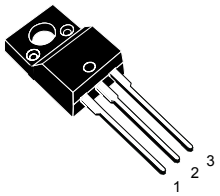
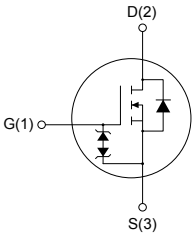
# STF11N60DM2

Datasheet

## N-channel 600 V, 370 mΩ typ., 10 A MDmesh DM2 Power MOSFET in a TO-220FP package




TO-220FP




NG1D2S3Z

| Order code | $V_{DS}$ @ $T_{Jmax}$ | $R_{DS(on)}$max. | $I_D$ | $P_{TOT}$ |
|---|---|---|---|---|
| STF11N60DM2 | 650 V | 420 mΩ | 10 A | 25 W |

- Fast-recovery body diode
- Extremely low gate charge and input capacitance
- Low on-resistance
- 100% avalanche tested
- Extremely high dv/dt ruggedness
- Zener-protected

## Applications

- Switching applications

## Description

This high-voltage N-channel Power MOSFET is part of the MDmesh DM2 fast-recovery diode series. It offers very low recovery charge ($Q_{rr}$) and time ($t_{rr}$) combined with low $R_{DS(on)}$, rendering it suitable for the most demanding high-efficiency converters and ideal for bridge topologies and ZVS phase-shift converters.

STPOWER

| Product status |
|---|
| STF11N60DM2 |

| Product summary | |
|---|---|
| **Order code** | STF11N60DM2 |
| **Marking** | 11N60DM2 |
| **Package** | TO220FP |
| **Packing** | Tube |

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{GS}$ | Gate-source voltage | ±25 | V |
| $I_D$ | Drain current (continuous) at $T_{case}$ = 25 °C | 10 | A |
| | Drain current (continuous) at $T_{case}$ = 100 °C | 6.3 | |
| $I_{DM}$ (1) | Drain current (pulsed) | 40 | A |
| $P_{TOT}$ | Total power dissipation at $T_{case}$ = 25 °C | 25 | W |
| dv/dt(2) | Peak diode recovery voltage slope | 50 | V/ns |
| dv/dt(3) | MOSFET dv/dt ruggedness | 50 | |
| $V_{ISO}$ (4) | Insulation withstand voltage (RMS) from all three leads to external heat sink | 2.5 | kV |
| $T_{stg}$ | Storage temperature range | -55 to 150 | °C |
| $T_j$ | Operating junction temperature range | | |

1. *Pulse width is limited by safe operating area.*
2. *$I_{SD}$ ≤ 10 A, di/dt=900 A/µs; $V_{DS}$ peak < $V_{(BR)DSS}$, $V_{DD}$ = 400 V*
3. *$V_{DS}$ ≤ 480 V.*
4. *t = 1 s; $T_C$ = 25 °C*

**Table 2. Thermal data**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thj\text{-}case}$ | Thermal resistance junction-case | 5 | °C/W |
| $R_{thj\text{-}amb}$ | Thermal resistance junction-ambient | 62.5 | |

**Table 3. Avalanche characteristics**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $I_{AR}$ (1) | Avalanche current, repetitive or not repetitive | 2.5 | A |
| $E_{AS}$ (2) | Single pulse avalanche energy | 250 | mJ |

1. *pulse width limited by $T_{jmax}$*
2. *starting $T_j$ = 25 °C, $I_D$ = $I_{AR}$, $V_{DD}$ = 50 V.*

# 2 Electrical characteristics

($T_{case}$ = 25 °C unless otherwise specified)

**Table 4. Static**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $V_{GS}$ = 0 V, $I_D$ = 1 mA | 600 | | | V |
| $I_{DSS}$ | Zero gate voltage drain current | $V_{GS}$ = 0 V, $V_{DS}$ = 600 V | | | 1.5 | µA |
| | | $V_{GS}$ = 0 V, $V_{DS}$ = 600 V, $T_{case}$ = 125 °C(1) | | | 100 | |
| $I_{GSS}$ | Gate-body leakage current | $V_{DS}$ = 0 V, $V_{GS}$ = ±25 V | | | ±5 | µA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 µA | 3 | 4 | 5 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS}$ = 10 V, $I_D$ = 5 A | | 370 | 420 | mΩ |

1. *Defined by design, not subject to production test.*

**Table 5. Dynamic**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$ | Input capacitance | $V_{DS}$ = 100 V, f = 1 MHz, $V_{GS}$ = 0 V | - | 614 | - | pF |
| $C_{oss}$ | Output capacitance | | - | 32 | - | |
| $C_{rss}$ | Reverse transfer capacitance | | - | 1.08 | - | |
| $C_{oss\ eq.}$ (1) | Equivalent output capacitance | $V_{DS}$ = 0 to 480 V, $V_{GS}$ = 0 V | - | 57 | - | pF |
| $R_G$ | Intrinsic gate resistance | f = 1 MHz, $I_D$ = 0 A | - | 6.2 | - | Ω |
| $Q_g$ | Total gate charge | $V_{DD}$ = 480 V, $I_D$ = 10 A, $V_{GS}$ = 0 to 10 V (see Figure 14. Test circuit for gate charge behavior) | - | 16.5 | - | nC |
| $Q_{gs}$ | Gate-source charge | | - | 3.8 | - | |
| $Q_{gd}$ | Gate-drain charge | | - | 9.2 | - | |

1. *$C_{oss\ eq.}$ is defined as a constant equivalent capacitance giving the same charging time as $C_{oss}$ when $V_{DS}$ increases from 0 to 80% $V_{DSS}$.*

**Table 6. Switching times**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD}$ = 300 V, $I_D$ = 5 A, $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V (see Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform) | - | 11.7 | - | ns |
| $t_r$ | Rise time | | - | 6.3 | - | |
| $t_{d(off)}$ | Turn-off delay time | | - | 31 | - | |
| $t_f$ | Fall time | | - | 9.5 | - | |

**Table 7. Source-drain diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$ (1) | Source-drain current | | - | | 10 | A |
| $I_{SDM}$ (2) | Source-drain current (pulsed) | | - | | 40 | A |
| $V_{SD}$ (3) | Forward on voltage | $V_{GS}$ = 0 V, $I_{SD}$ = 10 A | - | | 1.6 | V |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 10 A, di/dt = 100 A/µs, $V_{DD}$ = 60 V (see Figure 15. Test circuit for inductive load switching and diode recovery times) | - | 90 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 248 | | nC |
| $I_{RRM}$ | Reverse recovery current | | - | 5.5 | | A |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 10 A, di/dt = 100 A/µs, $V_{DD}$ = 60 V, $T_j$ = 150 °C (see Figure 15. Test circuit for inductive load switching and diode recovery times ) | - | 160 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 664 | | nC |
| $I_{RRM}$ | Reverse recovery current | | - | 8.3 | | A |

1. *Limited by maximum junction temperature.*
2. *Pulse width is limited by safe operating area.*
3. *Pulse test: pulse duration = 300 µs, duty cycle 1.5%.*

**Table 8. Gate-source Zener diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{(BR)GSO}$ | Gate-source breakdown voltage | $I_{GS}$ = ±250 µA, $I_D$ = 0 A | ±30 | - | - | V |

The built-in back-to-back Zener diodes are specifically designed to enhance the ESD performance of the device. The Zener voltage facilitates efficient and cost-effective device integrity protection, thus eliminating the need for additional external componentry.

## 2.1 Electrical characteristics (curves)

**Figure 1. Safe operating area**

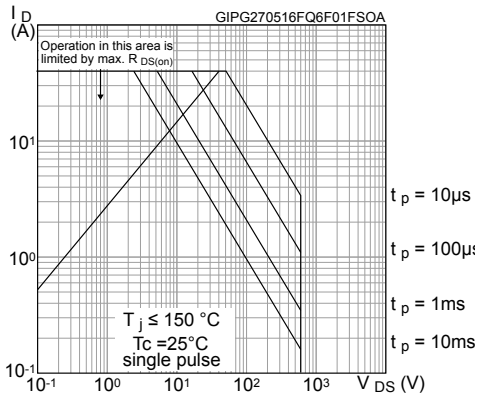



**Figure 2. Thermal impedance**

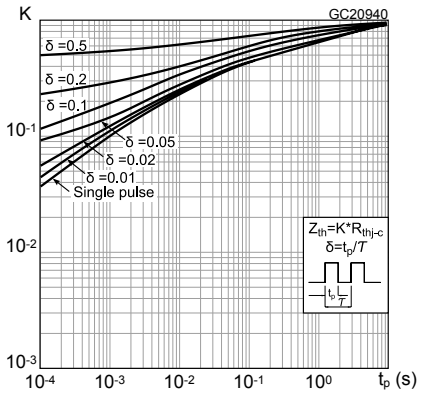



**Figure 3. Output characteristics**

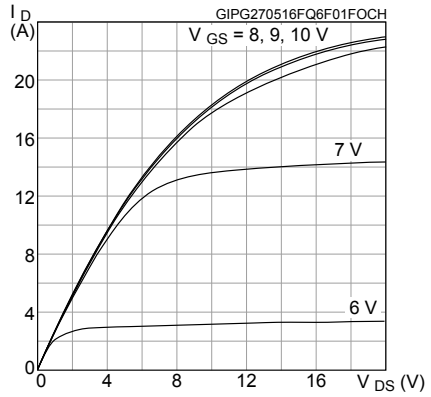



**Figure 4. Transfer characteristics**

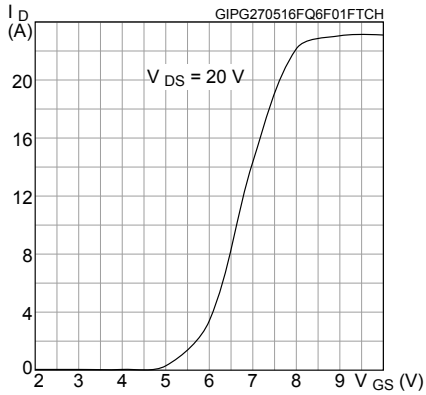



**Figure 5. Gate charge vs gate-source voltage**

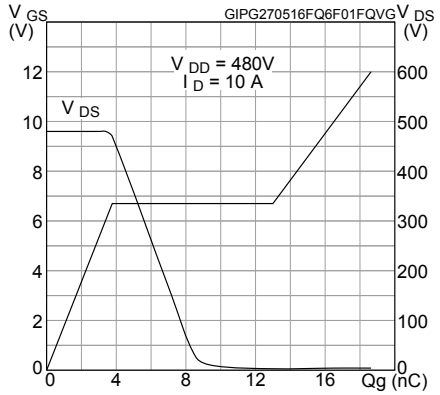



**Figure 6. Static drain-source on-resistance**

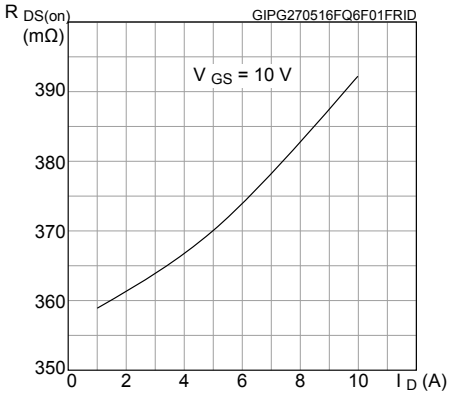


**Figure 7. Capacitance variations**

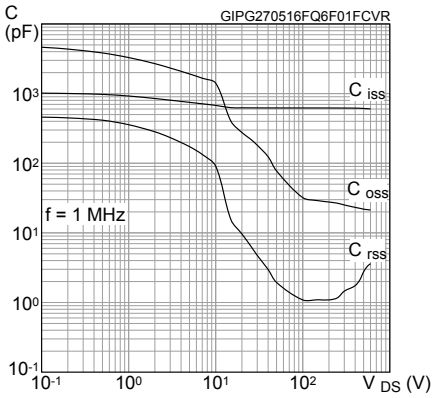



**Figure 8. Normalized gate threshold voltage vs temperature**

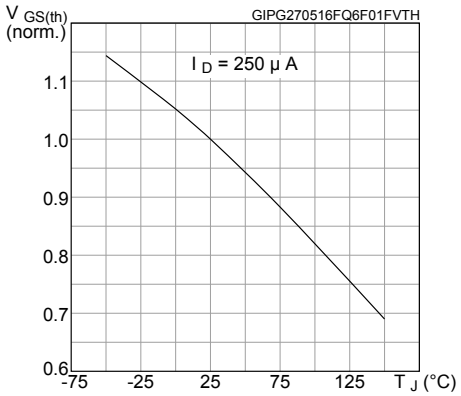



**Figure 9. Normalized on-resistance vs temperature**

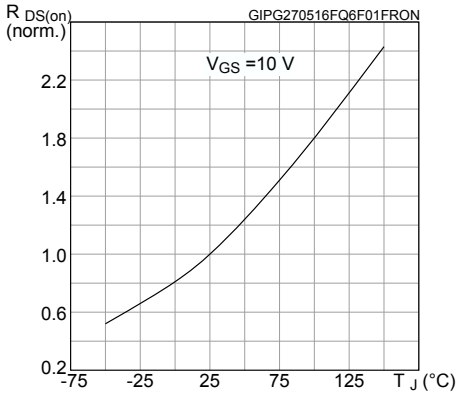



**Figure 10. Normalized $V_{(BR)DSS}$ vs temperature**

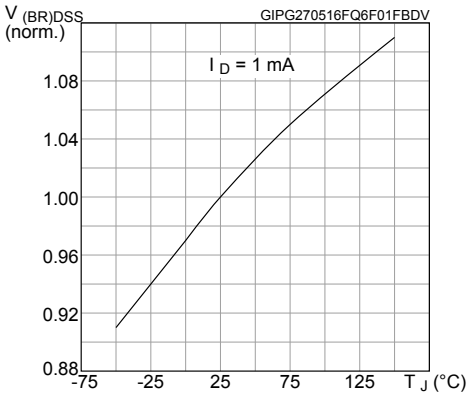



**Figure 11. Output capacitance stored energy**

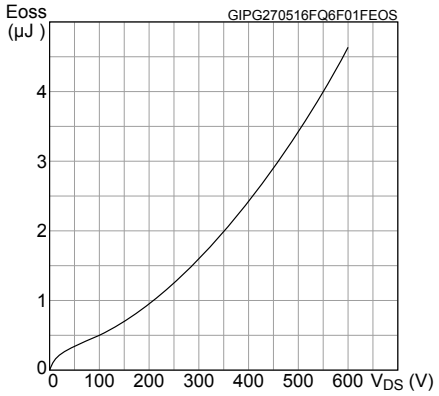
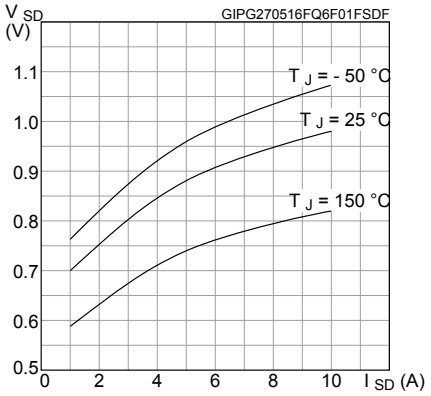



**Figure 12. Source-drain diode forward characteristics**



# 3 Test circuits

**Figure 13. Test circuit for resistive load switching times**

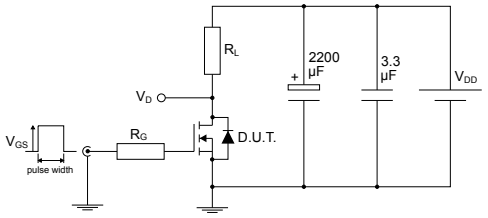



**Figure 14. Test circuit for gate charge behavior**

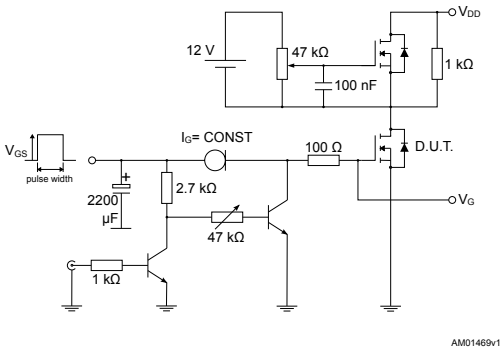



**Figure 15. Test circuit for inductive load switching and diode recovery times**

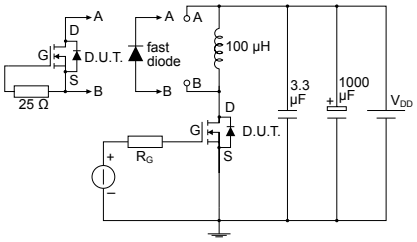



**Figure 16. Unclamped inductive load test circuit**

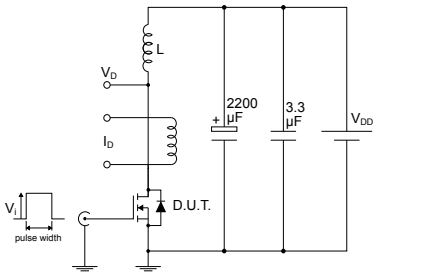



**Figure 17. Unclamped inductive waveform**

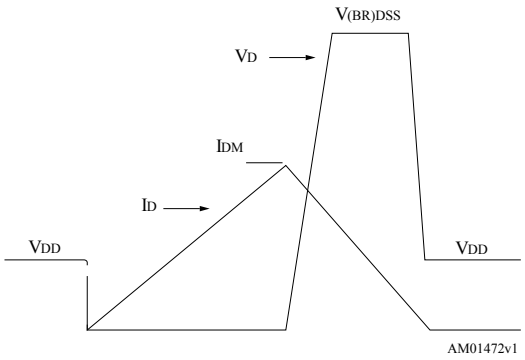
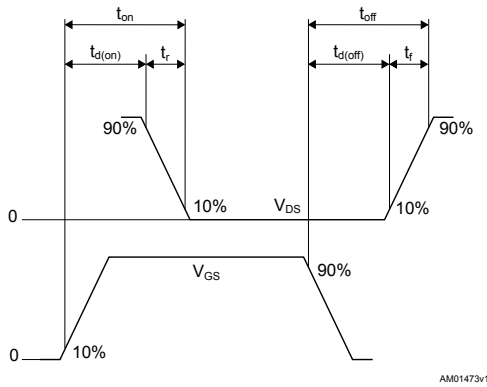



**Figure 18. Switching time waveform**



# 4 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: www.st.com. ECOPACK is an ST trademark.

## 4.1 TO-220FP package information

**Figure 19. TO-220FP package outline**

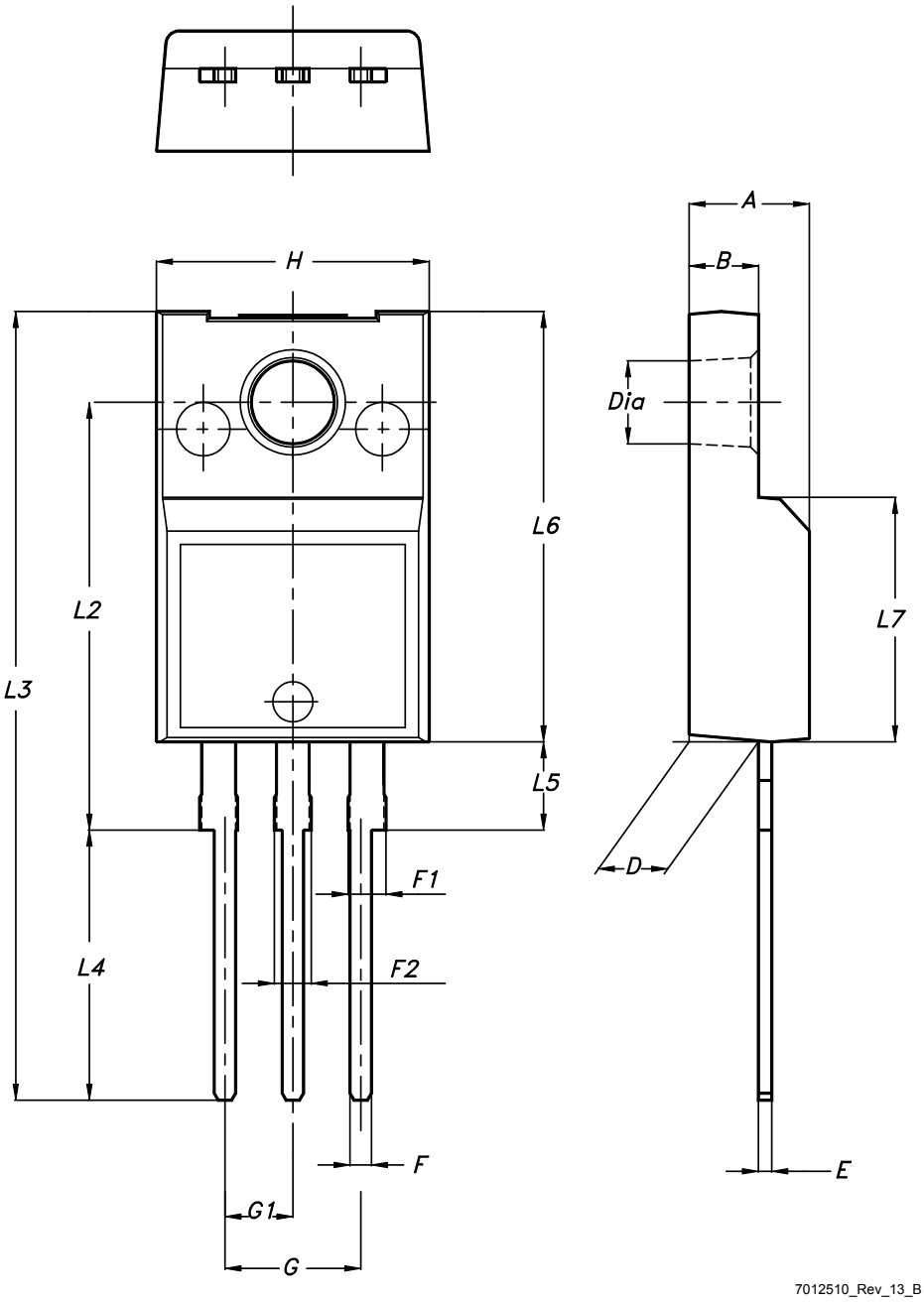


Table 9. TO-220FP package mechanical data

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 |
| B | 2.50 | | 2.70 |
| D | 2.50 | | 2.75 |
| E | 0.45 | | 0.70 |
| F | 0.75 | | 1.00 |
| F1 | 1.15 | | 1.70 |
| F2 | 1.15 | | 1.70 |
| G | 4.95 | | 5.20 |
| G1 | 2.40 | | 2.70 |
| H | 10.00 | | 10.40 |
| L2 | | 16.00 | |
| L3 | 28.60 | | 30.60 |
| L4 | 9.80 | | 10.60 |
| L5 | 2.90 | | 3.60 |
| L6 | 15.90 | | 16.40 |
| L7 | 9.00 | | 9.30 |
| Dia | 3.00 | | 3.20 |

## Revision history

**Table 10. Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 17-Jun-2016 | 1 | First release. |
| 04-Nov-2019 | 2 | Modified Table 1. Absolute maximum ratings.<br>Minor text changes. |

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