HS-26CLV31RH, HS-26CLV31EH

Radiation Hardened 3.3V Quad Differential Line Drivers

Description

The HS-26CLV31RH, HS-26CLV31EH are radiation hardened 3.3V quad differential line drivers designed for digital data transmission over balanced lines, in low voltage RS-422 protocol applications. CMOS processing assures low power consumption, high speed, and reliable operation in the most severe radiation environments.

The HS-26CLV31RH and HS-26CLV31EH accept CMOS level inputs and converts them to differential outputs. Enable pins allow several devices to be connected to the same data source and addressed independently. These devices have unique outputs that become high impedance when the driver is disabled or powered-down (V_{DD} = 0V), maintaining signal integrity in multi-driver applications.

Detailed Electrical Specifications for these devices are contained in SMD 5962-96663. A link is provided on our homepage for downloading.

Features

- Electrically screened to SMD #5962-96663
- QML qualified per MIL-PRF-38535 requirements
- 1.2 micron radiation hardened CMOS
- Extremely low stand-by current: 100µA (maximum)
- Operating supply range: 3.0V to 3.6V
- CMOS level inputs: V_{IH}>(0.7) (V_{DD}); V_{IL}< (0.3) (V_{DD})
- Differential outputs: V_{OH} > 1.8V; V_{OL} < 0.5V
- High impedance outputs when disabled or powered down (V_{DD} = 0V)
- Low output impedance: 10Ω or less
- Radiation acceptance testing - HS-26C31RH
  - HDR (50-300rad (Si)/s): 300krad(Si)
- Radiation acceptance testing - HS-26C31EH
  - HDR (50-300rad(Si)/s): 300krad(Si)
  - LDR (0.01rad(Si)/s): 50krad(Si)
- SEL immune to LET: 100MeV•cm^2/mg
- Full -55°C to +125°C military temperature range
- Pb-free (RoHS compliant)

Applications

- Line transmitter for MIL-STD-1553 serial data bus
- Line Transmitter for RS-422

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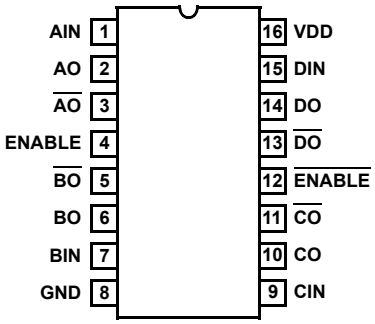
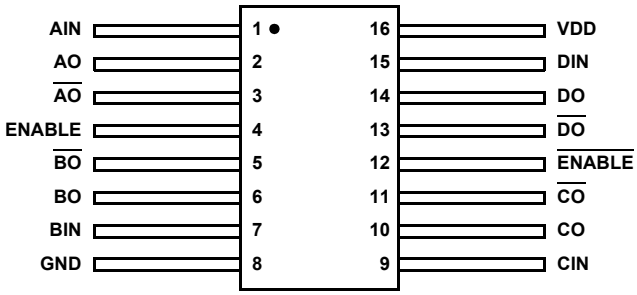
1. Pin Information

1.1 Pin Assignments

HS1-26CLV31RH, HS1-26CLV31EH
(16 LD SBDIP)
CDIP2-T16- Top View



HS9-26CLV31RH, HS9-26CLV31EH
(16 LD Flatpack)
CDFP4-F16 - Top View



1.2 Pin Descriptions

Pin Number	Pin Name
1	AIN
2	AO
3	$\overline{AO}$
4	ENABLE
5	$\overline{BO}$
6	BO
7	BIN
8	GND
9	CIN
10	CO
11	$\overline{CO}$
12	$\overline{ENABLE}$
13	$\overline{DO}$
14	DO
15	DIN
16	VDD

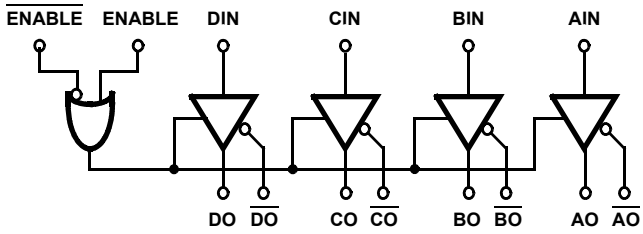


Figure 1. Logic Diagram

Table 1. Truth Table[1]

Device Power On/Off	Inputs			Outputs	
	ENABLE	$\overline{\text{ENABLE}}$	IN	OUT	$\overline{\text{OUT}}$
ON	0	1	X	HI-Z	HI-Z
ON	1	X	0	0	1
ON	X	0	0	0	1
ON	1	X	1	1	0
ON	X	0	1	1	0
OFF (0V)	X	X	X	HI-Z	HI-Z

1. X = Don't Care, 0 = Low, 1 = High

2. Specifications

2.1 Absolute Maximum Ratings

Caution: Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions can adversely impact product reliability and result in failures not covered by warranty.

Parameter	Minimum	Maximum	Unit
Supply Voltage	-0.5	7.0	V_{DC}
INPUTS, E, $\overline{E}$ Voltage	-0.5	V_{DD} + 0.5	V_{DC}
Output Voltage with Power On or Off (0V	-0.5	7.0	V_{DC}
DC Diode Input Current (any input)	-	±20	mA
DC Drain Current (any one output)	-	350	mA
DC VDD or Ground Current	-	400	mA
Junction Temperature	-	175	°C
Storage Temperature	-65	150	°C
Human Body Model (Tested per MIL-PRF-883 3015.7)	-	300	V

2.2 Recommended Operating Conditions

Parameter	Minimum	Maximum	Unit
Supply Voltage, V_{DD}	3.0	3.6	V
Ambient Temperature	-55	+125	°C
Low Input Voltage	0	0.3 V_{DD} Maximum	V
High Input Voltage	V_{DD}	0.7 V_{DD} Minimum	V

2.3 Thermal Specifications

Parameter	Package	Symbol	Conditions	Typical Value	Unit
Thermal Resistance	16Ld Flatpack Package	θ_{JA}[1]	Junction to ambient	114	°C/W
		θ_{JC}[2]	Junction to case	29	°C/W
Thermal Resistance	16Ld SBDIP Package	θ_{JA}[1]	Junction to ambient	73	°C/W
		θ_{JC}[2]	Junction to case	24	°C/W

1. θ_{JA} is measured with the component mounted on a high effective thermal conductivity test board (two buried 1oz copper planes) with direct attach features (package base mounted to PCB thermal land with a 10 mil gap fill material having a k of 1W/m-K. See TB379.
2. For θ_{JC}, the case temperature location is the center of the package underside.

2.4 Electrical Specifications

Test Conditions: V_{DD} = 3.0V to 3.6V; Typical values are at T_A = +25°C; unless otherwise specified[1]. **Boldface limits apply across the operating temperature range, -55°C to +125°C; over a total ionizing dose of 50krad(Si) at +25°C with exposure at a low dose rate of <10mrad(Si)/s.; and over a total ionizing dose of 300krad(SI) at +25°C with exposure of a high dose rate of 50krad(SI)/s to 300krad(SI)/s.**

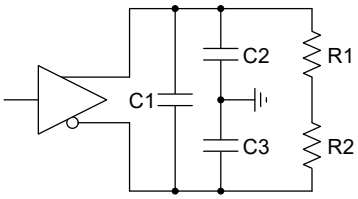
Parameter	Symbol	Test Conditions	Temp (°C)	Min[2]	Typ[3]	Max[2]	Unit
High Level Output Voltage	V_{OH}	VDD = 3.0V and 3.6V, IO = -20mA[4][5]	Full	**1.8**	-	-	V
Low Level Output Voltage	V_{OL}	VDD = 3.0V and 3.6V, IO = 20mA[4][5]	Full	-	-	**0.5**	V
Differential Output Voltage	VT, $\overline{VT}$	VDD = VIH = 3.0V, RL = R1 + R2, VIL = 0V[6]	Full	**1.8**	-	-	V

Test Conditions: V_{DD} = 3.0V to 3.6V; Typical values are at T_A = +25°C; unless otherwise specified[1]. **Boldface limits apply across the operating temperature range, -55°C to +125°C; over a total ionizing dose of 50krad(Si) at +25°C with exposure at a low dose rate of <10mrad(Si)/s.; and over a total ionizing dose of 300krad(SI) at +25°C with exposure of a high dose rate of 50krad(SI)/s to 300krad(SI)/s. (Cont.)**

Parameter	Symbol	Test Conditions	Temp (°C)	Min[2]	Typ[3]	Max[2]	Unit
Difference in Differential Output	|VT| - |$\overline{VT}$|	VDD = VIH = 3.0V, RL = R1 + R2, VIL = 0V[6]	Full	-	-	**0.4**	V
Common Mode Output Voltage	VOS, $\overline{VOS}$	VDD = VIH = 3.0V, RL = R1 + R2, VIL = 0V[6]	Full	-	-	**3.0**	V
Difference in Common Mode Output Voltage	|VOS| - |$\overline{VOS}$|	VDD = VIH = 3.0V, RL = R1 + R2, VIL = 0V[6]	Full	-	-	**0.4**	V
High Level Input Voltage	V_{IH}	VDD = 3.0V, 3.6V[7]	Full	**0.7VDD**	-	-	V
Low Level Input Voltage	V_{IL}	VDD = 3.0V, 3.6V[7]	Full	-	-	**0.3VDD**	V
Standby Supply Current	I_{DDSB}	VDD = 3.6V, Output = OPEN, VIN = VDD or GND	Full	-	-	**100**	µA
Three-state Output Leakage Current	IOZ	VDD = 3.6V, Force Voltage = 0V or VDD[8]	Full	-	-	**±5**	µA
Input Leakage	I_{IN}	VDD = 3.6V, VIN = VDD or GND	Full	-	-	**±1.0**	µA
Output Leakage Current Power OFF	I_{OFF}	VDD = 0V, VOUT = 6V, -250mV inputs = GND	Full	**-100**	-	**+100**	µA
Input Clamp Voltage	V_{IC}	At -1.0mA	Full	-	-	**-1.5**	V
		At +1.0mA	Full	-	-	**+1.5**	V
Input Capacitance	C_{IN}	VDD = OPEN, f = 1MHz[9][10]	Full	-	-	**12**	pF
Output Capacitance	C_{OUT}	VDD = OPEN, f = 1MHz[9][10]	Full	-	-	**12**	pF
Operating Short Circuit	I_{OS}	VDD = 3.6V, VIN = VDD or GND[9][10][11]	Full	**-30**	-	**-150**	mA
On-state Resistance	R_{ON}	VDD = 3.0V, VOUT = 1.5V, VIN = VDD or GND[9][10]	Full	-	-	**10**	Ω
Propagation Delay	t_{PLH}, t_{PHL}	VDD = 3.0V[12]	Full	**2**	-	**30**	ns
	t_{PZH}, t_{PZL}	-	Full	**5**	-	**42**	ns
	t_{PHZ}, t_{PLZ}	-	Full	**2**	-	**28**	ns
Output Skew	t_{SKEW}	VDD = 3.0V, RL = 100Ω, CL = 40pF[12][13]	Full	-	-	**7**	ns
Rise and Fall Times	t_{THL}, t_{TLH}	VDD = 3.0V[12]	Full	**1**	-	**14**	ns

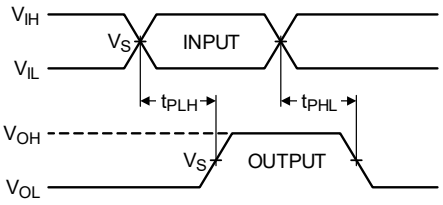
1. All voltages are referenced to device ground unless otherwise specified.
2. Parameters with MIN and/or MAX limits are 100% tested at -55°C, +25°C and +125°C, unless otherwise specified.
3. Typical values are at 3.3V. Parameters with a single entry in the “TYP” column apply to 3.3V. Typical values shown are not guaranteed.
4. Force / measure functions may be interchanged.
5. V_{IL} = 0.3 V_{DD}, V_{IH} = 0.7V_{DD}.
6. These test conditions are detailed in EIA specification RS-422. R1 = R2 = 50Ω.
7. This parameter tested as inputs levels in V_{OL} / V_{OH}, I_{OZ}, functional test and/or discrete voltage level.
8. The input is conditioned to have the output in the opposite state of the forcing I_{OZ} condition.
9. These parameters are controlled through design or process parameters and are not directly tested. These parameters are characterized upon initial design and after major design or process changes that affect these parameters.
10. Post irradiation electrical performance testing not performed for these parameters.
11. Only one output at a time may be shorted.
12. See table EIA RS-422. See Figure 2 and Figure 3.
13. Skew is defined as the difference in propagation delays between complementary outputs at the 50% point.

2.5 Timing and Load Circuit Diagrams



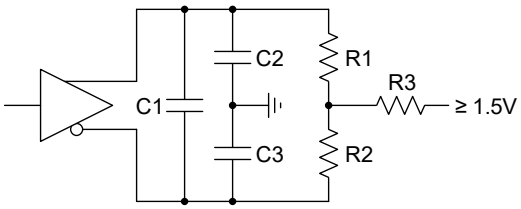
C1 = C2 = C3 = 40pF
R1 = R2 = 50Ω

Figure 2. Propagation Delay Load Circuit



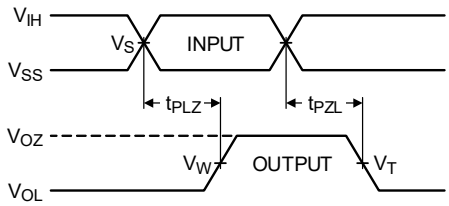
Note: Voltage Levels:
V_{DD} = 3.0V
V_{IH} = 3.0V
V_S = 50%
V_{IL} = 0V
GND = 0V

Figure 3. Propagation Delay Timing Diagram



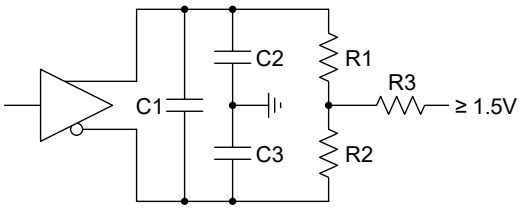
C1 = C2 = C3 = 40pF
R1 = R2 = 50Ω
R3 = 500Ω

Figure 4. Tri-State Low Load Circuit



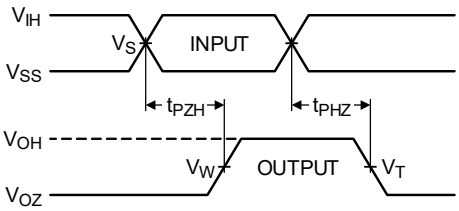
Note: Voltage Levels:
V_{DD} = 3.0V
V_{IH} = 3.0V
V_S = 50%
$V_W = V_{OL}$+0.3V
V_T = 0.8V

Figure 5. Tri-State Low Timing Diagram



C1 = C2 = C3 = 40pF
R1 = R2 = 50Ω
R3 = 500Ω

Figure 6. Tri-State High Load Circuit



Note: Voltage Levels:
V_{DD} = 3.0V
V_{IH} = 3.0V
V_S = 50%
$V_W = V_{OL}$+0.3V
V_T = 2.0V

Figure 7. Tri-State High Timing Diagram

3. Die and Assembly Characteristics

Table 2. Die and Assembly Related Information

Die Information	
Dimensions	96.5 mils x 195 mils x 19 mils ±1mil 2451µm x 4953µm x 483µm ±25µm
Interface Materials	
Glassivation	Type: PSG (Phosphorus Silicon Glass) Thickness: 8kÅ ±1kÅ
Metallization	M1: Mo/TiW (Bottom) Thickness: 5800Å ±1kÅ M2: AlSiCu (Top) Thickness: 10kÅ ±1kÅ
Substrate	AVLSI1RA
Backside Finish	Silicon
Assembly Information	
Substrate Potential (Powered Up)	Internally tied to V_{DD}
Additional Information	
Worst Case Current Density	$<2.0 \times 10^5 A/cm^2$
Bond Pad Size	110µm x 100µm

3.1 Metallization Mask Layout

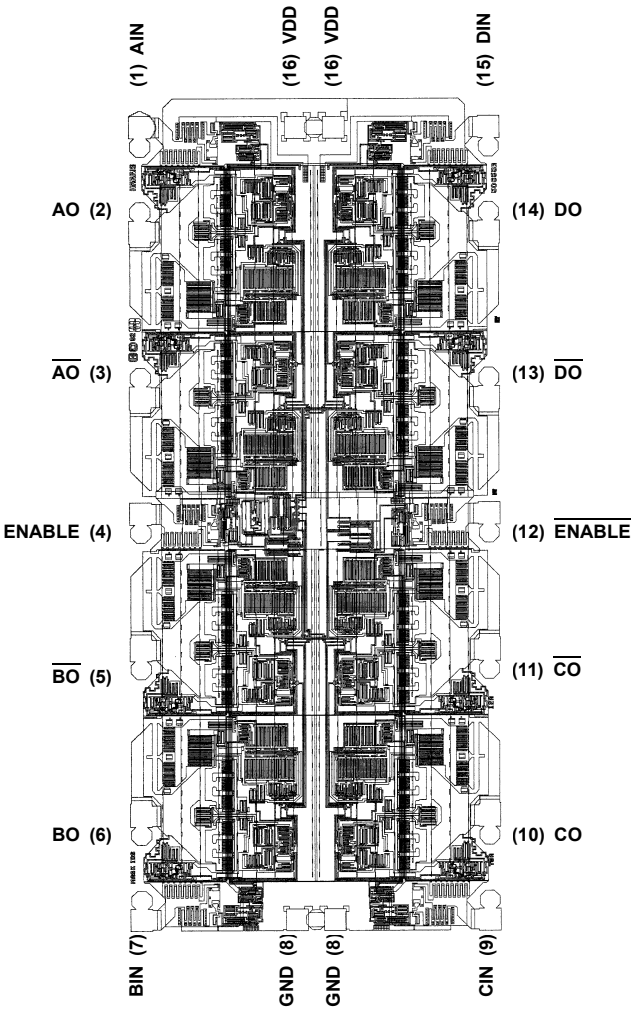


Table 3. HS-26CLV31RH, HS-26CLV31EH Pad Coordinates

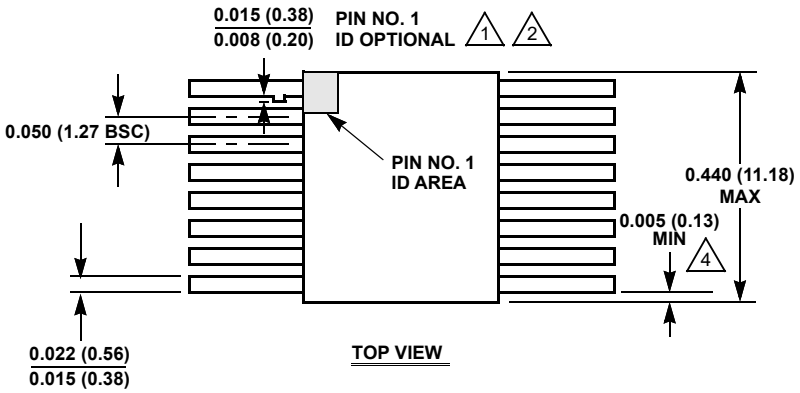
Pin Number	Pad Name	Relative To Pin 1[1]	
		X Coordinates	Y Coordinates
1	AIN	0	0
2	A0	0	-570.7
3	$\overline{A0}$	0	-1483.5
4	ENABLE	0	-2124.8
5	$\overline{B0}$	0	-2873.5
6	B0	0	-3786.3
7	BIN	0	-4357
8	GND	852.4	-4357
8	GND	1062.4	-4357
9	CIN	1912.8	-4357
10	$\overline{C0}$	1912.8	-3786.3
11	C0	1912.8	-2873.5
12	$\overline{ENABLE}$	1912.8	-2124.8
13	$\overline{D0}$	1912.8	-1483.5
14	D0	1912.8	-570.7
15	**DIN**	**1912.8**	**0**
16	**VIN**	**1062.4**	**0**
16	**VIN**	**852.4**	**0**

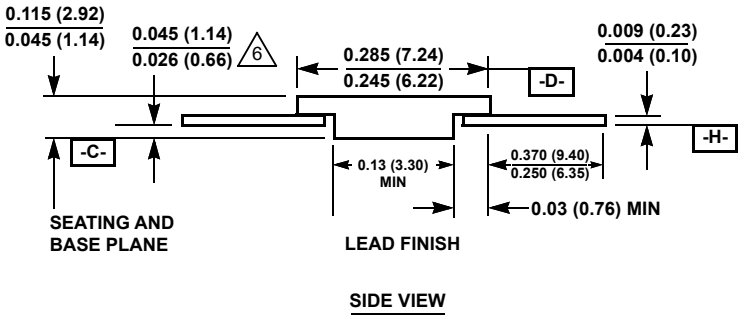
1. **Dimensions in microns.**

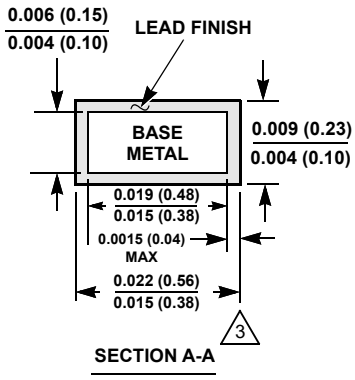
4. Package Outline Drawings

For the most recent package outline drawing, see K16.A.

K16.A
16 Lead Ceramic Metal Seal Flatpack Package
Rev 2, 1/10





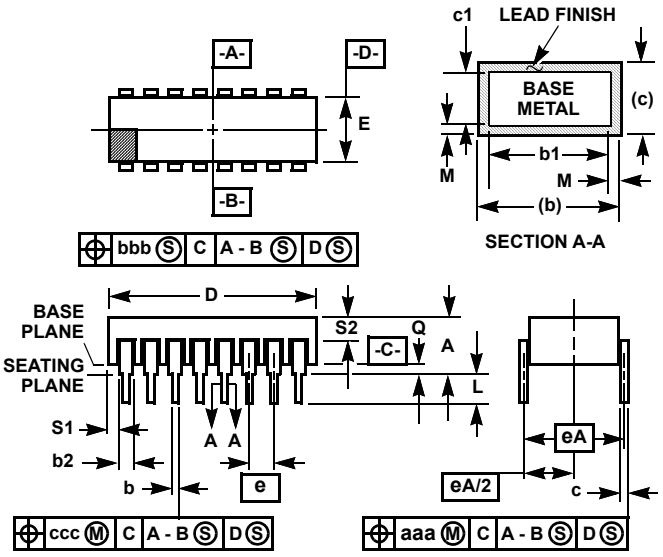


NOTES:

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. Alternately, a tab may be used to identify pin one.
2. If a pin one identification mark is used in addition to a tab, the limits of the tab dimension do not apply.
3. The maximum limits of lead dimensions (section A-A) shall be measured at the centroid of the finished lead surfaces, when solder dip or tin plate lead finish is applied.
4. Measure dimension at all four corners.
5. For bottom-brazed lead packages, no organic or polymeric materials shall be molded to the bottom of the package to cover the leads.
6. Dimension shall be measured at the point of exit (beyond the meniscus) of the lead from the body. Dimension minimum shall be reduced by 0.0015 inch (0.038mm) maximum when solder dip lead finish is applied.
7. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
8. Controlling dimension: INCH.

For the most recent package outline drawing, see D16.3.

Ceramic Dual-In-Line Metal Seal Packages (SBDIP)



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 b2.
5. Dimension Q shall be measured from the seating plane to the base plane.
6. Measure dimension S1 at all four corners.
7. Measure dimension S2 from the top of the ceramic body to the nearest metallization or lead.
8. N is the maximum number of terminal positions.
9. Braze fillets shall be concave.
10. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
11. Controlling dimension: INCH.

D16.3 MIL-STD-1835 CDIP2-T16 (D-2, CONFIGURATION C)
16 LEAD CERAMIC DUAL-IN-LINE METAL SEAL 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	-	0.840	-	21.34	-
E	0.220	0.310	5.59	7.87	-
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	0.060	0.38	1.52	5
S1	0.005	-	0.13	-	6
S2	0.005	-	0.13	-	7
a	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	16		16		8

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5. Ordering Information

SMD Part Number[1]	Part Number[2]	Radiation Hardness (Total Ionizing Dose)	Package Description (RoHS Compliant)	Package Drawing	Carrier Type	Temp. Range
5962F9666302QEC	HS1-26CLV31RH-8	HDR to 300krad(Si)	16 Ld SBDIP	D16.3	Tube	-55 to +125°C
5962F9666302QXC	HS9-26CLV31RH-8		16 Ld FLATPACK	K16.A	Tray	
5962F9666302VEC	HS1-26CLV31RH-Q		16 Ld SBDIP	D16.3	Tube	
5962F9666302VXC	HS9-26CLV31RH-Q		16 Ld FLATPACK	K16.A	Tray	
5962F9666302V9A	HS0-26CLV31RH-Q[3]		Die	N/A	N/A	
5962F9666302VYC	HS9G-26CLV31RH-Q[4]		16 Ld FLATPACK	K16.A	Tray	
N/A	HS0-26CLV31RH/SAMPLE[3][5]	N/A	Die	N/A	N/A	-55 to +125°C
	HS1-26CLV31RH/PROTO[5]		16 Ld SBDIP	D16.3	Tube	
	HS9-26CLV31RH/PROTO[5]		16 Ld FLATPACK	K16.A	Tray	
	HS9G-26CLV31RH/PROTO[4][5]		16 Ld FLATPACK	K16.A	Tray	
5962F9666304VEC	HS1-26CLV31EH-Q	HDR to 300krad(Si) LDR to 50krad(Si)	16 Ld SBDIP	D16.3	Tube	-55 to +125°C
5962F9666304VXC	HS9-26CLV31EH-Q		16 Ld FLATPACK	K16.A	Tray	
5962F9666304V9A	HS0-26CLV31EH-Q[3]		Die	N/A	N/A	
5962F9666304VYC	HS9G-26CLV31EH-Q[4]		16 Ld FLATPACK	K16.A	Tray	

1. Specifications for Rad Hard QML devices are controlled by the Defense Logistics Agency Land and Maritime (DLA). The SMD numbers listed must be used when ordering.
2. These Pb-free Hermetic packaged products employ 100% Au plate - e4 termination finish, which is RoHS compliant and compatible with both SnPb and Pb-free soldering operations.
3. Die product tested at T_A = + 25°C. The wafer probe test includes functional and parametric testing sufficient to make the die capable of meeting the electrical performance outlined in SMD.
4. The lid of these packages are connected to the ground pin of the device.
5. The /PROTO and /SAMPLE are not rated or certified for Total Ionizing Dose (TID) or Single Event Effect (SEE) immunity. These parts are intended for engineering evaluation purposes only. The /PROTO parts meet the electrical limits and conditions across the temperature range specified in the DLA SMD and are in the same form and fit as the qualified device. The /SAMPLE parts are capable of meeting the electrical limits and conditions specified in the DLA SMD. The /SAMPLE parts do not receive 100% screening across temperature to the DLA SMD electrical limits. These part types do not come with a certificate of conformance because they are not DLA qualified devices.

6. Revision History

Revision	Date	Change
6.03	May 30, 2025	Updated Figures 2 through 7.
6.02	Apr 15, 2025	Placed into the latest template. Added Pin Description table, ABS Max Ratings, Electrical Specifications, and Timing and Load Circuit Diagrams.
6.01	Aug 5, 2022	Updated Table 1.

Revision	Date	Change
6.00	Oct 21, 2021	Removed Related Literature section. Added Radiation acceptance testing bullets for RH and EH parts to the features section. Updated Ordering Information table by adding carrier type and radiation testing information columns, verified part numbers in table are correct, and added Note 3 and updated Note 5. Added Truth Table. Updated the Die Characteristics information as follows: -Die thickness changed from:21mils, to:19mils. -Updated Substrate Potential (Powered Up) information.
5.00	Oct 26, 2018	Added Related Literature section. Updated Ordering Information table - added HS9G-26CLV31EH-Q part and added Notes 1 and 4. Removed part Marking column. Added Revision History. Added PODs D16.3 and K16.A Updated Disclaimer.

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