

## DS16F95QML EIA-485/EIA-422A Differential Bus Transceiver

Check for Samples: [DS16F95QML](#)

### FEATURES

- **Radiation Ensured 300 krad(Si)**
- **Meets EIA-485 and EIA-422A**
- **Meets SCSI-1 (5 MHZ) Specifications**
- **Designed for Multipoint Transmission**
- **Wide Positive and Negative Input/Output Bus Voltage Ranges**
- **Thermal Shutdown Protection**
- **Driver Positive and Negative Current-Limiting**
- **High Impedance Receiver Input**
- **Receiver Input Hysteresis of 50 mV Typical**
- **Operates from Single 5.0V Supply**
- **Reduced Power Consumption**
- **Pin Compatible with DS3695 and SN75176A**

### DESCRIPTION

The DS16F95 Differential Bus Transceiver is a monolithic integrated circuit designed for bidirectional data communication on balanced multipoint bus transmission lines. The transceiver meets EIA standard RS-485 as well as RS-422A.

The DS16F95 offers improved performance due to the use of state-of-the-art L-FAST bipolar technology. The L-FAST technology allows for higher speeds and lower currents by utilizing extremely short gate delay times. Thus, the DS16F95QML features lower power, extended temperature range and improved specifications.

The DS16F95 combines a TRI-STATE differential line driver and a differential input line receiver, both of which operate from a single 5.0V power supply. The driver and receiver have an active Enable that can be externally connected to function as a direction control. The driver differential outputs and the receiver differential inputs are internally connected to form differential input/output (I/O) bus ports that are designed to offer minimum loading to the bus whenever the driver is disabled or when  $V_{CC} = 0V$ . These ports feature wide positive and negative common mode voltage ranges, making the device suitable for multipoint applications in noisy environments.

The driver is designed to accommodate loads of up to 60 mA of sink or source current and features positive and negative current limiting in addition to thermal shutdown for protection from line fault conditions.

The DS16F95 can be used in transmission line applications employing the DS96F172 and the DS96F174 quad differential line drivers and the DS96F173 and DS96F175 quad differential line receivers.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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## Connection Diagram

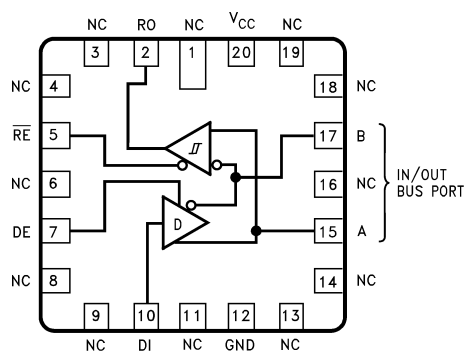


Figure 1. 20-Lead Ceramic Leadless Chip Carrier

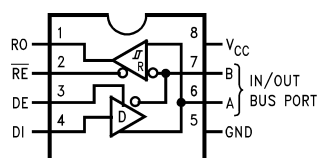


Figure 2. 8-Lead Dual-In-Line Package

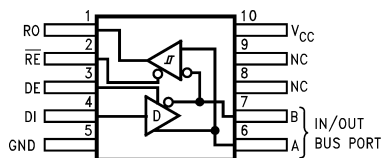
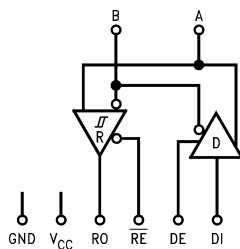


Figure 3. 10-Lead Flatpak Package

### Logic Diagram



## Function Tables

Table 1. Driver<sup>(1)</sup>

| Driver Input | Enable | Outputs |   |
|--------------|--------|---------|---|
| DI           | DE     | A       | B |
| H            | H      | H       | L |
| L            | H      | L       | H |
| X            | L      | Z       | Z |

(1) H = High Level, L = Low Level, X = Immaterial, Z = High Impedance (Off)

**Table 2. Receiver<sup>(1)</sup>**

| Differential Inputs | Enable          | Output |
|---------------------|-----------------|--------|
| A-B                 | $\overline{RE}$ | RO     |
| $V_{ID} \geq 0.2V$  | L               | H      |
| $V_{ID} \leq -0.2V$ | L               | L      |
| X                   | H               | Z      |

(1) H = High Level, L = Low Level, X = Immaterial, Z = High Impedance (Off)



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## Absolute Maximum Ratings<sup>(1)</sup>

|                                                  |                      |                    |                                 |
|--------------------------------------------------|----------------------|--------------------|---------------------------------|
| Storage Temperature Range                        |                      |                    | -65°C ≤ T <sub>A</sub> ≤ +175°C |
| Lead Temperature                                 | (Soldering, 60 sec.) |                    | 300°C                           |
| Maximum Power Dissipation at 25°C <sup>(2)</sup> | LCCC 'NAJ' Package   |                    | 1800 mW                         |
|                                                  | CDIP 'NAB' Package   |                    | 1274 mW                         |
|                                                  | CLGA 'NAD' Package   |                    | 725 mW                          |
| Supply Voltage                                   |                      |                    | 7.0V                            |
| Input Voltage (Bus Terminal)                     |                      |                    | +15V/−10V                       |
| Enable Input Voltage                             |                      |                    | 5.5V                            |
| Junction Temperature (T <sub>J</sub> )           |                      |                    | +175°C                          |
| Thermal Resistance                               | θ <sub>JA</sub>      | LCCC 'NAJ' Package | 83°C/W @ 0.5W                   |
|                                                  |                      | CDIP 'NAB' Package | 118°C/W @ 1.0W                  |
|                                                  |                      | CLGA 'NAD' Package | 207°C/W @ 0.5W                  |
|                                                  | θ <sub>JC</sub>      | LCCC 'NAJ' Package | 17°C/W                          |
|                                                  |                      | CDIP 'NAB' Package | 14°C/W                          |
|                                                  |                      | CLGA 'NAD' Package | 18°C/W                          |
| ESD Tolerance <sup>(3)</sup>                     |                      |                    | 500V                            |

(1) Absolute Maximum Ratings are those values beyond which the safety of the device cannot be ensured. They are not meant to imply that the devices should be operated at these limits. The tables of [Electrical Characteristics](#) provide conditions for actual device operation.

(2) Above T<sub>A</sub> = 25°C, derate NAJ package 12.1mW/°C, NAB package 8.5 mW/°C, NAD package 4.8mW/°C.

(3) Human body model, 1.5kΩ in series with 100pF

## Recommended Operating Conditions

|                                               |                                                                  |                 |
|-----------------------------------------------|------------------------------------------------------------------|-----------------|
| Supply Voltage (V <sub>CC</sub> )             |                                                                  | 4.50 to 5.50V   |
| Voltage at Any Bus Terminal                   | (Separately or Common Mode) (V <sub>I</sub> or V <sub>CM</sub> ) | –7.0V to +12V   |
| Differential Input Voltage (V <sub>ID</sub> ) |                                                                  | –7.0V to ±12V   |
| Output Current HIGH (I <sub>OH</sub> ) Driver | Driver                                                           | –60mA           |
|                                               | Receiver                                                         | –400μA          |
| Output Current LOW (I <sub>OL</sub> )         | Driver                                                           | 60mA            |
|                                               | Receiver                                                         | 16mA            |
| Operating Temperature (T <sub>A</sub> )       |                                                                  | –55°C to +125°C |

## Quality Conformance Inspection

MIL-STD-883, Method 5005 - Group A

| Subgroup | Description         | Temp (°C) |
|----------|---------------------|-----------|
| 1        | Static tests at     | +25       |
| 2        | Static tests at     | +125      |
| 3        | Static tests at     | -55       |
| 4        | Dynamic tests at    | +25       |
| 5        | Dynamic tests at    | +125      |
| 6        | Dynamic tests at    | -55       |
| 7        | Functional tests at | +25       |
| 8A       | Functional tests at | +125      |
| 8B       | Functional tests at | -55       |
| 9        | Switching tests at  | +25       |
| 10       | Switching tests at  | +125      |
| 11       | Switching tests at  | -55       |

## DC - Driver Electrical Characteristics<sup>(1)</sup>

 The following conditions apply to all parameters, unless otherwise specified.  $V_{CC} = 5.5V$ 

| Symbol          | Parameter                                         | Conditions                                 | Notes              | Min  | Max | Unit | Sub-group |
|-----------------|---------------------------------------------------|--------------------------------------------|--------------------|------|-----|------|-----------|
| VOD1            | Differential Vout                                 | $V_{CC} = 5.5V, I_O = 0A, V_{IN} = .8V$    |                    |      | 6   | V    | 1, 2, 3   |
|                 |                                                   | $V_{CC} = 5.5V, I_O = 0A, V_{IN} = 2V$     |                    |      | 6   | V    | 1, 2, 3   |
| VOD2            | Differential Vout (See <a href="#">Figure 4</a> ) | $V_{CC} = 4.5V, R_L = 100\Omega$           |                    | 2    |     | V    | 1, 2, 3   |
|                 |                                                   | $V_{CC} = 4.5V, R_L = 54\Omega$            |                    | 1.5  |     | V    | 1, 2, 3   |
| $\Delta V_{OD}$ | Change In Differential Vout                       | $V_{CC} = 4.5V, R_L = 100\Omega$           | See <sup>(2)</sup> | -200 | 200 | mV   | 1, 2, 3   |
|                 |                                                   | $V_{CC} = 4.5V, R_L = 54\Omega$            |                    | -200 | 200 | mV   | 1, 2, 3   |
| $\Delta V_{OC}$ | Change In Common Mode Vout                        | $V_{CC} = 4.5V, R_L = 100\Omega$           | See <sup>(2)</sup> | -200 | 200 | mV   | 1, 2, 3   |
|                 |                                                   | $V_{CC} = 4.5V, R_L = 54\Omega$            |                    | -200 | 200 | mV   | 1, 2, 3   |
| $V_{OC}$        | Common Mode Vout                                  | $R_L = 100\Omega$                          |                    |      | 3   | V    | 1, 2, 3   |
|                 |                                                   | $R_L = 54\Omega$                           |                    |      | 3   | V    | 1, 2, 3   |
| $I_{IH}$        | Logical "1" Input Current                         | $V_I = 2.4V$                               |                    |      | 20  | uA   | 1, 2, 3   |
| $I_O$           | Output Current                                    | Output Disable, $V_O = 12V$                |                    |      | 1   | mA   | 1, 2, 3   |
|                 |                                                   | Output Disable, $V_O = -7V$                | See <sup>(3)</sup> | -0.8 |     | mA   | 1, 2, 3   |
|                 |                                                   | $V_{CC} = 0$ , Output Disable, $V_O = 12V$ |                    |      | 1   | mA   | 1, 2, 3   |
|                 |                                                   | $V_{CC} = 0$ , Output Disable, $V_O = -7V$ | See <sup>(3)</sup> | -0.8 |     | mA   | 1, 2, 3   |

- (1) Pre and post irradiation limits are identical to those listed under A C and DC electrical characteristics. These parts may be dose rate sensitive in a space environment and demonstrate enhanced low dose rate effect. Radiation end point limits for the noted parameters are ensured only for the conditions as specified in MIL-STD 883, Method 1019, condition A.
- (2)  $\Delta|V_{OD}|$  and  $\Delta|V_{OC}|$  are the changes in magnitude of  $V_{OD}$  and  $V_{OC}$ , respectively, that occur when the input is changed from a high level to a low level.
- (3) Negative sign of the limits indicates the direction of the current flow only.

## DC - Driver Electrical Characteristics<sup>(1)</sup> (continued)

The following conditions apply to all parameters, unless otherwise specified.  $V_{CC} = 5.5V$

| Symbol   | Parameter                  | Conditions                      | Notes              | Min  | Max | Unit | Sub-group |
|----------|----------------------------|---------------------------------|--------------------|------|-----|------|-----------|
| $I_{OS}$ | Output Short Circuit       | $V_{IN} = 3V, V_{OUT} = V_{CC}$ | See <sup>(4)</sup> |      | 150 | mA   | 1, 2, 3   |
|          |                            | $V_{IN} = 3V, V_{OUT} = -7V$    |                    | -250 |     | mA   | 1, 2, 3   |
|          |                            | $V_{IN} = 3V, V_{OUT} = 0V$     |                    | -150 |     | mA   | 1, 2, 3   |
|          |                            | $V_{IN} = 3V, V_{OUT} = 12V$    |                    |      | 250 | mA   | 1, 2, 3   |
|          |                            | $V_{IN} = 0V, V_{OUT} = 12V$    |                    |      | 250 | mA   | 1, 2, 3   |
|          |                            | $V_{IN} = 0V, V_{OUT} = V_{CC}$ |                    |      | 150 | mA   | 1, 2, 3   |
|          |                            | $V_{IN} = 0V, V_{OUT} = -7V$    | See <sup>(4)</sup> | -250 |     | mA   | 1, 2, 3   |
|          |                            | $V_{IN} = 0V, V_{OUT} = 0V$     |                    | -150 |     | mA   | 1, 2, 3   |
| $V_{OH}$ | Logical "1" Output Voltage | $V_{CC} = 4.5V, I_O = -20mA$    |                    | 3    |     | V    | 1, 2, 3   |
| $V_{OL}$ | Logical "0" Output Voltage | $V_{CC} = 4.5V, I_O = 20mA$     |                    |      | 2   | V    | 1, 2, 3   |
| VOD3     | Differential Vout          | $V_{CM} = -7V$ to 12V           |                    | 1    |     | V    | 1, 2, 3   |

(4) Negative sign of the limits indicates the direction of the current flow only.

## DC - Receiver Electrical Characteristics<sup>(1)</sup>

The following conditions apply to all parameters, unless otherwise specified.  $V_{CC} = 5.5V$

| Symbol   | Parameter                                    | Conditions                                       | Notes              | Min | Max | Unit       | Sub-group |
|----------|----------------------------------------------|--------------------------------------------------|--------------------|-----|-----|------------|-----------|
| $V_{OH}$ | Logical "1" Output Voltage<br>(See Figure 5) | $V_{CC} = 4.5V, V_{LD} = 200mV, I_{OH} = -400uA$ |                    | 2.5 |     | V          | 1, 2, 3   |
| $V_{OL}$ | Logical "0" Output Voltage<br>(See Figure 5) | $V_{CC} = 4.5V, V_{LD} = -200mV, I_{OL} = 8mA$   |                    |     | .45 | V          | 1, 2, 3   |
|          |                                              | $V_{CC} = 4.5V, V_{LD} = -200mV, I_{OL} = 16mA$  |                    |     | .5  | V          | 1, 2, 3   |
| $I_I$    | Line Input Current                           | Untested Input = 0V, $V_I = 12V$                 | See <sup>(2)</sup> |     | 1   | mA         | 1, 2, 3   |
|          |                                              | Untested Input = 0V, $V_I = -7V$                 |                    | -.8 |     | mA         | 1, 2, 3   |
|          |                                              | $V_{CC} = 0V$ , Untested Input = 0V, $V_I = 12V$ | See <sup>(2)</sup> |     | 1   | mA         | 1, 2, 3   |
|          |                                              | $V_{CC} = 0V$ , Untested Input = 0V, $V_I = -7V$ |                    | -.8 |     | mA         | 1, 2, 3   |
| $I_{IH}$ | Logical "1" Input Current                    | $V_I = 2.7V$ (Receiver)                          |                    |     | 20  | uA         | 1, 2, 3   |
| $R_{IN}$ | Input Resistance                             | Untested Input = 0V, $V_I = 12V$                 | See <sup>(3)</sup> | 10  |     | K $\Omega$ | 1, 2, 3   |
|          |                                              | Untested Input = 0V, $V_I = -7V$                 |                    | 10  |     | K $\Omega$ | 1, 2, 3   |
|          |                                              | $V_{CC} = 0V$ , Untested Input = 0V, $V_I = 12V$ | See <sup>(3)</sup> | 10  |     | K $\Omega$ | 1, 2, 3   |
|          |                                              | $V_{CC} = 0V$ , Untested Input = 0V, $V_I = -7V$ |                    | 10  |     | K $\Omega$ | 1, 2, 3   |
| $I_{OZ}$ | High Impedance State                         | $V_I = 0.4V$                                     |                    | -20 | 20  | uA         | 1, 2, 3   |
|          |                                              | $V_I = 2.4V$                                     |                    | -20 | 20  | uA         | 1, 2, 3   |

(1) Pre and post irradiation limits are identical to those listed under A C and DC electrical characteristics. These parts may be dose rate sensitive in a space environment and demonstrate enhanced low dose rate effect. Radiation end point limits for the noted parameters are ensured only for the conditions as specified in MIL-STD 883, Method 1019, condition A.

(2) Negative sign of the limits indicates the direction of the current flow only.

(3)  $R_{IN}$  is guaranteed by testing "Line Input Current" ( $I_I$ ).

## DC - Receiver Electrical Characteristics<sup>(1)</sup> (continued)

The following conditions apply to all parameters, unless otherwise specified.  $V_{CC} = 5.5V$

| Symbol                         | Parameter                         | Conditions                                                                                        | Notes | Min | Max | Unit | Sub-group |
|--------------------------------|-----------------------------------|---------------------------------------------------------------------------------------------------|-------|-----|-----|------|-----------|
| $I_{OS}$                       | Output Short Circuit              | $V_{IN} = 1V$ , $V_{OUT} = 0V$                                                                    |       | -85 | -15 | mA   | 1, 2, 3   |
| $V_{TH}$                       | Differential Input High Threshold | $V_{CC} = 4.5V$ , $V_O = 2.5V$ ,<br>$V_{CM} = 12V \text{ \& } 0V \text{ \& } -7V$ , $I_O = -.4mA$ |       |     | .2  | V    | 1, 2, 3   |
|                                |                                   | $V_{CC} = 5.5V$ , $V_O = 2.5V$ ,<br>$V_{CM} = 12V \text{ \& } 0V \text{ \& } -7V$ , $I_O = -.4mA$ |       |     | .2  | V    | 1, 2, 3   |
| $V_{T1}$                       | Differential Input Low Threshold  | $V_{CC} = 4.5V$ , $V_O = .5V$ ,<br>$V_{CM} = 12V \text{ \& } 0V \text{ \& } -7V$ , $I_O = 8mA$    |       | -.2 |     | V    | 1, 2, 3   |
|                                |                                   | $V_{CC} = 5.5V$ , $V_O = .5V$ ,<br>$V_{CM} = 12V \text{ \& } 0V \text{ \& } -7V$ , $I_O = 8mA$    |       | -.2 |     | V    | 1, 2, 3   |
| $V_{TH}^+$<br>- ( $V_{TH}^-$ ) | Hyteresis                         | $V_{CC} = 4.5V$ , $V_{CM} = 0V$                                                                   |       | 35  |     | mV   | 1, 2, 3   |
|                                |                                   | $V_{CC} = 5.5V$ , $V_{CM} = 0V$                                                                   |       | 35  |     | mV   | 1, 2, 3   |

## DC - Both Driver and Receiver Electrical Characteristics<sup>(1)</sup>

The following conditions apply to all parameters, unless otherwise specified.  $V_{CC} = 5.5V$

| Symbol   | Parameter                            | Conditions                                   | Notes              | Min  | Max | Unit | Sub-group |
|----------|--------------------------------------|----------------------------------------------|--------------------|------|-----|------|-----------|
| $I_{CC}$ | Supply Current $I_{CC}$ Both Disable | $\overline{RE} = 2V$ , $\overline{DE} = .8V$ |                    |      | 25  | mA   | 1, 2, 3   |
| $I_{CC}$ | Supply Current $I_{CC}$ Both Enable  | $\overline{RE} = .8V$ , $\overline{DE} = 2V$ |                    |      | 28  | mA   | 1, 2, 3   |
| $V_{IC}$ | Input Clamp Volt                     | $I_I = -18mA$                                |                    | -1.3 |     | V    | 1, 2, 3   |
| $V_{IH}$ | Logical "1" Input Voltage            |                                              |                    | 2    |     | V    | 1, 2, 3   |
| $V_{IL}$ | Logical "0" Input Voltage            |                                              |                    |      | .8  | V    | 1, 2, 3   |
| $V_{IH}$ | Logical "1" Enable Input Voltage     |                                              |                    | 2    |     | V    | 1, 2, 3   |
| $V_{IL}$ | Logical "0" Enable Input Voltage     |                                              |                    |      | .8  | V    | 1, 2, 3   |
| $I_{IL}$ | Logical "0" Input Current            | $V_I = 0.4V$                                 | See <sup>(2)</sup> | -50  |     | uA   | 1, 2, 3   |

- (1) Pre and post irradiation limits are identical to those listed under A C and DC electrical characteristics. These parts may be dose rate sensitive in a space environment and demonstrate enhanced low dose rate effect. Radiation end point limits for the noted parameters are ensured only for the conditions as specified in MIL-STD 883, Method 1019, condition A.

- (2) Negative sign of the limits indicates the direction of the current flow only.

## AC - Driver Electrical Characteristics<sup>(1)</sup>

The following conditions apply to all parameters, unless otherwise specified.

$V_{CC} = 5V$ ,  $PRR = 1MHz$ ,  $T_R \leq T_F \leq 6nS$ , 50% duty cycle,  $AMP = 3V$ ,  $V_{LO}$ ,  $Z_{OUT} = 50\Omega$

| Symbol    | Parameter                                                           | Conditions        | Notes                 | Min | Max | Unit | Sub-group |
|-----------|---------------------------------------------------------------------|-------------------|-----------------------|-----|-----|------|-----------|
| $t_{DD}$  | Differential Output Delay Time<br>(See <a href="#">Figure 6</a> )   | $R_L = 60\Omega$  | See <sup>(2)</sup>    | 8   | 25  | nS   | 9         |
|           |                                                                     |                   |                       | 8   | 30  | nS   | 10, 11    |
| $t_{TD}$  | Differential Output Transition Time (See <a href="#">Figure 6</a> ) | $R_L = 60\Omega$  | See <sup>(2)(3)</sup> | 8   | 25  | nS   | 9         |
|           |                                                                     |                   |                       | 8   | 30  | nS   | 10, 11    |
| $t_{PLH}$ | Propagation Delay Time Low to High (See <a href="#">Figure 7</a> )  | $R_L = 27\Omega$  |                       | 6   | 18  | nS   | 9         |
|           |                                                                     |                   |                       | 6   | 25  | nS   | 10, 11    |
| $t_{PHL}$ | Propagation Delay Time high to Low (See <a href="#">Figure 7</a> )  | $R_L = 27\Omega$  |                       | 6   | 18  | nS   | 9         |
|           |                                                                     |                   |                       | 6   | 25  | nS   | 10, 11    |
| $t_{PZH}$ | Output Enable Time to H<br>(See <a href="#">Figure 8</a> )          | $R_L = 110\Omega$ |                       |     | 35  | nS   | 9         |
|           |                                                                     |                   |                       |     | 45  | nS   | 10, 11    |
| $t_{PZL}$ | Output Enable Time to L<br>(See <a href="#">Figure 9</a> )          | $R_L = 110\Omega$ |                       |     | 40  | nS   | 9         |
|           |                                                                     |                   |                       |     | 50  | nS   | 10, 11    |

- (1) Pre and post irradiation limits are identical to those listed under A C and DC electrical characteristics. These parts may be dose rate sensitive in a space environment and demonstrate enhanced low dose rate effect. Radiation end point limits for the noted parameters are ensured only for the conditions as specified in MIL-STD 883, Method 1019, condition A.

- (2) Rise time 20% to 80%, Fall time 80% to 20%.

- (3)  $t_{TD} = \text{Non-inverting output rise time} + \text{inverting output fall time} / 2$ ,  $t_{TD} = \text{Non-inverting output fall time} + \text{inverting output rise time} / 2$ .

## AC - Driver Electrical Characteristics<sup>(1)</sup> (continued)

The following conditions apply to all parameters, unless otherwise specified.

$V_{CC} = 5V$ ,  $PRR = 1MHz$ ,  $T_R \leq T_F \leq 6nS$ , 50% duty cycle,  $AMP = 3V$ ,  $V_{L_O}$ ,  $Z_{OUT} = 50\Omega$

| Symbol     | Parameter                                       | Conditions        | Notes | Min | Max | Unit | Sub-group |
|------------|-------------------------------------------------|-------------------|-------|-----|-----|------|-----------|
| $t_{PHZ}$  | Output Disable Time to H<br>(See Figure 8)      | $R_L = 110\Omega$ |       |     | 30  | nS   | 9         |
|            |                                                 |                   |       |     | 40  | nS   | 10, 11    |
| $t_{PLZ}$  | Output Disable Time to L<br>(See Figure 9)      | $R_L = 110\Omega$ |       |     | 30  | nS   | 9         |
|            |                                                 |                   |       |     | 40  | nS   | 10, 11    |
| $T_{SKEW}$ | Differential Output Skew Time<br>(See Figure 6) |                   |       |     | 6   | nS   | 9         |
|            |                                                 |                   |       |     | 12  | nS   | 10, 11    |

## AC - Receiver Electrical Characteristics<sup>(1)</sup>

The following conditions apply to all parameters, unless otherwise specified.

$V_{CC} = 5V$ ,  $PRR = 1MHz$ ,  $T_R \leq T_F \leq 6nS$ , 50% duty cycle,  $AMP = 3V$ ,  $V_{L_O}$ ,  $Z_{OUT} = 50\Omega$

| Symbol                | Parameter                                             | Conditions   | Notes              | Min | Max | Unit | Sub-group |
|-----------------------|-------------------------------------------------------|--------------|--------------------|-----|-----|------|-----------|
| $t_{PLH}$             | Propagation Delay Time Low to High<br>(See Figure 10) | $C_L = 15pF$ |                    | 10  | 27  | nS   | 9         |
|                       |                                                       |              |                    | 10  | 38  | nS   | 10, 11    |
| $t_{PHL}$             | Propagation Delay Time High to Low<br>(See Figure 10) | $C_L = 15pF$ |                    | 10  | 27  | nS   | 9         |
|                       |                                                       |              |                    | 10  | 38  | nS   | 10, 11    |
| $t_{PZH}$             | Output Enable Time to H<br>(See Figure 11)            | $C_L = 15pF$ |                    |     | 20  | nS   | 9         |
|                       |                                                       |              |                    |     | 30  | nS   | 10, 11    |
| $t_{PZL}$             | Output Enable Time to L<br>(See Figure 11)            | $C_L = 15pF$ |                    |     | 20  | nS   | 9         |
|                       |                                                       |              |                    |     | 30  | nS   | 10, 11    |
| $ t_{PLH} - t_{PHL} $ | Output to Output Delay Time<br>(See Figure 10)        |              |                    |     | 8   | nS   | 9         |
|                       |                                                       |              |                    |     | 16  | nS   | 10, 11    |
| $t_{PHZ}$             | Output Disable Time From H<br>(See Figure 11)         | $C_L = 20pF$ | See <sup>(2)</sup> |     | 30  | nS   | 9         |
|                       |                                                       |              |                    |     | 40  | nS   | 10, 11    |
|                       |                                                       | $C_L = 5pF$  | See <sup>(2)</sup> |     | 20  | nS   | 9         |
|                       |                                                       |              |                    |     | 30  | nS   | 10, 11    |
| $t_{PLZ}$             | Output Disable Time From L<br>(See Figure 11)         | $C_L = 5pF$  |                    |     | 20  | nS   | 9         |
|                       |                                                       |              |                    |     | 30  | nS   | 10, 11    |

(1) Pre and post irradiation limits are identical to those listed under A C and DC electrical characteristics. These parts may be dose rate sensitive in a space environment and demonstrate enhanced low dose rate effect. Radiation end point limits for the noted parameters are ensured only for the conditions as specified in MIL-STD 883, Method 1019, condition A.

(2) Testing at 20pF assures conformance to spec at 5pF.



## Parameter Measurement Information

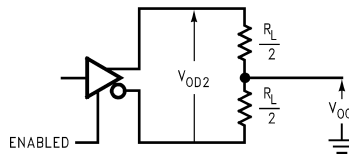


Figure 4. Driver  $V_{OD}$  and  $V_{OC}$ (1)

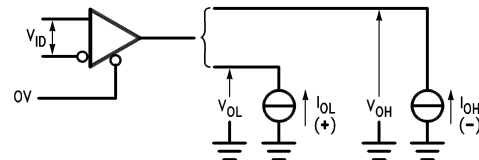
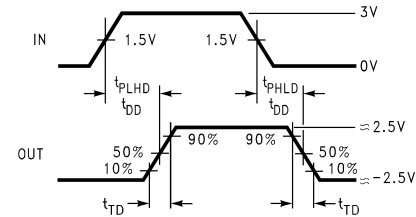
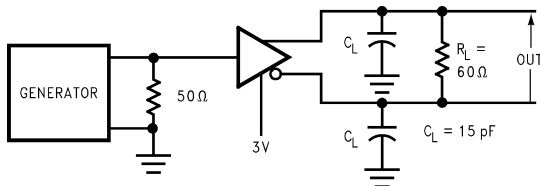


Figure 5. Receiver  $V_{OH}$  and  $V_{OL}$



$$t_{\text{SKEW}} = |t_{\text{PLHD}} - t_{\text{PHLD}}|$$

Figure 6. Driver Differential Output Delay and Transition Times(2)(3)

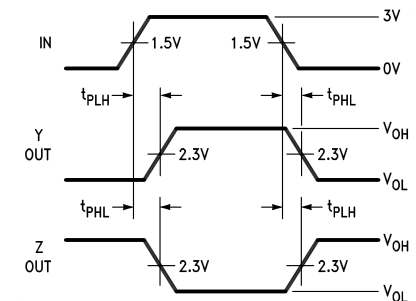
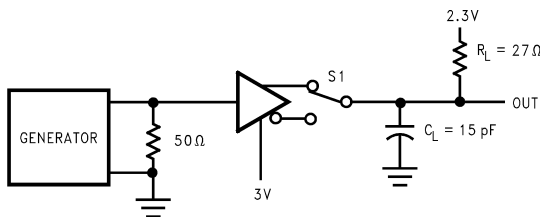


Figure 7. Driver Propagation Times(2)(4)

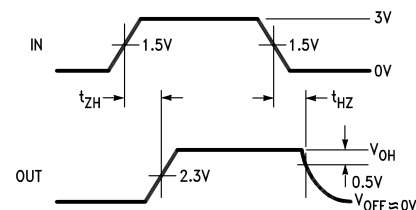
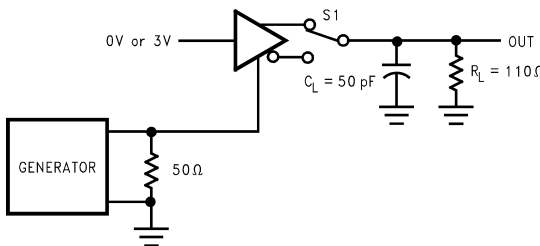


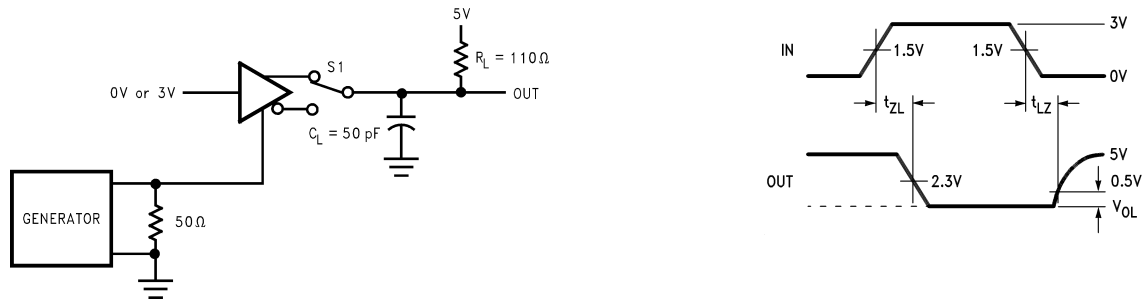
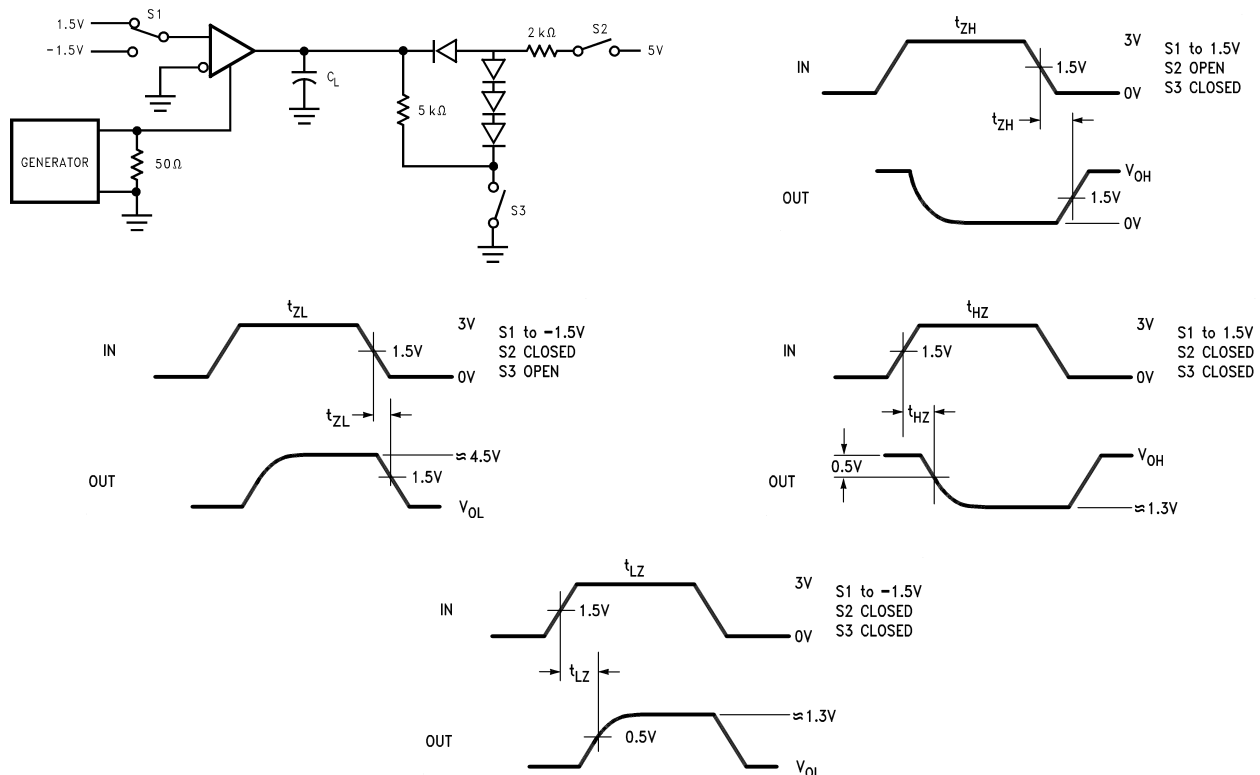
Figure 8. Driver Enable and Disable Times ( $t_{ZH}$ ,  $t_{HZ}$ )(2)(3)(4)

(1) All diodes are 1N916 or equivalent.

(2) The input pulse is supplied by a generator having the following characteristics: PRR = 1.0 MHz, 50% duty cycle,  $t_r \leq 6.0$  ns,  $t_f \leq 6.0$  ns,  $Z_O = 50\Omega$ .

(3) DS16F95 Driver enable is Active-High.

(4)  $C_L$  includes probe and stray capacitance.

Figure 9. Driver Enable and Disable Times ( $t_{ZL}$ ,  $t_{LZ}$ )<sup>(1)(2)(3)</sup>Figure 10. Receiver Propagation Delay Times<sup>(1)(3)</sup>Figure 11. Receiver Enable and Disable Times<sup>(1)(3)(4)</sup>

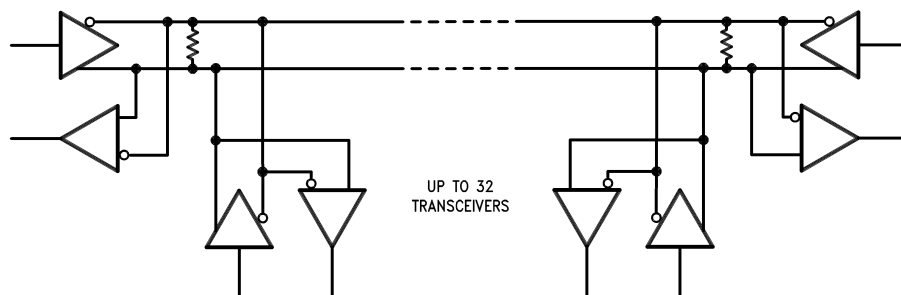
(1) The input pulse is supplied by a generator having the following characteristics: PRR = 1.0 MHz, 50% duty cycle,  $t_r \leq 6.0$  ns,  $t_f \leq 6.0$  ns,  $Z_O = 50\Omega$ .

(2) DS16F95 Driver enable is Active-High.

(3)  $C_L$  includes probe and stray capacitance.

(4) All diodes are 1N916 or equivalent.

### Typical Application



The line should be terminated at both ends in its characteristic impedance, typically 120Ω. Stub lengths off the main line should be kept as short as possible.

## REVISION HISTORY

| Date Released | Revision | Section                                                                                                                                                         | Changes                                                                                                                                                                                                            |
|---------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9/23/2005     | A        | New Release, Corporate format                                                                                                                                   | 1 MDS data sheet converted into Corporate data sheet format. MDS data sheet MNDS16F95-X-RH, Rev. 0A1 will be Archived.                                                                                             |
| 10/26/2010    | B        | Features, Ordering Table, Connection Diagrams W pkg, Absolute Ratings, Electricals - DC Receiver $V_T1$ , AC Driver conditions, Physical Dimensions Mkt drawing | Update with current device information and format. Correction to rad info., Code K NSID's removed, removed reference to WG pkg, typo correction to conditions, Removed WG pkg drawing. Revision A will be Archived |
| 4/12/2013     | B        | All                                                                                                                                                             | Changed layout of National Data Sheet to TI format.                                                                                                                                                                |

**PACKAGING INFORMATION**

| Orderable part number           | Status<br>(1) | Material type<br>(2) | Package   Pins  | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6)                                                                     |
|---------------------------------|---------------|----------------------|-----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|-----------------------------------------------------------------------------------------|
| <a href="#">5962-89615012A</a>  | Active        | Production           | LCCC (NAJ)   20 | 50   TUBE             | No          | Call TI                              | Call TI                           | -55 to 125   | DS16F95E<br>/883 Q<br>5962-89615<br>012A ACO<br>012A >T                                 |
| <a href="#">5962-8961501PA</a>  | Active        | Production           | CDIP (NAB)   8  | 40   TUBE             | No          | Call TI                              | Call TI                           | -55 to 125   | DS16F95J/883<br>5962-89615<br>01PA Q ACO<br>(DS9638J/883, DS96<br>38J/883)<br>01PA Q >T |
| <a href="#">5962F8961501VHA</a> | Active        | Production           | CFP (NAD)   10  | 19   TUBE             | No          | Call TI                              | Call TI                           | -55 to 125   | DS16F95<br>WFQMLV Q<br>5962F89615<br>01VHA ACO<br>01VHA >T                              |
| DS16F95 MDR                     | Active        | Production           | DIESALE (Y)   0 | 34   OTHER            | Yes         | Call TI                              | Level-1-NA-UNLIM                  | -55 to 125   |                                                                                         |
| DS16F95-MDR.A                   | Active        | Production           | DIESALE (Y)   0 | 34   OTHER            | Yes         | Call TI                              | Level-1-NA-UNLIM                  | -55 to 125   |                                                                                         |
| <a href="#">DS16F95E/883</a>    | Active        | Production           | LCCC (NAJ)   20 | 50   TUBE             | No          | Call TI                              | Call TI                           | -55 to 125   | DS16F95E<br>/883 Q<br>5962-89615<br>012A ACO<br>012A >T                                 |
| <a href="#">DS16F95J/883</a>    | Active        | Production           | CDIP (NAB)   8  | 40   TUBE             | No          | Call TI                              | Call TI                           | -55 to 125   | DS16F95J/883<br>5962-89615<br>01PA Q ACO<br>(DS9638J/883, DS96<br>38J/883)<br>01PA Q >T |
| <a href="#">DS16F95W/883</a>    | Active        | Production           | CFP (NAD)   10  | 19   TUBE             | No          | Call TI                              | Call TI                           | -55 to 125   | DS16F95W<br>/883 Q ACO<br>/883 Q >T                                                     |

| Orderable part number         | Status<br>(1) | Material type<br>(2) | Package   Pins | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6)                                        |
|-------------------------------|---------------|----------------------|----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|------------------------------------------------------------|
| <a href="#">DS16F95WFQMLV</a> | Active        | Production           | CFP (NAD)   10 | 19   TUBE             | No          | Call TI                              | Call TI                           | -55 to 125   | DS16F95<br>WFQMLV Q<br>5962F89615<br>01VHA ACO<br>01VHA >T |
| DS16F95WFQMLV.A               | Active        | Production           | CFP (NAD)   10 | 19   TUBE             | No          | Call TI                              | Call TI                           | -55 to 125   | DS16F95<br>WFQMLV Q<br>5962F89615<br>01VHA ACO<br>01VHA >T |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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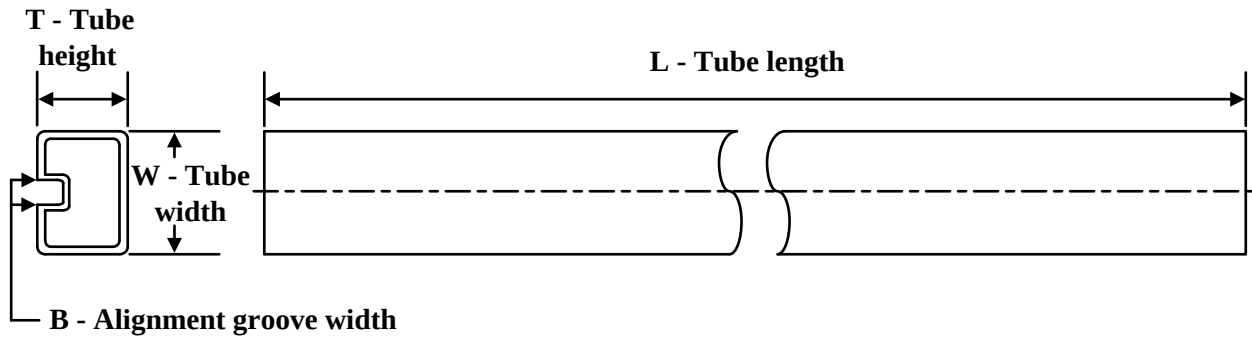
**OTHER QUALIFIED VERSIONS OF DS16F95QML, DS16F95QML-SP :**

- Military : [DS16F95QML](#)
- Space : [DS16F95QML-SP](#)

**NOTE: Qualified Version Definitions:**

- Military - QML certified for Military and Defense Applications
- Space - Radiation tolerant, ceramic packaging and qualified for use in Space-based application

## TUBE

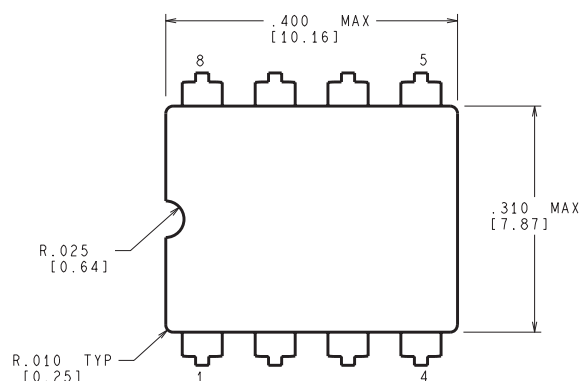


\*All dimensions are nominal

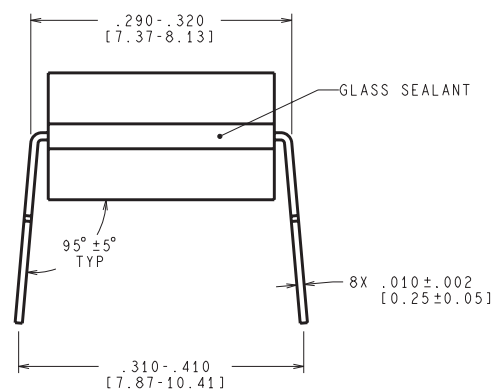
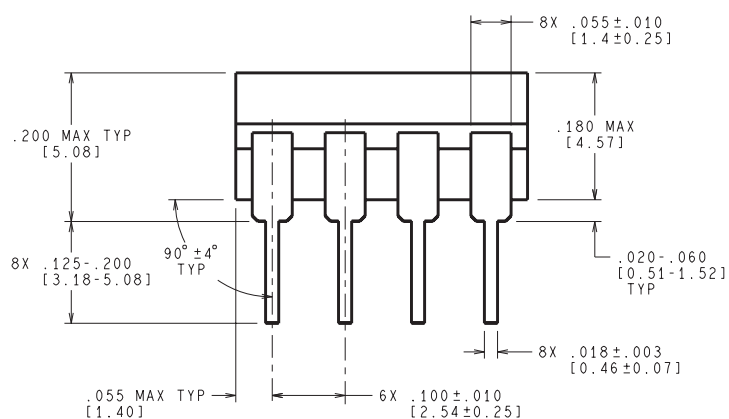
| Device          | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|-----------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| 5962-89615012A  | NAJ          | LCCC         | 20   | 50  | 470    | 11     | 3810   | 0      |
| 5962-8961501PA  | NAB          | CDIP         | 8    | 40  | 506.98 | 15.24  | 13440  | NA     |
| 5962F8961501VHA | NAD          | CFP          | 10   | 19  | 502    | 23     | 9398   | 9.78   |
| DS16F95E/883    | NAJ          | LCCC         | 20   | 50  | 470    | 11     | 3810   | 0      |
| DS16F95J/883    | NAB          | CDIP         | 8    | 40  | 506.98 | 15.24  | 13440  | NA     |
| DS16F95W/883    | NAD          | CFP          | 10   | 19  | 502    | 23     | 9398   | 9.78   |
| DS16F95WFQMLV   | NAD          | CFP          | 10   | 19  | 502    | 23     | 9398   | 9.78   |
| DS16F95WFQMLV.A | NAD          | CFP          | 10   | 19  | 502    | 23     | 9398   | 9.78   |



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J08A (Rev M)

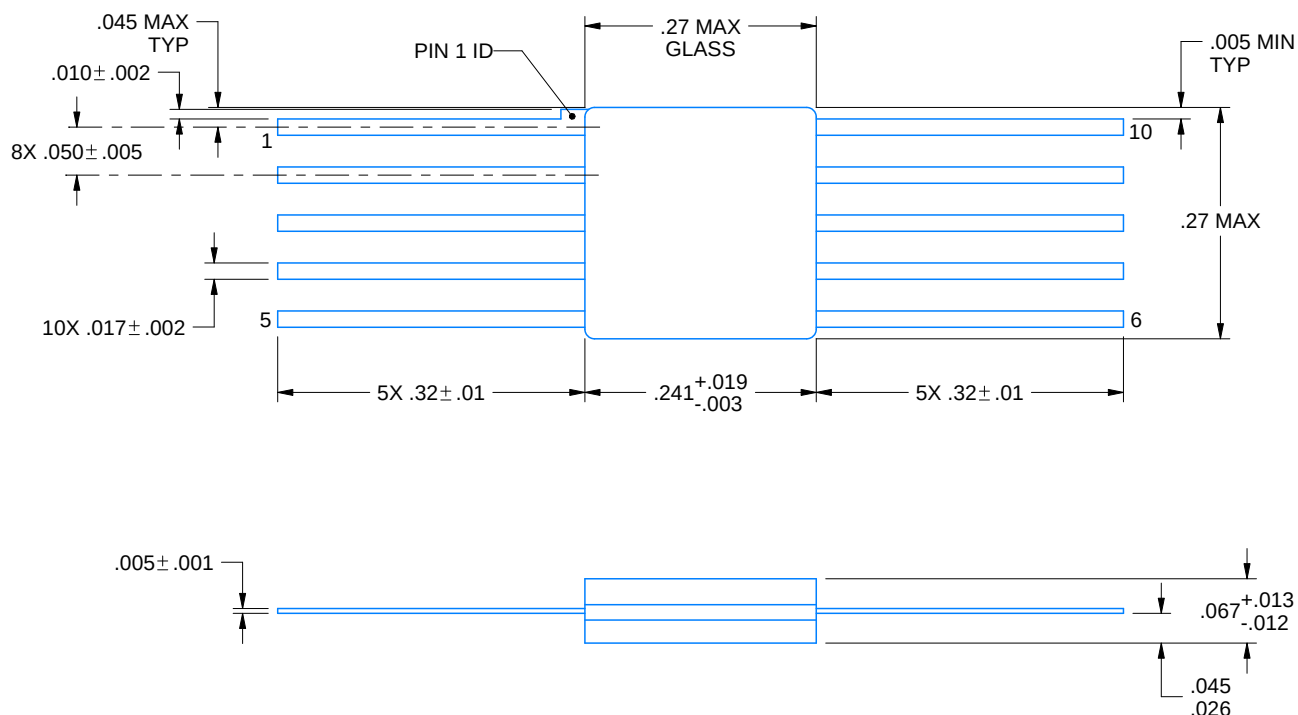
NAD0010A



## PACKAGE OUTLINE

CFP - 2.03 mm max height

CERAMIC FLATPACK

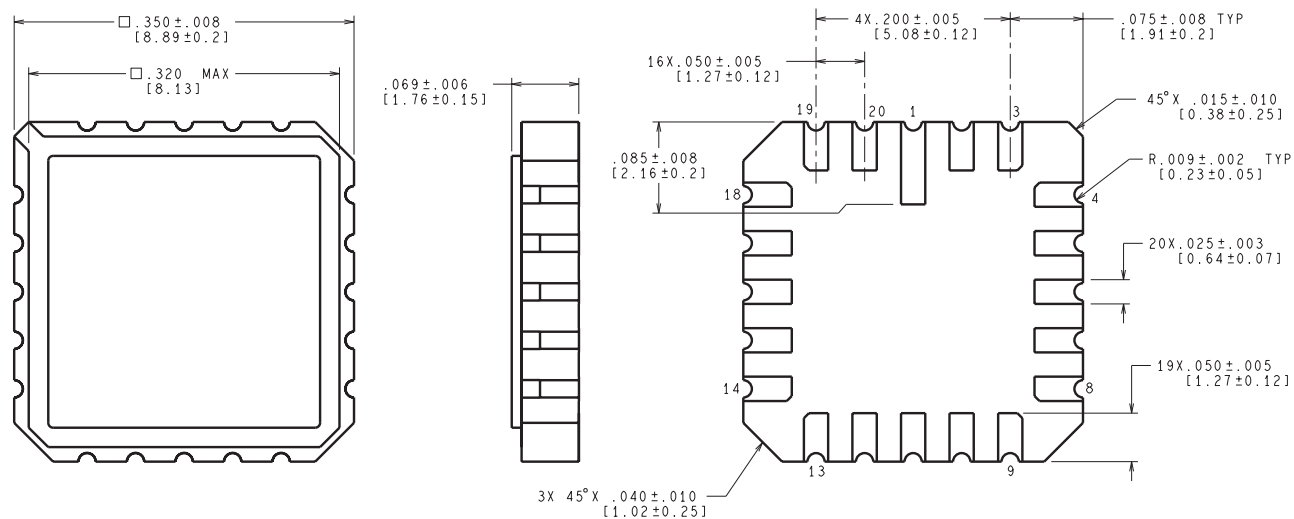


4215191/A 06/2021

### NOTES:

1. All linear dimensions are in inches. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

NAJ0020A



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E20A (Rev F)

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Last updated 10/2025