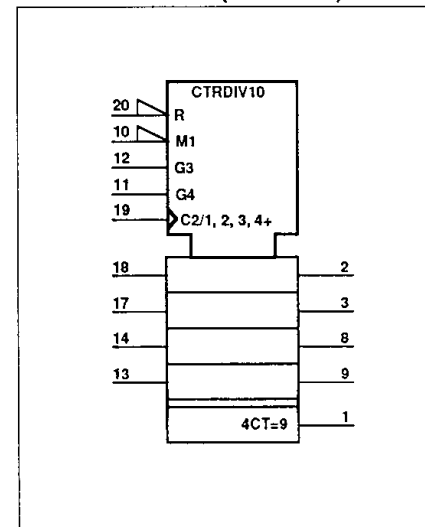
PIN CONFIGURATION



LOGIC SYMBOL



LOGIC SYMBOL (IEEE/IEC)



Synchronous presettable synchronous BCD decade counter, asynchronous reset

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The outputs of the counters may be preset to High or Low levels. A Low level at the Parallel Enable (\overline{PE}) input disables the counting action and causes the data at the $D_0 - D_3$ inputs to be loaded into the counter on the rising edge of the clock. Preset takes place regardless of the levels at Count Enable (CEP, CET) inputs.

A Low level at the Master Reset (\overline{MR}) input sets all four outputs of the flip-flops ($Q_0 - Q_3$) to Low levels, regardless of the levels at CP, \overline{PE} , CET, and CEP inputs (thus providing an asynchronous clear function).

The carry look-ahead 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 (TC) output. The TC output thus enabled will produce a High output pulse of a duration approximately equal to the High level output of Q_0 . This pulse can be used to enable the next cascaded stage.

PIN DESCRIPTION

| PIN NUMBER | SYMBOL | NAME AND FUNCTION |
|----------------|-----------------|---|
| 20 | \overline{MR} | Asynchronous master reset (active Low) |
| 19 | CP | Clock input (Low-to-High, edge-triggered) |
| 18, 17, 14, 13 | $D_0 - D_3$ | Data inputs |
| 12 | CEP | Count enable input |
| 10 | \overline{PE} | Parallel enable input (active Low) |
| 11 | CET | Count enable carry input |
| 18, 17, 14, 13 | $Q_0 - Q_3$ | Counter outputs |
| 1 | TC | Terminal count output |
| 4, 5, 6, 7 | GND | Ground (0V) |
| 15, 16 | V_{CC} | Positive supply voltage |

FUNCTION TABLE

| OPERATING MODE | INPUTS | | | | | | OUTPUTS | |
|-------------------|-----------------|----|-----|-----|-----------------|-------|---------|-----|
| | \overline{MR} | CP | CEP | CET | \overline{PE} | D_n | Q_n | TC |
| Reset (clear) | L | X | X | X | X | X | L | L |
| Parallel load | H | ↑ | X | X | l | l | L | L |
| | H | ↑ | X | X | l | h | H | (1) |
| Count | H | ↑ | h | h | h | X | count | (1) |
| Hold (do nothing) | H | X | l | X | h | X | q_n | (1) |
| | H | X | X | l | h | X | q_n | L |

H = High voltage level

L = Low voltage level

h = High voltage level one setup time prior to the Low-to-High clock transition

l = Low voltage level one setup time prior to the Low-to-High clock transition

X = Don't care

q = State of the referenced output prior to the Low-to-High clock transition

↑ = Low-to-High clock transition

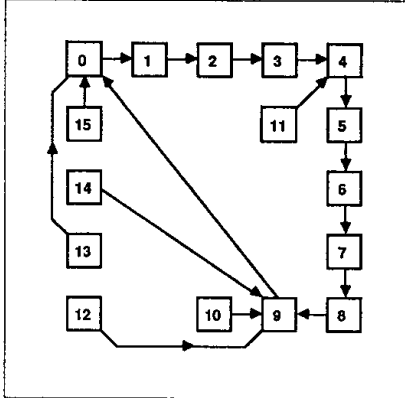
NOTE:

- The TC output is High when CET is High and the counter is at Terminal Count (HLLH).

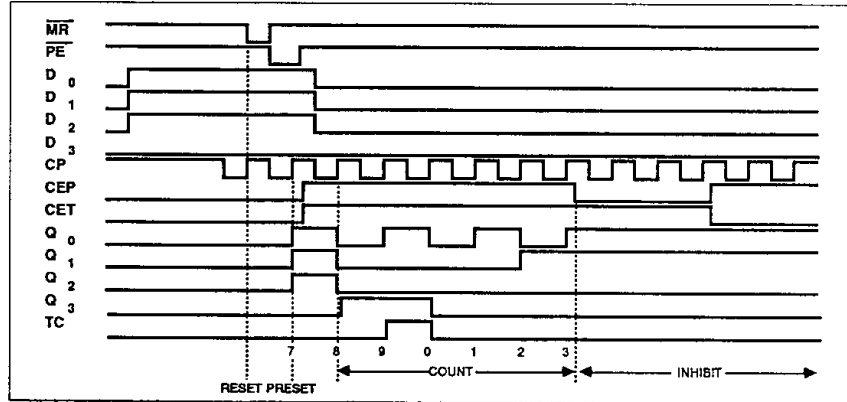
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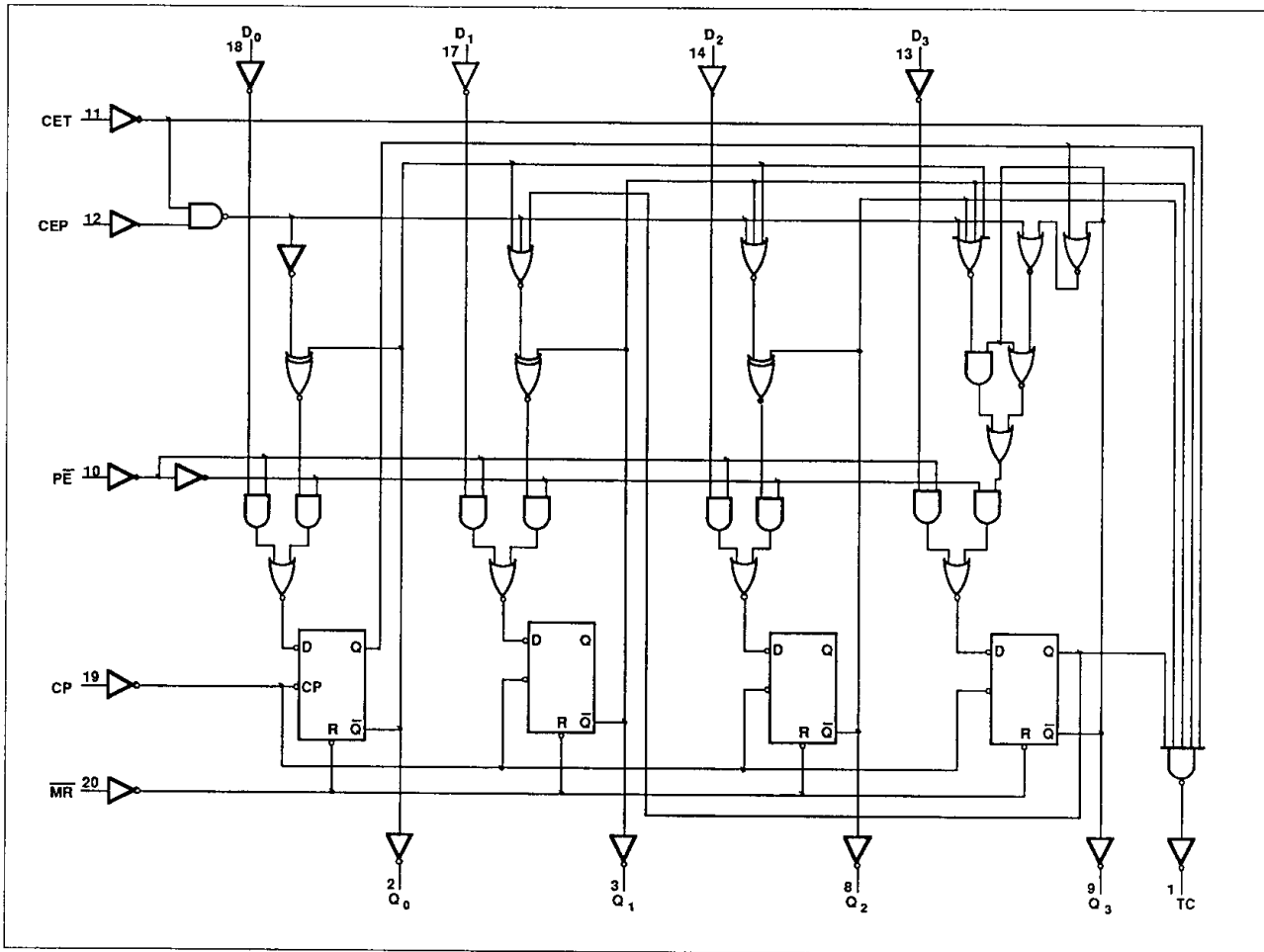
STATE DIAGRAM



TIMING DIAGRAM



LOGIC DIAGRAM



Synchronous presettable synchronous BCD decade counter, asynchronous reset

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RECOMMENDED OPERATING CONDITIONS

| SYMBOL | PARAMETER | AC11160 | | | ACT11160 | | | UNIT |
|---------------------|--------------------------------------|------------------|-----|----------|----------|-----|----------|------|
| | | Min | Nom | Max | Min | Nom | Max | |
| V_{CC} | DC supply voltage | 3.0 ¹ | 5.0 | 5.5 | 4.5 | 5.0 | 5.5 | V |
| V_I | Input voltage | 0 | | V_{CC} | 0 | | V_{CC} | V |
| V_O | Output voltage | 0 | | V_{CC} | 0 | | V_{CC} | V |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | 0 | | 10 | 0 | | 10 | ns/V |
| T_{amb} | Operating free-air temperature range | -40 | | +85 | -40 | | +85 | °C |

NOTE:

- No electrical or switching characteristics are specified at $V_{CC} < 3V$. Operation between 2V and 3V is not recommended, but within that range, a device output will maintain a previously established logic state.

ABSOLUTE MAXIMUM RATINGS¹

| SYMBOL | PARAMETER | TEST CONDITIONS | RATING | UNIT |
|-----------------------------|---|--------------------------------------|------------------------|------|
| V_{CC} | DC supply voltage | | -0.5 TO +7.0 | V |
| I_{IK} or V_I | DC input diode current ² | $V_I < 0$ | -20 | mA |
| | | $V_I > V_{CC}$ | 20 | |
| | DC input voltage | | -0.5 to $V_{CC} + 0.5$ | V |
| I_{OK} or V_O | DC output diode current ² | $V_O < 0$ | -50 | mA |
| | | $V_O > V_{CC}$ | 50 | |
| | DC output voltage | | -0.5 to $V_{CC} + 0.5$ | V |
| I_O | DC output source or sink current per output pin | $V_O = 0$ to V_{CC} | ± 50 | mA |
| I_{CC} or I_{GND} | DC V_{CC} current | | ± 125 | mA |
| | DC ground current | | ± 125 | |
| T_{STG} | Storage temperature | | -65 to 150 | °C |
| P_{TOT} | Power dissipation per package | Above 70°C; derate linearly by 8mW/K | 500 | mW |
| | Power dissipation per package Plastic surface mount (SO) | Above 70°C; derate linearly by 8mW/K | 400 | mW |

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.

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DC ELECTRICAL CHARACTERISTICS

| SYMBOL | PARAMETER | TEST CONDITIONS | V _{CC} V | 74AC11160 | | | | 74ACT11160 | | | | UNIT | |
|--------------------------------------|--|---|-------------------------|--------------------------|------|-----------------------------------|------|--------------------------|------|-----------------------------------|------|------|------|
| | | | | T _{amb} = +25°C | | T _{amb} = -40°C to +85°C | | T _{amb} = +25°C | | T _{amb} = -40°C to +85°C | | | |
| | | | | Min | Max | Min | Max | Min | Max | Min | Max | | |
| V _{IH} | High-level input voltage | | 3.0 | 2.10 | | 2.10 | | | | | | V | |
| | | | 4.5 | 3.15 | | 3.15 | | 2.0 | | 2.0 | | | |
| | | | 5.5 | 3.85 | | 3.85 | | 2.0 | | 2.0 | | | |
| V _{IL} | Low-level input voltage | | 3.0 | | 0.90 | | 0.90 | | | | | V | |
| | | | 4.5 | | 1.35 | | 1.35 | | 0.8 | | 0.8 | | |
| | | | 5.5 | | 1.65 | | 1.65 | | 0.8 | | 0.8 | | |
| V _{OH} | High-level output voltage | V _I = V _{IL} or V _{IH} | I _{OH} = -50μA | 3.0 | 2.9 | | 2.9 | | | | | V | |
| | | | | 4.5 | 4.4 | | 4.4 | | 4.4 | | 4.4 | | |
| | | | | 5.5 | 5.4 | | 5.4 | | 5.4 | | 5.4 | | |
| | | | I _{OH} = -4mA | 3.0 | 2.58 | | 2.48 | | | | | | |
| | | | | 4.5 | 3.94 | | 3.8 | | 3.94 | | 3.8 | | |
| | | | | 5.5 | 4.94 | | 4.8 | | 4.94 | | 4.8 | | |
| I _{OH} = -75mA ¹ | 5.5 | | | 3.85 | | | | 3.85 | | | | | |
| V _{OL} | Low-level output voltage | V _I = V _{IL} or V _{IH} | I _{OL} = 50μA | 3.0 | | 0.1 | | 0.1 | | | | V | |
| | | | | 4.5 | | 0.1 | | 0.1 | | 0.1 | | | 0.1 |
| | | | | 5.5 | | 0.1 | | 0.1 | | 0.1 | | | 0.1 |
| | | | I _{OL} = 12mA | 3.0 | | 0.36 | | 0.44 | | | | | |
| | | | | 4.5 | | 0.36 | | 0.44 | | 0.36 | | | 0.44 |
| | | | | 5.5 | | 0.36 | | 0.44 | | 0.36 | | | 0.44 |
| I _{OL} = 75mA ¹ | 5.5 | | | | 1.65 | | | | 1.65 | | | | |
| I _I | Input leakage current | V _I = V _{CC} or GND | 5.5 | | ±0.1 | | ±1.0 | | ±0.1 | | ±1.0 | μA | |
| I _{CC} | Quiescent supply current | V _I = V _{CC} or GND, I _O = 0mA | 5.5 | | 8.0 | | 80 | | 8.0 | | 80 | μA | |
| ΔI _{CC} | Supply current, TTL inputs High ² | One input at 3.4V, other inputs at V _{CC} or GND | 5.5 | | | | | | 0.9 | | 1.0 | mA | |

NOTES:

- Not more than one output should be tested at a time, and the duration of the test should not exceed 10ms.
- This is the increase in supply current for each input that is at one of the specified TTL voltage levels rather than 0V or V_{CC}.

Synchronous presettable synchronous BCD decade counter, asynchronous reset

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AC ELECTRICAL CHARACTERISTICS

| SYMBOL | PARAMETER | WAVEFORM | 74AC11160 | | | | | UNIT |
|--------------------------------------|--|----------|--------------------------|--------------|--------------|-----------------------------------|--------------|------|
| | | | T _{amb} = +25°C | | | T _{amb} = -40°C to +85°C | | |
| | | | Min | Typ | Max | Min | Max | |
| f _{MAX} | Maximum clock frequency | 1 | 66 | 90 | | 66 | | MHz |
| t _{PLH} t _{PHL} | Propagation delay CP to Q _n (\overline{PE} = "H") | 1 | 1.5 1.5 | 9.0 10.6 | 11.2 13.4 | 1.5 1.5 | 12.5 15.1 | ns |
| t _{PLH} t _{PHL} | Propagation delay CP to Q _n (\overline{PE} = "L") | 1 | 1.5 1.5 | 8.6 10.1 | 10.8 12.8 | 1.5 1.5 | 12.1 14.4 | ns |
| t _{PLH} t _{PHL} | Propagation delay CP to TC | 1 | 1.5 1.5 | 11.2 12.2 | 13.6 15.1 | 1.5 1.5 | 15.2 17.2 | ns |
| t _{PLH} t _{PHL} | Propagation delay CET to TC | 3 | 1.5 1.5 | 6.0 6.8 | 7.6 8.9 | 1.5 1.5 | 8.3 9.9 | ns |
| t _{PHL} | Propagation delay MR to Q _n | 2 | 1.5 | 12.0 | 15.2 | 1.5 | 17.3 | ns |
| t _{PHL} | Propagation delay MR to TC | 2 | 1.5 | 14.1 | 17.3 | 1.5 | 19.7 | ns |
| t _s | Setup time, High or Low D _n to CP | 4 | 6.5 | | | 6.5 | | ns |
| t _h | Hold time, High or Low D _n to CP | 4 | 1.0 | | | 1.0 | | ns |
| t _s | Setup time, High or Low \overline{PE} to CP | 4 | 6.5 | | | 6.5 | | ns |
| t _h | Hold time, High or Low \overline{PE} to CP | 4 | 1.0 | | | 1.0 | | ns |
| t _s | Setup time, High or Low CEP or CET to CP | 5 | 6.0 | | | 6.0 | | ns |
| t _h | Hold time, High or Low CEP or CET to CP | 5 | 1.0 | | | 1.0 | | ns |
| t _w | Clock pulse width (load) High or Low | 1 | 7.5 | | | 7.5 | | ns |
| t _w | Clock pulse width (count) High or Low | 1 | 7.5 | | | 7.5 | | ns |
| t _w | MR pulse width, Low | 2 | 6.0 | | | 6.0 | | ns |
| t _{REC} | Recovery time MR to CP | 2 | 6.0 | | | 6.0 | | ns |

Synchronous presettable synchronous BCD decade counter, asynchronous reset

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AC ELECTRICAL CHARACTERISTICS AT 5.0V ±0.5V

| SYMBOL | PARAMETER | WAVEFORM | 74AC11160 | | | | | UNIT |
|--------------------------------------|--|----------|--------------------------|------------|-------------|-----------------------------------|--------------|------|
| | | | T _{amb} = +25°C | | | T _{amb} = -40°C to +85°C | | |
| | | | Min | Typ | Max | Min | Max | |
| f _{MAX} | Maximum clock frequency | 1 | 110 | 140 | | 110 | | MHz |
| t _{PLH} t _{PHL} | Propagation delay CP to Q _n (\overline{PE} = "H") | 1 | 1.5 1.5 | 6.3 7.4 | 8.0 9.8 | 1.5 1.5 | 8.9 11.2 | ns |
| t _{PLH} t _{PHL} | Propagation delay CP to Q _n (\overline{PE} = "L") | 1 | 1.5 1.5 | 6.0 7.1 | 7.5 9.4 | 1.5 1.5 | 8.4 10.7 | ns |
| t _{PLH} t _{PHL} | Propagation delay CP to TC | 1 | 1.5 1.5 | 7.8 8.5 | 9.5 10.6 | 1.5 1.5 | 10.7 12.1 | ns |
| t _{PLH} t _{PHL} | Propagation delay CET to TC | 3 | 1.5 1.5 | 4.2 5.0 | 5.5 6.7 | 1.5 1.5 | 6.0 7.5 | ns |
| t _{PHL} | Propagation delay \overline{MR} to Q _n | 2 | 1.5 | 8.2 | 10.7 | 1.5 | 12.1 | ns |
| t _{PHL} | Propagation delay \overline{MR} to TC | 2 | 1.5 | 9.9 | 12.2 | 1.5 | 13.8 | ns |
| t _S | Setup time, High or Low D _n to CP | 4 | 3.5 | | | 3.5 | | ns |
| t _H | Hold time, High or Low D _n to CP | 4 | 1.0 | | | 1.0 | | ns |
| t _S | Setup time, High or Low \overline{PE} to CP | 4 | 6.5 | | | 6.5 | | ns |
| t _H | Hold time, High or Low \overline{PE} to CP | 4 | 1.0 | | | 1.0 | | ns |
| t _S | Setup time, High or Low CEP or CET to CP | 5 | 4.5 | | | 4.5 | | ns |
| t _H | Hold time, High or Low CEP or CET to CP | 5 | 1.0 | | | 1.0 | | ns |
| t _W | Clock pulse width (load) High or Low | 1 | 4.5 | | | 4.5 | | ns |
| t _W | Clock pulse width (count) High or Low | 1 | 4.5 | | | 4.5 | | ns |
| t _W | \overline{MR} pulse width, Low | 2 | 4.5 | | | 4.5 | | ns |
| t _{REC} | Recovery time \overline{MR} to CP | 2 | 6.0 | | | 6.0 | | ns |

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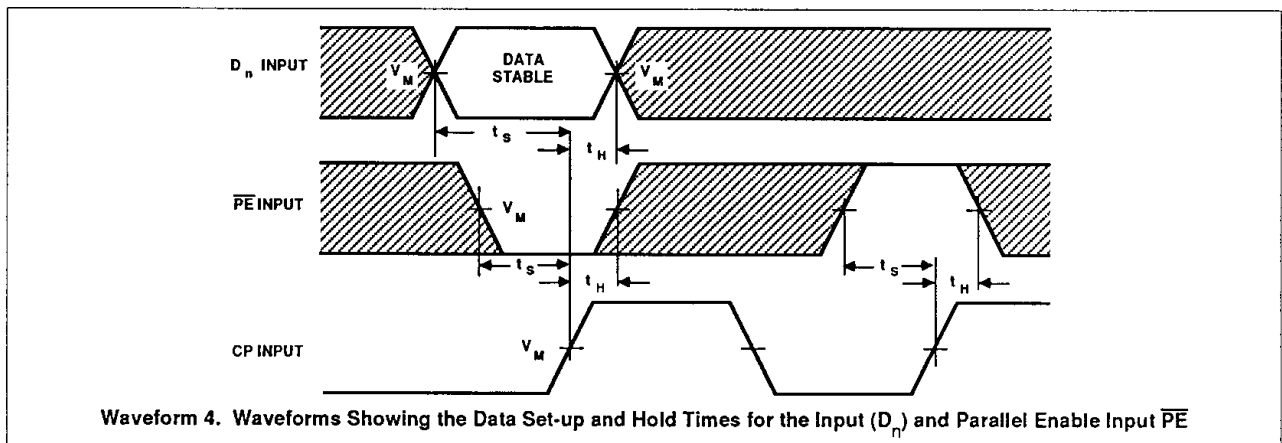
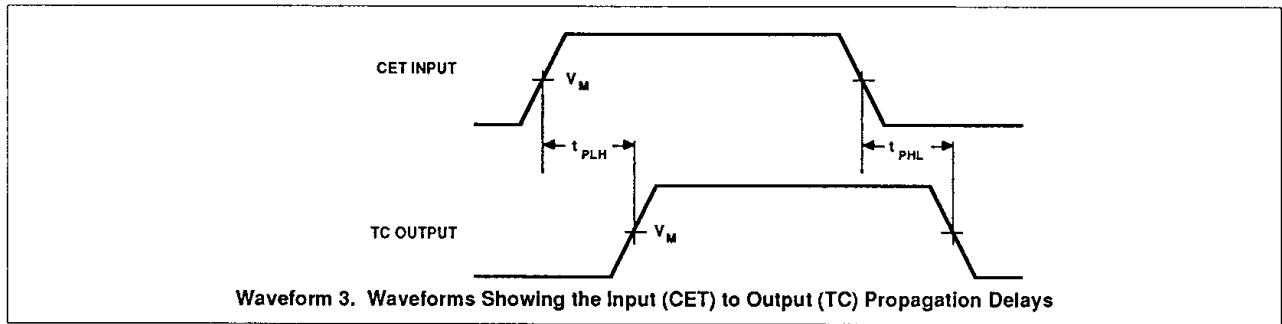
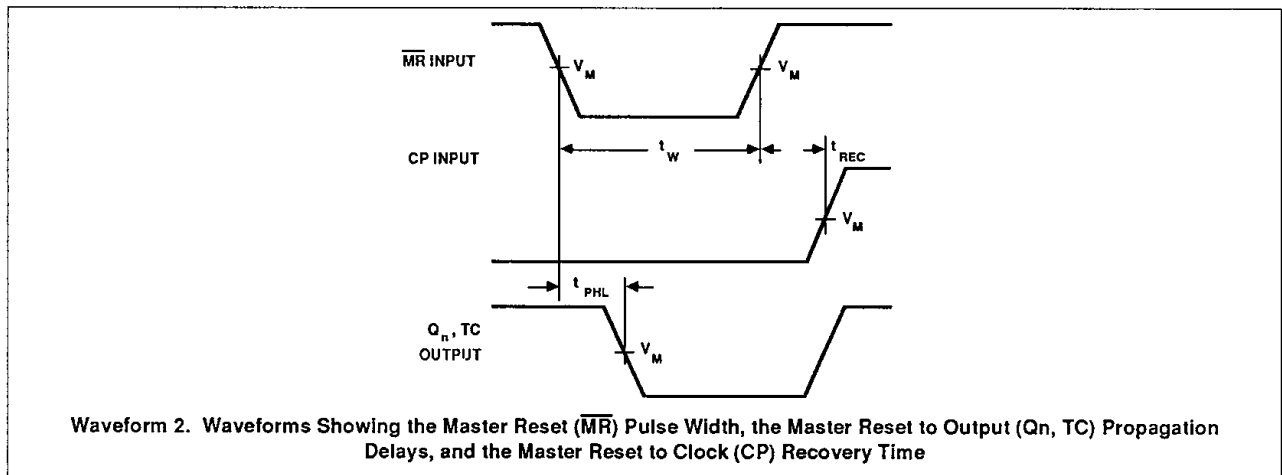
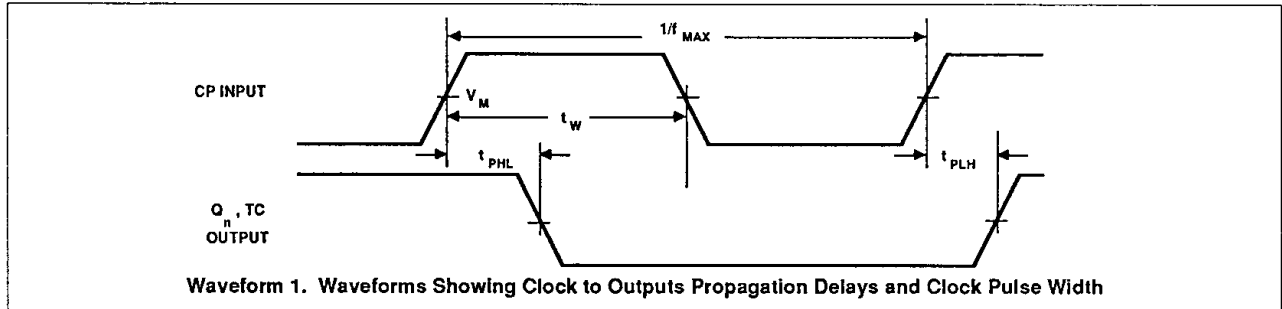
AC ELECTRICAL CHARACTERISTICS AT 5.0V ±0.5V

| SYMBOL | PARAMETER | WAVEFORM | 74ACT11160 | | | | | UNIT |
|--------------------------------------|--|----------|--------------------------|------------|-------------|-----------------------------------|--------------|------|
| | | | T _{amb} = +25°C | | | T _{amb} = -40°C to +85°C | | |
| | | | Min | Typ | Max | Min | Max | |
| f _{MAX} | Maximum clock frequency | 1 | 100 | 125 | | 100 | | MHz |
| t _{PLH} t _{PHL} | Propagation delay CP to Q _n (\overline{PE} = "H") | 1 | 2.8 3.5 | 5.9 6.8 | 8.3 9.1 | 2.8 3.5 | 9.1 10.2 | ns |
| t _{PLH} t _{PHL} | Propagation delay CP to Q _n (\overline{PE} = "L") | 1 | 3.0 3.7 | 5.8 6.7 | 7.9 8.8 | 3.0 3.7 | 8.6 9.8 | ns |
| t _{PLH} t _{PHL} | Propagation delay CP to TC | 1 | 3.8 4.4 | 6.9 8.3 | 9.1 10.8 | 3.8 4.4 | 10.1 12.0 | ns |
| t _{PLH} t _{PHL} | Propagation delay CET to TC | 3 | 2.3 3.1 | 4.3 6.7 | 5.6 9.2 | 2.3 3.1 | 6.0 10.1 | ns |
| t _{PHL} | Propagation delay \overline{MR} to Q _n | 2 | 4.4 | 8.7 | 11.9 | 4.4 | 13.2 | ns |
| t _{PHL} | Propagation delay \overline{MR} to TC | 2 | 5.4 | 10.1 | 13.2 | 5.4 | 14.7 | ns |
| t _S | Setup time, High or Low D _n to CP | 4 | 5.5 | | | 5.5 | | ns |
| t _H | Hold time, High or Low D _n to CP | 4 | 1.0 | | | 1.0 | | ns |
| t _S | Setup time, High or Low \overline{PE} to CP | 4 | 7.0 | | | 7.0 | | ns |
| t _H | Hold time, High or Low \overline{PE} to CP | 4 | 1.0 | | | 1.0 | | ns |
| t _S | Setup time, High or Low CEP or CET to CP | 5 | 7.0 | | | 7.0 | | ns |
| t _H | Hold time, High or Low CEP or CET to CP | 5 | 1.0 | | | 1.0 | | ns |
| t _W | Clock pulse width (load) High or Low | 1 | 5.0 | | | 5.0 | | ns |
| t _W | Clock pulse width (count) High or Low | 1 | 5.0 | | | 5.0 | | ns |
| t _W | \overline{MR} pulse width, Low | 2 | 5.0 | | | 5.0 | | ns |
| t _{REC} | Recovery time \overline{MR} to CP | 2 | 5.0 | | | 5.0 | | ns |

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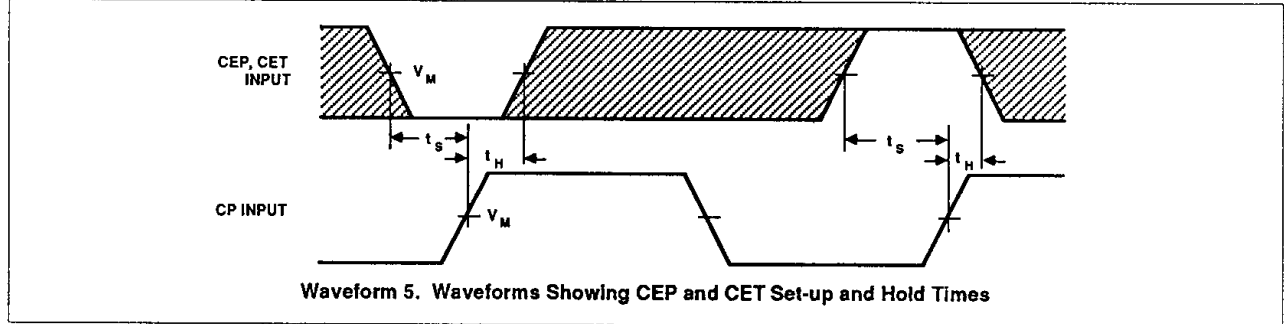
AC WAVEFORMS



Synchronous presettable synchronous BCD decade counter, asynchronous reset

74AC/ACT11160

AC WAVEFORMS (Continued)



WAVEFORM CONDITIONS

| | INPUTS | OUTPUTS |
|-----|---|---------------------------------------|
| AC | $V_{IN} = \text{GND to } V_{CC}$, $V_M = 50\% V_{CC}$ | $V_{OUT} = V_{OL} \text{ to } V_{OH}$ |
| ACT | $V_{IN} = \text{GND to } 3.0V$, $V_M = 1.5V$ | $V_M = 50\% V_{CC}$ |

TEST CIRCUIT

