# ESD Protection Diodes

## Low Capacitance ESD Protection for High Speed Video Interface

# MG2040, SZMG2040

The MG2040 ESD protection diode is designed specifically to protect HDMI and Display Port with full functionality ESD protection and back drive current protection for $V_{CC}$ line. Ultra-low capacitance and low ESD clamping voltage make this device an ideal solution for protecting voltage sensitive high speed data lines. The flow-through style package allows for easy PCB layout and matched trace lengths necessary to maintain consistent impedance for the high speed TMDS lines.

### Features

- Full Function HDMI / Display Port Solution
- Single Connect, Flow through Routing for TMDS Lines
- Low Capacitance (0.35 pF Typical, I/O to GND)
- Protection for the Following IEC Standards:
  IEC 61000-4-2 Level 4 (±8 kV Contact)
- UL Flammability Rating of 94 V-0
- SZ Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable
- This is a Pb-Free Device

### Typical Applications

- HDMI
- Display Port

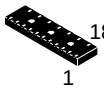
**MAXIMUM RATINGS** ($T_J$ = 25 °C unless otherwise noted)

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Operating Junction Temperature Range | $T_J$ | −55 to +125 | °C |
| Storage Temperature Range | $T_{stg}$ | −55 to +150 | °C |
| Lead Solder Temperature − Maximum (10 Seconds) | $T_L$ | 260 | °C |
| IEC 61000-4-2 Contact (ESD)<br>IEC 61000-4-2 Air (ESD) | ESD<br>ESD | ±15<br>±15 | kV<br>kV |

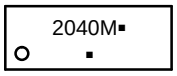
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

See Application Note AND8308/D for further description of survivability specs.

**MARKING DIAGRAM**




**UDFN18**
**CASE 517CP**




2040 = Specific Device Code
M = Date Code
▪ = Pb-Free Package
(Note: Microdot may be in either location)

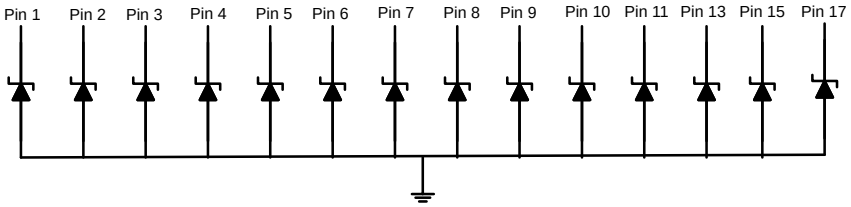
**ORDERING INFORMATION**

| Device | Package | Shipping |
|---|---|---|
| MG2040MUTAG | UDFN18 (Pb-Free) | 3000 / Tape & Reel |
| SZMG2040MUTAG | UDFN18 (Pb-Free) | 3000 / Tape & Reel |

† For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

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Center Pins, Pin 12, 14, 16, 18
Note: Common GND – Only Minimum of 1 GND connection required

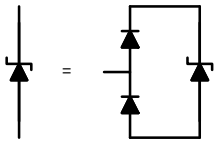



**Figure 1. Pin Schematic**

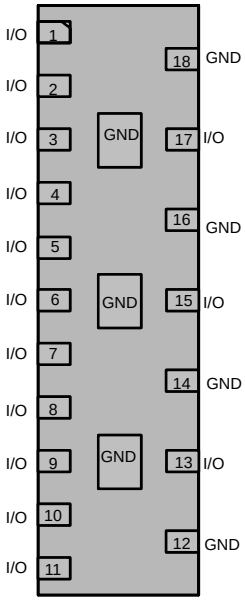



**Figure 2. Pin Configuration**

Note: Pins 12, 14, 16, 18 and center pins are connected internally as a common ground.
Only minimum of one pin needs to be connected to ground for functionality of all pins.



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**ELECTRICAL CHARACTERISTICS** ($T_A$ = 25 °C unless otherwise specified)

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Reverse Working Voltage | $V_{RWM}$ | I/O Pin to GND (Note 1) | | | 5.0 | V |
| Breakdown Voltage | $V_{BR}$ | $I_T$ = 1 mA, I/O Pin to GND | 5.5 | | | V |
| Reverse Leakage Current | $I_R$ | $V_{RWM}$ = 5 V, I/O Pin to GND | | | 1.0 | μA |
| Clamping Voltage (Note 1) | $V_C$ | $I_{PP}$ = 1 A, I/O Pin to GND (8 x 20 μs pulse) | | | 10 | V |
| Clamping Voltage (Note 2) | $V_C$ | IEC61000-4-2, ±8 kV Contact | See Figures 3 and 4 | | | V |
| Clamping Voltage TLP (Note 3) See Figures 8 through 11 | $V_C$ | $I_{PP}$ = 8 A<br>$I_{PP}$ = 16 A<br>$I_{PP}$ = −8 A<br>$I_{PP}$ = −16 A | | 11.4<br>15.3<br>−4.6<br>−8.1 | | |
| Junction Capacitance | $C_J$ | $V_R$ = 0 V, f = 1 MHz between I/O Pins | | 0.15 | 0.20 | pF |
| | | $V_R$ = 0 V, f = 1 MHz between I/O Pins and GND | | 0.35 | 0.42 | |
| Junction Capacitance Difference | $\Delta C_J$ | $V_R$ = 0 V, f = 1 MHz between I/O Pins | | 0.02 | | pF |
| | | $V_R$ = 0 V, f = 1 MHz between I/O Pins and GND | | 0.04 | | |

1. Surge current waveform per Figure 7.
2. For test procedure see Figures 5 and 6 and application note AND8307/D.
3. ANSI/ESD STM5.5.1 − Electrostatic Discharge Sensitivity Testing using Transmission Line Pulse (TLP) Model.
   TLP conditions: $Z_0$ = 50 Ω, $t_p$ = 100 ns, $t_r$ = 4 ns, averaging window; $t_1$ = 30 ns to $t_2$ = 60 ns.

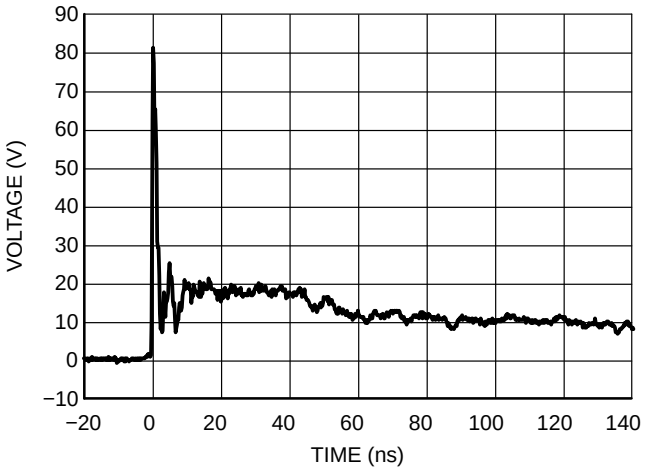



**Figure 3. IEC61000-4-2 +8 KV Contact Clamping Voltage**

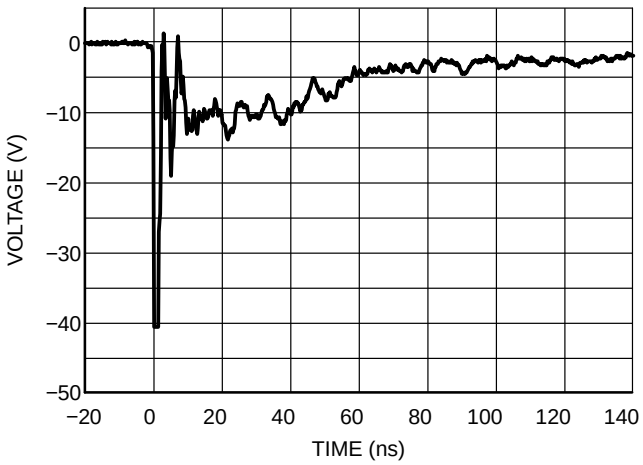



**Figure 4. IEC61000-4-2 −8 KV Contact Clamping Voltage**



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**IEC 61000-4-2 Spec.**

| Level | Test Voltage (kV) | First Peak Current (A) | Current at 30 ns (A) | Current at 60 ns (A) |
|---|---|---|---|---|
| 1 | 2 | 7.5 | 4 | 2 |
| 2 | 4 | 15 | 8 | 4 |
| 3 | 6 | 22.5 | 12 | 6 |
| 4 | 8 | 30 | 16 | 8 |

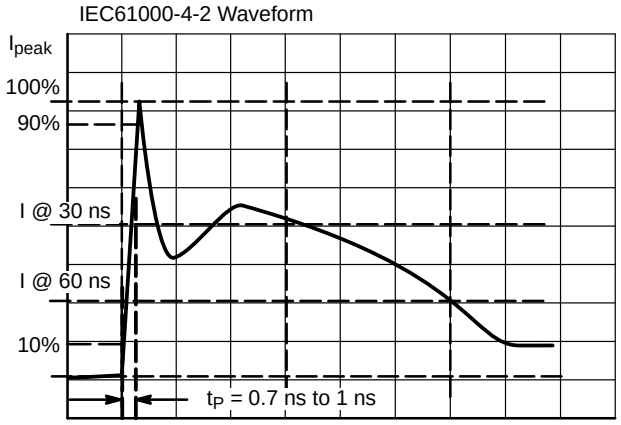



**Figure 5. IEC61000-4-2 Spec**

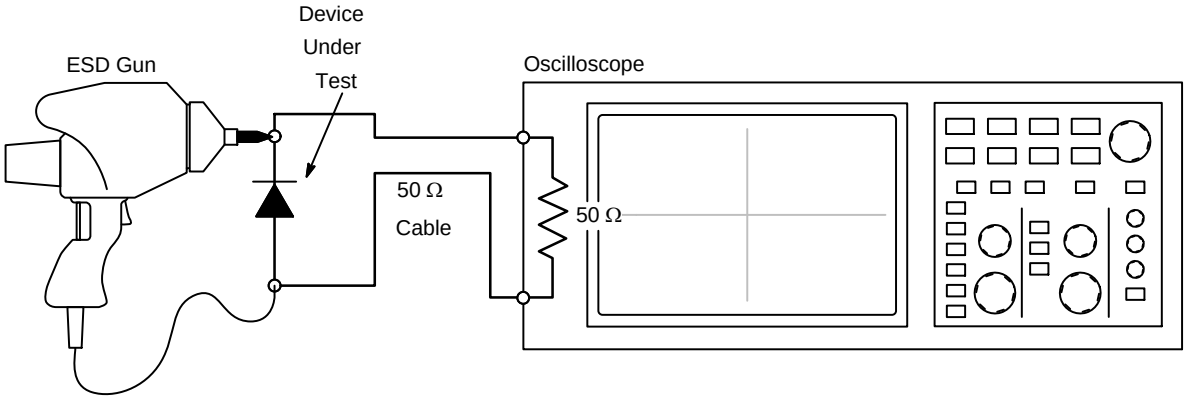



**Figure 6. Diagram of ESD Clamping Voltage Test Setup**

**The following is taken from Application Note AND8308/D − Interpretation of Datasheet Parameters for ESD Devices.**

### ESD Voltage Clamping

For sensitive circuit elements it is important to limit the voltage that an IC will be exposed to during an ESD event to as low a voltage as possible. The ESD clamping voltage is the voltage drop across the ESD protection diode during an ESD event per the IEC61000-4-2 waveform. Since the IEC61000-4-2 was written as a pass/fail spec for larger systems such as cell phones or laptop computers it is not clearly defined in the spec how to specify a clamping voltage at the device level. **onsemi** has developed a way to examine the entire voltage waveform across the ESD protection diode over the time domain of an ESD pulse in the form of an oscilloscope screenshot, which can be found on the datasheets for all ESD protection diodes. For more information on how **onsemi** creates these screenshots and how to interpret them please refer to AND8307/D.

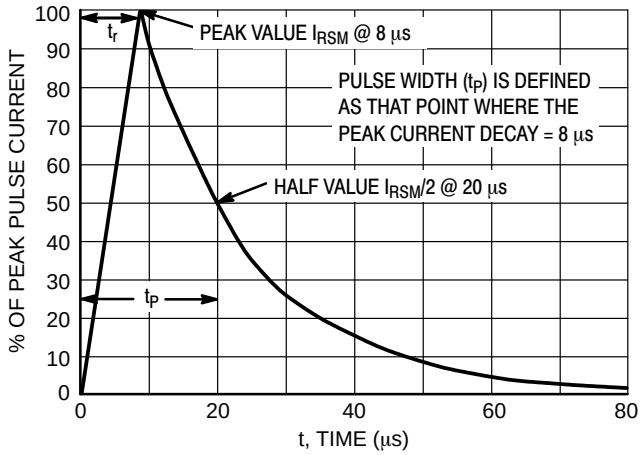



**Figure 7. 8 x 20 μs Pulse Waveform**



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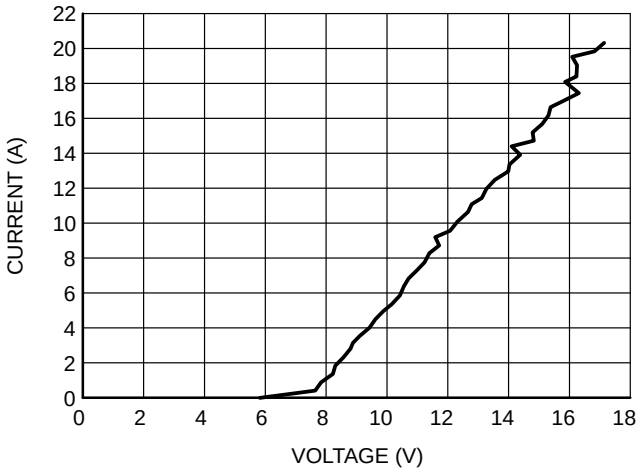



**Figure 8. Positive TLP I-V Curve**

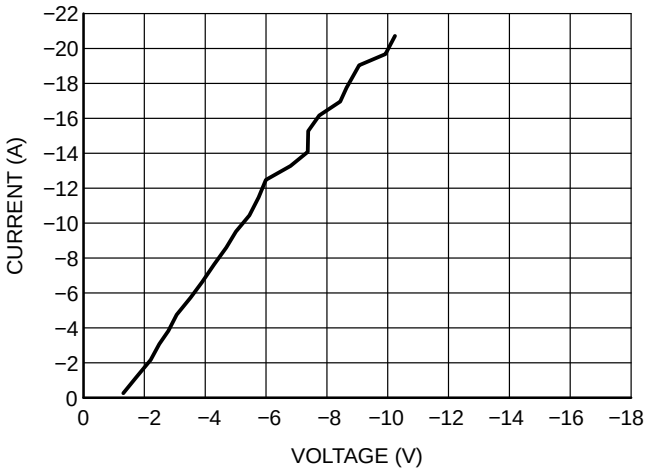



**Figure 9. Negative TLP I-V Curve**

### Transmission Line Pulse (TLP) Measurement

Transmission Line Pulse (TLP) provides current versus voltage (I-V) curves in which each data point is obtained from a 100 ns long rectangular pulse from a charged transmission line. A simplified schematic of a typical TLP system is shown in Figure 10. TLP I-V curves of ESD protection devices accurately demonstrate the product's ESD capability because the 10s of amps current levels and under 100 ns time scale match those of an ESD event. This is illustrated in Figure 11 where an 8 kV IEC 61000-4-2 current waveform is compared with TLP current pulses at 8 A and 16 A. A TLP I-V curve shows the voltage at which the device turns on as well as how well the device clamps voltage over a range of current levels.

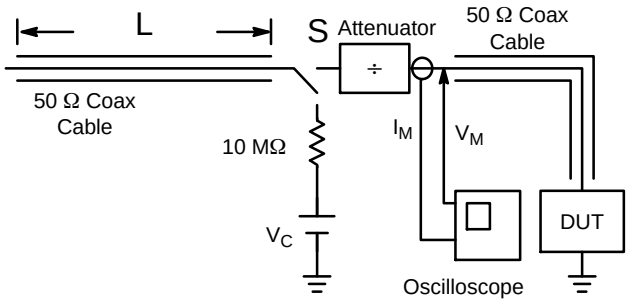



**Figure 10. Simplified Schematic of a Typical TLP System**

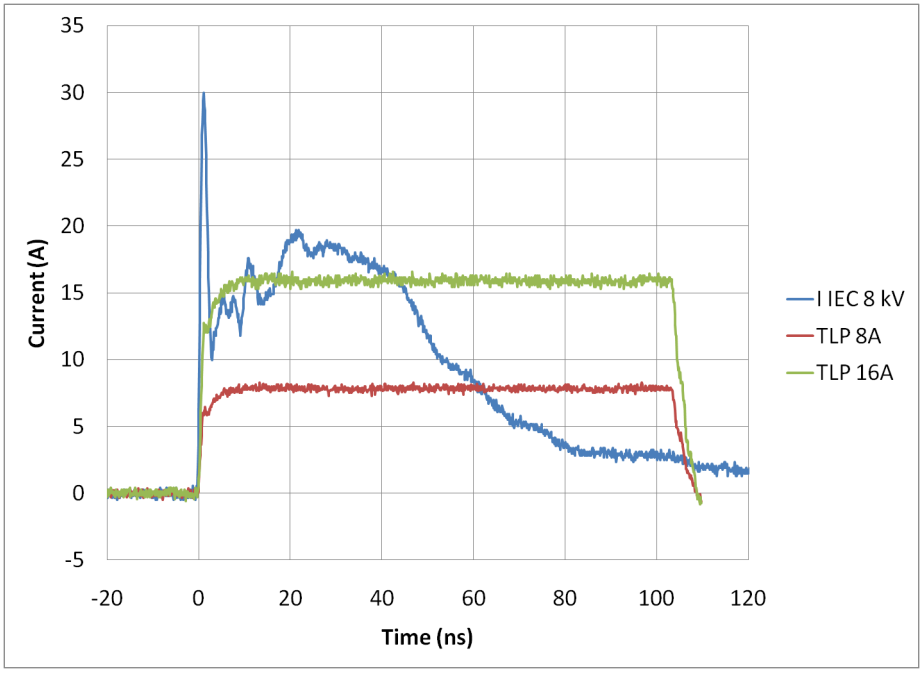



**Figure 11. Comparison Between 8 kV IEC 61000-4-2 and 8 A and 16 A TLP Waveforms**



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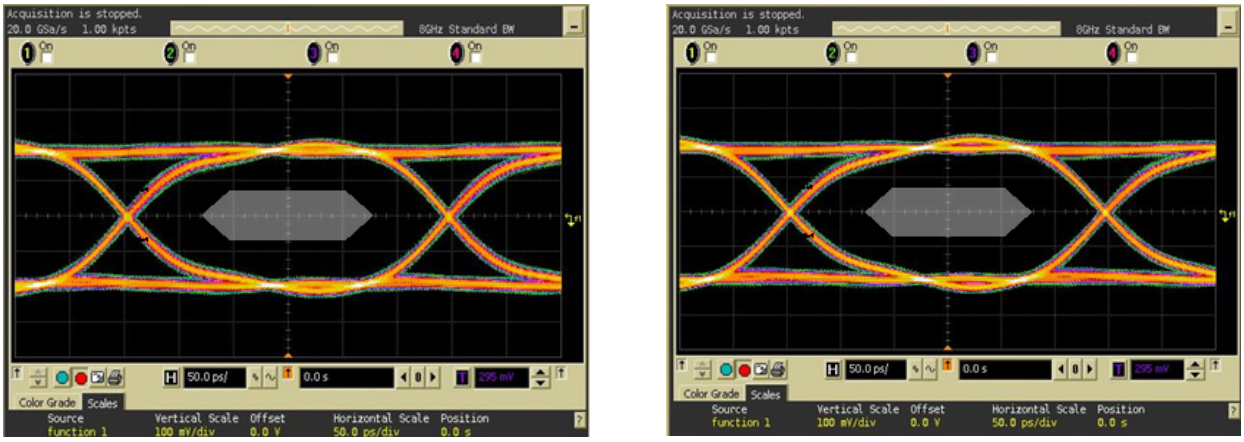



**Figure 12. HDMI1.4 Eye Diagram with and without MG2040. 3.4 Gb/s, 400 $mV_{PP}$**

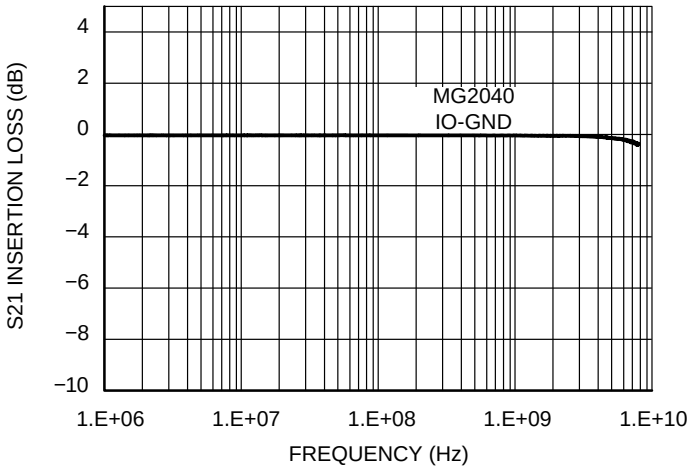



**Figure 13. MG2040 Insertion Loss**



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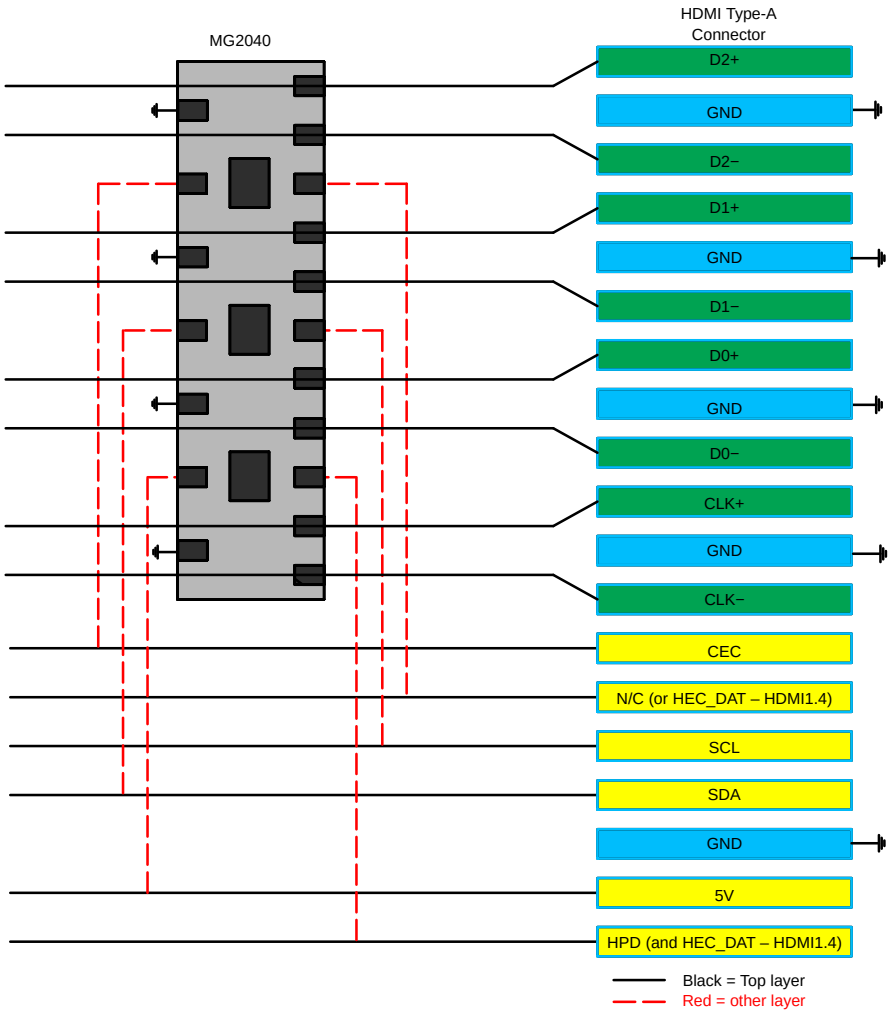



**Figure 14. HDMI Layout Diagram**



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## REVISION HISTORY

| Revision | Description of Changes | Date |
|---|---|---|
| 6 | Rebranded the document to **onsemi** format. | 4/21/2026 |

This document has undergone updates prior to the inclusion of this revision history table. The changes tracked here only reflect updates made on the noted approval dates.

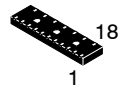


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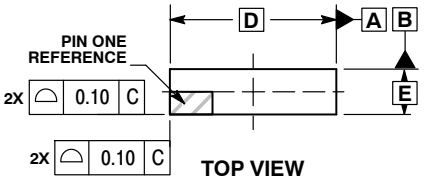
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CASE 517CP
ISSUE A

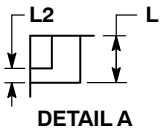
DATE 07 FEB 2013



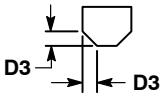

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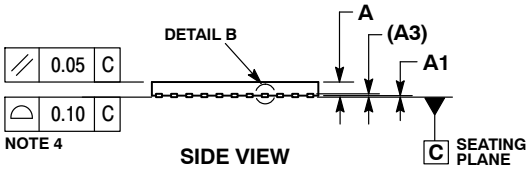

**TOP VIEW**



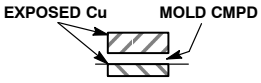

**DETAIL A**
OPTIONAL CONSTRUCTION



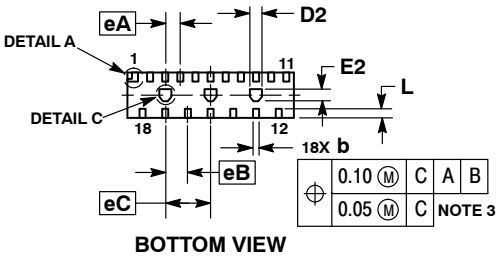

**DETAIL C**



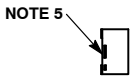

**SIDE VIEW**




**DETAIL B**
OPTIONAL CONSTRUCTION




**BOTTOM VIEW**

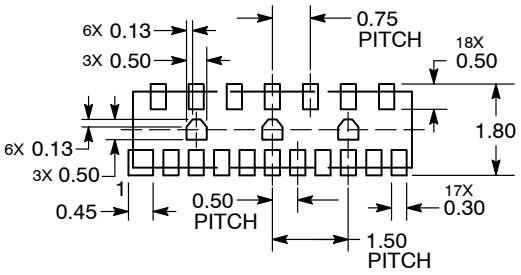



**END VIEW**

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.10 AND 0.20 MM FROM TERMINAL TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.
5. EXPOSED ENDS OF TERMINALS ARE ELECTRICALLY ACTIVE.

| | MILLIMETERS | |
|---|---|---|
| DIM | MIN | MAX |
| A | 0.45 | 0.55 |
| A1 | 0.00 | 0.05 |
| A3 | 0.13 REF | |
| b | 0.15 | 0.25 |
| D | 5.50 BSC | |
| D2 | 0.35 | 0.45 |
| D3 | 0.10 REF | |
| E | 1.50 BSC | |
| E2 | 0.35 | 0.45 |
| eA | 0.50 BSC | |
| eB | 0.75 BSC | |
| eC | 1.50 BSC | |
| L | 0.20 | 0.40 |
| L2 | 0.10 REF | |

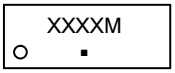
## RECOMMENDED SOLDERING FOOTPRINT*




NOTE: CENTER PADS OPTIONAL DIMENSION: MILLIMETERS

*For additional information on our Pb−Free strategy and soldering details, please download the **onsemi** Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

## GENERIC MARKING DIAGRAM*




XXXX = Specific Device Code
M = Date Code
▪ = Pb−Free Package

*This information is generic. Please refer to device data sheet for actual part marking.

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