

## SCT4065DWAHR-VB Datasheet

### N-Channel 650V (D-S) SiC Power MOSFET

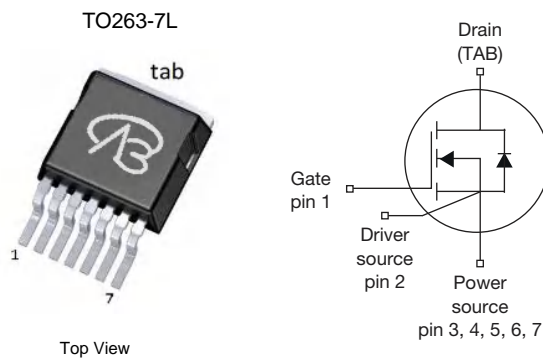
| PRODUCT SUMMARY                    |                 |       |
|------------------------------------|-----------------|-------|
| $V_{DS}$ (V)                       | 650             |       |
| $R_{DS(on)}$ at 25 °C ( $\Omega$ ) | $V_{GS} = 18$ V | 0.055 |
| $Q_g$ (nC)                         | 40              |       |

#### FEATURES

- Low figure-of-merit (FOM)  $R_{on} \times Q_g$
- Higher robustness and system reliability
- Kelvin source provides up to 4 times lower switching losses
- Ultra low gate charge ( $Q_g$ )
- Avalanche energy rated (UIS)

#### APPLICATIONS

- Server and telecom power supplies
- EV charging infrastructure
- Solar PV inverters
- DC/DC converter




| ABSOLUTE MAXIMUM RATINGS ( $T_C = 25$ °C, unless otherwise noted) |                  |                |             |      |
|---|------------------|----------------|-------------|------|
| PARAMETER   | SYMBOL           | LIMIT          | UNIT        |      |
| Drain-Source Voltage  | $V_{DS}$         | 650            | V           |      |
| Gate-Source Voltage   | $V_{GS}$         | -10 / +22      |             |      |
| Continuous Drain Current ( $T_J = 175$ °C)                        | $V_{GS}$ at 18 V | $T_C = 25$ °C  | 35          | A    |
|   |                  | $T_C = 100$ °C | 25          |      |
| Pulsed Drain Current <sup>a</sup>                                 |                  | $I_{DM}$       | 95          |      |
| Linear Derating Factor  |                  |                | 2.1         | W/°C |
| Single Pulse Avalanche Energy <sup>b</sup>                        |                  | $E_{AS}$       | 160         | mJ   |
| Maximum Power Dissipation   |                  | $P_D$          | 187         | W    |
| Operating Junction and Storage Temperature Range                  |                  | $T_J, T_{stg}$ | -55 to +175 | °C   |
| Drain-Source Voltage Slope  | $T_J = 125$ °C   | $dV/dt$        | 150         | V/ns |
| Reverse Diode $dV/dt$ <sup>d</sup>                                |                  |                | 100         |      |
| Soldering Recommendations (Peak Temperature) <sup>c</sup>         | for 10 s         |                | 260         | °C   |

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature.
- $V_{DD} = 50$  V, starting  $T_J = 25$  °C,  $L = 1$  mH,  $R_g = 25$   $\Omega$ .
- 1.6 mm from case.
- $I_{SD} \leq I_D$ ,  $dI/dt = 100$  A/ $\mu$ s, starting  $T_J = 25$  °C.

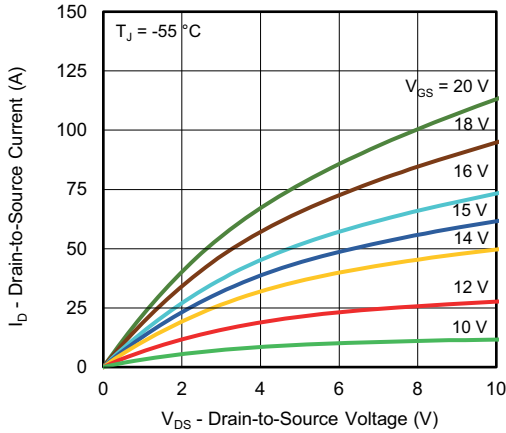
| THERMAL RESISTANCE RATINGS       |            |      |      |      |
|----------------------------------|------------|------|------|------|
| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
| Maximum Junction-to-Ambient      | $R_{thJA}$ | -    | 62   | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | -    | 0.8  |      |

| SPECIFICATIONS ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted) |                     |   |  |      |       |      |               |
|---|---------------------|---|--|------|-------|------|---------------|
| PARAMETER   | SYMBOL              | TEST CONDITIONS   |  | MIN. | TYP.  | MAX. | UNIT          |
| <b>Static</b>   |                     |   |  |      |       |      |               |
| Drain-Source Breakdown Voltage  | $V_{DS}$            | $V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$  |  | 650  | -     | -    | V             |
| $V_{DS}$ Temperature Coefficient  | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}$   |  | -    | 0.70  | -    | V/°C          |
| Gate-Source Threshold Voltage (N)   | $V_{GS(th)}$        | $V_{DS} = V_{GS}, I_D = 5\text{ mA}$  |  | 2    | -     | 4.5  | V             |
| Gate-Source Leakage   | $I_{GSS}$           | $V_{GS} = +18\text{ V}$   |  | -    | -     | 100  | nA            |
|   |                     | $V_{GS} = -8\text{ V}$  |  | -    | -     | 100  | nA            |
| Zero Gate Voltage Drain Current   | $I_{DSS}$           | $V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}$  |  | -    | 10    | -    | $\mu\text{A}$ |
|   |                     | $V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$   |  | -    | -     | 100  |               |
| Drain-Source On-State Resistance  | $R_{DS(on)}$        | $V_{GS} = 18\text{ V}$  | $I_D = 20\text{ A}$                        | -    | 0.055 | -    | $\Omega$      |
| Forward Transconductance  | $g_{fs}$            | $V_{DS} = 0\text{ V}, I_D = 20\text{ A}$  |  | -    | 10    | -    | S             |
| <b>Dynamic</b>  |                     |   |  |      |       |      |               |
| Input Capacitance   | $C_{iss}$           | $V_{GS} = 0\text{ V},$<br>$V_{DS} = 600\text{ V},$<br>$f = 100\text{ KHz}$  |  | -    | 1500  | -    | pF            |
| Output Capacitance  | $C_{oss}$           |   |  | -    | 90    | -    |               |
| Reverse Transfer Capacitance  | $C_{rss}$           |   |  | -    | 3     | -    |               |
| Effective Output Capacitance, Energy Related <sup>a</sup>                   | $C_{o(er)}$         | $V_{DS} = 0\text{ V to } 400\text{ V}, V_{GS} = 0\text{ V}$   |  | -    | 120   | -    |               |
| Effective Output Capacitance, Time Related <sup>b</sup>                     | $C_{o(tr)}$         |   |  | -    | 160   | -    |               |
| Total Gate Charge   | $Q_g$               | $V_{GS} = -5/18\text{ V}$   | $I_D = 20\text{ A}, V_{DS} = 400\text{ V}$ | -    | 40    | -    | nC            |
| Gate-Source Charge  | $Q_{gs}$            |   |  | -    | 20    | -    |               |
| Gate-Drain Charge   | $Q_{gd}$            |   |  | -    | 23    | -    |               |
| Turn-On Delay Time  | $t_{d(on)}$         | $V_{DD} = 400\text{ V}, I_D = 20\text{ A}$<br><br>$V_{GS} = -5/15\text{ V}$   |  | -    | 12    | 15   | ns            |
| Rise Time   | $t_r$               |   |  | -    | 10    | 13   |               |
| Turn-Off Delay Time   | $t_{d(off)}$        |   |  | -    | 20    | -    |               |
| Fall Time   | $t_f$               |   |  | -    | 10    | -    |               |
| Gate Input Resistance   | $R_g$               | $f = 1\text{ MHz}, \text{ open drain}$  |  | -    | 8.2   | -    | $\Omega$      |
| <b>Drain-Source Body Diode Characteristics</b>                              |                     |   |  |      |       |      |               |
| Continuous Source-Drain Diode Current                                       | $I_S$               | MOSFET symbol showing the integral reverse p - n junction diode  |  | -    | -     | 30   | A             |
| Pulsed Diode Forward Current  | $I_{SM}$            |   |  | -    | -     | 90   |               |
| Diode Forward Voltage   | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}, I_S = 20\text{ A}, V_{GS} = 0$   |  | -    | -     | 4.1  | V             |
| Reverse Recovery Time   | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}, I_F = I_S = 20\text{ A},$<br>$di/dt = 1000\text{ A}/\mu\text{s}, V_R = 400\text{ V}$                                 |  | -    | 12    | -    | ns            |
| Reverse Recovery Charge   | $Q_{rr}$            |   |  | -    | 0.06  | -    | $\mu\text{C}$ |
| Reverse Recovery Current  | $I_{RRM}$           |   |  | -    | 10    | -    | 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 60 %  $V_{DSS}$ .  
 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 60 %  $V_{DSS}$ .

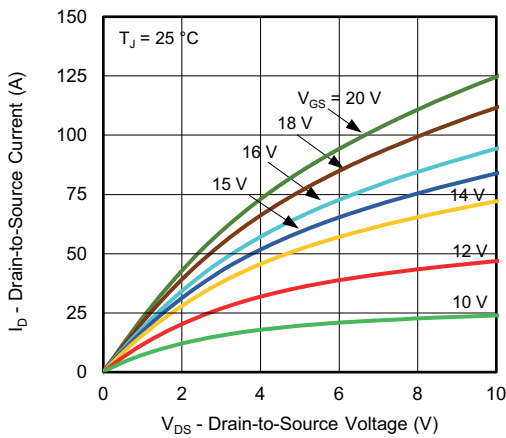
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



**Fig. 1 - Typical Output Characteristics**



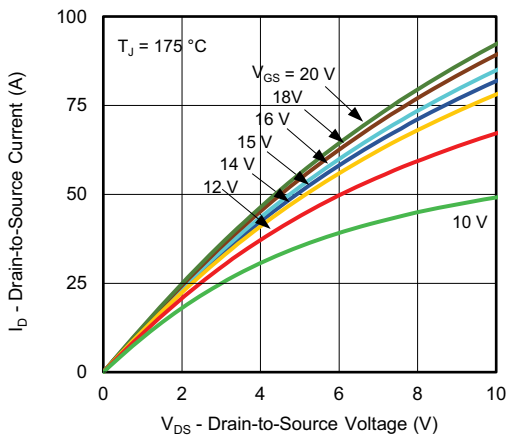
**Fig. 4 - Typical Transfer Characteristics**



**Fig. 2 - Typical Output Characteristics**



**Fig. 5 - Normalized On-Resistance vs. Drain Current**



**Fig. 3 - Typical Output Characteristics**



**Fig. 6 - Typical Capacitance vs. Drain-to-Source Voltage**

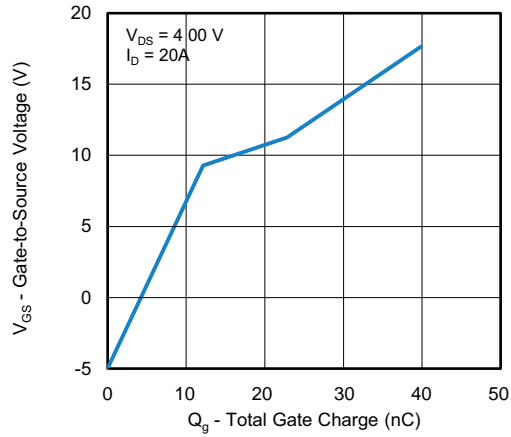


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

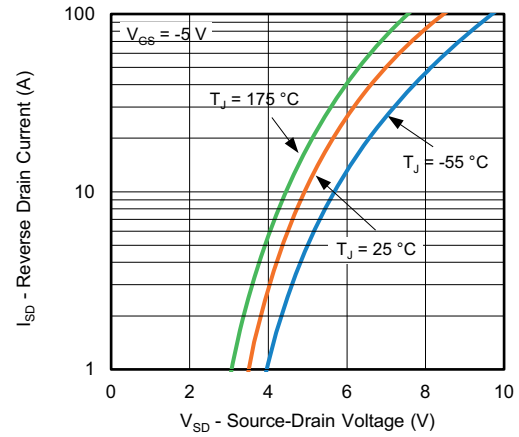


Fig. 10 - Typical Source-Drain Diode Forward Voltage

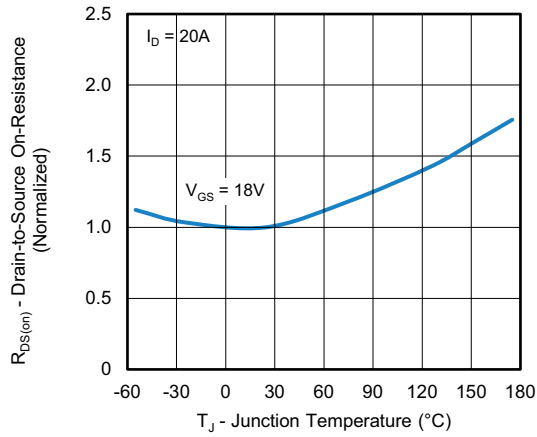


Fig. 8 - Normalized On-Resistance vs. Temperature

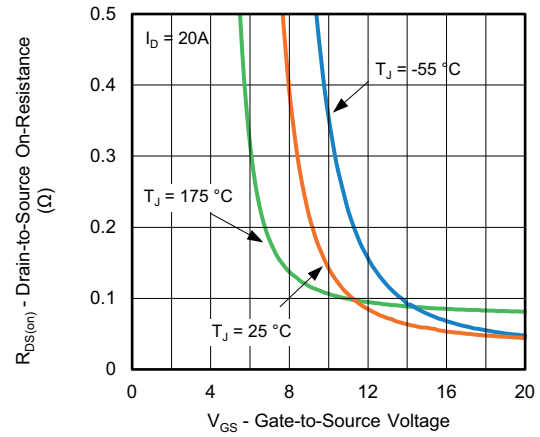


Fig. 11 - On-Resistance vs. Gate-to-Source Voltage

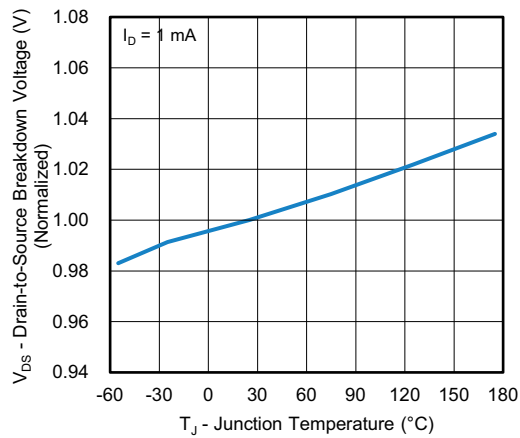


Fig. 9 - Drain-to-Source Voltage vs. Temperature

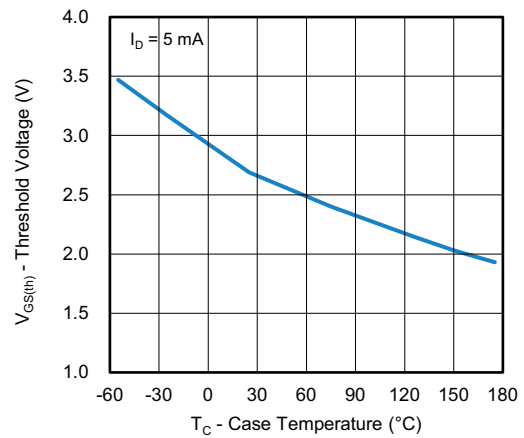


Fig. 12 - Threshold Voltage vs. Case Temperature

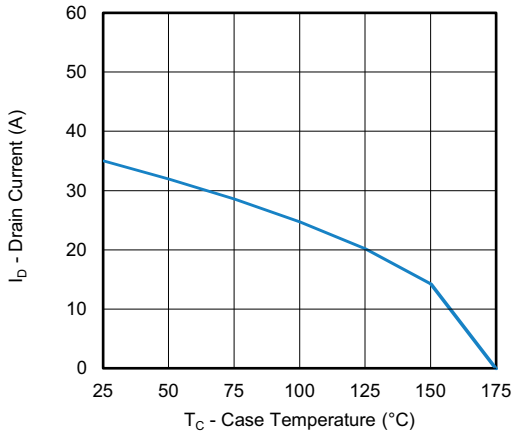


Fig. 13 - Drain Current vs. Case Temperature

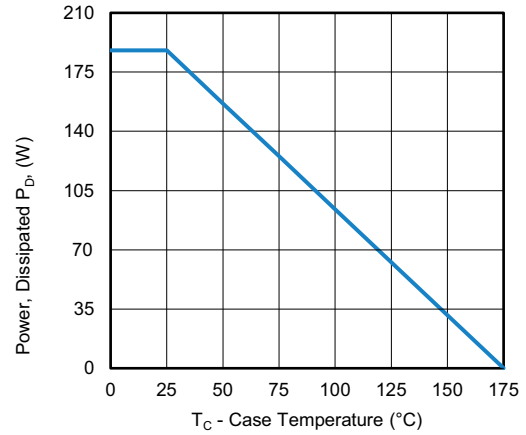


Fig. 15 - Power, Dissipated P<sub>D</sub> vs. Case Temperature

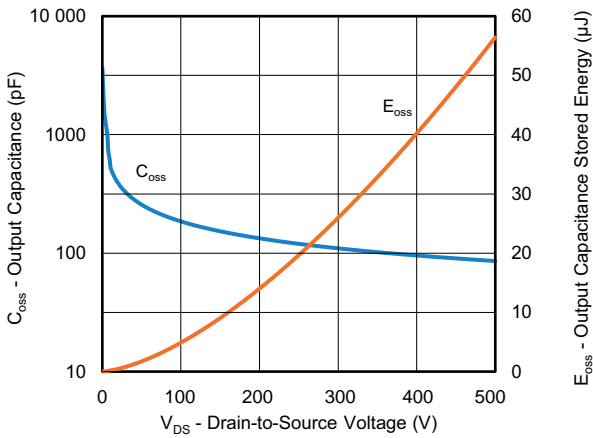


Fig. 14 - Output Capacitance and its Stored Energy vs. Drain-to-Source Voltage

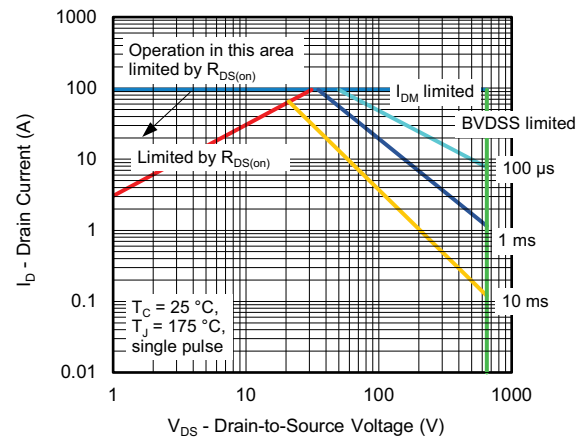


Fig. 16 - Safe Operating Area

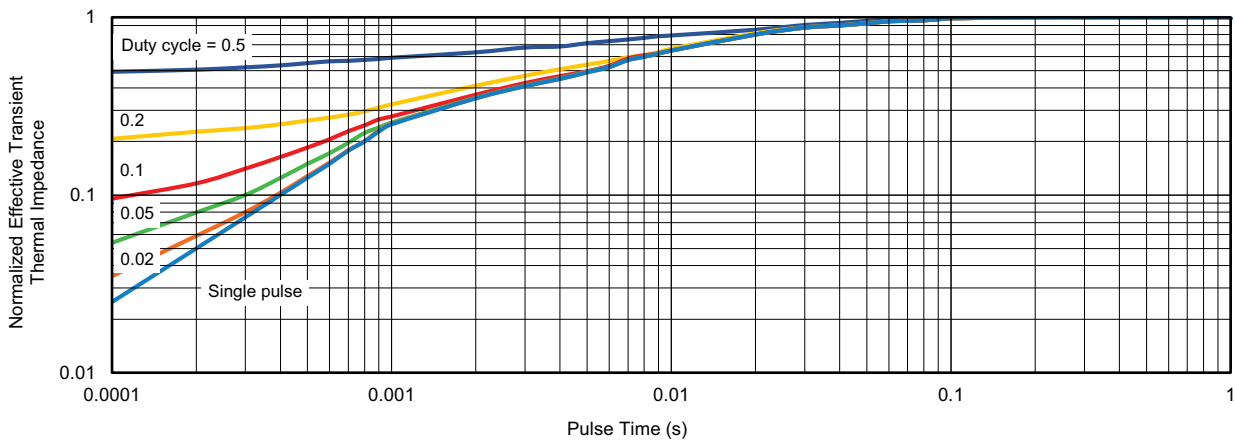


Fig. 17 - Transient Thermal Impedance

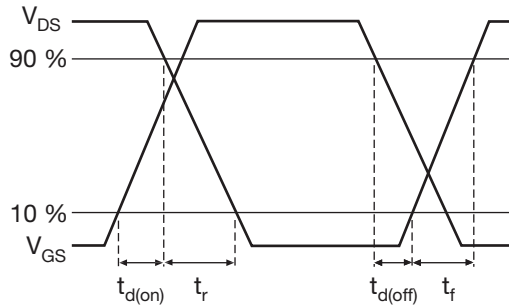


Fig. 18 - Waveforms of Switching Time

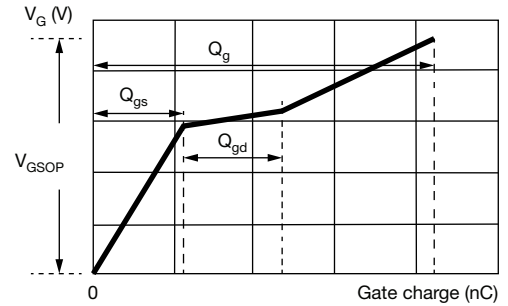


Fig. 21 - Waveforms for Gate Charge

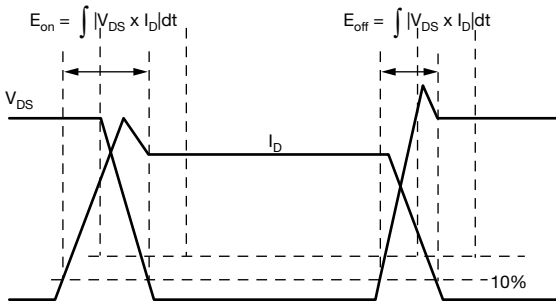


Fig. 19 - Waveforms for Switching Energy

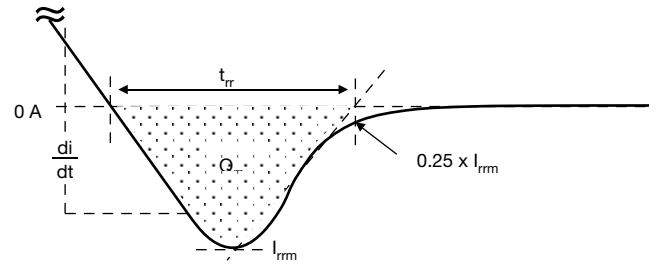


Fig. 22 - Waveforms for Reverse Recovery

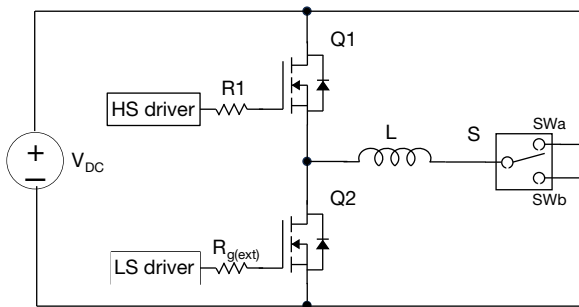


Fig. 20 - Switching and Reverse Diode Characteristics Measurement Circuit

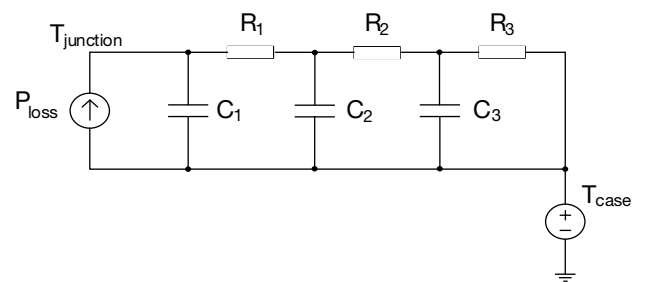


Fig. 23 - Thermal Equivalent Circuit

TO-263-7L(HV) PACKAGE OUTLINE DIMENSIONS



| Symbol | Dimensions In Millimeters |        |        | Dimensions In Inches |       |       |
|--------|---------------------------|--------|--------|----------------------|-------|-------|
|        | Min.                      | Nom.   | Max.   | Min.                 | Nom.  | Max.  |
| A      | 4.300                     | 4.400  | 4.500  | 0.169                | 0.173 | 0.177 |
| A1     | 0.000                     | 0.100  | 0.200  | 0.000                | 0.004 | 0.008 |
| A2     | 2.300                     | 2.400  | 2.500  | 0.091                | 0.094 | 0.098 |
| b      | 0.500                     | 0.600  | 0.700  | 0.020                | 0.024 | 0.028 |
| b1     | 0.000                     | 0.075  | 0.150  | 0.000                | 0.003 | 0.006 |
| c      | 0.400                     | 0.500  | 0.600  | 0.016                | 0.020 | 0.024 |
| c1     | 1.170                     | 1.270  | 1.370  | 0.046                | 0.050 | 0.054 |
| D      | 9.050                     | 9.250  | 9.450  | 0.356                | 0.364 | 0.372 |
| D1     | 7.300                     | 7.400  | 7.500  | 0.287                | 0.291 | 0.295 |
| E      | 9.800                     | 10.000 | 10.200 | 0.386                | 0.394 | 0.402 |
| E1     | 9.360                     | 9.460  | 9.560  | 0.369                | 0.372 | 0.376 |
| E2     | 8.400                     | 8.500  | 8.600  | 0.331                | 0.335 | 0.339 |
| e      | 1.270 REF.                |        |        | 0.050 REF.           |       |       |
| H      | 15.000 REF.               |        |        | 0.591 REF.           |       |       |
| L      | 4.200                     | 4.700  | 5.200  | 0.165                | 0.185 | 0.205 |
| L1     | 0.700                     | 1.000  | 1.300  | 0.028                | 0.039 | 0.051 |
| L2     | 1.700                     | 2.000  | 2.300  | 0.067                | 0.079 | 0.091 |
| L3     | 2.700 REF.                |        |        | 0.106 REF.           |       |       |
| L4     | 2.850 REF.                |        |        | 0.112 REF.           |       |       |
| P      | 0.350                     | 0.450  | 0.550  | 0.014                | 0.018 | 0.022 |
| Q      | 4.020                     | 4.120  | 4.220  | 0.158                | 0.162 | 0.166 |
| R      | 2.030                     | 2.130  | 2.230  | 0.080                | 0.084 | 0.088 |
| S      | 1.400                     | 1.500  | 1.600  | 0.055                | 0.059 | 0.063 |
| θ      | 0°                        | 4°     | 8°     | 0°                   | 4°    | 8°    |

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