



## 5V/3.3V PROGRAMMABLE FREQUENCY SYNTHESIZER (25MHz to 400MHz)

Precision Edge®  
SY89429V

### FEATURES

- 3.3V and 5V power supply options
- 25MHz to 400MHz differential PECL outputs
- 50ps peak-to-peak output jitter
- Minimal frequency over-shoot
- Synthesized architecture
- Serial 3-wire interface
- Parallel interface for power-on
- Internal quartz reference oscillator driven by quartz crystal
- Application Note (AN-07) for ease of design-ins
- Available in 28-pin PLCC and SOIC packages



Precision Edge®

### DESCRIPTION

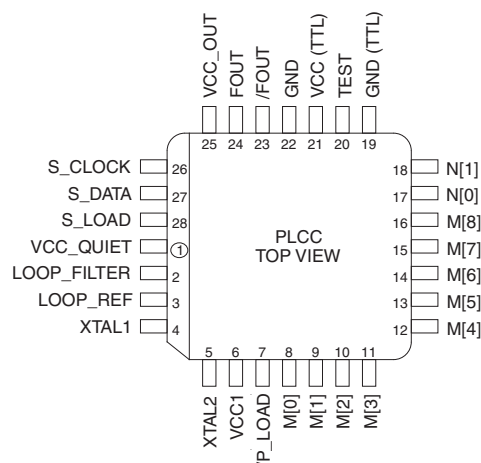
The SY89429V is a general purpose, synthesized clock source targeting applications that require both serial and parallel interfaces. Its internal VCO will operate over a range of frequencies from 400MHz to 800MHz. The differential PECL output can be configured to be the VCO frequency divided by 2, 4, 8 or 16. With the output configured to divide the VCO frequency by 2, and with a 16MHz external quartz crystal used to provide the reference frequency, the output frequency can be specified in 1MHz steps.

Data sheets and support documentation can be found on Micrel's web site at: [www.micrel.com](http://www.micrel.com).

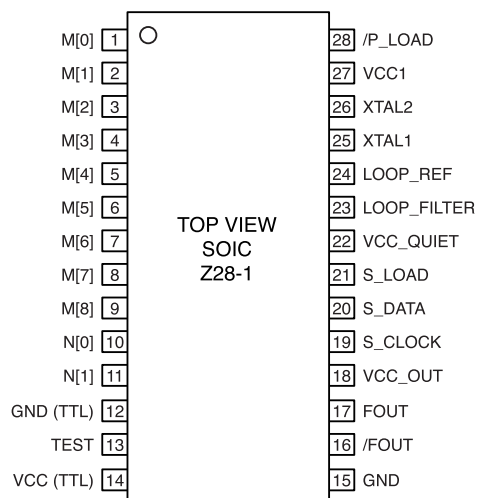
### APPLICATIONS

- Workstations
- Advanced communications
- High end consumer
- High-performance computing
- RISC CPU clock
- Graphics pixel clock
- Test equipment
- Other high-performance processor-based applications

## PACKAGE/ORDERING INFORMATION



28-Pin PLCC (J28-1)



28-Pin SOIC (Z28-1)

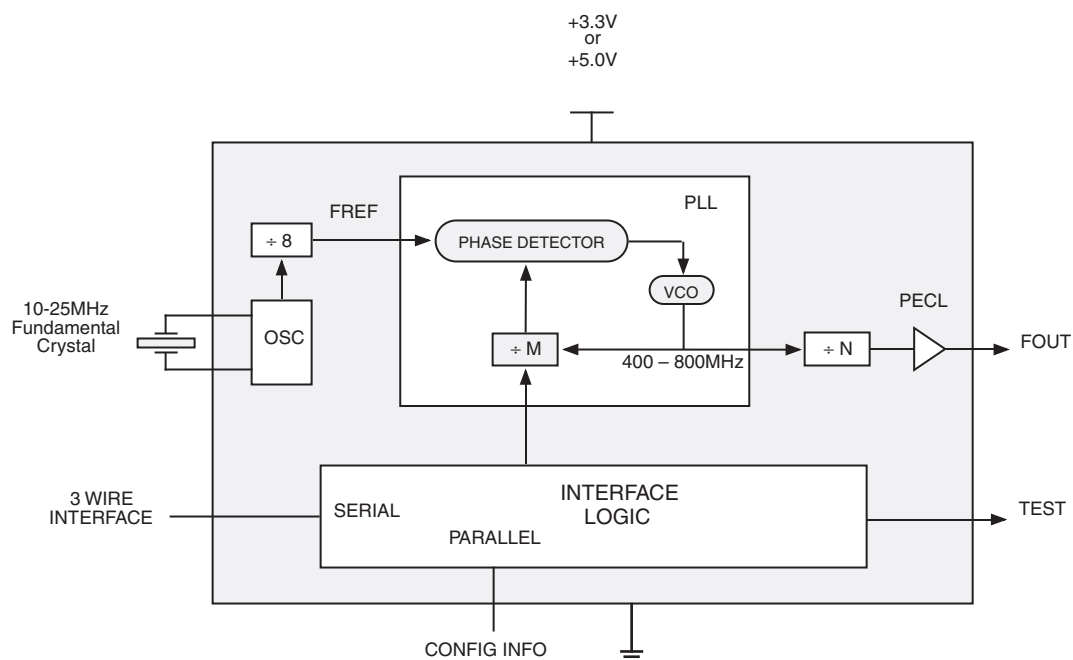
Ordering Information<sup>(1)</sup>

| Part Number                    | Package Type | Operating Range | Package Marking                            | Lead Finish      |
|--------------------------------|--------------|-----------------|--------------------------------------------|------------------|
| SY89429VJC                     | J28-1        | Commercial      | SY89429VJC                                 | Sn-Pb            |
| SY89429VJCTR <sup>(2)</sup>    | J28-1        | Commercial      | SY89429VJC                                 | Sn-Pb            |
| SY89429VZC                     | Z28-1        | Commercial      | SY89429VZC                                 | Sn-Pb            |
| SY89429VZCTR <sup>(2)</sup>    | Z28-1        | Commercial      | SY89429VZC                                 | Sn-Pb            |
| SY89429VJZ <sup>(3)</sup>      | J28-1        | Commercial      | SY89429VJZ with Pb-Free bar line indicator | Matte-Sn Pb-Free |
| SY89429VJZTR <sup>(2, 3)</sup> | J28-1        | Commercial      | SY89429VJZ with Pb-Free bar line indicator | Matte-Sn Pb-Free |
| SY89429VZH <sup>(3)</sup>      | Z28-1        | Commercial      | SY89429VZH with Pb-Free bar line indicator | NiPdAu Pb-Free   |
| SY89429VZHTR <sup>(2, 3)</sup> | Z28-1        | Commercial      | SY89429VZH with Pb-Free bar line indicator | NiPdAu Pb-Free   |

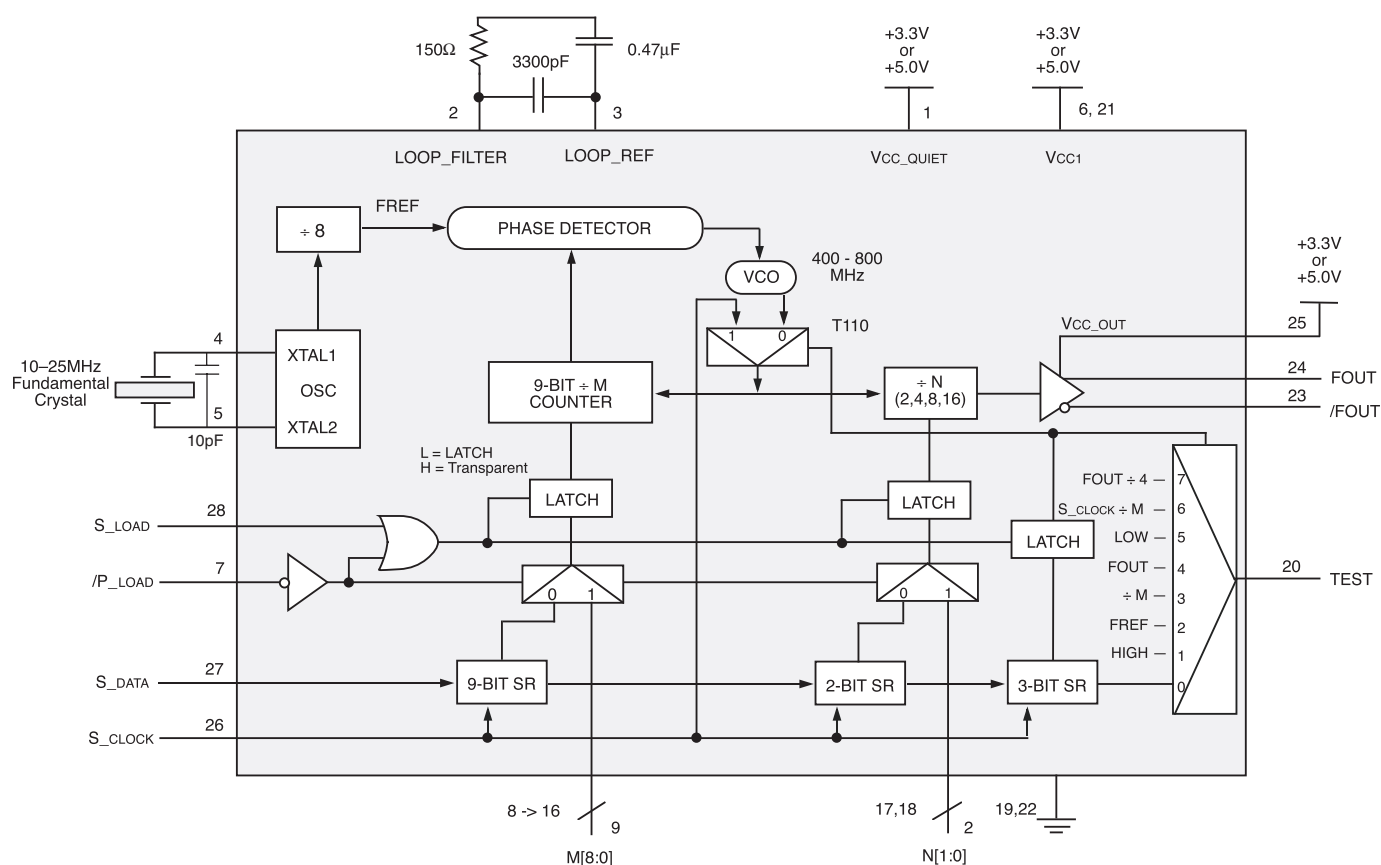
## Notes:

1. Contact factory for die availability. Dice are guaranteed at  $T_A = 25^\circ\text{C}$ , DC Electricals only.
2. Tape and Reel.
3. Pb-Free package is recommended for new designs.

### DETAILED BLOCK DIAGRAM



## DETAILED BLOCK DIAGRAM



Pin numbers reference PLCC pinout.

## PIN DESCRIPTIONS

### INPUTS

#### XTAL1, XTAL2

These pins form an oscillator when connected to an external crystal. The crystal is series resonant. See “AN-07” for Crystal Interface Guideline.

#### S\_LOAD

This TTL pin loads the configuration latches with the contents of the shift registers. The latches will be transparent when this signal is HIGH; thus, the register data must be stable on the HIGH-to-LOW transition of S\_LOAD for proper operation.

#### S\_DATA

This TTL pin is the input to the serial configuration shift registers.

#### S\_CLOCK

This TTL pin clocks the serial configuration shift registers. On the rising edge of this signal, data from S\_DATA is sampled.

#### /P\_LOAD

This TTL pin loads the configuration latches with the contents of the parallel inputs. The latches will be transparent when this signal is LOW: Thus, the parallel data must be stable on the LOW-to-HIGH transition of /P\_LOAD for proper operation. During power up, hold /P\_LOAD low with a valid M count on M[0] - M[8] until supplies have stabilized.

#### M[8:0]

These TTL pins are used to configure the PLL loop divider. They are sampled on the LOW-to-HIGH transition of /P\_LOAD. M[8] is the MSB, M[0] is the LSB. The binary count on the M pins equates to the divide-by value for the PLL.

#### N[1:0]

These TTL pins are used to configure the output divider modulus. They are sampled on the LOW-to-HIGH transition of /P\_LOAD.

| N[1:0] | Output Division |
|--------|-----------------|
| 0 0    | 2               |
| 0 1    | 4               |
| 1 0    | 8               |
| 1 1    | 16              |

### OUTPUTS

#### FOUT, /FOUT

These differential positive-referenced ECL signals (PECL) are the output of the synthesizer.

#### TEST

The function of this TTL output is determined by the serial configuration bits T[2:0].

### POWER

#### V<sub>CC1</sub>

This is the positive supply for the chip and is normally connected to +3.3V or +5.0V.

#### V<sub>CC\_OUT</sub>

This is the positive reference for the PECL outputs, FOUT and /FOUT. It is constrained to be less than or equal to V<sub>CC1</sub>.

#### V<sub>CC\_QUIET</sub>

This is the positive supply for the PLL and should be as noise-free as possible for low-jitter operation.

#### GND

These pins are the negative supply for the chip and are normally all connected to ground.

### OTHER

#### LOOP\_FILTER

This is an analog I/O pin that provides the loop filter for the PLL.

#### LOOP\_REF

This is an analog I/O pin that provides a reference voltage for the PLL.

**WITH 16MHZ INPUT**

| VCO Frequency<br>(MHz) | M Count | 256 | 128 | 64 | 32 | 16 | 8  | 4  | 2  | 1  |
|------------------------|---------|-----|-----|----|----|----|----|----|----|----|
|                        |         | M8  | M7  | M6 | M5 | M4 | M3 | M2 | M1 | M0 |
| 400                    | 200     | 0   | 1   | 1  | 0  | 0  | 1  | 0  | 0  | 0  |
| 402                    | 201     | 0   | 1   | 1  | 0  | 0  | 1  | 0  | 0  | 1  |
| 404                    | 202     | 0   | 1   | 1  | 0  | 0  | 1  | 0  | 1  | 0  |
| 406                    | 203     | 0   | 1   | 1  | 0  | 0  | 1  | 0  | 1  | 1  |
| •                      | •       | •   | •   | •  | •  | •  | •  | •  | •  | •  |
| •                      | •       | •   | •   | •  | •  | •  | •  | •  | •  | •  |
| •                      | •       | •   | •   | •  | •  | •  | •  | •  | •  | •  |
| 794                    | 397     | 1   | 1   | 0  | 0  | 0  | 1  | 1  | 0  | 1  |
| 796                    | 398     | 1   | 1   | 0  | 0  | 0  | 1  | 1  | 1  | 0  |
| 798                    | 399     | 1   | 1   | 0  | 0  | 0  | 1  | 1  | 1  | 1  |
| 800                    | 400     | 1   | 1   | 0  | 0  | 1  | 0  | 0  | 0  | 0  |

**FUNCTIONAL DESCRIPTION**

The internal oscillator uses the external quartz crystal as the basis of its frequency reference. The output of the reference oscillator is divided by eight before being sent to the phase detector. With a 16MHz crystal, this provides a reference frequency of 2MHz.

The VCO, within the PLL, operates over a range of 400–800MHz. Its output is scaled by a divider that is configured by either the serial or parallel interfaces. The output of this loop divider is also applied to the phase detector.

The phase detector and loop filter force the VCO output frequency to be M times the reference frequency by adjusting the VCO control voltage. Note that for some values of M (either too high or too low) the PLL will not achieve loop lock. External loop filter components are utilized to allow for optimal phase jitter performance.

The output of the VCO is also passed through an output divider before being sent to the PECL output driver. The output divider is configured through either the serial or the parallel interfaces and can provide one of four divider ratios (2, 4, 8 or 16). This divider extends the performance of the part while providing a 50% duty cycle.

The output driver is driven differentially from the output divider and is capable of driving a pair of transmission lines terminated

in 50Ω to  $V_{CC}-2$  volts. The positive reference for the output driver is provided by a dedicated power pin (VCC\_OUT) to reduce noise induced jitter.

The configuration logic has two sections: serial and parallel. The parallel interface uses the values at the M[8:0] and N[1:0] inputs to configure the internal counters. Normally, upon system reset, the /P\_LOAD input is held LOW until some time after power becomes valid. With S\_LOAD held LOW, on the LOW-to-HIGH transition of /P\_LOAD, the parallel inputs are captured. The parallel interface has priority over the serial interface. Internal pull-up resistors are provided on the M[8:0] and N[1:0] inputs to reduce component count.

The serial interface logic is implemented with a 14-bit shift register scheme. The register shifts once per rising edge of the S\_CLOCK input. The serial input S\_DATA must meet set-up and hold timing as specified in the AC parameters section of this data-sheet. With /P\_LOAD held HIGH, the configuration latches will capture the value in the shift register on the HIGH-to-LOW edge of the S\_LOAD input. See the programming section for more information.

The TEST output reflects various internal node values and is controlled by the T[2:0] bits in the serial data stream. See the programming subsection of this data sheet for more information.

## PROGRAMMING INTERFACE

Programming the device is accomplished by properly configuring the internal dividers to produce the desired frequency at the outputs. The output frequency can be represented by this formula:

$$F_{OUT} = \left( \frac{F_{XTAL}}{8} \right) \times \frac{M}{N}$$

Where  $F_{XTAL}$  is the crystal frequency,  $M$  is the loop divider modulus, and  $N$  is the output divider modulus. Note that it is possible to select values of  $M$  such that the PLL is unable to achieve loop lock. To avoid this, always ensure that  $M$  is selected to be  $200 \leq M \leq 400$  for a 16MHz input reference.

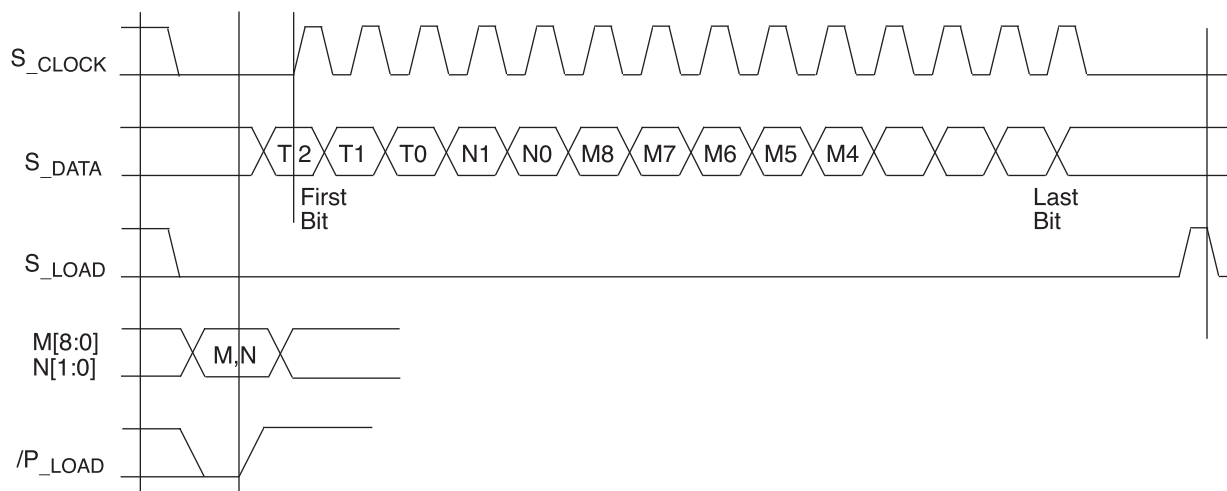
$M[8:0]$  and  $N[1:0]$  are normally specified once at power-on, through the parallel interface, and then possibly again through the serial interface. This approach allows the designer to bring up the application at one frequency and then change or fine-tune the clock, as the ability to control the serial interface becomes available. To minimize transients in the frequency domain, the output should be varied in the smallest step size possible.

| T2 | T1 | T0 | TEST                   | FOUT // FOUT |
|----|----|----|------------------------|--------------|
| 0  | 0  | 0  | Data Out – Last Bit SR | FVCO ÷ N     |
| 0  | 0  | 1  | HIGH                   | FVCO ÷ N     |
| 0  | 1  | 0  | FREF                   | FVCO ÷ N     |
| 0  | 1  | 1  | M Counter Output       | FVCO ÷ N     |
| 1  | 0  | 0  | FOUT                   | FVCO ÷ N     |
| 1  | 0  | 1  | LOW                    | FVCO ÷ N     |
| 1  | 1  | 0  | S_CLOCK ÷ M            | S_CLOCK ÷ N  |
| 1  | 1  | 1  | FOUT ÷ 4               | FVCO ÷ N     |

The TEST output provides visibility for one of several internal nodes (as determined by the  $T[1:0]$  bits in the serial configuration stream). It is not configurable through the parallel interface. Although it is possible to select the node that represents FOUT, the TTL output may not be able to toggle fast enough for some of the higher output frequencies. The  $T_2$ ,  $T_1$ ,  $T_0$  configuration latches are preset to 000 when  $/P\_LOAD$  is low, so that the FOUT outputs are as jitter-free as possible. The serial configuration port can be used to select one of the alternate functions for this pin.

The Test register is loaded with the first three bits, the  $N$  register with the next two and the  $M$  register with the final eight bits of the data stream on the  $S\_DATA$  input. For each register, the most significant bit is loaded first ( $T_2$ ,  $N_1$  and  $M_8$ ).

When  $T[2:0]$  is set to 100 the SY89429V is placed in PLL bypass mode. In this mode the  $S\_CLOCK$  input is fed directly into the  $M$  and  $N$  dividers. The  $N$  divider drives the FOUT differential pair and the  $M$  counter drives the TEST output pin. In this mode the  $S\_CLOCK$  input could be used for low speed board level functional test or debug. Bypassing the PLL and driving FOUT directly gives the user more control on the test clocks sent through the clock tree (See detailed Block Diagram). Because the  $S\_CLOCK$  is a TTL level the input frequency is limited to 250MHz or less. This means the fastest the FOUT pin can be toggled via the  $S\_CLOCK$  is 125MHz as the minimum divide ratio of the  $N$  counter is 2. Note that the  $M$  counter output on the TEST output will not be a 50% duty cycle due to the way the divider is implemented.



**ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>**

| Symbol             | Parameter                           | Value        | Unit |
|--------------------|-------------------------------------|--------------|------|
| V <sub>CC</sub>    | Power Supply Voltage                | −0.5 to +7.0 | V    |
| V <sub>I</sub>     | Input Voltage                       | −0.5 to +7.0 | V    |
| I <sub>OUT</sub>   | Output Source<br>Continuous Surge   | 50<br>100    | mA   |
| T <sub>LEAD</sub>  | Lead Temperature (soldering 20sec.) | +260         | °C   |
| T <sub>store</sub> | Storage Temperature                 | −65 to +150  | °C   |
| T <sub>A</sub>     | Operating Temperature               | −0 to +75    | °C   |

**NOTE:**

1. Permanent device damage may occur if absolute maximum ratings are exceeded. This is a stress rating only and functional operation is not implied at conditions other than those detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**100H ECL DC ELECTRICAL CHARACTERISTICS**

V<sub>CC1</sub> = V<sub>CC\_QUIET</sub> = V<sub>CC\_TTL</sub> = V<sub>CC\_OUT</sub> = +3.3V to +5.0V ±5%; T<sub>A</sub> = 0°C to +75°C

| Symbol          | Parameter           | Min.                       | Max.                       | Unit | Condition                      |
|-----------------|---------------------|----------------------------|----------------------------|------|--------------------------------|
| V <sub>OH</sub> | Output HIGH Voltage | V <sub>CC_OUT</sub> −1.075 | V <sub>CC_OUT</sub> −0.830 | V    | 50Ω to V <sub>CC_OUT</sub> −2V |
| V <sub>OL</sub> | Output LOW Voltage  | V <sub>CC_OUT</sub> −1.860 | V <sub>CC_OUT</sub> −1.570 | V    | 50Ω to V <sub>CC_OUT</sub> −2V |

**TTL DC ELECTRICAL CHARACTERISTICS**

V<sub>CC1</sub> = V<sub>CC\_QUIET</sub> = V<sub>CC\_TTL</sub> = V<sub>CC\_OUT</sub> = +3.3V to +5.0V ±5%; T<sub>A</sub> = 0°C to +75°C

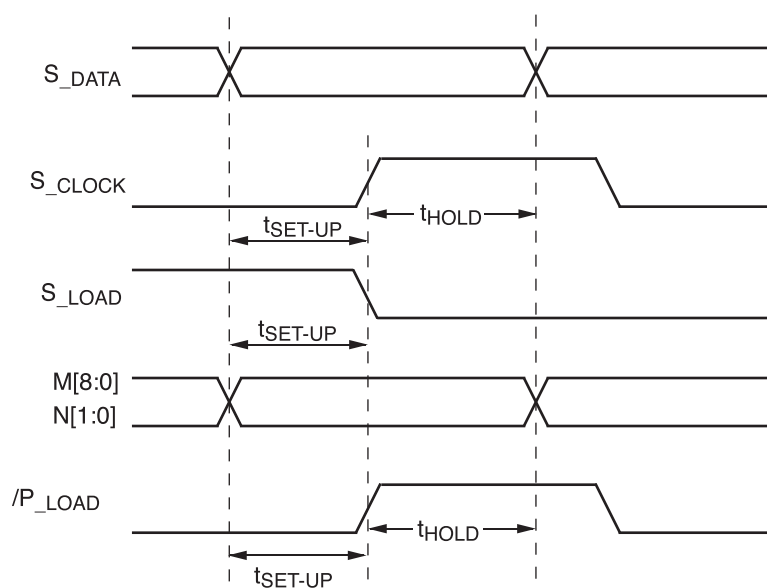
| Symbol           | Parameter                     | T <sub>A</sub> = 0°C      |      | T <sub>A</sub> = +25°C |      | T <sub>A</sub> = +75°C |      | Unit | Condition                |
|------------------|-------------------------------|---------------------------|------|------------------------|------|------------------------|------|------|--------------------------|
|                  |                               | Min.                      | Max. | Min.                   | Max. | Min.                   | Max. |      |                          |
| V <sub>IH</sub>  | Input HIGH Voltage            | 2.0                       | —    | 2.0                    | —    | 2.0                    | —    | V    | —                        |
| V <sub>IL</sub>  | Input LOW Voltage             | —                         | 0.8  | —                      | 0.8  | —                      | 0.8  | V    | —                        |
| I <sub>IH</sub>  | Input HIGH Current            | —                         | 50   | —                      | 50   | —                      | 50   | μA   | V <sub>IN</sub> = 2.7V   |
| I <sub>IL</sub>  | Input LOW Current             | —                         | −0.6 | —                      | −0.6 | —                      | −0.6 | mA   | V <sub>IN</sub> = 0.5V   |
| V <sub>IK</sub>  | Input Clamp Voltage           | —                         | −1.2 | —                      | −1.2 | —                      | −1.2 | V    | I <sub>IN</sub> = −12mA  |
| V <sub>OH</sub>  | Output HIGH Voltage           | —                         | 2.0  | —                      | 2.0  | —                      | 2.0  | V    | I <sub>OH</sub> = −2.0mA |
| V <sub>OL</sub>  | Output LOW Voltage            | —                         | 0.5  | —                      | 0.5  | —                      | 0.5  | V    | I <sub>OL</sub> = 8mA    |
| I <sub>OS</sub>  | Output Short Circuit Current  | −100 (Typ.)               |      | −100 (Typ.)            |      | −100 (Typ.)            |      | mA   | V <sub>OUT</sub> = 0V    |
| I <sub>CC1</sub> | Supply Current                | —                         | 190  | —                      | 190  | —                      | 190  | mA   | 5.0V ±5%                 |
|                  |                               | 0.89X of 5V Val.          |      | 0.89X of 5V Val.       |      | 0.89X of 5V Val.       |      | mA   | 3.3V ±5%                 |
|                  | Typical % of I <sub>CC1</sub> | V <sub>CC1</sub> 33%      |      | 33%                    |      | 33%                    |      |      |                          |
|                  |                               | V <sub>CC_OUT</sub> 9%    |      | 9%                     |      | 9%                     |      |      |                          |
|                  |                               | V <sub>CC_QUIET</sub> 14% |      | 14%                    |      | 14%                    |      |      |                          |
|                  |                               | V <sub>CC_TTL</sub> 44%   |      | 44%                    |      | 44%                    |      |      |                          |

**AC ELECTRICAL CHARACTERISTICS**
 $V_{CC1} = V_{CC\_QUIET} = V_{CC\_TTL} = V_{CC\_OUT} = +3.3V \text{ to } +5.0V \pm 5\%; T_A = 0^\circ C \text{ to } +75^\circ C$ 

| Symbol         | Parameter                                                                           | $T_A = 0^\circ C$ |            | $T_A = +25^\circ C$ |            | $T_A = +75^\circ C$ |            | Unit | Condition              |
|----------------|-------------------------------------------------------------------------------------|-------------------|------------|---------------------|------------|---------------------|------------|------|------------------------|
|                |                                                                                     | Min.              | Max.       | Min.                | Max.       | Min.                | Max.       |      |                        |
| $f_{MAXI}$     | Maximum Input Frequency $S\_CLOCK$<br><b>Note 1</b> Xtal Oscillator                 | —<br>10           | 10<br>25   | —<br>10             | 10<br>25   | —<br>10             | 10<br>25   | MHz  | Fundamental<br>Crystal |
| $f_{MAXO}$     | Maximum Output Frequency VCO (Internal)<br>FOUT                                     | 400<br>25         | 800<br>400 | 400<br>25           | 800<br>400 | 400<br>25           | 800<br>400 | MHz  |                        |
| $t_{LOCK}$     | Maximum PLL Lock Time                                                               | —                 | 10         | —                   | 10         | —                   | 10         | ms   |                        |
| $t_{jitter}$   | Cycle-to-Cycle Jitter (Peak-to-Peak)                                                | —                 | 50         | —                   | 50         | —                   | 50         | ps   | Test output static     |
| $t_S$          | Setup Time $S\_DATA$ to $S\_CLOCK$<br>$S\_CLOCK$ to $S\_LOAD$<br>M, N to $/P\_LOAD$ | 20                | —          | 20                  | —          | 20                  | —          | ns   |                        |
|                |                                                                                     | 20                | —          | 20                  | —          | 20                  | —          |      |                        |
|                |                                                                                     | 20                | —          | 20                  | —          | 20                  | —          |      |                        |
| $t_H$          | Hold Time $S\_DATA$ to $S\_CLOCK$<br>$S\_CLOCK$ to $S\_LOAD$<br>M, N to $/P\_LOAD$  | 20                | —          | 20                  | —          | 20                  | —          | ns   |                        |
|                |                                                                                     | 20                | —          | 20                  | —          | 20                  | —          |      |                        |
|                |                                                                                     | 20                | —          | 20                  | —          | 20                  | —          |      |                        |
| $t_{pw(MIN)}$  | Minimum Pulse Width $S\_LOAD$<br>$/P\_LOAD$                                         | 50                | —          | 50                  | —          | 50                  | —          | ns   |                        |
|                |                                                                                     | 50                | —          | 50                  | —          | 50                  | —          |      |                        |
| $t_{DC}$       | FOUT Duty Cycle                                                                     | 45                | 55         | 45                  | 55         | 45                  | 55         | %    |                        |
| $t_r$<br>$t_f$ | Output Rise/Fall<br>20% to 80% FOUT                                                 | 300               | 800        | 300                 | 800        | 300                 | 800        | ps   |                        |

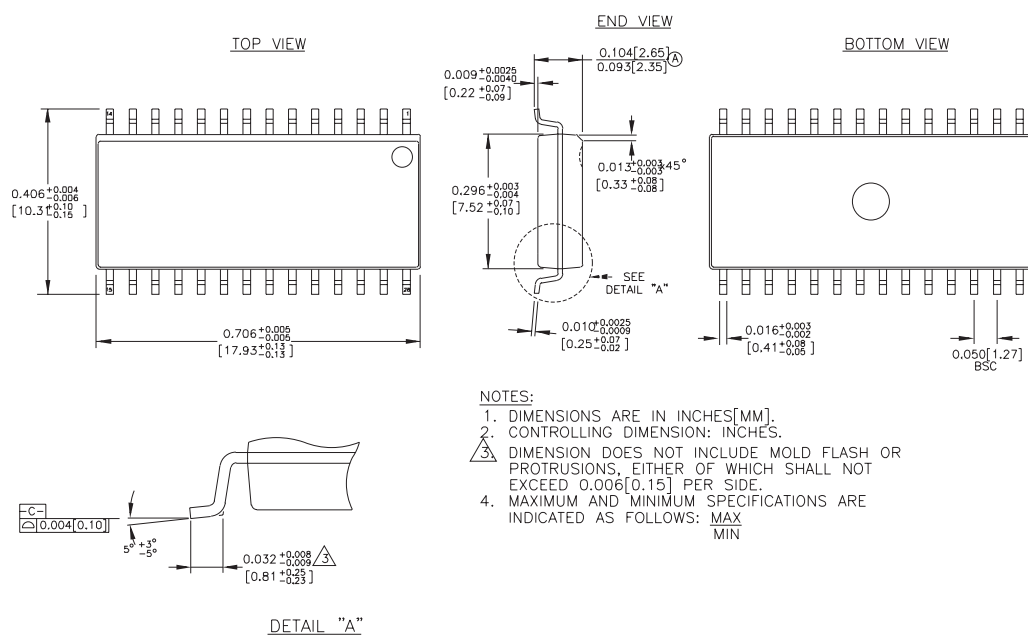
**NOTE:**

1. 10MHz is the maximum frequency to load the feedback divide registers.  $S\_CLOCK$  can be switched at high frequencies when used as a test clock in TEST\_MODE 6.

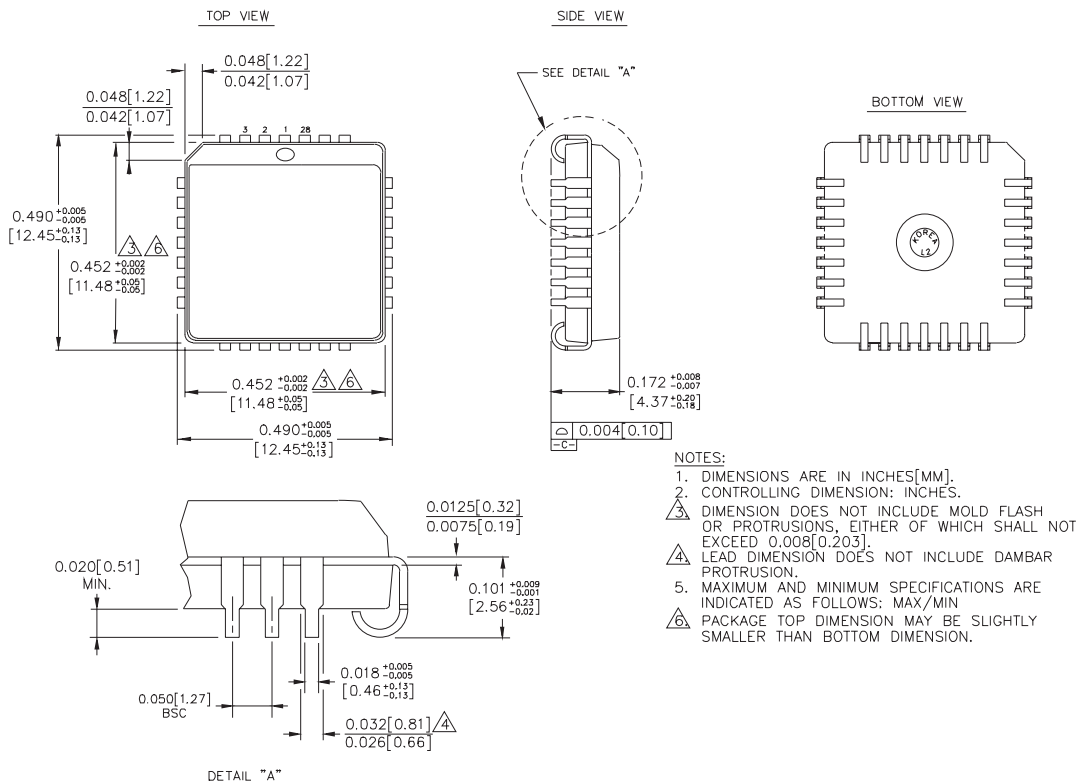
**TIMING DIAGRAM**



## 28-PIN SOIC .300" WIDE (Z28-1)



## 28-PIN PLCC (J28-1)



Rev. 03

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