

EF Series Power MOSFET with Fast Body Diode

| PRODUCT SUMMARY | | |
|---|-----------------|-------|
| V_{DS} (V) at T_J max. | 650 | |
| $R_{DS(on)}$ max. at 25 °C (Ω) | $V_{GS} = 10$ V | 0.065 |
| Q_g max. (nC) | 228 | |
| Q_{gs} (nC) | 32 | |
| Q_{gd} (nC) | 62 | |
| Configuration | Single | |

FEATURES

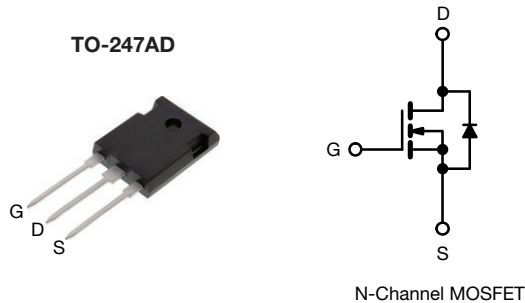
- Fast body diode MOSFET using E series technology
- Reduced t_{rr} , Q_{rr} , and I_{RRM}
- Low figure-of-merit (FOM) $R_{on} \times Q_g$
- Low input capacitance (C_{iss})
- Increased robustness due to low Q_{rr}
- Ultra low gate charge (Q_g)
- Avalanche energy rated (UIS)
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912



RoHS
COMPLIANT
HALOGEN
FREE

APPLICATIONS

- Telecommunications
 - Server and telecom power supplies
- Lighting
 - High-intensity lighting (HID)
 - Light emitting diodes (LEDs)
- Consumer and computing
 - ATX power supplies
- Industrial
 - Welding
 - Battery chargers
- Renewable energy
 - Solar (PV inverters)
- Switching mode power supplies (SMPS)
 - Applications using the following topologies
 - LLC
 - Phase shifted bridge (ZVS)
 - 3-level inverter
 - AC/DC bridge



| ORDERING INFORMATION | |
|---------------------------------|-----------------|
| Package | TO-247AD |
| Lead (Pb)-free and Halogen-free | SiHW47N60EF-GE3 |


| ABSOLUTE MAXIMUM RATINGS ($T_C = 25$ °C, unless otherwise noted) | | | | |
|---|------------------|----------------|-------------|------|
| PARAMETER | SYMBOL | | LIMIT | UNIT |
| Drain-Source Voltage | V_{DS} | | 600 | V |
| Gate-Source Voltage | V_{GS} | | ± 30 | |
| Continuous Drain Current ($T_J = 150$ °C) | V_{GS} at 10 V | $T_C = 25$ °C | 47 | A |
| | | $T_C = 100$ °C | 29 | |
| Pulsed Drain Current ^a | I_{DM} | | 138 | |
| Linear Derating Factor | | | 3 | W/°C |
| Single Pulse Avalanche Energy ^b | E_{AS} | | 1500 | mJ |
| Maximum Power Dissipation | P_D | | 379 | W |
| Operating Junction and Storage Temperature Range | T_J, T_{stg} | | -55 to +150 | °C |
| Drain-Source Voltage Slope | $T_J = 125$ °C | | 70 | V/ns |
| Reverse Diode dV/dt ^d | dV/dt | | 50 | |
| Soldering Recommendations (Peak Temperature) ^c | for 10 s | | 300 | °C |

Notes

- Repetitive rating; pulse width limited by maximum junction temperature
- $V_{DD} = 50$ V, starting $T_J = 25$ °C, $L = 73.5$ mH, $R_g = 25$ Ω , $I_{AS} = 6.4$ A
- 1.6 mm from case
- $I_{SD} \leq I_D$, $dI/dt = 500$ A/ μ s, starting $T_J = 25$ °C



| THERMAL RESISTANCE RATINGS | | | | |
|----------------------------------|------------|------|------|------|
| PARAMETER | SYMBOL | TYP. | MAX. | UNIT |
| Maximum Junction-to-Ambient | R_{thJA} | - | 40 | °C/W |
| Maximum Junction-to-Case (Drain) | R_{thJC} | - | 0.33 | |

| SPECIFICATIONS ($T_J = 25\text{ }^\circ\text{C}$, unless otherwise noted) | | | | | | | | | |
|---|---------------------|---|---|---|-------|-----------|---------------|------|-----|
| PARAMETER | SYMBOL | TEST CONDITIONS | | MIN. | TYP. | MAX. | UNIT | | |
| Static | | | | | | | | | |
| Drain-Source Breakdown Voltage | V_{DS} | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$ | | 600 | - | - | V | | |
| V_{DS} Temperature Coefficient | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}, I_D = 1\text{ mA}$ | | - | - | - | V/°C | | |
| Gate-Source Threshold Voltage (N) | $V_{GS(th)}$ | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$ | | 2.0 | - | 4.0 | V | | |
| Gate-Source Leakage | I_{GSS} | $V_{GS} = \pm 20\text{ V}$ | | - | - | ± 100 | nA | | |
| | | $V_{GS} = \pm 30\text{ V}$ | | - | - | ± 1 | μA | | |
| Zero Gate Voltage Drain Current | I_{DSS} | $V_{DS} = 480\text{ V}, V_{GS} = 0\text{ V}$ | | - | - | 1 | μA | | |
| | | $V_{DS} = 480\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$ | | - | - | 500 | | | |
| Drain-Source On-State Resistance | $R_{DS(on)}$ | $V_{GS} = 10\text{ V}$ | $I_D = 24\text{ A}$ | - | 0.056 | 0.065 | Ω | | |
| Forward Transconductance | g_{fs} | $V_{DS} = 30\text{ V}, I_D = 24\text{ A}$ | | - | 17 | - | S | | |
| Dynamic | | | | | | | | | |
| Input Capacitance | C_{iss} | $V_{GS} = 0\text{ V}, V_{DS} = 100\text{ V}, f = 1\text{ MHz}$ | | - | 5000 | - | pF | | |
| Output Capacitance | C_{oss} | | | - | 220 | - | | | |
| Reverse Transfer Capacitance | C_{rss} | | | - | 7 | - | | | |
| Effective Output Capacitance, Energy Related ^a | $C_{o(er)}$ | | | $V_{DS} = 0\text{ V to } 480\text{ V}, V_{GS} = 0\text{ V}$ | | - | | 172 | - |
| Effective Output Capacitance, Time Related ^b | $C_{o(tr)}$ | | | | | - | | 634 | - |
| Total Gate Charge | Q_g | $V_{GS} = 10\text{ V}$ | $I_D = 24\text{ A}, V_{DS} = 480\text{ V}$ | - | 152 | 228 | nC | | |
| Gate-Source Charge | Q_{gs} | | | - | 32 | - | | | |
| Gate-Drain Charge | Q_{gd} | | | - | 62 | - | | | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD} = 480\text{ V}, I_D = 24\text{ A}, V_{GS} = 10\text{ V}, R_g = 4.4\text{ }\Omega$ | | - | 30 | 60 | ns | | |
| Rise Time | t_r | | | - | 56 | 84 | | | |
| Turn-Off Delay Time | $t_{d(off)}$ | | | - | 91 | 137 | | | |
| Fall Time | t_f | | | - | 56 | 84 | | | |
| Gate Input Resistance | R_g | | | $f = 1\text{ MHz}, \text{open drain}$ | | 0.2 | | 0.46 | 1.0 |
| Drain-Source Body Diode Characteristics | | | | | | | | | |
| Continuous Source-Drain Diode Current | I_S | MOSFET symbol showing the integral reverse p - n junction diode |  | - | - | 47 | A | | |
| Pulsed Diode Forward Current | I_{SM} | | | - | - | 138 | | | |
| Diode Forward Voltage | V_{SD} | $T_J = 25\text{ }^\circ\text{C}, I_S = 24\text{ A}, V_{GS} = 0\text{ V}$ | | - | 0.9 | 1.2 | V | | |
| Body Diode Reverse Recovery Time | t_{rr} | $T_J = 25\text{ }^\circ\text{C}, I_F = I_S = 24\text{ A}, di/dt = 100\text{ A}/\mu\text{s}, V_R = 400\text{ V}$ | | - | 199 | 398 | ns | | |
| Body Diode Reverse Recovery Charge | Q_{rr} | | | - | 1.4 | 2.8 | μC | | |
| Reverse Recovery Current | I_{RRM} | | | - | 13.2 | - | A | | |

Notes

- a. $C_{oss(er)}$ is a fixed capacitance that gives the same energy as C_{oss} while V_{DS} is rising from 0 % to 80 % V_{DSS}
- b. $C_{oss(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 % to 80 % V_{DSS}



TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

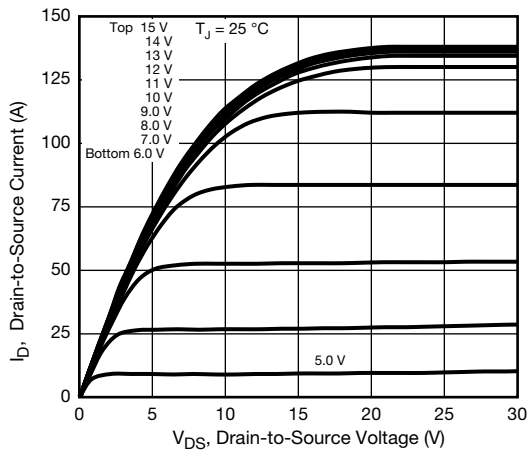


Fig. 1 - Typical Output Characteristics

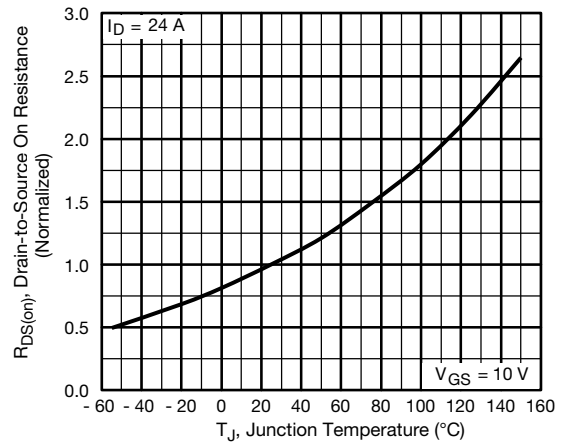


Fig. 4 - Normalized On-Resistance vs. Temperature

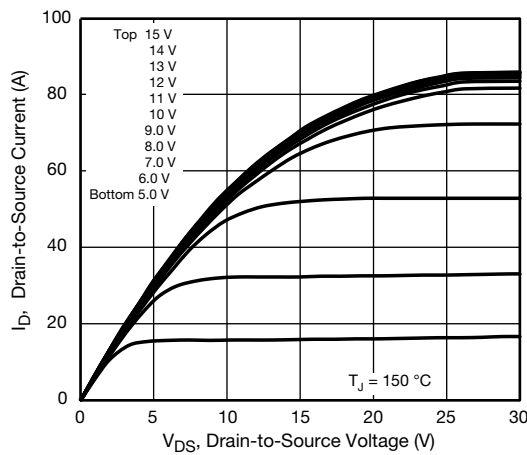


Fig. 2 - Typical Output Characteristics

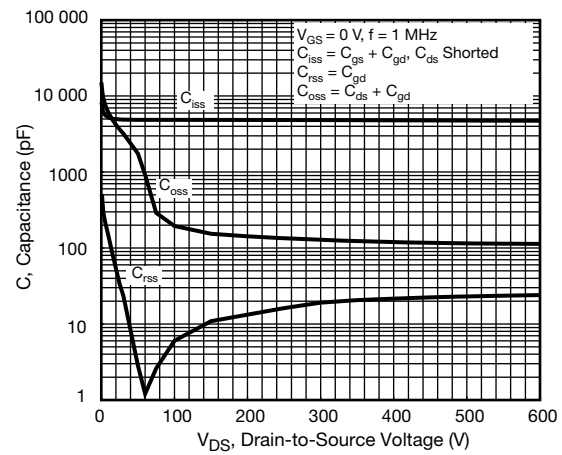


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

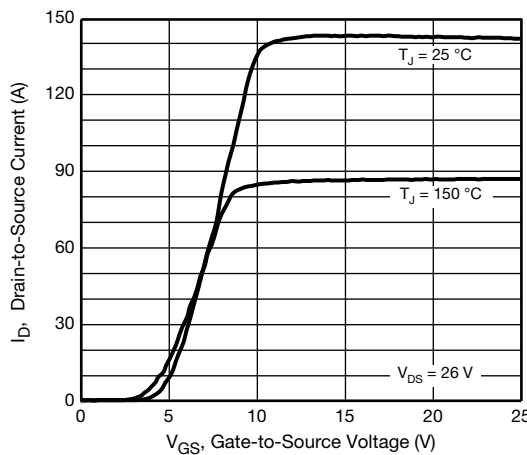


Fig. 3 - Typical Transfer Characteristics

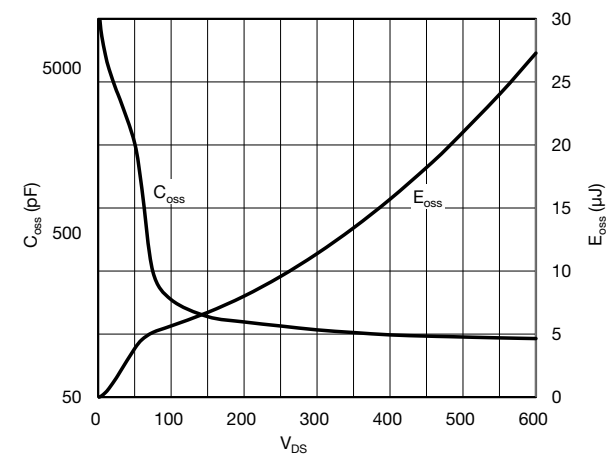


Fig. 6 - C_{oss} and E_{oss} vs. V_{DS}

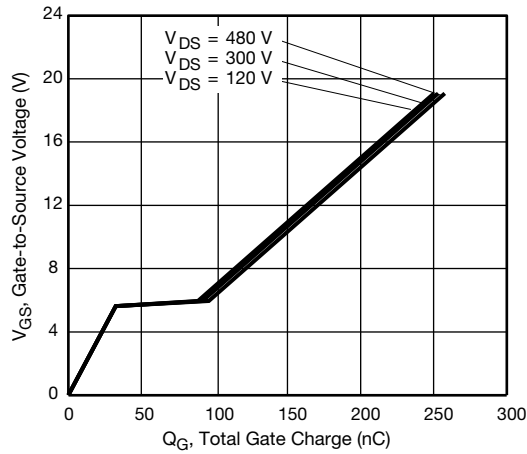


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

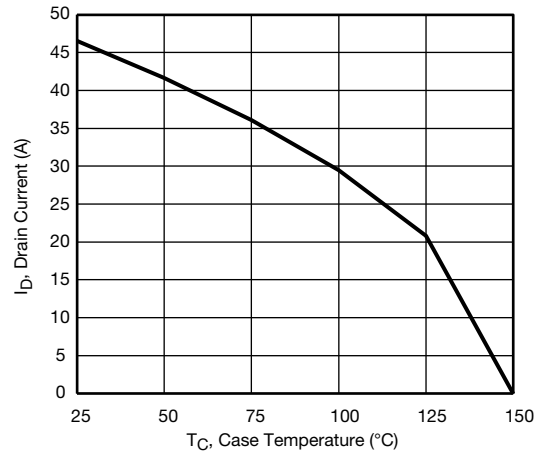


Fig. 10 - Maximum Drain Current vs. Case Temperature

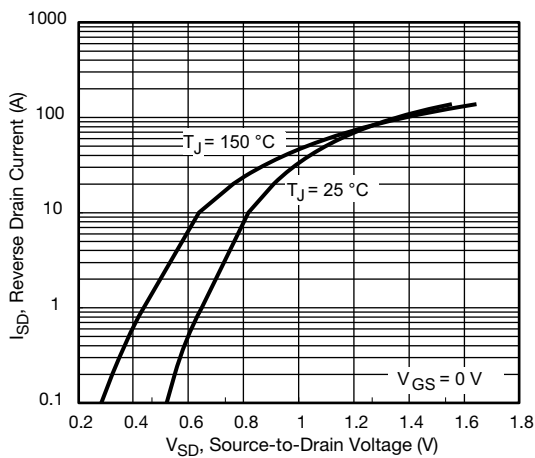


Fig. 8 - Typical Source-Drain Diode Forward Voltage

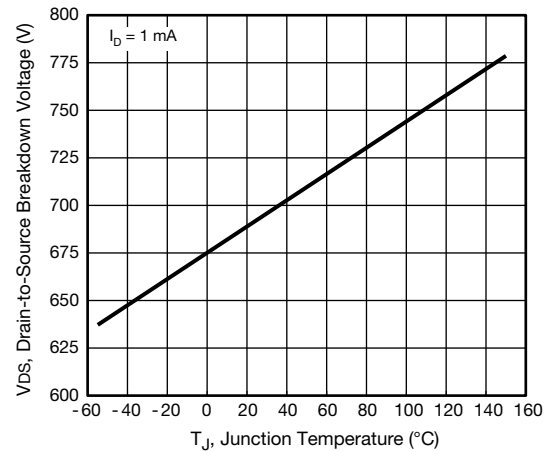


Fig. 11 - Temperature vs. Drain-to-Source Voltage

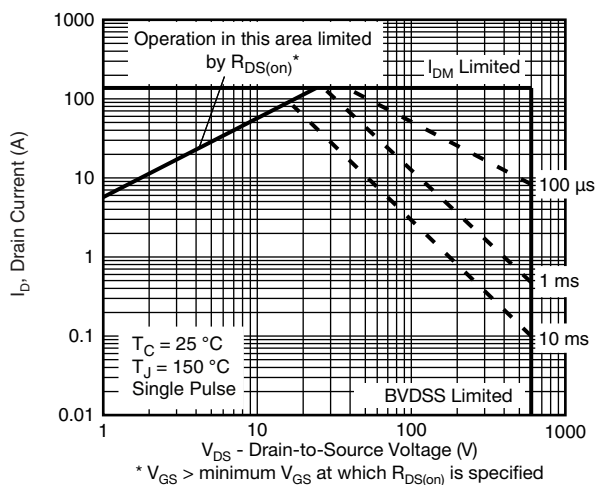


Fig. 9 - Maximum Safe Operating Area

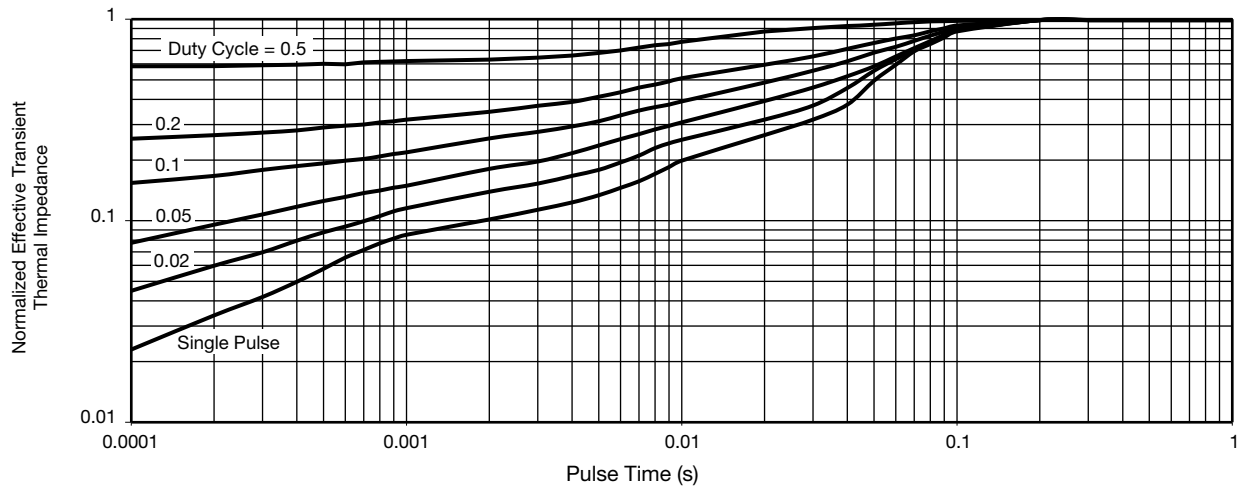


Fig. 12 - Normalized Thermal Transient Impedance, Junction-to-Case



Fig. 13 - Switching Time Test Circuit

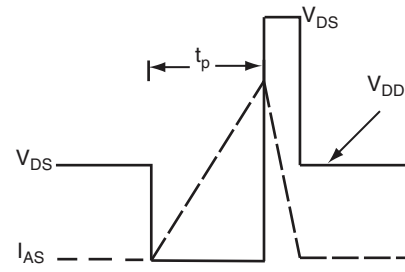


Fig. 16 - Unclamped Inductive Waveforms

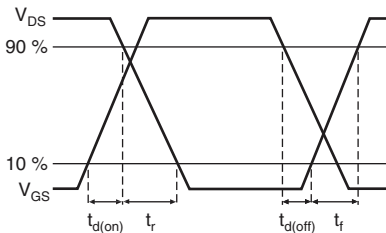


Fig. 14 - Switching Time Waveforms

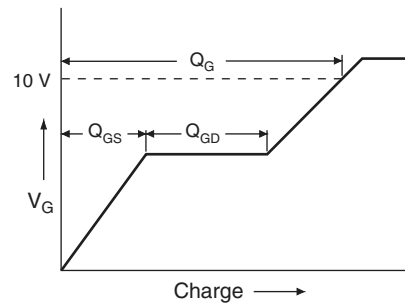


Fig. 17 - Basic Gate Charge Waveform

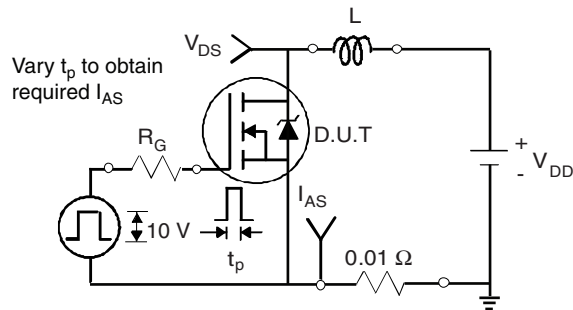


Fig. 15 - Unclamped Inductive Test Circuit

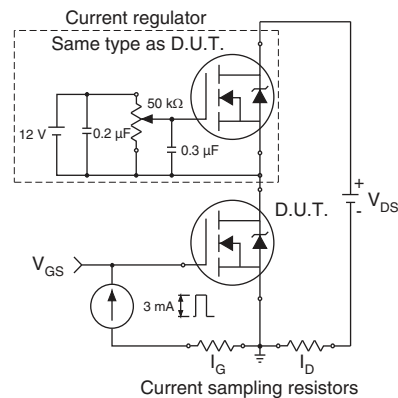


Fig. 18 - Gate Charge Test Circuit



Note

a. $V_{GS} = 5 V$ for logic level devices

Fig. 18 - For N-Channel

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TO-247AD (High Voltage)



| DIM. | MILLIMETERS | | INCHES | |
|---------------------------------|-------------|-------|-----------|-------|
| | MIN. | MAX. | MIN. | MAX. |
| A | 4.70 | 5.31 | 0.185 | 0.209 |
| A1 | 2.21 | 2.59 | 0.087 | 0.102 |
| A2 | 1.50 | 2.49 | 0.059 | 0.098 |
| b | 0.99 | 1.40 | 0.039 | 0.055 |
| b2 | 1.65 | 2.41 | 0.065 | 0.095 |
| b4 | 2.59 | 3.43 | 0.102 | 0.135 |
| c | 0.61 BSC | | 0.024 BSC | |
| D | 20.80 | 21.46 | 0.819 | 0.845 |
| D1 | 3.68 | 5.49 | 0.145 | 0.216 |
| (e) | 5.46 BSC | | 0.215 BSC | |
| E | 15.49 | 16.26 | 0.610 | 0.640 |
| L | 19.81 | 20.32 | 0.780 | 0.800 |
| L1 | 4.06 | 4.50 | 0.160 | 0.177 |
| Ø p | 3.51 | 3.66 | 0.138 | 0.144 |
| ECN: S17-0178-Rev. B, 06-Feb-17 | | | | |
| DWG: 6010 | | | | |



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