

## ISL9N302AP3

### N-Channel Logic Level PWM Optimized UltraFET® Trench Power MOSFETs

#### General Description

This device employs a new advanced trench MOSFET technology and features low gate charge while maintaining low on-resistance.

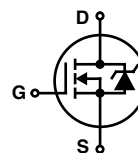
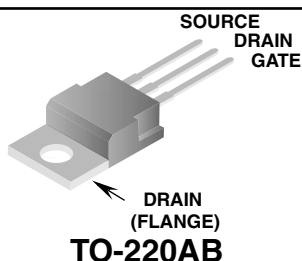
Optimized for switching applications, this device improves the overall efficiency of DC/DC converters and allows operation to higher switching frequencies.

#### Applications

- DC/DC converters

#### Features

- Fast switching
- $r_{DS(ON)} = 0.0019\Omega$  (Typ),  $V_{GS} = 10V$
- $r_{DS(ON)} = 0.0027\Omega$  (Typ),  $V_{GS} = 4.5V$
- $Q_g$  (Typ) = 110nC,  $V_{GS} = 5V$
- $Q_{gd}$  (Typ) = 31nC
- $C_{ISS}$  (Typ) = 11000pF



#### MOSFET Maximum Ratings $T_A = 25^\circ\text{C}$ unless otherwise noted

| Symbol         | Parameter                                                  | Ratings    | Units               |
|----------------|------------------------------------------------------------|------------|---------------------|
| $V_{DSS}$      | Drain to Source Voltage                                    | 30         | V                   |
| $V_{GS}$       | Gate to Source Voltage                                     | $\pm 20$   | V                   |
| $I_D$          | Drain Current                                              |            |                     |
|                | Continuous ( $T_C = 25^\circ\text{C}$ , $V_{GS} = 10V$ )   | 75         | A                   |
|                | Continuous ( $T_C = 100^\circ\text{C}$ , $V_{GS} = 4.5V$ ) | 75         | A                   |
|                | Pulsed                                                     | Figure 4   | A                   |
| $P_D$          | Power dissipation                                          | 345        | W                   |
|                | Derate above $25^\circ\text{C}$                            | 2.3        | W/ $^\circ\text{C}$ |
| $T_J, T_{STG}$ | Operating and Storage Temperature                          | -55 to 175 | $^\circ\text{C}$    |

#### Thermal Characteristics

|                 |                                               |      |                    |
|-----------------|-----------------------------------------------|------|--------------------|
| $R_{\theta JC}$ | Thermal Resistance Junction to Case TO-220    | 0.43 | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance Junction to Ambient TO-220 | 62   | $^\circ\text{C/W}$ |

#### Package Marking and Ordering Information

| Device Marking | Device      | Package  | Reel Size | Tape Width | Quantity |
|----------------|-------------|----------|-----------|------------|----------|
| N302AP         | ISL9N302AP3 | TO-220AB | Tube      | N/A        | 50       |

**Electrical Characteristics**  $T_A = 25^\circ\text{C}$  unless otherwise noted

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|--------|-----------|-----------------|-----|-----|-----|-------|
|--------|-----------|-----------------|-----|-----|-----|-------|

**Off Characteristics**

|              |                                   |                                                                 |    |   |           |               |
|--------------|-----------------------------------|-----------------------------------------------------------------|----|---|-----------|---------------|
| $B_{V_{DS}}$ | Drain to Source Breakdown Voltage | $I_D = 250\mu\text{A}$ , $V_{GS} = 0\text{V}$                   | 30 | - | -         | V             |
| $I_{DSS}$    | Zero Gate Voltage Drain Current   | $V_{DS} = 25\text{V}$<br>$V_{GS} = 0\text{V}$ $T_C = 150^\circ$ | -  | - | 1         | $\mu\text{A}$ |
| $I_{GSS}$    | Gate to Source Leakage Current    | $V_{GS} = \pm 20\text{V}$                                       | -  | - | $\pm 100$ | nA            |

**On Characteristics**

|              |                                  |                                             |   |        |        |          |
|--------------|----------------------------------|---------------------------------------------|---|--------|--------|----------|
| $V_{GS(TH)}$ | Gate to Source Threshold Voltage | $V_{GS} = V_{DS}$ , $I_D = 250\mu\text{A}$  | 1 | -      | 3      | V        |
| $r_{DS(ON)}$ | Drain to Source On Resistance    | $I_D = 75\text{A}$ , $V_{GS} = 10\text{V}$  | - | 0.0019 | 0.0025 | $\Omega$ |
|              |                                  | $I_D = 75\text{A}$ , $V_{GS} = 4.5\text{V}$ | - | 0.0027 | 0.0033 |          |

**Dynamic Characteristics**

|              |                               |                                                                     |                                                                     |       |     |    |
|--------------|-------------------------------|---------------------------------------------------------------------|---------------------------------------------------------------------|-------|-----|----|
| $C_{ISS}$    | Input Capacitance             | $V_{DS} = 15\text{V}$ , $V_{GS} = 0\text{V}$ ,<br>$f = 1\text{MHz}$ | -                                                                   | 11000 | -   | pF |
| $C_{OSS}$    | Output Capacitance            |                                                                     | -                                                                   | 2000  | -   | pF |
| $C_{RSS}$    | Reverse Transfer Capacitance  |                                                                     | -                                                                   | 900   | -   | pF |
| $Q_{g(TOT)}$ | Total Gate Charge at 10V      | $V_{GS} = 0\text{V}$ to 10V                                         | $V_{DD} = 15\text{V}$<br>$I_D = 75\text{A}$<br>$I_g = 1.0\text{mA}$ | 200   | 300 | nC |
| $Q_{g(5)}$   | Total Gate Charge at 5V       | $V_{GS} = 0\text{V}$ to 5V                                          |                                                                     | 110   | 165 | nC |
| $Q_{g(TH)}$  | Threshold Gate Charge         | $V_{GS} = 0\text{V}$ to 1V                                          |                                                                     | 12    | 18  | nC |
| $Q_{gs}$     | Gate to Source Gate Charge    |                                                                     |                                                                     | 25    | -   | nC |
| $Q_{gd}$     | Gate to Drain "Miller" Charge |                                                                     |                                                                     | 31    | -   | nC |

**Switching Characteristics** ( $V_{GS} = 4.5\text{V}$ )

|              |                     |                                                                                             |   |     |     |    |
|--------------|---------------------|---------------------------------------------------------------------------------------------|---|-----|-----|----|
| $t_{ON}$     | Turn-On Time        | $V_{DD} = 15\text{V}$ , $I_D = 28\text{A}$<br>$V_{GS} = 4.5\text{V}$ , $R_{GS} = 1.5\Omega$ | - | -   | 224 | ns |
| $t_{d(ON)}$  | Turn-On Delay Time  |                                                                                             | - | 29  | -   | ns |
| $t_r$        | Rise Time           |                                                                                             | - | 120 | -   | ns |
| $t_{d(OFF)}$ | Turn-Off Delay Time |                                                                                             | - | 45  | -   | ns |
| $t_f$        | Fall Time           |                                                                                             | - | 34  | -   | ns |
| $t_{OFF}$    | Turn-Off Time       |                                                                                             | - | -   | 119 | ns |

**Switching Characteristics** ( $V_{GS} = 10\text{V}$ )

|              |                     |                                                                                            |   |     |     |    |
|--------------|---------------------|--------------------------------------------------------------------------------------------|---|-----|-----|----|
| $t_{ON}$     | Turn-On Time        | $V_{DD} = 15\text{V}$ , $I_D = 28\text{A}$<br>$V_{GS} = 10\text{V}$ , $R_{GS} = 1.5\Omega$ | - | -   | 204 | ns |
| $t_{d(ON)}$  | Turn-On Delay Time  |                                                                                            | - | 16  | -   | ns |
| $t_r$        | Rise Time           |                                                                                            | - | 120 | -   | ns |
| $t_{d(OFF)}$ | Turn-Off Delay Time |                                                                                            | - | 70  | -   | ns |
| $t_f$        | Fall Time           |                                                                                            | - | 30  | -   | ns |
| $t_{OFF}$    | Turn-Off Time       |                                                                                            | - | -   | 150 | ns |

**Unclamped Inductive Switching**

|          |                |                                          |     |   |   |               |
|----------|----------------|------------------------------------------|-----|---|---|---------------|
| $t_{AV}$ | Avalanche Time | $I_D = 7.2\text{A}$ , $L = 3.0\text{mH}$ | 480 | - | - | $\mu\text{s}$ |
|----------|----------------|------------------------------------------|-----|---|---|---------------|

**Drain-Source Diode Characteristics**

|          |                               |                                                                |   |   |      |    |
|----------|-------------------------------|----------------------------------------------------------------|---|---|------|----|
| $V_{SD}$ | Source to Drain Diode Voltage | $I_{SD} = 75\text{A}$                                          | - | - | 1.25 | V  |
|          |                               | $I_{SD} = 40\text{A}$                                          | - | - | 1.0  | V  |
| $t_{rr}$ | Reverse Recovery Time         | $I_{SD} = 75\text{A}$ , $dI_{SD}/dt = 100\text{A}/\mu\text{s}$ | - | - | 42   | ns |
| $Q_{RR}$ | Reverse Recovered Charge      | $I_{SD} = 75\text{A}$ , $dI_{SD}/dt = 100\text{A}/\mu\text{s}$ | - | - | 34   | nC |

# Typical Characteristic

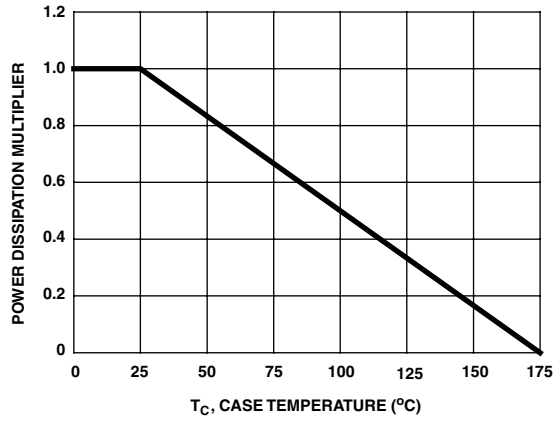


Figure 1. Normalized Power Dissipation vs Ambient Temperature

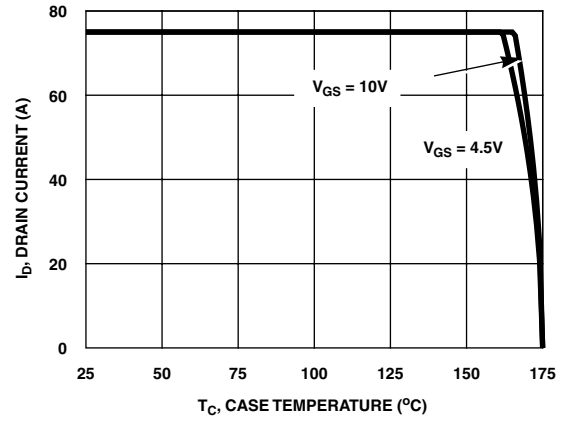


Figure 2. Maximum Continuous Drain Current vs Case Temperature

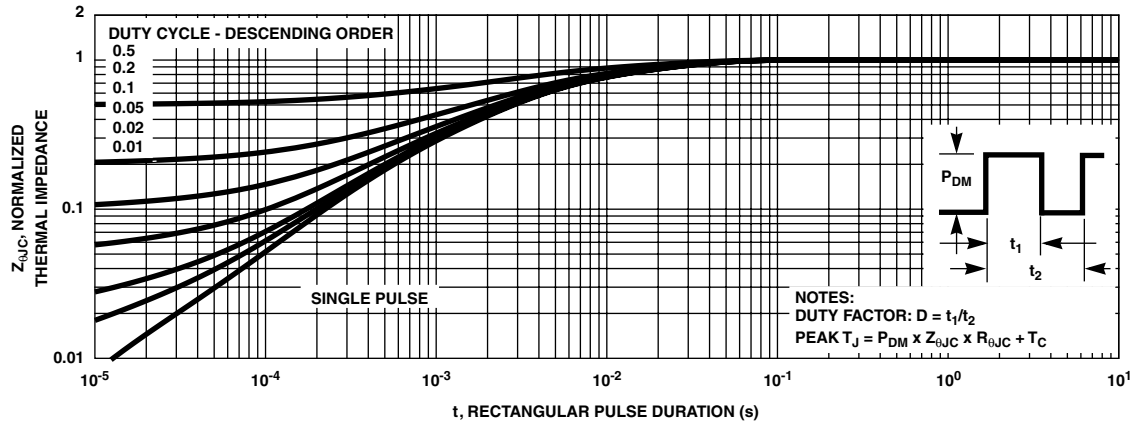


Figure 3. Normalized Maximum Transient Thermal Impedance

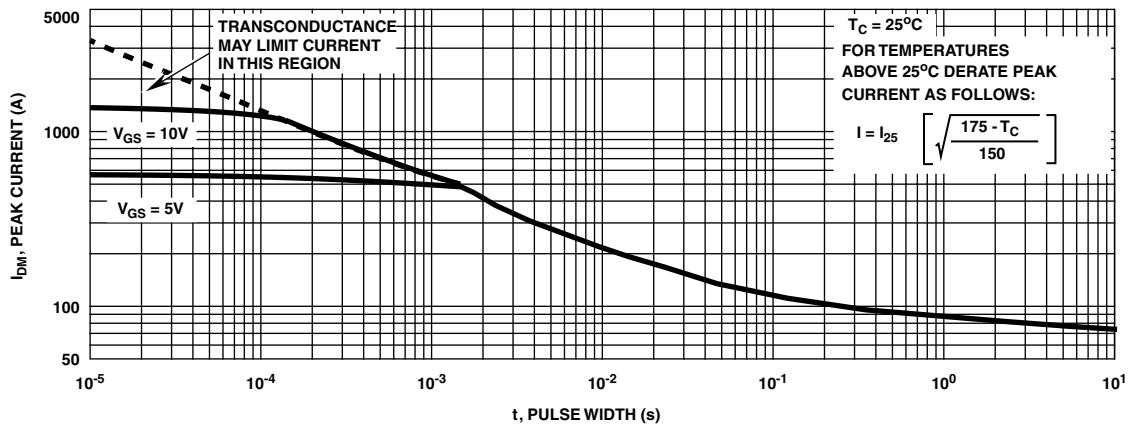


Figure 4. Peak Current Capability

# Typical Characteristic (Continued)

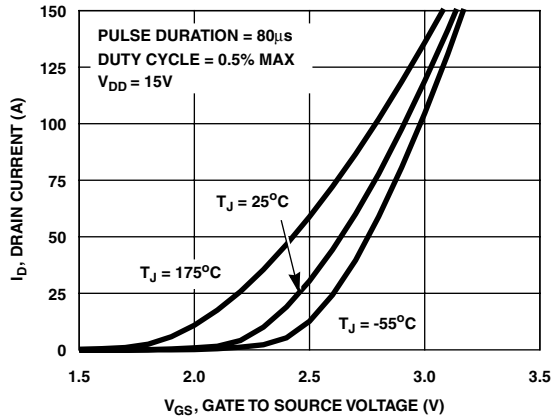


Figure 5. Transfer Characteristics

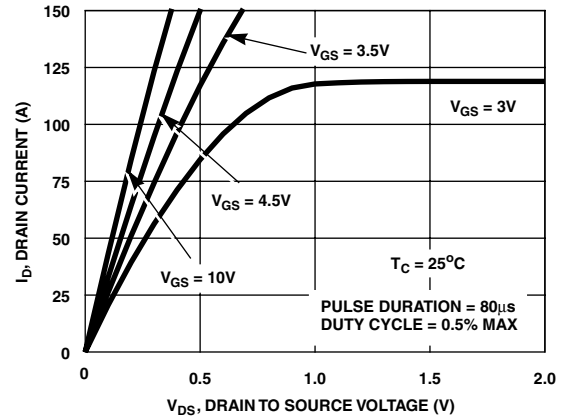


Figure 6. Saturation Characteristics

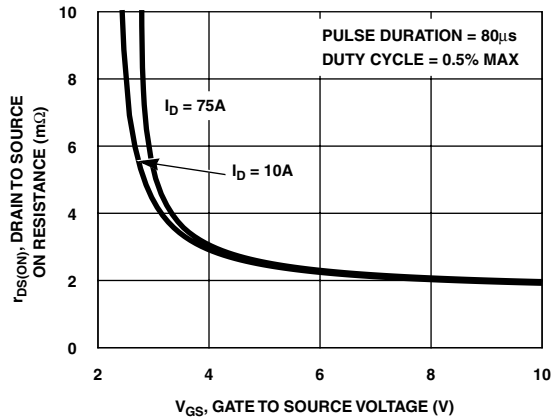


Figure 7. Drain to Source On Resistance vs. Gate Voltage and Drain Current

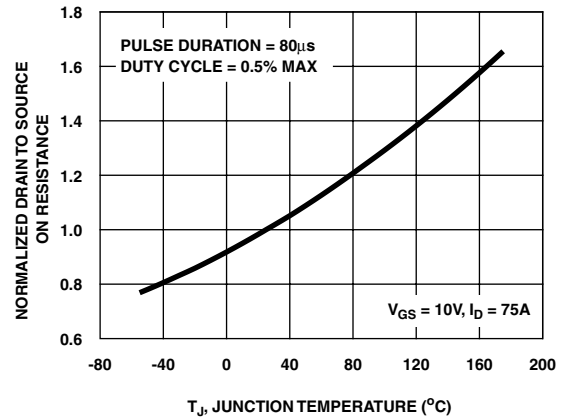


Figure 8. Normalized Drain to Source On Resistance vs. Junction Temperature

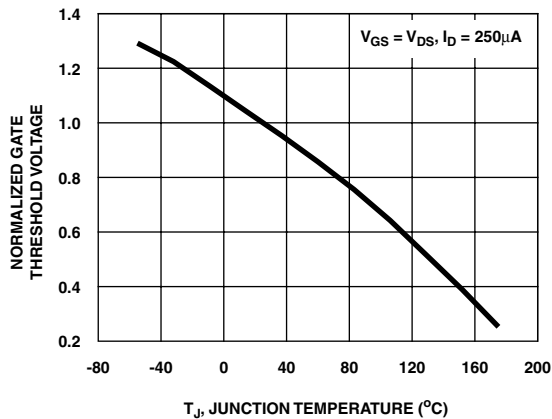


Figure 9. Normalized Gate Threshold Voltage vs. Junction Temperature

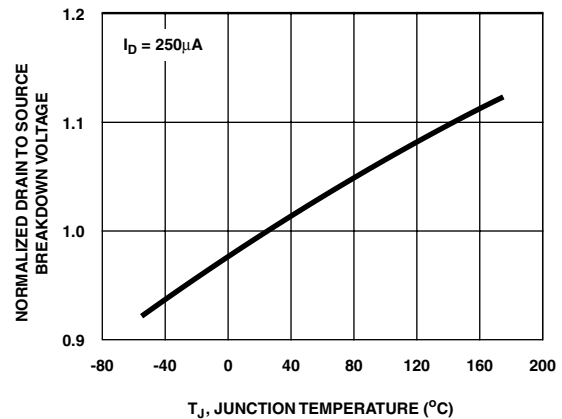


Figure 10. Normalized Drain to Source Breakdown Voltage vs. Junction Temperature

## Typical Characteristic (Continued)

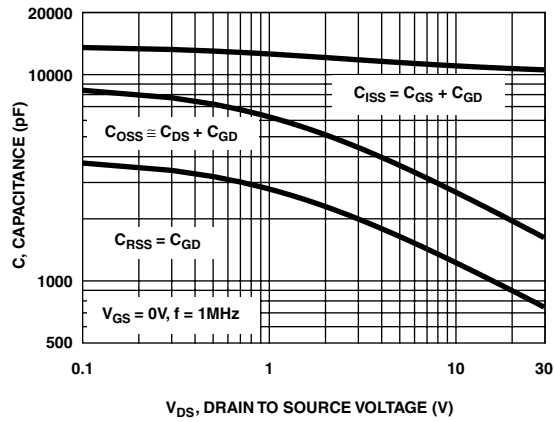


Figure 11. Capacitance vs Drain to Source Voltage

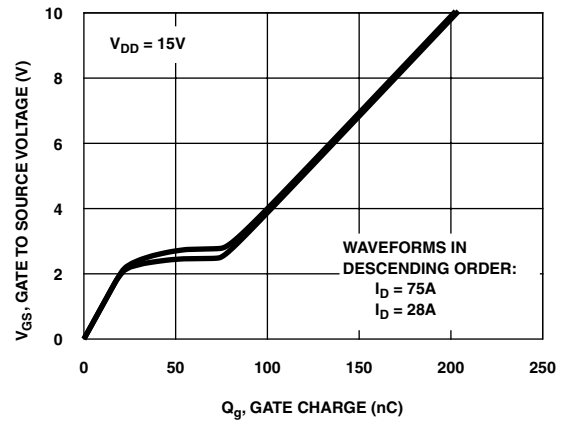


Figure 12. Gate Charge Waveforms for Constant Gate Currents

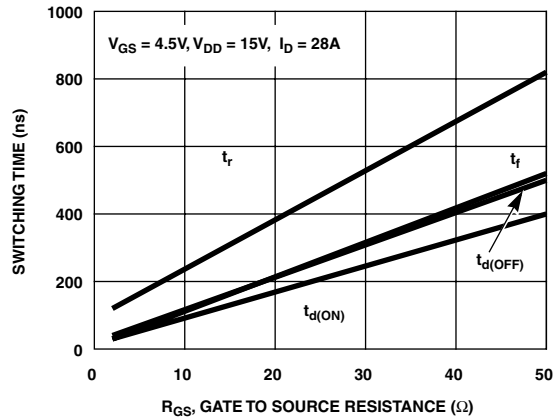


Figure 13. Switching Time vs Gate Resistance

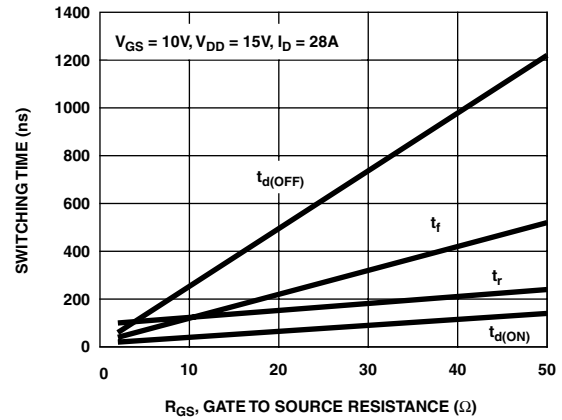


Figure 14. Switching Time vs Gate Resistance

## Test Circuits and Waveforms

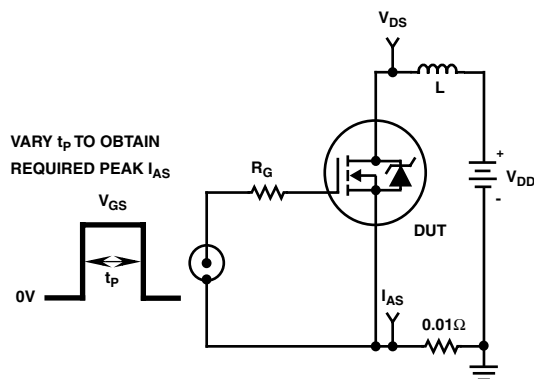


Figure 15. Unclamped Energy Test Circuit

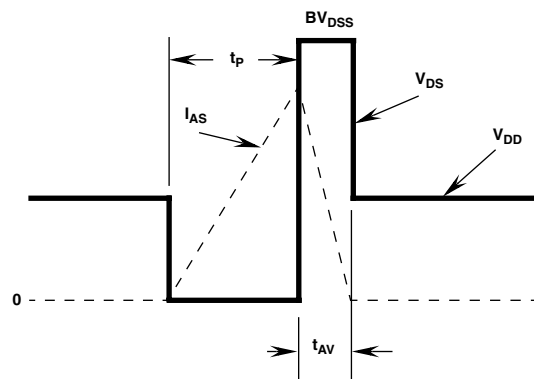


Figure 16. Unclamped Energy Waveforms

# Test Circuits and Waveforms (Continued)

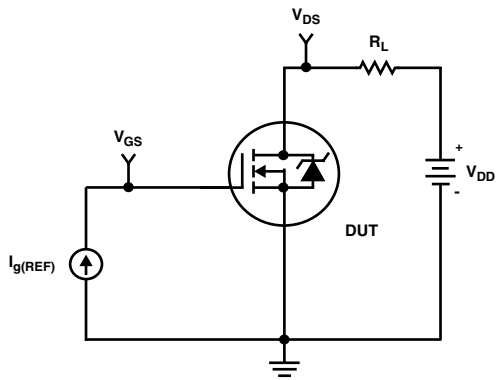


Figure 17. Gate Charge Test Circuit

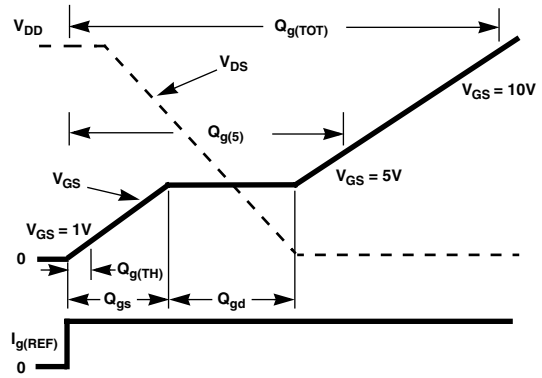


Figure 18. Gate Charge Waveforms

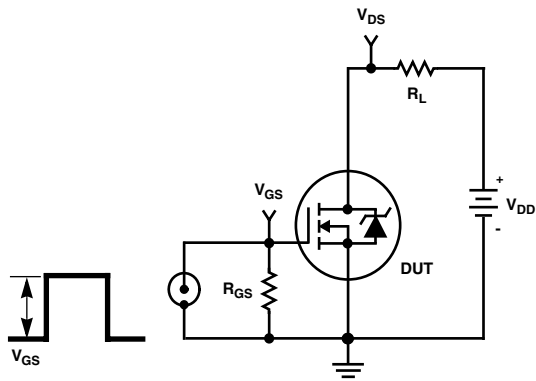


Figure 19. Switching Time Test Circuit

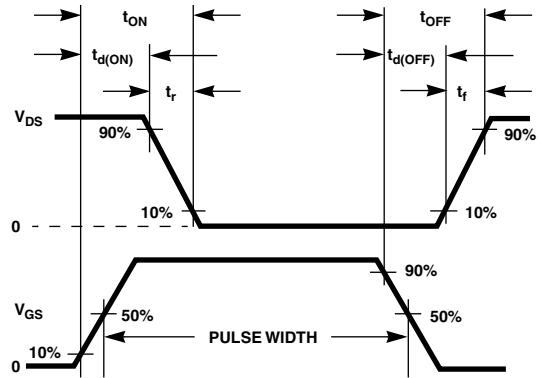


Figure 20. Switching Time Waveforms

**PSpICE Electrical Model**

SUBCKT ISL9N302AP3 2 1 3 ; rev Nov 2001

CA 12 8 9e-9  
 Cb 15 14 5.5e-9  
 Cin 6 8 1e-8

Dbody 7 5 DbodyMOD  
 Dbreak 5 11 DbreakMOD  
 Dplcap 10 5 DplcapMOD

Ebreak 11 7 17 18 30.4  
 Eds 14 8 5 8 1  
 Egs 13 8 6 8 1  
 Esg 6 10 6 8 1  
 Evthres 6 21 19 8 1  
 Evtemp 20 6 18 22 1

It 8 17 1

Lgate 1 9 5.618e-9  
 Ldrain 2 5 1e-9  
 Lsource 3 7 1.98e-9

RLgate 1 9 56.1  
 RLdrain 2 5 15  
 RLsource 3 7 19.8

Mmed 16 6 8 8 MmedMOD  
 Mstro 16 6 8 8 MstroMOD  
 Mweak 16 21 8 8 MweakMOD

Rbreak 17 18 RbreakMOD 1  
 Rdrain 50 16 RdrainMOD 4e-4  
 Rgate 9 20 5.93e-1  
 RSLC1 5 51 RSLCMOD 1e-6  
 RSLC2 5 50 1e3  
 Rsource 8 7 RsourceMOD 1.3e-3  
 Rvthres 22 8 RvthresMOD 1  
 Rvtemp 18 19 RvtempMOD 1  
 S1a 6 12 13 8 S1AMOD  
 S1b 13 12 13 8 S1BMOD  
 S2a 6 15 14 13 S2AMOD  
 S2b 13 15 14 13 S2BMOD

Vbat 22 19 DC 1

$$\text{ESLC } 51 \ 50 \ \text{VALUE}=\{(V(5,51)/\text{ABS}(V(5,51))) * (\text{PWR}(V(5,51)/(1e-6 * 500), 3))\}$$

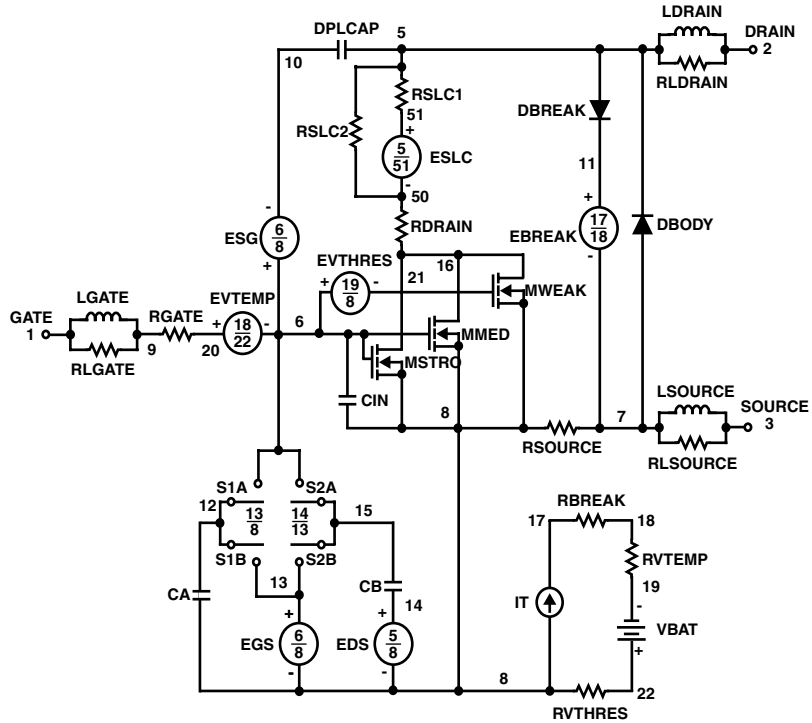
.MODEL DbodyMOD D (IS=2e-10 N=1.05 RS=1.8e-3 TRS1=9e-4 TRS2=1e-6 + CJO=4.9e-9 M=4.9e-1 TT=1e-13 XT1=0)  
 .MODEL DbreakMOD D (RS=2.5e-1 TRS1=1e-3 TRS2=-8.9e-6)  
 .MODEL DplcapMOD D (CJO=3.5e-9 IS=1e-30 N=10 M=4.7e-1)

.MODEL MstroMOD NMOS (VTO=2.1 KP=550 IS=1e-25 N=10 TOX=1 L=1u W=1u)  
 .MODEL MmedMOD NMOS (VTO=1.6 KP=30 IS=1e-30 N=10 TOX=1 L=1u W=1u RG=5.93e-1)  
 .MODEL MweakMOD NMOS (VTO=1.22 KP=1e-1 IS=1e-40 N=10 TOX=1 L=1u W=1u RG=5.93 RS=1e-1)

.MODEL RbreakMOD RES (TC1=1e-3 TC2=-7e-7)  
 .MODEL RdrainMOD RES (TC1=1.2e-2 TC2=2.5e-5)  
 .MODEL RSLCMOD RES (TC1=3.5e-9 TC2=5e-6)  
 .MODEL RsourceMOD RES (TC1=1e-3 TC2=1e-6)  
 .MODEL RvthresMOD RES (TC1=-2.9e-3 TC2=-9e-6)  
 .MODEL RvtempMOD RES (TC1=-1.8e-3 TC2=1e-6)

.MODEL S1AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-3.5 VOFF=-1.5)  
 .MODEL S1BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-1.5 VOFF=-3.5)  
 .MODEL S2AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-0.4 VOFF=0.1)  
 .MODEL S2BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=0.1 VOFF=-0.4)  
 .ENDS

NOTE: For further discussion of the PSpICE model, consult **A New PSpICE Sub-Circuit for the Power MOSFET Featuring Global Temperature Options**; IEEE Power Electronics Specialist Conference Records, 1991, written by William J. Hepp and C. Frank Wheatley.





## SPICE Thermal Model

REV May 2001

TISL9N302AP3

CTHERM1 th 6 4.5e-3  
CTHERM2 6 5 2e-2  
CTHERM3 5 4 1.5e-2  
CTHERM4 4 3 2.5e-2  
CTHERM5 3 2 7e-2  
CTHERM6 2 tl 2.5e-1

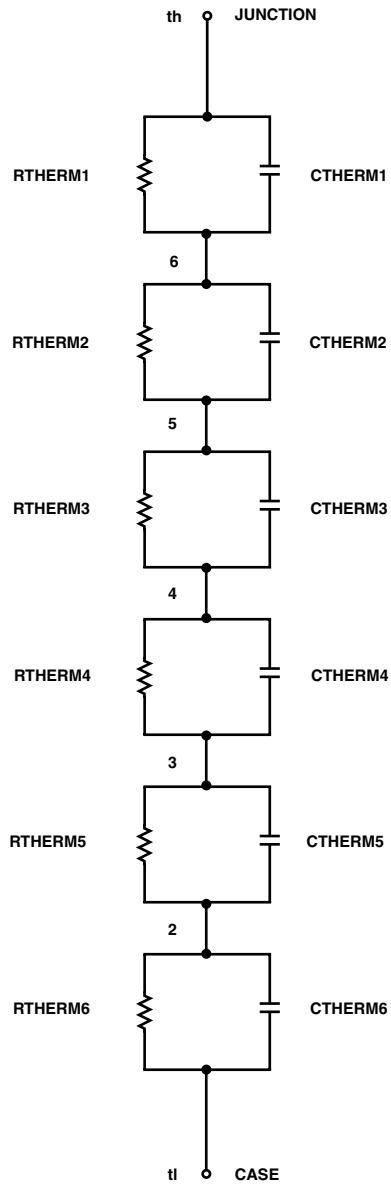
RTHERM1 th 6 2e-3  
RTHERM2 6 5 8.5e-3  
RTHERM3 5 4 6e-2  
RTHERM4 4 3 8e-2  
RTHERM5 3 2 9e-2  
RTHERM6 2 tl 1e-1

## SABER Thermal Model

SABER thermal model TISL9N302AP3

```
template thermal_model th tl
thermal_c th, tl
{
  ctherm.ctherm1 th 6 = 4.5e-3
  ctherm.ctherm2 6 5 = 2e-2
  ctherm.ctherm3 5 4 = 1.5e-2
  ctherm.ctherm4 4 3 = 2.5e-2
  ctherm.ctherm5 3 2 = 7e-2
  ctherm.ctherm6 2 tl = 2.5e-1

  rtherm.rtherm1 th 6 = 2e-3
  rtherm.rtherm2 6 5 = 8.5e-3
  rtherm.rtherm3 5 4 = 6e-2
  rtherm.rtherm4 4 3 = 8e-2
  rtherm.rtherm5 3 2 = 9e-2
  rtherm.rtherm6 2 tl = 1e-1
}
```



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| Bottomless™          | FAST <sup>r</sup> ™ | OPTOPLANAR™                  | STAR*POWER™           |      |
| CoolFET™             | FRFET™              | PACMAN™                      | Stealth™              |      |
| CROSSVOLT™           | GlobalOptoisolator™ | POP™                         | SuperSOT™-3           |      |
| DenseTrench™         | GTO™                | Power247™                    | SuperSOT™-6           |      |
| DOME™                | HiSeC™              | PowerTrench <sup>®</sup>     | SuperSOT™-8           |      |
| EcoSPARK™            | ISOPLANAR™          | QFET™                        | SyncFET™              |      |
| E <sup>2</sup> CMOS™ | LittleFET™          | QS™                          | TinyLogic™            |      |
| EnSigna™             | MicroFET™           | QT Optoelectronics™          | TruTranslation™       |      |
| FACT™                | MicroPak™           | Quiet Series™                | UHC™                  |      |
| FACT Quiet Series™   | MICROWIRE™          | SILENT SWITCHER <sup>®</sup> | UltraFET <sup>®</sup> |      |

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

## PRODUCT STATUS DEFINITIONS

### Definition of Terms

| Datasheet Identification | Product Status         | Definition                                                                                                                                                                                                            |
|--------------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Advance Information      | Formative or In Design | This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.                                                                                    |
| Preliminary              | First Production       | This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design. |
| No Identification Needed | Full Production        | This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.                                                       |
| Obsolete                 | Not In Production      | This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.                                                   |



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