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March 2015



FDD3672

N-Channel UltraFET® Trench MOSFET **100V**, **44A**, **28m** Ω

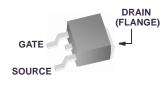
Features

- $r_{DS(ON)} = 24m\Omega$ (Typ.), $V_{GS} = 10V$, $I_D = 44A$
- $Q_q(tot) = 24nC (Typ.), V_{GS} = 10V$
- Low Miller Charge
- · Low Qrr Body Diode
- Optimized efficiency at high frequencies
- UIS Capability (Single Pulse and Repetitive Pulse)

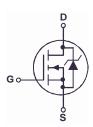
Applications

- DC/DC converters and Off-Line UPS
- · Distributed Power Architectures and VRMs
- Primary Switch for 24V and 48V Systems
- High Voltage Synchronous Rectifier

Formerly developmental type 82760







MOSFET Maximum Ratings T_C = 25°C unless otherwise noted

| Symbol | Parameter | Ratings | Units |
|-----------------------------------|---|------------|-------|
| V _{DSS} | Drain to Source Voltage | 100 | V |
| V _{GS} | Gate to Source Voltage | ±20 | V |
| | Drain Current | | |
| | Continuous ($T_C = 25^{\circ}C$, $V_{GS} = 10V$) | 44 | Α |
| I_D | Continuous (T _C = 100°C, V _{GS} = 10V) | 31 | А |
| | Continuous ($T_{amb} = 25^{\circ}C$, $V_{GS} = 10V$, $R_{\theta JA} = 52^{\circ}C/W$) | 6.5 | А |
| | Pulsed | Figure 4 | А |
| E _{AS} | Single Pulse Avalanche Energy (Note 1) | 120 | mJ |
| | Power dissipation | 135 | W |
| P_{D} | Derate above 25°C | 0.9 | W/°C |
| T _J , T _{STG} | Operating and Storage Temperature | -55 to 175 | °C |

Thermal Characteristics

| $R_{\theta JC}$ | Thermal Resistance Junction to Case TO-252 | 1.11 | °C/W |
|-----------------|---|------|------|
| $R_{\theta JA}$ | Thermal Resistance Junction to Ambient TO-252 | 100 | °C/W |
| $R_{\theta JA}$ | Thermal Resistance Junction to Ambient TO-252, 1in ² copper pad area | 52 | °C/W |

Reliability data can be found at: http://www.fairchildsemi.com/products/discrete/reliability/index.html. All Fairchild Semiconductor products are manufactured, assembled and tested under ISO9000 and QS9000 quality systems certification.

Package Marking and Ordering Information

| Device Marking | Device | Package | Reel Size | Tape Width | Quantity |
|-----------------------|---------|----------|-----------|------------|------------|
| FDD3672 | FDD3672 | TO-252AA | 330mm | 16mm | 2500 units |

Electrical Characteristics $T_C = 25^{\circ}C$ unless otherwise noted

| Symbol | Parameter | Test Conditions | Min | Тур | Max | Units |
|---------------------|-----------------------------------|------------------------------------|-----|-----|------|-------|
| Off Characteristics | | | | | | |
| B _{VDSS} | Drain to Source Breakdown Voltage | $I_D = 250 \mu A, V_{GS} = 0 V$ | 100 | - | - | V |
| | Zoro Coto Voltago Proin Current | V _{DS} = 80V | - | - | 1 | ^ |
| IDSS | Zero Gate Voltage Drain Current | $V_{GS} = 0V$ $T_C = 150^{\circ}C$ | - | - | 250 | μΑ |
| I_{GSS} | Gate to Source Leakage Current | $V_{GS} = \pm 20V$ | - | - | ±100 | nA |

On Characteristics

| V _{GS(TH)} | Gate to Source Threshold Voltage | $V_{GS} = V_{DS}, I_{D} = 250 \mu A$ | 2 | - | 4 | V |
|---------------------|----------------------------------|--|---|-------|-------|---|
| r _{DS(ON)} | Drain to Source On Resistance | $I_D = 44A, V_{GS} = 10V$ | - | 0.024 | 0.028 | |
| | | $I_D = 21A, V_{GS} = 6V,$ | - | 0.031 | 0.047 | Ω |
| | | I _D =44A, V _{GS} =10V, T _C =175°C | - | 0.054 | 0.068 | |

Dynamic Characteristics

| C _{ISS} | Input Capacitance | V 25V V 0V | - | 1710 | - | pF |
|------------------|----------------------------------|---|---|------|-----|----|
| Coss | Output Capacitance | $V_{DS} = 25V, V_{GS} = 0V,$ f = 1MHz | - | 247 | - | pF |
| C _{RSS} | Reverse Transfer Capacitance | 1 – 1111112 | - | 62 | - | pF |
| $Q_{g(TOT)}$ | Total Gate Charge at 10V | V _{GS} = 0V to 10V | - | 24 | 36 | nC |
| $Q_{g(TH)}$ | Threshold Gate Charge | $V_{GS} = 0V \text{ to } 2V$ $V_{DD} = 50V$ | - | 3 | 4.5 | nC |
| Q_{gs} | Gate to Source Gate Charge | | | 8.6 | - | nC |
| Q _{gs2} | Gate Charge Threshold to Plateau | $I_g = 1.0 \text{mA}$ | - | 5.6 | - | nC |
| Q_{gd} | Gate to Drain "Miller" Charge | | - | 5.6 | - | nC |

Resistive Switching Characteristics (V_{GS} = 10V)

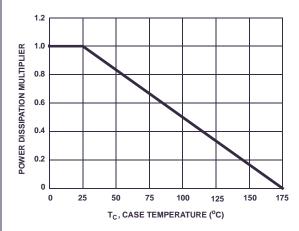
| t _{ON} | Turn-On Time | | - | - | 104 | ns |
|---------------------|---------------------|-------------------------------------|---|----|-----|----|
| t _{d(ON)} | Turn-On Delay Time | | - | 11 | - | ns |
| t _r | Rise Time | $V_{DD} = 50V, I_{D} = 44A$ | - | 59 | - | ns |
| t _{d(OFF)} | Turn-Off Delay Time | $V_{GS} = 10V, R_{GS} = 11.0\Omega$ | - | 26 | - | ns |
| t _f | Fall Time | | - | 44 | - | ns |
| t _{OFF} | Turn-Off Time | | - | - | 104 | ns |

Drain-Source Diode Characteristics

| V _{SD} | Source to Drain Diode Voltage | I _{SD} = 44A | - | - | 1.25 | V |
|-----------------|-------------------------------|--|---|---|------|----|
| | | I _{SD} = 21A | - | - | 1.0 | V |
| t _{rr} | Reverse Recovery Time | $I_{SD} = 44A$, $dI_{SD}/dt = 100A/\mu s$ | - | - | 52 | ns |
| Q _{RR} | Reverse Recovery Charge | $I_{SD} = 44A$, $dI_{SD}/dt = 100A/\mu s$ | - | - | 80 | nC |

Starting T_J = 25°C, L = 0.6mH, I_{AS} = 20A.
 Pulse Width = 100s

Typical Characteristics $T_C = 25^{\circ}C$ unless otherwise noted



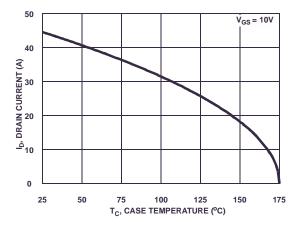


Figure 1. Normalized Power Dissipation vs Ambient Temperature

Figure 2. Maximum Continuous Drain Current vs Case Temperature

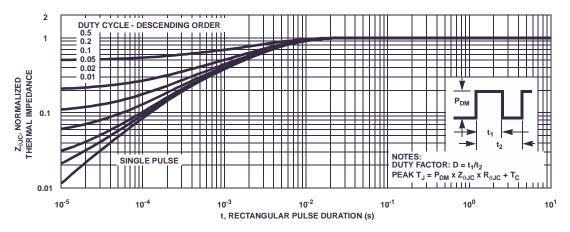


Figure 3. Normalized Maximum Transient Thermal Impedance

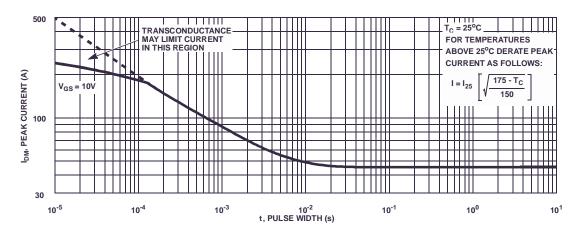
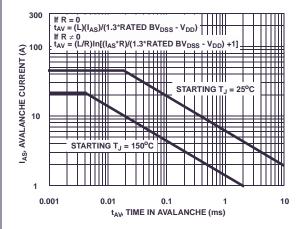


Figure 4. Peak Current Capability

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Typical Characteristics T_C = 25°C unless otherwise noted



80 PULSE DURATION = 80 µs
DUTY CYCLE = 0.5% MAX
VDD = 15V

T_J = 175°C

T_J = -55°C

T_J = -55°C

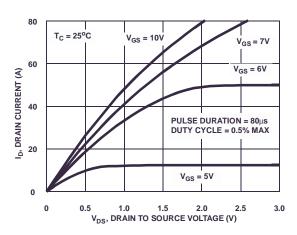
T_S, GATE TO SOURCE VOLTAGE (V)

NOTE: Refer to Fairchild Application Notes AN7514 and AN7515

Figure 5. Unclamped Inductive Switching

Capability

Figure 6. Transfer Characteristics



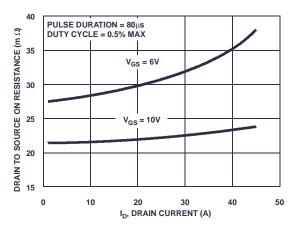
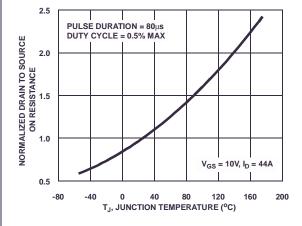


Figure 7. Saturation Characteristics

Figure 8. Drain to Source On Resistance vs Drain Current



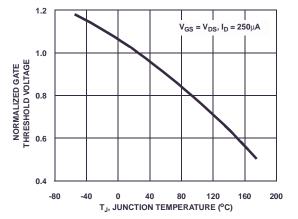


Figure 9. Normalized Drain to Source On Resistance vs Junction Temperature

Figure 10. Normalized Gate Threshold Voltage vs Junction Temperature

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Typical Characteristics $T_C = 25^{\circ}C$ unless otherwise noted

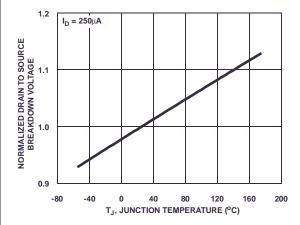


Figure 11. Normalized Drain to Source Breakdown Voltage vs Junction Temperature

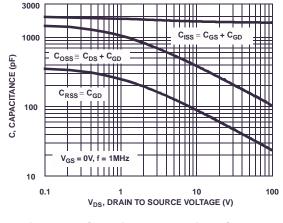


Figure 12. Capacitance vs Drain to Source Voltage

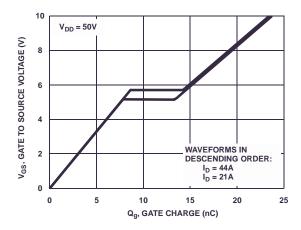


Figure 13. Gate Charge Waveforms for Constant Gate Currents

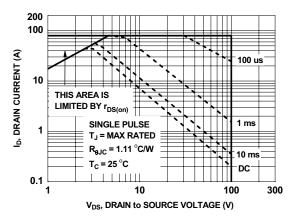
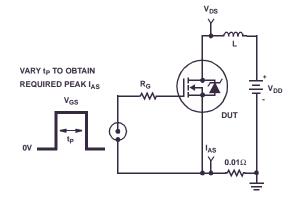


Figure 14. Forward Bias Safe Operating Area

Test Circuits and Waveforms



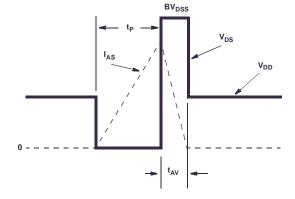
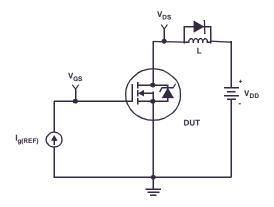


Figure 14. Unclamped Energy Test Circuit

Figure 15. Unclamped Energy Waveforms

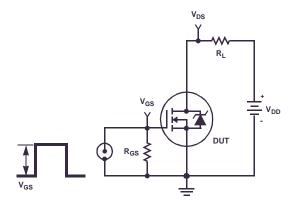
 $\mathbf{Q}_{\mathbf{g}(\mathsf{TOT})}$



 $V_{GS} = 10V$ $V_{GS} = 10V$ $V_{GS} = 10V$ $V_{GS} = 10V$ $V_{GS} = 10V$

Figure 16. Gate Charge Test Circuit

Figure 17. Gate Charge Waveforms



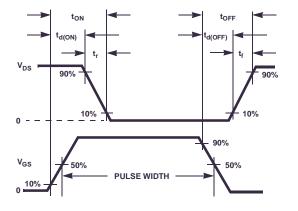


Figure 18. Switching Time Test Circuit

Figure 19. Switching Time Waveforms

Thermal Resistance vs. Mounting Pad Area

The maximum rated junction temperature, T_{JM} , and the thermal resistance of the heat dissipating path determines the maximum allowable device power dissipation, P_{DM} , in an application. Therefore the application's ambient temperature, T_A (°C), and thermal resistance $R_{\theta JA}$ (°C/W) must be reviewed to ensure that T_{JM} is never exceeded. Equation 1 mathematically represents the relationship and serves as the basis for establishing the rating of the part.

$$P_{DM} = \frac{(T_{JM} - T_A)}{R_{\theta JA}} \tag{EQ. 1}$$

In using surface mount devices such as the TO-252 package, the environment in which it is applied will have a significant influence on the part's current and maximum power dissipation ratings. Precise determination of P_{DM} is complex and influenced by many factors:

- Mounting pad area onto which the device is attached and whether there is copper on one side or both sides of the board.
- The number of copper layers and the thickness of the board.
- 3. The use of external heat sinks.
- 4. The use of thermal vias.
- 5. Air flow and board orientation.
- For non steady state applications, the pulse width, the duty cycle and the transient thermal response of the part, the board and the environment they are in.

Fairchild provides thermal information to assist the designer's preliminary application evaluation. Figure 20 defines the $R_{\theta JA}$ for the device as a function of the top copper (component side) area. This is for a horizontally positioned FR-4 board with 1oz copper after 1000 seconds of steady state power with no air flow. This graph provides the necessary information for calculation of the steady state junction temperature or power dissipation. Pulse applications can be evaluated using the Fairchild device Spice thermal model or manually utilizing the normalized maximum transient thermal impedance curve.

Thermal resistances corresponding to other copper areas can be obtained from Figure 20 or by calculation using Equation 2 or 3. Equation 2 is used for copper area defined in inches square and equation 3 is for area in centimeters square. The area, in square inches or square centimeters is the top copper area including the gate and source pads.

$$R_{\theta JA} = 33.32 + \frac{23.84}{(0.268 + Area)}$$
 (EQ. 2)

Area in Inches Squared

$$R_{\theta JA} = 33.32 + \frac{154}{(1.73 + Area)}$$
 (EQ. 3)

Area in Centimeters Squared

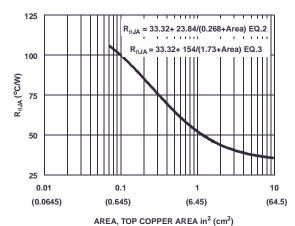


Figure 20. Thermal Resistance vs Mounting
Pad Area

```
PSPICE Electrical Model
.SUBCKT FDD3672 2 1 3;
                           rev May 2002
CA 12 8 5.8e-10
Cb 15 14 6.8e-10
                                                                                                  LDRAIN
Cin 6 8 1.6e-9
                                                             DPLCAP
                                                                                                           DRAIN
Dbody 7 5 DbodyMOD
                                                                                                 RLDRAIN
Dbreak 5 11 DbreakMOD
                                                                      €RSLC1
                                                                                   DBREAK 
Dplcap 10 5 DplcapMOD
                                                           RSLC2<sup>₹</sup>
                                                                         ESLC
Ebreak 11 7 17 18 105
                                                                                         11
Eds 14 8 5 8 1
                                                                        50
Egs 13 8 6 8 1
                                                                      ≨RDRAIN
                                                                                          17
                                                                                               DBODY
Esg 6 10 6 8 1
                                                    ESG
                                                                                  FRRFAK
Evthres 6 21 19 8 1
                                                              EVTHRES
Evtemp 20 6 18 22 1
                                                                (19)
8
                                                                                    MWEAK
                                    LGATE
                                                  EVTEMP
                                            RGATE
                                                    18
22
It 8 17 1
                                                                          ←MMED
                                           9
                                                 20
                                                                  MSTRC
                                    RLGATE
Lgate 1 9 9.56e-9
                                                                                                 LSOURCE
Ldrain 2 5 1.0e-9
                                                                  CIN
                                                                                                          SOURCE
Lsource 3 7 4.45e-9
                                                                                    RSOURCE
                                                                                                 RLSOURCE
RLgate 1 9 95.6
RLdrain 2 5 10
                                                                                       RBREAK
                                                      <u>13</u>
8
                                                           14
13
RLsource 3 7 44.5
                                                                                    17
                                                                                                RVTEMP
                                                   S1B
                                                           oS2B
Mmed 16 6 8 8 MmedMOD
                                                         13
                                                                  СВ
                                                                                                19
Mstro 16 6 8 8 MstroMOD
                                             CA
                                                                                  IT
Mweak 16 21 8 8 MweakMOD
                                                                                                 VBAT
                                                                    <u>5</u>
                                                      EGS
Rbreak 17 18 RbreakMOD 1
                                                                                 8
Rdrain 50 16 Rdrain MOD 6.0e-3
Rgate 9 20 1.5
                                                                                       RVTHRES
RSLC1 5 51 RSLCMOD 1.0e-6
RSLC2 5 50 1.0e3
Rsource 8 7 RsourceMOD 9.5e-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
ESLC 51 50 VALUE={(V(5,51)/ABS(V(5,51)))*(PWR(V(5,51)/(1e-6*98),3))}
.MODEL DbodyMOD D (IS=1.0E-11 N=1.05 RS=3.7e-3 TRS1=2.5e-3 TRS2=1.0e-6
+ CJO=1.2e-9 M=0.58 TT=3.75e-8 XTI=4.0)
.MODEL DbreakMOD D (RS=15 TRS1=4.0e-3 TRS2=-5.0e-6)
.MODEL DplcapMOD D (CJO=3.8e-10 IS=1.0e-30 N=10 M=0.60)
.MODEL MmedMOD NMOS (VTO=3.6 KP=3 IS=1e-40 N=10 TOX=1 L=1u W=1u RG=1.5)
.MODEL MstroMOD NMOS (VTO=4.3 KP=59 IS=1e-30 N=10 TOX=1 L=1u W=1u)
.MODEL MweakMOD NMOS (VTO=3.09 KP=0.05 IS=1e-30 N=10 TOX=1 L=1u W=1u RG=15 RS=0.1)
.MODEL RbreakMOD RES (TC1=9.0e-4 TC2=-1.0e-7)
.MODEL RdrainMOD RES (TC1=11.0e-3 TC2=5.0e-5)
.MODEL RSLCMOD RES (TC1=3.0e-3 TC2=1.0e-6)
.MODEL RsourceMOD RES (TC1=4.0e-3 TC2=1.0e-6)
.MODEL RvthresMOD RES (TC1=-3.5e-3 TC2=-1.5e-5)
.MODEL RvtempMOD RES (TC1=-4.3e-3 TC2=1.5e-6)
.MODEL S1AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-5.0 VOFF=-3.5)
.MODEL S1BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-3.5 VOFF=-5.0)
.MODEL S2AMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=-0.5 VOFF=0.3)
.MODEL S2BMOD VSWITCH (RON=1e-5 ROFF=0.1 VON=0.3 VOFF=-0.5)
FNDS
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.
```

SABER Electrical Model REV May 2002 template FDD3672 n2,n1,n3 electrical n2,n1,n3 var i iscl dp..model dbodymod = (isl=1.0e-11,nl=1.05,rs=3.7e-3,trs1=2.5e-3,trs2=1.0e-6,cjo=1.2e-9,m=0.58,tt=3.75e-8,xti=4.0) dp..model dbreakmod = (rs=15.trs1=4.0e-3.trs2=-5.0e-6)dp..model dplcapmod = (cjo=3.8e-10,isl=10.0e-30,nl=10,m=0.60) $m..model mmedmod = (type=_n, vto=3.6, kp=3, is=1e-40, tox=1)$ m..model mstrongmod = (type=_n,vto=4.3,kp=59,is=1e-30, tox=1) m..model mstronginod = (type=_n,vto=3.09,kp=0.05,is=1e-30, tox=1,rs=0.1) m..model mweakmod = (type=_n,vto=3.09,kp=0.05,is=1e-30, tox=1,rs=0.1) **LDRAIN** DRAIN sw_vcsp..model s1amod = (ron=1e-5,roff=0.1,von=-5.0,voff=-3.5) sw_vcsp..model s1bmod = (ron=1e-5,roff=0.1,von=-3.5,voff=-5.0) 10 RLDRAIN sw_vcsp..model s2amod = (ron=1e-5,roff=0.1,von=-0.5,voff=0.3) **≨**RSLC1 sw_vcsp..model s2bmod = (ron=1e-5,roff=0.1,von=0.3,voff=-0.5) RSLC2 € c.ca n12 n8 = 5.8e-10c.cb n15 n14 = 6.8e-10ISCI c.cin n6 n8 = 1.6e-9DBREAK 3 50 dp.dbody n7 n5 = model=dbodymod **≷**RDRAIN 8 FSG (11 dp.dbreak n5 n11 = model=dbreakmod DBODY **EVTHRES** dp.dplcap n10 n5 = model=dplcapmod MWFAK LGATE **EVTEMP RGATE** spe.ebreak n11 n7 n17 n18 = 105 GATE 18 22 **←**MMED spe.eds n14 n8 n5 n8 = 120 ← MSTRO spe.egs n13 n8 n6 n8 = 1 RLGATE spe.esg n6 n10 n6 n8 = 1 **LSOURCE** CIN SOURCE spe.evthres n6 n21 n19 n8 = 1 spe.evtemp n20 n6 n18 n22 = 1 RSOURCE RLSOURCE i.it n8 n17 = 1RBREAK 17 I.lgate n1 n9 = 95.6e-9I.ldrain n2 n5 = 1.0e-9RVTEMP S₁B oS2B I.lsource n3 n7 = 4.45e-9СВ 19 14 res.rlgate n1 n9 = 9.56 VBAT EGS EDS res.rldrain n2 n5 = 10res.rlsource n3 n7 = 44.5 **RVTHRES** m.mmed n16 n6 n8 n8 = model=mmedmod, l=1u, w=1u m.mstrong n16 n6 n8 n8 = model=mstrongmod, l=1u, w=1u m.mweak n16 n21 n8 n8 = model=mweakmod, l=1u, w=1u res.rbreak n17 n18 = 1, tc1=9.0e-4,tc2=-1.0e-7

```
res.rdrain n50 n16 = 6.0e-3, tc1=11.0e-3,tc2=5.0e-5
res.rgate n9 n20 = 1.5
res.rslc1 n5 n51 = 1.0e-6, tc1=3.0e-3,tc2=1.0e-6
res.rslc2 n5 n50 = 1.0e3
res.rsource n8 n7 = 9.5e-3, tc1=4.0e-3,tc2=1.0e-6
res.rvthres n22 n8 = 1, tc1=-3.5e-3,tc2=1.5e-6
res.rvtemp n18 n19 = 1, tc1=-4.3e-3,tc2=1.5e-6
sw_vcsp.s1a n6 n12 n13 n8 = model=s1amod
sw_vcsp.s1b n13 n12 n13 n8 = model=s1bmod
sw_vcsp.s2a n6 n15 n14 n13 = model=s2amod
sw_vcsp.s2b n13 n15 n14 n13 = model=s2bmod
v.vbat n22 n19 = dc=1
equations {
i (n51->n50) +=iscl
iscl: v(n51,n50) = ((v(n5,n51)/(1e-9+abs(v(n5,n51))))*((abs(v(n5,n51)*1e6/98))** 3))
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SPICE Thermal Model JUNCTION REV May 2002 FDD3672 CTHERM1 TH 6 3.2e-3 CTHERM2 6 5 3.3e-3 CTHERM3 5 4 3.4e-3 RTHERM1 CTHERM1 CTHERM4 4 3 3.5e-3 CTHERM5 3 2 6.4e-3 CTHERM6 2 TL 1.9e-2 6 RTHERM1 TH 6 5.5e-4 RTHERM2 6 5 5.0e-3 RTHERM3 5 4 4.5e-2 RTHERM2 CTHERM2 RTHERM4 4 3 10.5e-2 RTHERM5 3 2 3.4e-1 RTHERM6 2 TL 3.5e-1 5 SABER Thermal Model SABER thermal model FDD3672 RTHERM3 CTHERM3 template thermal_model th tl thermal_c th, tl cctherm.ctherm1 th 6 =3.2e-3 ctherm.ctherm2 6 5 =3.3e-3 ctherm.ctherm3 5 4 =3.4e-3 ctherm.ctherm4 4 3 =3.5e-3 ctherm.ctherm5 3 2 =6.4e-3 RTHERM4 CTHERM4 ctherm.ctherm6 2 tl =1.9e-2 rtherm.rtherm1 th 6 =5.5e-4 rtherm.rtherm2 6 5 = 5.0e-33 rtherm.rtherm3 5 4 =4.5e-2 rtherm.rtherm4 4 3 =10.5e-2 rtherm.rtherm5 3 2 =3.4e-1 CTHERM5 RTHERM5 rtherm.rtherm6 2 tl =3.5e-1 2 RTHERM6 CTHERM6 tl CASE





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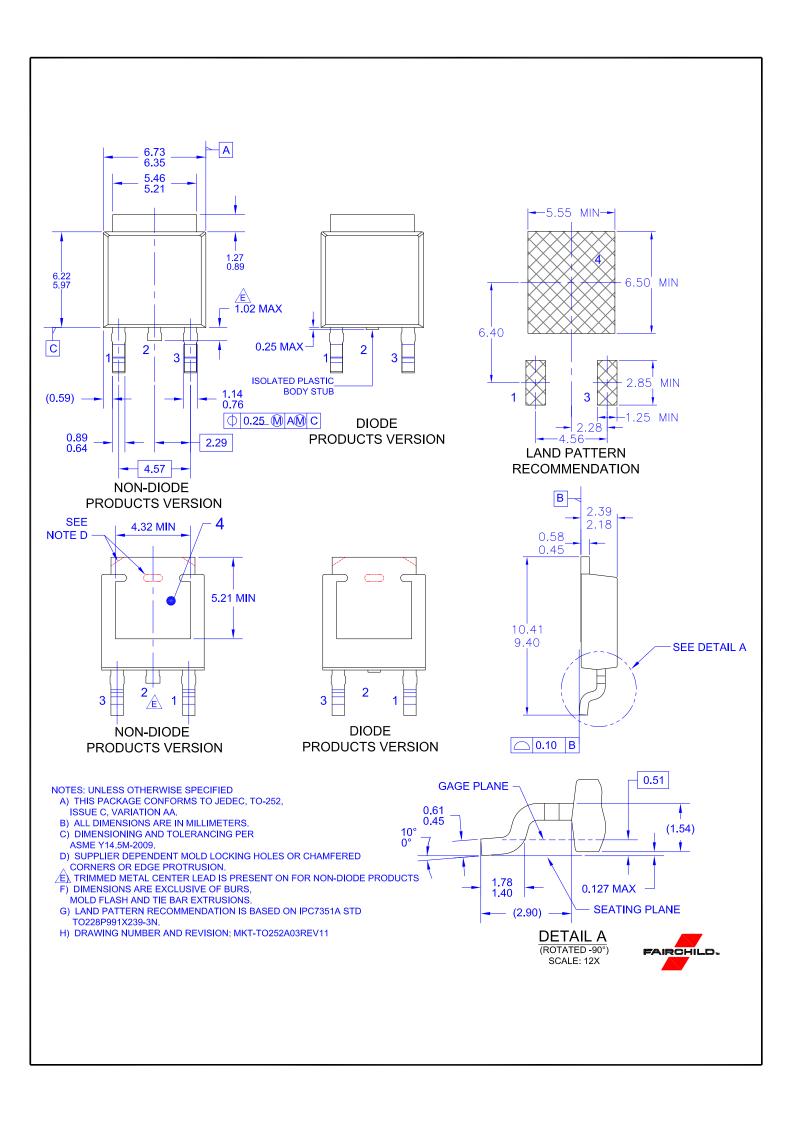
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