

June 1994

## 6-Bit, 30 MSPS Flash A/D Converter

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- 30 MSPS with No Missing Codes
- 20MHz Full Power Input Bandwidth
- No Missing Codes Over Temperature
- Sample and Hold Not Required
- Single +5V Supply Voltage
- CMOS/TTL
- Overflow Bit

### Applications

- Video Digitizing
- Radar Systems
- Medical Imaging
- Communication Systems
- High Speed Data Acquisition Systems

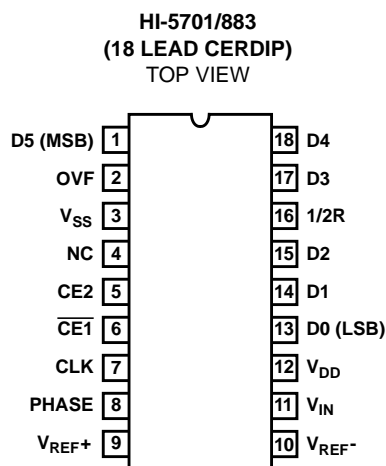
### Description

The HI-5701/883 is a monolithic, 6-bit, CMOS Flash Analog-to-Digital Converter. It is designed for high speed applications where wide bandwidth and low power consumption are essential. Its 30 MSPS speed is made possible by a parallel architecture which also eliminates the need for an external sample and hold circuit. The HI-5701/883 delivers  $\pm 0.7$  LSB differential nonlinearity while consuming only 250mW (typical) at 30 MSPS. Microprocessor compatible data output latches are provided which present valid data to the output bus 1.5 clock cycles after the convert command is received. An overflow bit is provided to allow the series connection of two converters to achieve 7-bit resolution.

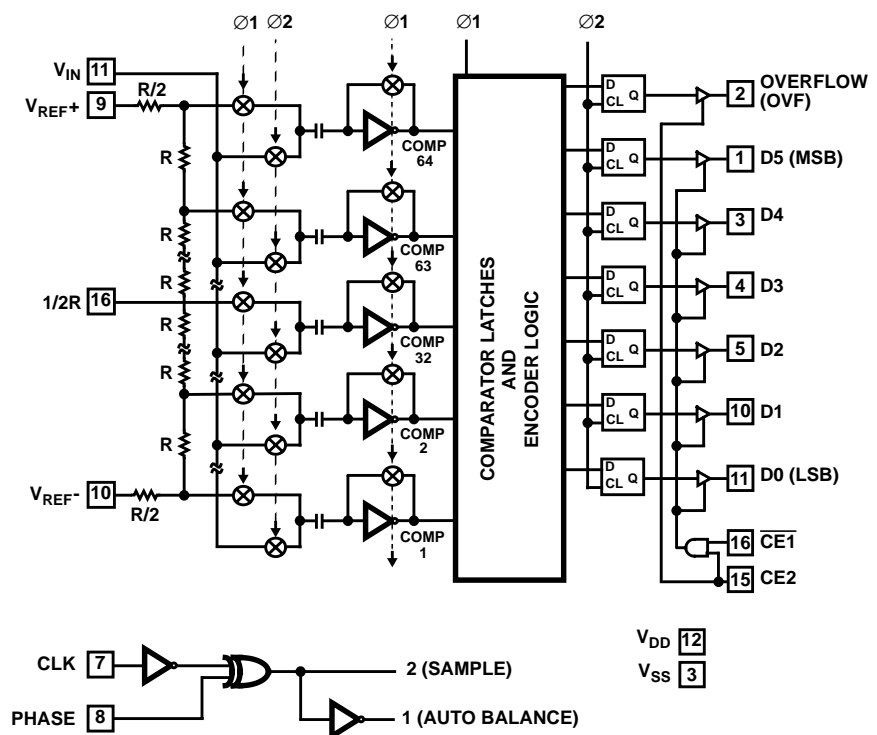
### Ordering Information

| PART NUMBER   | TEMPERATURE RANGE | PACKAGE        |
|---------------|-------------------|----------------|
| HI1-5701T/883 | -55°C to +125°C   | 18 Lead CerDIP |

### Pinout



### Functional Block Diagram



**Pin Description**

| PIN # | NAME              | DESCRIPTION   |
|-------|-------------------|---|
| 1     | D5                | Bit 6, Output (MSB)   |
| 2     | OVF               | Overflow, Output  |
| 3     | V <sub>SS</sub>   | Digital Ground  |
| 4     | NC                | No Connection   |
| 5     | CE2               | Three-State Output Enable Input, Active high (See Truth Table)  |
| 6     | $\overline{CE1}$  | Three-State Output Enable Input, Active Low (See Truth Table)   |
| 7     | CLK               | Clock Input   |
| 8     | PHASE             | Sample Clock Phase Control Input. When Phase is Low, Sample Unknown ( $\phi1$ ) occurs when the Clock is Low and Auto Balance ( $\phi2$ ) occurs when the Clock is High (See Phase Control Table) |
| 9     | V <sub>REF+</sub> | Reference Voltage Positive Input  |
| 10    | V <sub>REF-</sub> | Reference Voltage Negative Input  |
| 11    | V <sub>IN</sub>   | Analog Signal Input   |
| 12    | V <sub>DD</sub>   | Power Supply, +5V   |
| 13    | D0                | Bit 1, Output (LSB)   |
| 14    | D1                | Bit 2, Output   |
| 15    | D2                | Bit 3, Output   |
| 16    | 1/2R              | Reference Ladder Midpoint   |
| 17    | D3                | Bit 4, Output   |
| 18    | D4                | Bit 5, Output   |

**Chip Enable Truth Table**

| $\overline{CE1}$ | CE2 | D0 - D5     | OVF         |
|------------------|-----|-------------|-------------|
| 0                | 1   | Valid       | Valid       |
| 1                | 1   | Three-State | Valid       |
| X                | 0   | Three-State | Three-State |

X = Don't Care.

**Phase Control**

| CLOCK | PHASE | INTERNAL GENERATION        |
|-------|-------|----------------------------|
| 0     | 0     | Sample Unknown ( $\phi2$ ) |
| 0     | 1     | Auto Balance ( $\phi1$ )   |
| 1     | 0     | Auto Balance ( $\phi1$ )   |
| 1     | 1     | Sample Unknown ( $\phi2$ ) |

## Specifications HI-5701/883

### Absolute Maximum Ratings

|  |  |
|--|--|
| Supply Voltage, $V_{DD}$ to $V_{SS}$ . . . . . | $(V_{SS} - 0.5) < V_{DD} < +7.0V$            |
| Analog and Reference Input Pins. . . . .       | $(V_{SS} - 0.5) < V_{INA} < (V_{DD} + 0.5V)$ |
| Digital I/O Pins . . . . .                     | $(V_{SS} - 0.5) < V_{I/O} < (V_{DD} + 0.5V)$ |
| Operating Temperature Range                    |  |
| HI1-5701T/883 . . . . .                        | -55°C to +125°C                              |
| Junction Temperature . . . . .                 | +175°C                                       |
| Storage Temperature Range . . . . .            | -65°C to +150°C                              |
| Lead Temperature (Soldering, 10s) . . . . .    | 300°C  |
| ESD Classification . . . . .                   | Class 1                                      |

### Thermal Information

|   |               |                           |
|---|---------------|---------------------------|
| Thermal Resistance                            | $\theta_{JA}$ | $\theta_{JC}$             |
| HI1-5701T/883. . . . .                        | 70°C/W        | 28°C/W                    |
| Power Dissipation at +75°C (Note 1)           |               |                           |
| HI1-5701T/883. . . . .                        |               | 1.4mW                     |
| Power Dissipation Derating Factor Above +75°C |               |                           |
| HI1-5701T/883. . . . .                        |               | 14mW/°C                   |
| Reliability Information                       |               |                           |
| Transistor Count . . . . .                    |               | 4815                      |
| Worst Case Density . . . . .                  |               | $3.05 \times 10^4 A/cm^2$ |

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at:  $V_{DD} = +5.0V$ ;  $V_{REF+} = +4.0V$ ;  $V_{REF-} = V_{SS} = GND$ ;  $F_S =$  Specified Clock Frequency at 50% Duty Cycle;  $C_L = 30pF$ ; Unless Otherwise Specified.

| PARAMETERS   | SYMBOL   | CONDITIONS                 | GROUP A SUBGROUP | TEMPERATURE   | LIMITS |       | UNIT |
|--|----------|----------------------------|------------------|---------------|--------|-------|------|
|  |          |                            |                  |               | MIN    | MAX   |      |
| <b>ACCURACY</b>  |          |                            |                  |               |        |       |      |
| Integral Linearity Error (Best Fit Method)                 | INL      | $F_S = 20MHz, f_{IN} = DC$ | 1                | +25°C         | -      | ±1.25 | LSB  |
|  |          |                            | 2, 3             | +125°C, -55°C | -      | ±2.0  | LSB  |
|  |          | $F_S = 30MHz, f_{IN} = DC$ | 1                | +25°C         | -      | ±1.5  | LSB  |
|  |          |                            | 2, 3             | +125°C, -55°C | -      | ±2.5  | LSB  |
| Differential Linearity Error (Guaranteed No Missing Codes) | DNL      | $F_S = 20MHz, f_{IN} = DC$ | 1                | +25°C         | -      | ±0.6  | LSB  |
|  |          |                            | 2, 3             | +125°C, -55°C | -      | ±0.75 | LSB  |
|  |          | $F_S = 30MHz, f_{IN} = DC$ | 1                | +25°C         | -      | ±0.75 | LSB  |
|  |          |                            | 2, 3             | +125°C, -55°C | -      | ±1.0  | LSB  |
| Offset Error (Adjustable to Zero)                          | VOS      | $F_S = 20MHz, f_{IN} = DC$ | 1                | +25°C         | -      | ±2.0  | LSB  |
|  |          |                            | 2, 3             | +125°C, -55°C | -      | ±2.5  | LSB  |
| Full Scale Error (Adjustable to Zero)                      | FSE      | $F_S = 20MHz, f_{IN} = DC$ | 1                | +25°C         | -      | ±2.0  | LSB  |
|  |          |                            | 2, 3             | +125°C, -55°C | -      | ±2.5  | LSB  |
| <b>ANALOG INPUT</b>  |          |                            |                  |               |        |       |      |
| Analog Input Resistance                                    | $R_{IN}$ | $V_{IN} = 4V$              | 1                | +25°C         | 4      | -     | MΩ   |
|  |          |                            | 2, 3             | +125°C, -55°C | 4      | -     | MΩ   |
| Analog Input Bias Current                                  | $I_B$    | $V_{IN} = 0V, 4V$          | 1                | +25°C         |        | ±1.0  | μA   |
|  |          |                            | 2, 3             | +125°C, -55°C |        | ±1.0  | μA   |
| <b>REFERENCE INPUT</b>                                     |          |                            |                  |               |        |       |      |
| Total Reference Resistance                                 | $R_L$    |                            | 1                | +25°C         | 250    | -     | Ω    |
|  |          |                            | 2, 3             | +125°C, -55°C | 235    | -     | Ω    |

## Specifications HI-5701/883

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at:  $V_{DD} = +5.0V$ ;  $V_{REF+} = +4.0V$ ;  $V_{REF-} = V_{SS} = GND$ ;  $F_S =$  Specified Clock Frequency at 50% Duty Cycle;  $C_L = 30pF$ ;  
Unless Otherwise Specified.

| PARAMETERS                    | SYMBOL       | CONDITIONS               | GROUP A<br>SUBGROUP | TEMPERATURE   | LIMITS |      | UNIT |
|-------------------------------|--------------|--------------------------|---------------------|---------------|--------|------|------|
|                               |              |                          |                     |               | MIN    | MAX  |      |
| <b>DIGITAL INPUTS</b>         |              |                          |                     |               |        |      |      |
| Input High Voltage            | $V_{IH}$     |                          | 1                   | +25°C         | 2.0    | -    | V    |
|                               |              |                          | 2, 3                | +125°C, -55°C | 2.0    | -    | V    |
| Input Low Voltage             | $V_{IL}$     |                          | 1                   | +25°C         | -      | 0.8  | V    |
|                               |              |                          | 2, 3                | +125°C, -55°C | -      | 0.8  | V    |
| Logic Input Current           | $I_{IN}$     | $V_{IN} = 0V, +5V$       | 1                   | +25°C         | -      | ±1   | μA   |
|                               |              |                          | 2, 3                | +125°C, -55°C | -      | ±1   | μA   |
| <b>DIGITAL OUTPUTS</b>        |              |                          |                     |               |        |      |      |
| Output Leakage                | $I_{OZ}$     | $CE2 = 0V, V_O = 0V, 5V$ | 1                   | +25°C         | -      | ±1.0 | μA   |
|                               |              |                          | 2, 3                | +125°C, -55°C | -      | ±1.0 | μA   |
| Output Logic Source Current   | $I_{OH}$     | $V_O = 4.5V$             | 1                   | +25°C         | -3.2   | -    | mA   |
|                               |              |                          | 2, 3                | +125°C, -55°C | -3.2   | -    | mA   |
| Output Logic Sink Current     | $I_{OL}$     | $V_O = 0.4V$             | 1                   | +25°C         | 3.2    | -    | mA   |
|                               |              |                          | 2, 3                | +125°C, -55°C | 3.2    | -    | mA   |
| <b>POWER SUPPLY REJECTION</b> |              |                          |                     |               |        |      |      |
| Offset Error PSRR             | $\Delta VOS$ | $V_{DD} = 5V \pm 10\%$   | 1                   | +25°C         | -      | ±1.0 | LSB  |
|                               |              |                          | 2, 3                | +125°C, -55°C | -      | ±1.5 | LSB  |
| Gain Error PSRR               | $\Delta FSE$ | $V_{DD} = 5V \pm 10\%$   | 1                   | +25°C         | -      | ±1.0 | LSB  |
|                               |              |                          | 2, 3                | +125°C, -55°C | -      | ±1.5 | LSB  |
| <b>POWER SUPPLY CURRENT</b>   |              |                          |                     |               |        |      |      |
| Supply Current                | $I_{DD}$     | $F_S = 30MHz$            | 1                   | +25°C         | -      | 60   | mA   |
|                               |              |                          | 2, 3                | +125°C, -55°C | -      | 75   | mA   |

**NOTE:**

1. Dissipation rating assumes device is mounted with all leads soldered to printed circuit board.

## Specifications HI-5701/883

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at:  $V_{DD} = +5.0V$ ;  $V_{REF+} = +4.0V$ ;  $V_{REF-} = V_{SS} = GND$ ;  $F_S =$  Specified Clock Frequency at 50% Duty Cycle;  $C_L = 30pF$ ;  
Unless Otherwise Specified.

| PARAMETER                | SYMBOL    | CONDITIONS       | GROUP A SUBGROUP | TEMPERATURE   | LIMITS |     | UNIT |
|--------------------------|-----------|------------------|------------------|---------------|--------|-----|------|
|                          |           |                  |                  |               | MIN    | MAX |      |
| Maximum Conversion Rate  |           | No Missing Codes | 9                | +25°C         | 30     | -   | MSPS |
|                          |           |                  | 10, 11           | +125°C, -55°C | 30     | -   | MSPS |
| Data Output Enable Time  | $t_{EN}$  |                  | 9                | +25°C         | -      | 20  | ns   |
|                          |           |                  | 10, 11           | +125°C, -55°C | -      | 20  | ns   |
| Data Output Disable Time | $t_{DIS}$ |                  | 9                | +25°C         | -      | 20  | ns   |
|                          |           |                  | 10, 11           | +125°C, -55°C | -      | 20  | ns   |
| Data Output Delay        | $t_{OD}$  |                  | 9                | +25°C         | -      | 20  | ns   |
|                          |           |                  | 10, 11           | +125°C, -55°C | -      | 20  | ns   |
| Data Output Hold         | $t_H$     |                  | 9                | +25°C         | 10     | -   | ns   |
|                          |           |                  | 10, 11           | +125°C, -55°C | 5      | -   | ns   |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (NOTE 1)**

Device Characterized at:  $V_{DD} = +5.0V$ ;  $V_{REF+} = +4.0V$ ;  $V_{REF-} = V_{SS} = GND$ ;  $F_S =$  Specified Clock Frequency at 50% Duty Cycle;  $C_L = 30pF$ ;  
Unless Otherwise Specified.

| PARAMETER               | SYMBOL | CONDITIONS       | TEMPERATURE          | LIMITS |       | UNIT |
|-------------------------|--------|------------------|----------------------|--------|-------|------|
|                         |        |                  |                      | MIN    | MAX   |      |
| Minimum Conversion Rate |        | No Missing Codes | +25°C, +125°C, -55°C | -      | 0.125 | MSPS |

NOTE:

- Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS               | SUBGROUPS (SEE TABLES 1 AND 2) |
|---|--------------------------------|
| Interim Electrical Parameters (Pre Burn-In) | 1                              |
| Final Electrical Test Parameters            | 1 (Note 1), 2, 3, 9, 10, 11    |
| Group A Test Requirements                   | 1, 2, 3, 9, 10, 11             |
| Groups C and D Endpoints                    | 1                              |

NOTE:

- PDA applies to Subgroup 1 only. No other subgroups are included in PDA.

**Die Characteristics**

**DIE DIMENSIONS:**

2220 $\mu$ m x 3320 $\mu$ m x 19  $\pm$  1mils

**METALLIZATION:**

Type: Si - Al  
 Thickness: 11k $\text{\AA}$   $\pm$  1k $\text{\AA}$

**GLASSIVATION:**

Type: SiO<sub>2</sub>  
 Thickness: 8k $\text{\AA}$   $\pm$  1k $\text{\AA}$

**DIE ATTACH:**

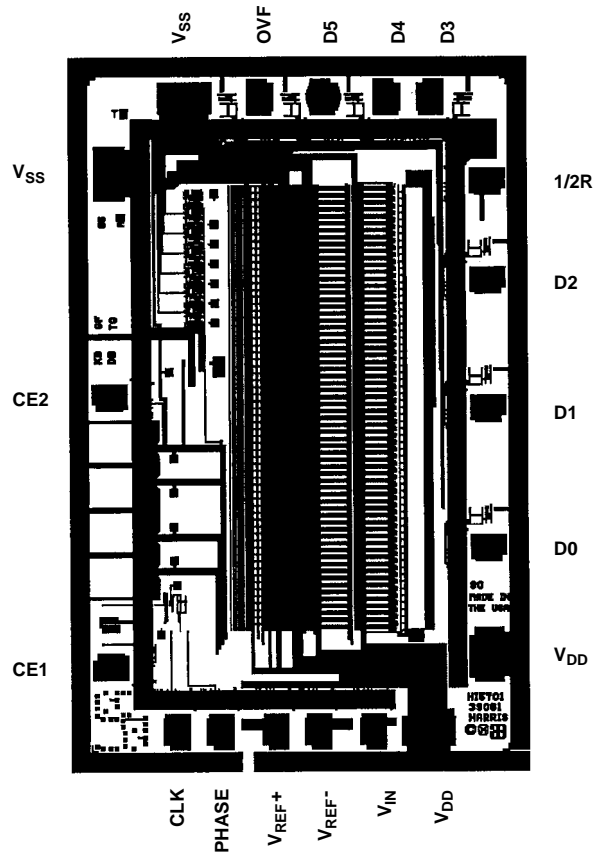
Material: Gold Silicon Eutectic Alloy  
 Temperature: Ceramic DIP - 460 $^{\circ}$ C (Max)

**WORST CASE CURRENT DENSITY:**

3.05 x 10<sup>4</sup> A/cm<sup>2</sup>

**Metallization Mask Layout**

HI-5701/883



**Timing Waveforms**

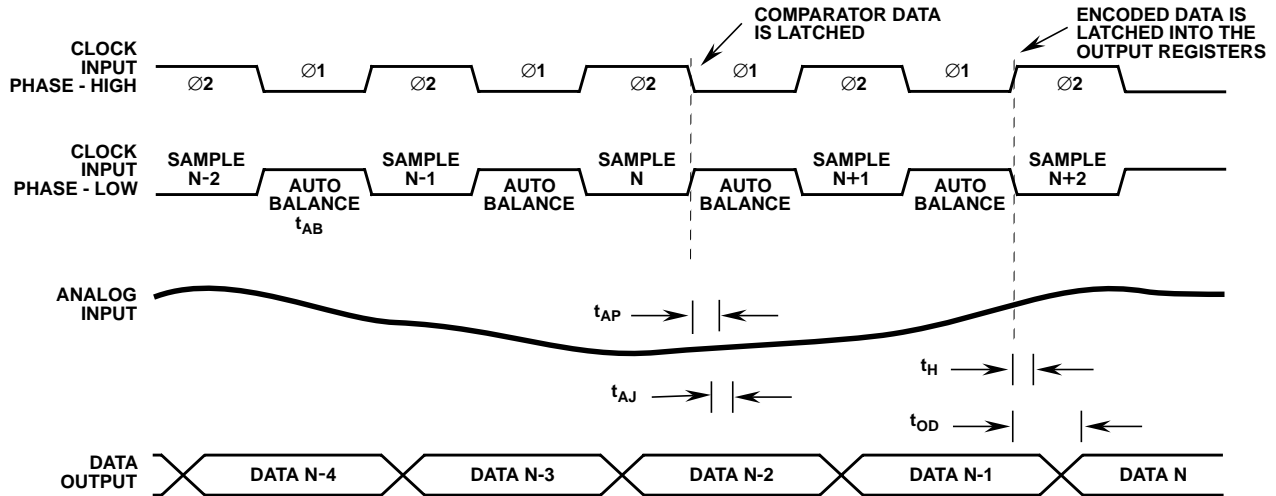


FIGURE 1. INPUT-TO-OUTPUT TIMING

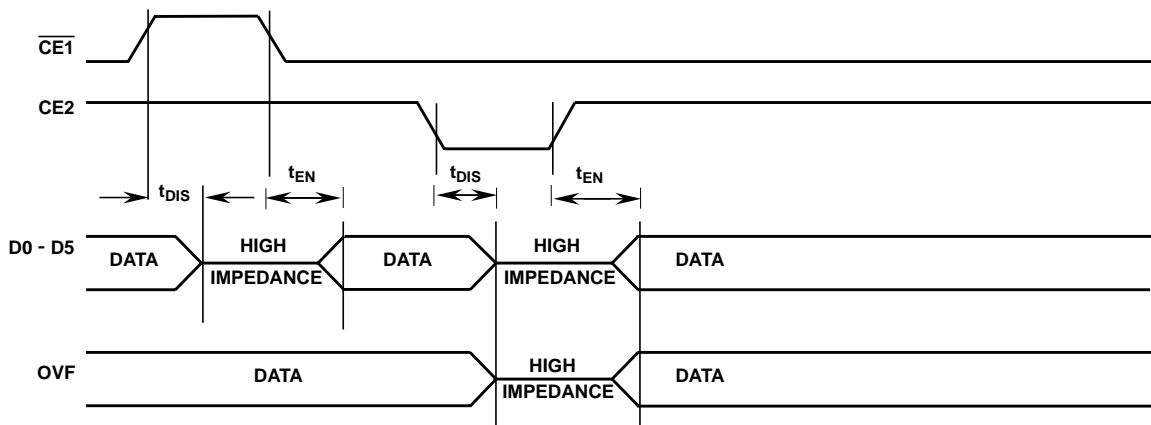
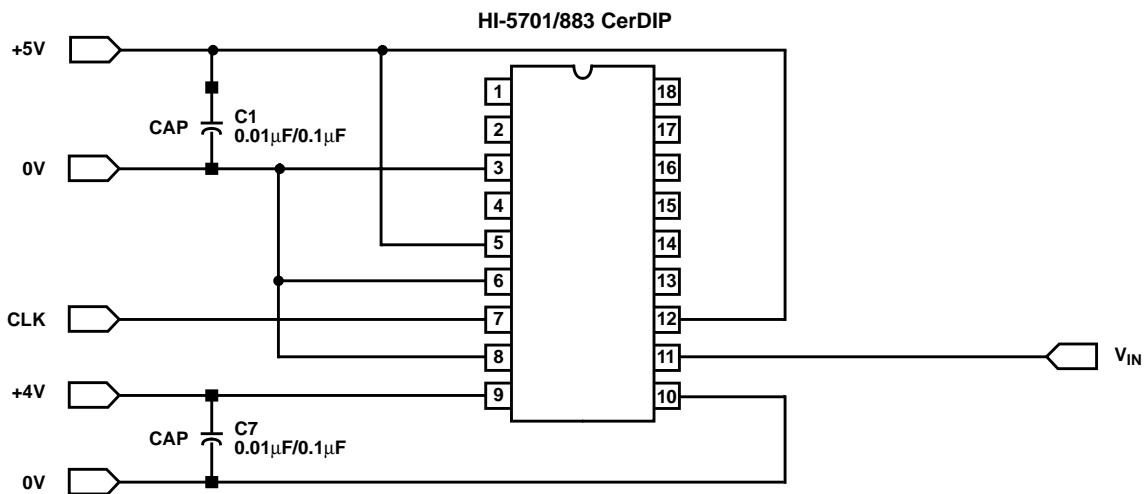


FIGURE 2. OUTPUT ENABLE TIMING

**Burn-In Circuit**

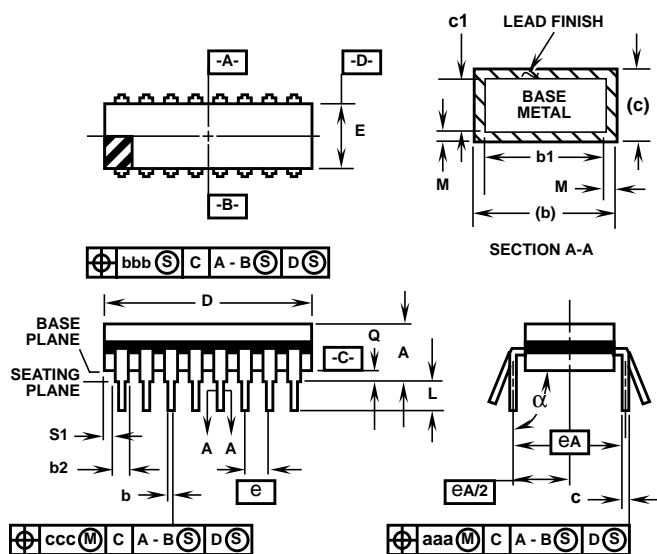


NOTES:

1. Power supply and the reference voltage input to be decoupled by 0.01 $\mu$ F in parallel with 1 $\mu$ F capacitor
2. Clock input is a pulse with 1:10 duty cycle, approximately 100KHz and 0V to 4V amplitude
3.  $V_{IN}$ , analog input is a slow triangular waveform ( $F_{IN} = 10$ KHz) and 0V to 4V amplitude
4. All supplies to be protected with <7V zener diodes

**Packaging**

**FRIT SEAL DUAL-IN-LINE CERAMIC PACKAGE**



**F18.3 MIL-STD-1835 GDIP1-T18 (D-6, CONFIGURATION A)  
18 LEAD FRIT SEAL DUAL-IN-LINE CERAMIC PACKAGE**

| SYMBOL   | INCHES    |        | MILLIMETERS |       | NOTES |
|----------|-----------|--------|-------------|-------|-------|
|          | MIN       | MAX    | MIN         | MAX   |       |
| A        | -         | 0.200  | -           | 5.08  | -     |
| b        | 0.014     | 0.026  | 0.36        | 0.66  | 2     |
| b1       | 0.014     | 0.023  | 0.36        | 0.58  | 3     |
| b2       | 0.045     | 0.065  | 1.14        | 1.65  | -     |
| b3       | 0.023     | 0.045  | 0.58        | 1.14  | 4     |
| c        | 0.008     | 0.018  | 0.20        | 0.46  | 2     |
| c1       | 0.008     | 0.015  | 0.20        | 0.38  | 3     |
| D        | -         | 0.960  | -           | 24.38 | 5     |
| E        | 0.220     | 0.310  | 5.59        | 7.87  | 5     |
| e        | 0.100 BSC |        | 2.54 BSC    |       | -     |
| eA       | 0.300 BSC |        | 7.62 BSC    |       | -     |
| eA/2     | 0.150 BSC |        | 3.81 BSC    |       | -     |
| L        | 0.125     | 0.200  | 3.18        | 5.08  | -     |
| Q        | 0.015     | 0.070  | 0.38        | 1.78  | 6     |
| S1       | 0.005     | -      | 0.13        | -     | 7     |
| S2       | 0.005     | -      | 0.13        | -     | -     |
| $\alpha$ | 90°       | 105°   | 90°         | 105°  | -     |
| aaa      | -         | 0.015  | -           | 0.38  | -     |
| bbb      | -         | 0.030  | -           | 0.76  | -     |
| ccc      | -         | 0.010  | -           | 0.25  | -     |
| M        | -         | 0.0015 | -           | 0.038 | 2     |
| N        | 18        |        | 18          |       | 8     |

**NOTES:**

1. Index area: A notch or a pin one identification mark shall be located adjacent to pin one and shall be located within the shaded area shown. The manufacturer's identification shall not be used as a pin one identification mark.
2. The maximum limits of lead dimensions b and c or M shall be measured at the centroid of the finished lead surfaces, when solder dip or tin plate lead finish is applied.
3. Dimensions b1 and c1 apply to lead base metal only. Dimension M applies to lead plating and finish thickness.
4. Corner leads (1, N, N/2, and N/2+1) may be configured with a partial lead paddle. For this configuration dimension b3 replaces dimension b1.

5. This dimension allows for off-center lid, meniscus, and glass overrun.
6. Dimension Q shall be measured from the seating plane to the base plane.
7. Measure dimension S1 at all four corners.
8. N is the maximum number of terminal positions.
9. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
10. Controlling Dimension: Inch.

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