

# Vacuum Fluorescent Display Tube Driver

## Description

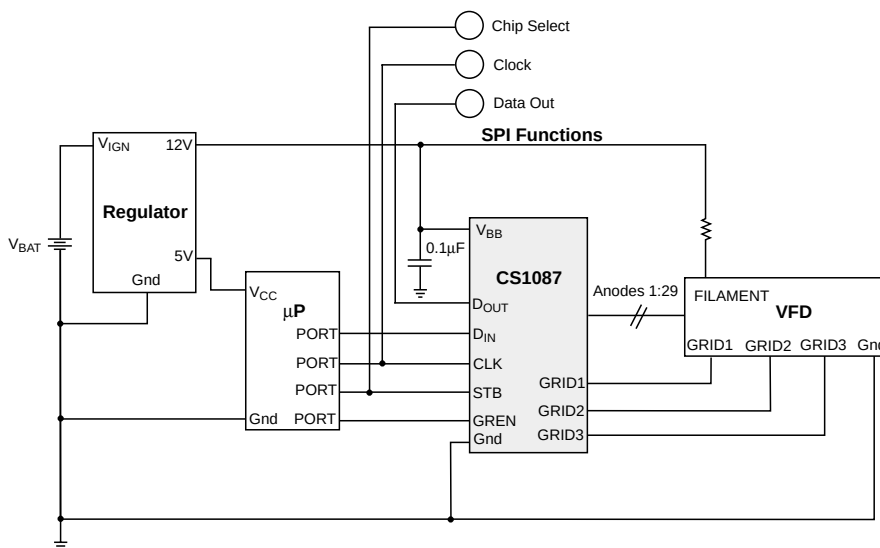
The VFD Driver is a microprocessor interface IC that drives a multiplexed VF (Vacuum Fluorescent) display tube. It consists of a 32-bit shift register, a 32-bit transparent data latch, a metal mask ROM, six 20mA anode output drivers, twenty-three 2mA anode output

drivers, and three 50mA grid drivers with output enables. The metal mask programmable ROM (at factory request) allows the 29 anode outputs and 3 grid outputs to be assigned to any of the 32 serial data bits.

## Absolute Maximum Ratings

|                                             |                                          |
|---------------------------------------------|------------------------------------------|
| Supply Voltage ( $V_{BB}$ )                 | .....-0.6V to 18.0V                      |
| Input Voltages ( $D_{IN}$ , CLK, STB, GREN) | .....-0.6V to 6.0V                       |
| Junction Temperature Range                  | .....-40°C to 150°C                      |
| Storage Temperature Range                   | .....-55°C to 150°C                      |
| ESD Susceptibility (Human Body Model)       | .....2kV                                 |
| ESD Susceptibility (Machine Model)          | .....200V                                |
| Lead Temperature Soldering                  |                                          |
| Wave Solder(through hole styles only)       | .....10 sec. max, 260°C peak             |
| Reflow (SMD styles only)                    | .....60 sec. max above 183°C, 230°C peak |

## Application Diagram

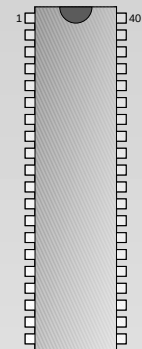


## Features

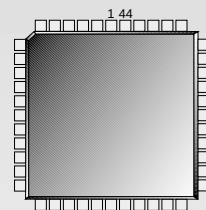
- **Metal Mask ROM**
- **Six 20mA Anode drivers**
- **Twenty-three, 2mA Anode Drivers**
- **Three, 50mA Grid Drivers**
- **Power On Reset**
- **Display Dimming Possible**

## Package Options

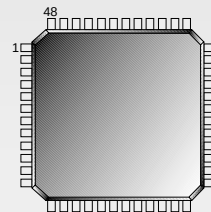
**40 Lead PDIP**



**44 Lead PLCC**



**48 Lead LQFP**



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**Electrical Characteristics:  $8.0V \leq V_{BB} \leq 16.5V$ ,  $Gnd = 0V$ ,  $-40^{\circ}C \leq T_J \leq 105^{\circ}C$ ; unless otherwise stated.**

| PARAMETER                                            | TEST CONDITIONS                     | MIN             | TYP | MAX      | UNIT    |
|------------------------------------------------------|-------------------------------------|-----------------|-----|----------|---------|
| <b>■ <math>V_{BB}</math> Input</b>                   |                                     |                 |     |          |         |
| $V_{BB}$ Input Voltage                               |                                     | 8.0             |     | 16.5     | V       |
| $I_{BB0}$ Current                                    | No outputs active, $V_{BB} = 16.5V$ |                 | 2   | 5        | mA      |
| Reset Mode                                           | All outputs forced low.             |                 | 6.5 | 7.5      | V       |
| <b>■ <math>D_{IN}</math>, CLK, STB Inputs</b>        |                                     |                 |     |          |         |
| $V_{IL}$ , Input Low Voltage                         |                                     |                 |     | 1.6      | V       |
| $V_{IH}$ , Input High Voltage                        |                                     | 3.3             |     |          | V       |
| $I_{IL}$ , Input Current                             | $V_{IN} = V_{IH}$                   | 0               | 7.5 | 20.0     | $\mu A$ |
| <b>■ GREN Input</b>                                  |                                     |                 |     |          |         |
| $V_{IL}$ , Input Low Voltage                         |                                     |                 |     | 1.6      | V       |
| $V_{IH}$ , Input High Voltage                        |                                     | 3.3             |     |          | V       |
| $I_{IH}$ , Input Pull-down Current                   | $V_{IN} = 3.325V$                   |                 | 30  | 60       | $\mu A$ |
| <b>■ GRID1, GRID2, GRID3 Outputs</b>                 |                                     |                 |     |          |         |
| $I_{OL}$                                             | Sink Current                        | 1.0             |     |          | mA      |
| $I_{OH}$                                             | Source Current                      | 50              |     |          | mA      |
| $V_{OL}$                                             | $I_{OUT} = 1mA$                     |                 |     | 0.5      | V       |
| $V_{OH}$                                             | $I_{OUT} = -50mA$ , $V_{BB} = 12V$  | $V_{BB} - 0.75$ |     | $V_{BB}$ | V       |
| <b>■ AN24-AN29 Outputs</b>                           |                                     |                 |     |          |         |
| $I_{OL}$                                             | Sink Current                        | 400             |     |          | $\mu A$ |
| $I_{OH}$                                             | Source Current                      | 20              |     |          | mA      |
| $V_{OL}$                                             | $I_{OUT} = 400\mu A$                |                 |     | 0.5      | V       |
| $V_{OH}$                                             | $I_{OUT} = -20mA$ , $V_{BB} = 12V$  | $V_{BB} - 0.5$  |     | $V_{BB}$ | V       |
| <b>■ AN1-AN23 Outputs</b>                            |                                     |                 |     |          |         |
| $I_{OL}$                                             | Sink Current                        | 100             |     |          | $\mu A$ |
| $I_{OH}$                                             | Source Current                      | 2.0             |     |          | mA      |
| $V_{OL}$                                             | $I_{OUT} = 100\mu A$                |                 |     | 0.5      | V       |
| $V_{OH}$                                             | $I_{OUT} = -2mA$ , $V_{BB} = 12V$   | $V_{BB} - 0.5$  |     | $V_{BB}$ | V       |
| <b>■ <math>D_{OUT}</math> Output</b>                 |                                     |                 |     |          |         |
| $I_{OL}$                                             | Sink Current                        | 1.0             |     |          | mA      |
| $I_{OH}$                                             | Source Current                      | 1.0             |     |          | mA      |
| $V_{OL}$                                             | $I_{OUT} = 1mA$                     |                 |     | 0.5      | V       |
| $V_{OH}$                                             | $I_{OUT} = -1mA$                    | 3.9             |     | 5.0      | V       |
| <b>■ AC Characteristics: Input and Output Timing</b> |                                     |                 |     |          |         |
| $f_C$ , CLK Frequency                                |                                     | 0               |     | 1        | MHz     |
| $T_{CL}$ , CLK Low Time                              |                                     | 200             |     |          | ns      |
| $T_{CH}$ , CLK High Time                             |                                     | 200             |     |          | ns      |

**Electrical Characteristics:  $8.0V \leq V_{BB} \leq 16.5V$ ,  $Gnd = 0V$ ,  $-40^{\circ}C \leq T_j \leq 105^{\circ}C$ ; unless otherwise stated.**

| PARAMETER                                                       | TEST CONDITIONS | MIN  | TYP | MAX  | UNIT    |
|-----------------------------------------------------------------|-----------------|------|-----|------|---------|
| <b>■ AC Characteristics: Input and Output Timing: continued</b> |                 |      |     |      |         |
| $T_{CR}$ , CLK Rise Time                                        |                 |      |     | 100  | ns      |
| $T_{CF}$ , CLK Fall Time                                        |                 |      |     | 100  | ns      |
| $T_{CD}$ , CLK Low to $D_{OUT}$ Propagation Delay               |                 |      |     | 200  | ns      |
| $T_{DR}$ , $D_{OUT}$ Rise Time                                  |                 |      |     | 200  | ns      |
| $T_{DF}$ , $D_{OUT}$ Fall Time                                  |                 |      |     | 200  | ns      |
| $T_{SC}$ , STB Low to CLK High Time                             |                 | 50   |     |      | ns      |
| $T_{ST}$ , STB High Time                                        |                 | 500  |     |      | ns      |
| $T_{AN}$ , STB High to Anode Output Propagation Delay           |                 |      |     | 5.0  | $\mu s$ |
| $T_{GL}$ , Grid Turn On Propagation Delay                       | $V_{BB} = 12V$  |      |     | 2    | $\mu s$ |
| $T_{GO}$ , Grid Turn Off Propagation Delay                      | $V_{BB} = 12V$  |      |     | 5    | $\mu s$ |
| $T_{GR}$ , Grid Rise Time                                       | At rated load.  | 0.50 |     | 2.00 | $\mu s$ |
| $T_{GF}$ , Grid Fall Time                                       | At rated load.  | 0.35 |     | 2.00 | $\mu s$ |
| $T_{AR}$ , Anode Rise Time                                      | At rated load.  | 0.40 |     | 2.00 | $\mu s$ |
| $T_{AF}$ , Anode Fall Time                                      | At rated load.  | 0.40 |     | 2.50 | $\mu s$ |

Note: Grid and anode rise / fall times are measured from 10% and 90% points.

Output currents are at the maximum rated currents for the respective stages.

**Package Lead Description**

| PACKAGE LEAD # |          |          | LEAD SYMBOL              | FUNCTION          |
|----------------|----------|----------|--------------------------|-------------------|
| 40L DIP        | 44L PLCC | 48L LQFP | (29 Anode Configuration) |                   |
| 1              | 14       | 8        | GRID1                    | 50mA grid output. |
| 2              | 15       | 9        | GRID2                    | 50mA grid output. |
| 3              | 16       | 10       | GRID3                    | 50mA grid output. |
| 4              | 17       | 11       | AN1                      | 2mA anode output. |
| 5              | 18       | 13       | AN2                      | 2mA anode output. |
| 6              | 19       | 14       | AN3                      | 2mA anode output. |
| 7              | 20       | 15       | AN4                      | 2mA anode output. |
| 8              | 21       | 16       | AN5                      | 2mA anode output. |
| 9              | 22       | 17       | AN6                      | 2mA anode output. |
| 10             | 24       | 19       | AN7                      | 2mA anode output. |
| 11             | 25       | 20       | AN8                      | 2mA anode output. |
| 12             | 26       | 21       | AN9                      | 2mA anode output. |
| 13             | 27       | 22       | AN10                     | 2mA anode output. |
| 14             | 28       | 23       | AN11                     | 2mA anode output. |
| 15             | 29       | 25       | AN12                     | 2mA anode output. |
| 16             | 30       | 26       | AN13                     | 2mA anode output. |

## Package Lead Description: continued

| PACKAGE LEAD # |                   |                                  | LEAD SYMBOL              | FUNCTION                                               |
|----------------|-------------------|----------------------------------|--------------------------|--------------------------------------------------------|
| 40L DIP        | 44L PLCC          | 48L LQFP                         | (29 Anode Configuration) |                                                        |
| 17             | 31                | 27                               | AN14                     | 2mA anode output.                                      |
| 18             | 32                | 28                               | AN15                     | 2mA anode output.                                      |
| 19             | 33                | 29                               | AN16                     | 2mA anode output.                                      |
| 20             | 35                | 31                               | Gnd                      | Ground connection.                                     |
| 21             | 36                | 32                               | AN17                     | 2mA anode output.                                      |
| 22             | 37                | 33                               | AN18                     | 2mA anode output.                                      |
| 23             | 38                | 34                               | AN19                     | 2mA anode output.                                      |
| 24             | 39                | 35                               | AN20                     | 2mA anode output.                                      |
| 25             | 40                | 37                               | AN21                     | 2mA anode output.                                      |
| 26             | 41                | 38                               | AN22                     | 2mA anode output.                                      |
| 27             | 42                | 39                               | AN23                     | 2mA anode output.                                      |
| 28             | 43                | 40                               | AN24                     | 20mA anode output.                                     |
| 29             | 44                | 41                               | AN25                     | 20mA anode output.                                     |
| 30             | 2                 | 43                               | AN26                     | 20mA anode output.                                     |
| 31             | 3                 | 44                               | AN27                     | 20mA anode output.                                     |
| 32             | 4                 | 45                               | AN28                     | 20mA anode output.                                     |
| 33             | 5                 | 46                               | AN29                     | 20mA anode output.                                     |
| 34             | 6                 | 47                               | D <sub>OUT</sub>         | Shift register data output.                            |
| 35             | 7                 | 1                                | D <sub>IN</sub>          | Shift register data input.                             |
| 36             | 8                 | 2                                | CLK                      | Shift register clock input.                            |
| 37             | 9                 | 3                                | STB                      | Transfer contents of shift registers to output stages. |
| 38             | 10                | 4                                | GREN                     | Grid outputs enable.                                   |
| 39             | 1, 11, 12, 23, 34 | 5, 6, 12, 18, 24, 30, 36, 42, 48 | NC                       | No Connection.                                         |
| 40             | 13                | 7                                | V <sub>BB</sub>          | Supply voltage input.                                  |

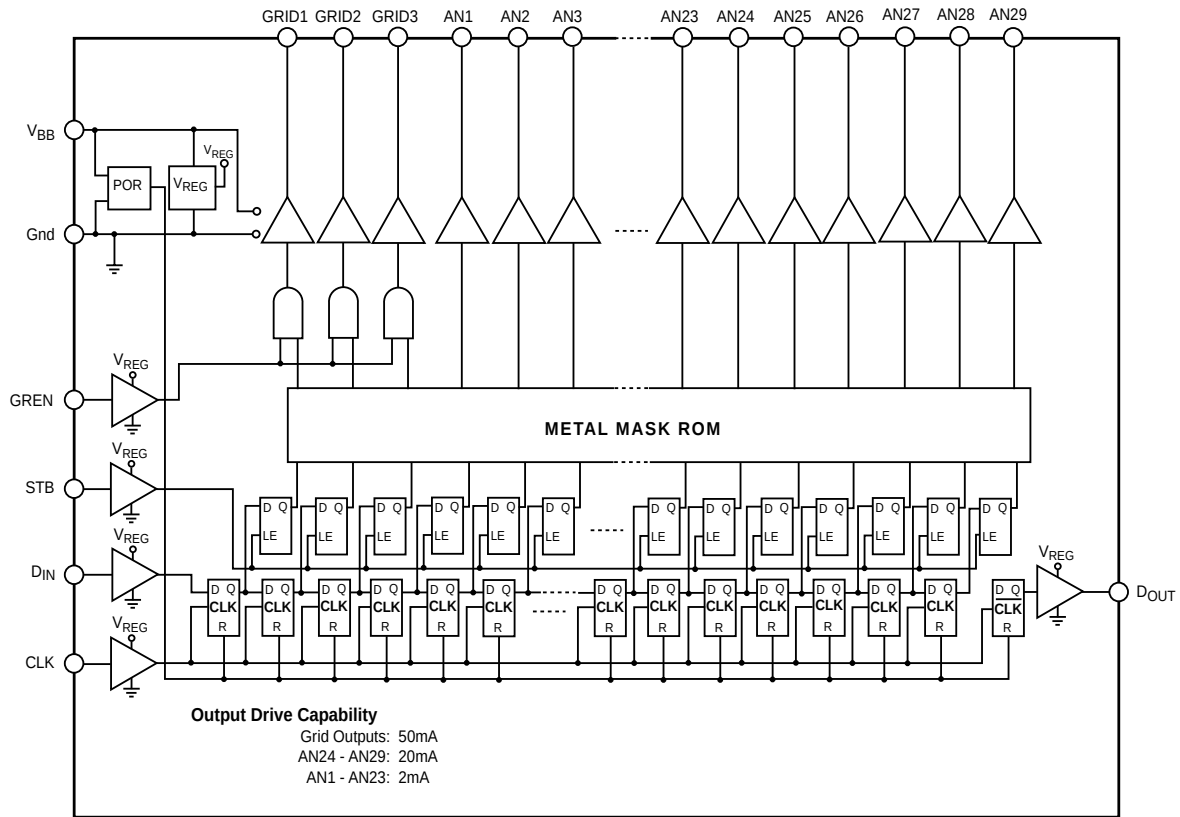
## Operation Description

Upon the initial application of power, the power on reset function will cause all of the anode and grid driver outputs to be off and all shift register outputs to be set low. Data is fed into the shift register through the D<sub>IN</sub> pin at the rising edge of the CLK input. Thirty two bits of data are capable of being stored by the shift register. Once the desired pattern is stored in the shift register, it can be transferred to the latch by setting the STB input high. The output of each latch drives its corresponding output stage. A logic high input to the shift register / latch will cause the corresponding output to turn on. A logic low input to the shift register / latch will cause the corresponding output to turn off. Please note that if the STB is held high, the outputs of the latch reflect the outputs of the corresponding shift register bits and will change if data is shifted in.

The three GRID outputs are gated by the GREN input. When GREN is low, the GRID outputs are forced low regardless of the state of the corresponding latch output. When GREN is high, the GRID outputs correspond to the state of their respective latch outputs. The anode outputs, AN1 to AN29 are always enabled.

The D<sub>OUT</sub> pin is the output of the last stage of the shift register to allow serial cascading of this IC with other devices. Data from the last stage of the shift register is supplied to the D<sub>OUT</sub> pin delayed by 1/2 CLK cycle. Data on the D<sub>OUT</sub> output changes with the falling edges of the CLK to prevent logic race conditions between the CLK and the D<sub>IN</sub> of the next IC in the serial chain.

## Block Diagram



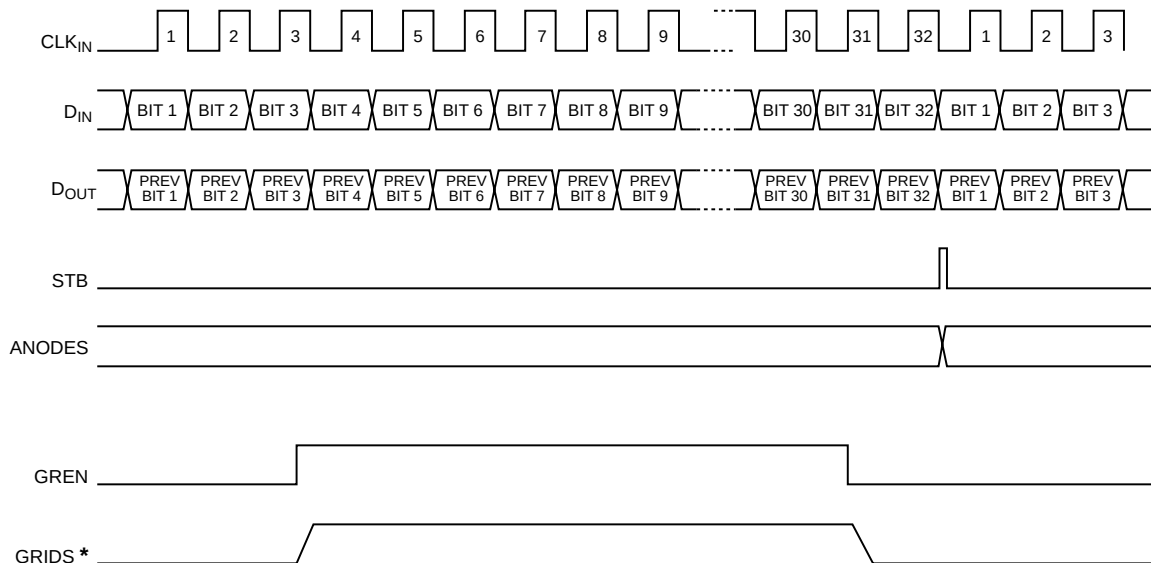
## Application Information

| Bit #    | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13  | 14  | 15  | 16  |
|----------|----|----|----|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|
| Pin Name | G1 | G2 | G3 | A1 | A2 | A3 | A4 | A5 | A6 | A7 | A8 | A9 | A10 | A11 | A12 | A13 |

| Bit #    | 17  | 18  | 19  | 20  | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  |
|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Pin Name | A14 | A15 | A16 | A17 | A18 | A19 | A20 | A21 | A22 | A23 | A24 | A25 | A26 | A27 | A28 | A29 |

**Table 1: Bit Pattern, G = Grid, A = Anode.**

## Typical Operation



\* Selected grid goes high only if input bit pattern from shift register to grid is high.

## Package Specification

## PACKAGE DIMENSIONS IN mm (INCHES)

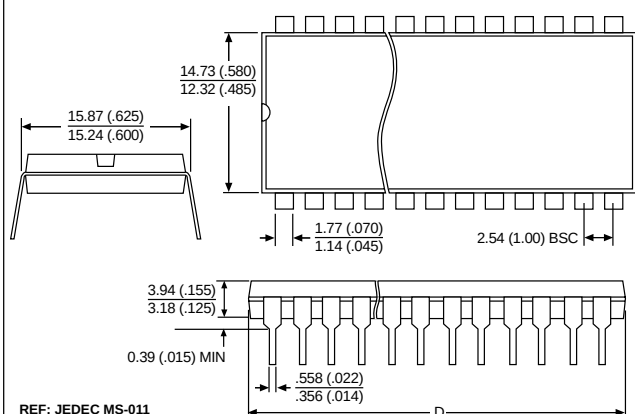
| Lead Count   | D      |      |         |       |
|--------------|--------|------|---------|-------|
|              | Metric |      | English |       |
|              | Max    | Min  | Max     | Min   |
| 40 Lead PDIP | 50.3   | 53.2 | 1.980   | 2.095 |

| Lead Count   | A      |       |         |       | B A B  |      |         |      |
|--------------|--------|-------|---------|-------|--------|------|---------|------|
|              | Metric |       | English |       | Metric |      | English |      |
|              | Max    | Min   | Max     | Min   | Max    | Min  | Max     | Min  |
| 44 Lead PLCC | 17.65  | 17.40 | 16.66   | 16.51 | .695   | .685 | .656    | .650 |

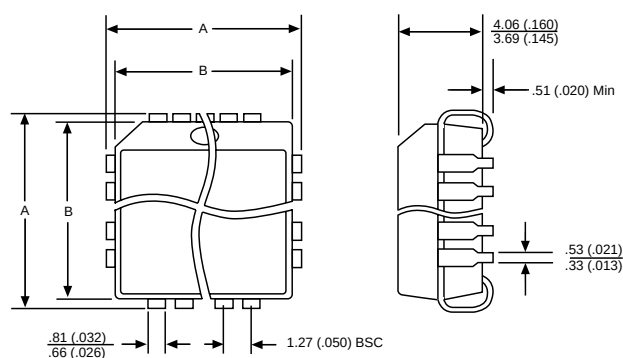
## PACKAGE THERMAL DATA

| Thermal Data    |     | 40 Lead PDIP | 44 Lead PLCC | 48 Lead LQFP |                      |
|-----------------|-----|--------------|--------------|--------------|----------------------|
| $R_{\theta JC}$ | typ | 20           | 16           | —            | $^{\circ}\text{C/W}$ |
| $R_{\theta JA}$ | typ | 45           | 55           | —            | $^{\circ}\text{C/W}$ |

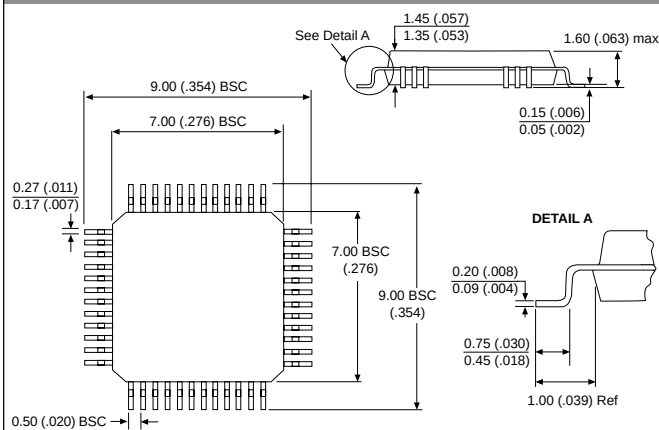
## Plastic DIP (N); 600 mil wide



## PLCC (FN)



## 48 Lead LQFP (FT) 7 × 7mm Body



## Ordering Information

| Part Number  | Description                |
|--------------|----------------------------|
| CS1087XN40   | 40 Lead PDIP               |
| CS1087XFN44  | 44 Lead PLCC               |
| CS1087XFNR44 | 44 Lead PLCC (tape & reel) |
| CS1087XFT48  | 48 Lead LQFP               |
| CS1087XFTR48 | 48 Lead LQFP (tape & reel) |

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