

## N - CHANNEL ENHANCEMENT MODE "ULTRA HIGH DENSITY" POWER MOS TRANSISTOR

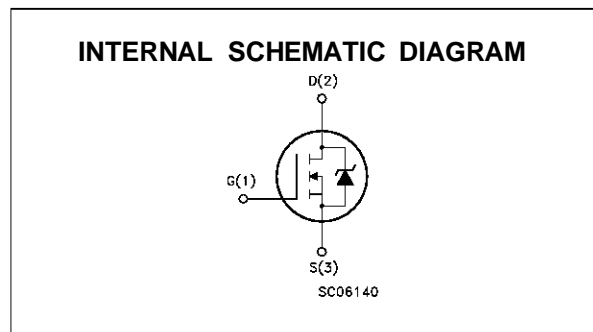
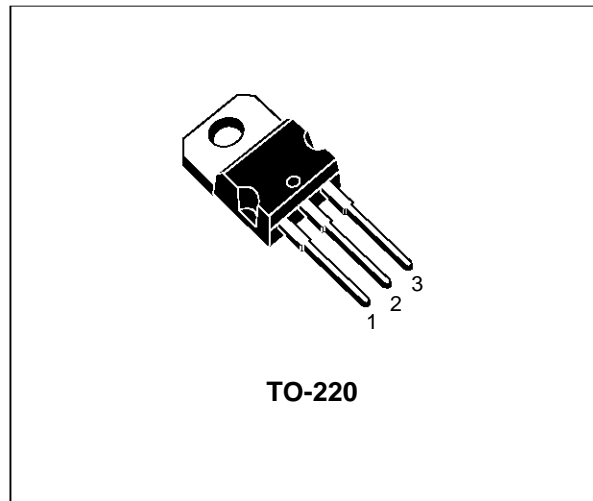
PRELIMINARY DATA

| TYPE         | V <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> |
|--------------|------------------|---------------------|----------------|
| STP40N03L-20 | 30 V             | < 0.02 Ω            | 40 A           |

- TYPICAL R<sub>DS(on)</sub> = 0.016 Ω
- AVALANCHE RUGGED TECHNOLOGY
- 100% AVALANCHE TESTED
- HIGH CURRENT CAPABILITY
- 175°C OPERATING TEMPERATURE
- HIGH dV/dt CAPABILITY
- APPLICATION ORIENTED CHARACTERIZATION

### APPLICATIONS

- HIGH CURRENT, HIGH SPEED SWITCHING
- POWER MOTOR CONTROL
- DC-DC & DC-AC CONVERTERS
- SYNCHRONOUS RECTIFICATION



### ABSOLUTE MAXIMUM RATINGS

| Symbol              | Parameter   | Value      | Unit |
|---------------------|---|------------|------|
| V <sub>DS</sub>     | Drain-source Voltage (V <sub>GS</sub> = 0)            | 30         | V    |
| V <sub>DGR</sub>    | Drain- gate Voltage (R <sub>GS</sub> = 20 kΩ)         | 30         | V    |
| V <sub>GS</sub>     | Gate-source Voltage                                   | ± 15       | V    |
| I <sub>D</sub>      | Drain Current (continuous) at T <sub>c</sub> = 25 °C  | 40         | A    |
| I <sub>D</sub>      | Drain Current (continuous) at T <sub>c</sub> = 100 °C | 28         | A    |
| I <sub>DM</sub> (•) | Drain Current (pulsed)                                | 160        | A    |
| P <sub>tot</sub>    | Total Dissipation at T <sub>c</sub> = 25 °C           | 90         | W    |
|                     | Derating Factor                                       | 0.6        | W/°C |
| dV/dt(1)            | Peak Diode Recovery voltage slope                     | 6          | V/ns |
| T <sub>stg</sub>    | Storage Temperature                                   | -65 to 175 | °C   |
| T <sub>j</sub>      | Max. Operating Junction Temperature                   | 175        | °C   |

(•) Pulse width limited by safe operating area

## STP40N03L-20

### THERMAL DATA

|                       |  |     |      |      |
|-----------------------|--|-----|------|------|
| R <sub>thj-case</sub> | Thermal Resistance Junction-case               | Max | 1.66 | °C/W |
| R <sub>thj-amb</sub>  | Thermal Resistance Junction-ambient            | Max | 62.5 | °C/W |
| R <sub>thc-sink</sub> | Thermal Resistance Case-sink                   | Typ | 0.5  | °C/W |
| T <sub>J</sub>        | Maximum Lead Temperature For Soldering Purpose |     | 300  | °C   |

### AVALANCHE CHARACTERISTICS

| Symbol          | Parameter  | Max Value | Unit |
|-----------------|--|-----------|------|
| I <sub>AR</sub> | Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by T <sub>J</sub> max, δ < 1%)                          | 40        | A    |
| E <sub>AS</sub> | Single Pulse Avalanche Energy (starting T <sub>J</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 25 V)   | 300       | mJ   |
| E <sub>AR</sub> | Repetitive Avalanche Energy (pulse width limited by T <sub>J</sub> max, δ < 1%)  | 75        | mJ   |
| I <sub>AR</sub> | Avalanche Current, Repetitive or Not-Repetitive (T <sub>c</sub> = 100 °C, pulse width limited by T <sub>J</sub> max, δ < 1%) | 28        | A    |

### ELECTRICAL CHARACTERISTICS (T<sub>case</sub> = 25 °C unless otherwise specified)

OFF

| Symbol               | Parameter   | Test Conditions  | Min. | Typ. | Max.        | Unit     |
|----------------------|---|--|------|------|-------------|----------|
| V <sub>(BR)DSS</sub> | Drain-source Breakdown Voltage                        | I <sub>D</sub> = 250 μA V <sub>GS</sub> = 0  | 30   |      |             | V        |
| I <sub>DSS</sub>     | Zero Gate Voltage Drain Current (V <sub>GS</sub> = 0) | V <sub>DS</sub> = Max Rating<br>V <sub>DS</sub> = Max Rating x 0.8 T <sub>c</sub> = 125 °C |      |      | 250<br>1000 | μA<br>μA |
| I <sub>GSS</sub>     | Gate-body Leakage Current (V <sub>DS</sub> = 0)       | V <sub>GS</sub> = ± 15 V   |      |      | ± 100       | nA       |

ON (\*)

| Symbol              | Parameter                         | Test Conditions   | Min. | Typ.           | Max.          | Unit        |
|---------------------|-----------------------------------|---|------|----------------|---------------|-------------|
| V <sub>GS(th)</sub> | Gate Threshold Voltage            | V <sub>DS</sub> = V <sub>GS</sub> I <sub>D</sub> = 250 μA   | 1    | 1.6            | 2             | V           |
| R <sub>DS(on)</sub> | Static Drain-source On Resistance | V <sub>GS</sub> = 10V I <sub>D</sub> = 20 A<br>V <sub>GS</sub> = 10V I <sub>D</sub> = 20 A T <sub>c</sub> = 100°C<br>V <sub>GS</sub> = 5V I <sub>D</sub> = 20 A |      | 0.016<br>0.019 | 0.02<br>0.023 | Ω<br>Ω<br>Ω |
| I <sub>D(on)</sub>  | On State Drain Current            | V <sub>DS</sub> > I <sub>D(on)</sub> x R <sub>DS(on)max</sub><br>V <sub>GS</sub> = 10 V   | 40   |                |               | A           |

DYNAMIC

| Symbol              | Parameter                    | Test Conditions   | Min. | Typ. | Max. | Unit |
|---------------------|------------------------------|---|------|------|------|------|
| g <sub>fs</sub> (*) | Forward Transconductance     | V <sub>DS</sub> > I <sub>D(on)</sub> x R <sub>DS(on)max</sub> I <sub>D</sub> = 20 A | 15   | 22   |      | S    |
| C <sub>iss</sub>    | Input Capacitance            | V <sub>DS</sub> = 25 V f = 1 MHz V <sub>GS</sub> = 0                                |      | 1800 | 2300 | pF   |
| C <sub>oss</sub>    | Output Capacitance           |   |      | 450  | 580  | pF   |
| C <sub>rss</sub>    | Reverse Transfer Capacitance |   |      | 180  | 230  | pF   |

**ELECTRICAL CHARACTERISTICS** (continued)

## SWITCHING ON

| Symbol                        | Parameter  | Test Conditions   | Min. | Typ.           | Max.      | Unit             |
|-------------------------------|--|---|------|----------------|-----------|------------------|
| $t_{d(on)}$<br>$t_r$          | Turn-on Time<br>Rise Time                                    | $V_{DD} = 15\text{ V}$ $I_D = 10\text{ A}$<br>$R_G = 4.7\ \Omega$ $V_{GS} = 5\text{ V}$<br>(see test circuit, figure 3) |      | 20<br>80       | 30<br>100 | ns<br>ns         |
| $(di/dt)_{on}$                | Turn-on Current Slope  | $V_{DD} = 24\text{ V}$ $I_D = 20\text{ A}$<br>$R_G = 50\ \Omega$ $V_{GS} = 5\text{ V}$<br>(see test circuit, figure 5)  |      | 200            |           | A/ $\mu\text{s}$ |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$ | Total Gate Charge<br>Gate-Source Charge<br>Gate-Drain Charge | $V_{DD} = 24\text{ V}$ $I_D = 20\text{ A}$ $V_{GS} = 5\text{ V}$  |      | 40<br>10<br>20 | 60        | nC<br>nC<br>nC   |

## SWITCHING OFF

| Symbol                          | Parameter   | Test Conditions   | Min. | Typ.           | Max.            | Unit           |
|---------------------------------|---|---|------|----------------|-----------------|----------------|
| $t_{r(Voff)}$<br>$t_f$<br>$t_c$ | Off-voltage Rise Time<br>Fall Time<br>Cross-over Time | $V_{DD} = 24\text{ V}$ $I_D = 20\text{ A}$<br>$R_G = 4.7\ \Omega$ $V_{GS} = 5\text{ V}$<br>(see test circuit, figure 5) |      | 42<br>45<br>76 | 55<br>60<br>100 | ns<br>ns<br>ns |

## SOURCE DRAIN DIODE

| Symbol                            | Parameter   | Test Conditions   | Min. | Typ.            | Max.      | Unit                     |
|-----------------------------------|---|---|------|-----------------|-----------|--------------------------|
| $I_{SD}$<br>$I_{SDM}(\bullet)$    | Source-drain Current<br>Source-drain Current<br>(pulsed)                              |   |      |                 | 40<br>160 | A<br>A                   |
| $V_{SD} (*)$                      | Forward On Voltage  | $I_{SD} = 40\text{ A}$ $V_{GS} = 0$   |      |                 | 1.5       | V                        |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse Recovery<br>Time<br>Reverse Recovery<br>Charge<br>Reverse Recovery<br>Current | $I_{SD} = 20\text{ A}$ $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 24\text{ V}$ $T_j = 150\text{ }^\circ\text{C}$<br>(see test circuit, figure 5) |      | 65<br>0.12<br>4 |           | ns<br>$\mu\text{C}$<br>A |

(\*) Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5 %

(\bullet) Pulse width limited by safe operating area

(1)  $I_{SD} \leq 40\text{ A}$ ,  $di/dt \leq 300\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_j \leq T_{JMAX}$

## STP40N03L-20

### PSPICE PARAMETERS SUBCIRCUIT COMPONENTS

| Symbol | Parameter                                      | Value              | Unit            |
|--------|--|--------------------|-----------------|
| S1     | (V14_16<0) (See Power Mosfet Model Subcircuit) | ON                 |                 |
| S2     | (V16_11<0) (See Power Mosfet Model Subcircuit) | ON                 |                 |
| LD     | Drain Inductance                               | 8                  | nH              |
| LG     | Gate Inductance                                | 10                 | nH              |
| LS     | Source Inductance                              | 10                 | nH              |
| RDRAIN | Drain Resistance                               | 1.9E <sup>-2</sup> | Ω               |
| RGATE  | Gate Resistance                                | 1                  | Ω               |
| CGD    | Gate Drain Capacitance                         | 3.92               | nF              |
| CGS    | Gate Source Capacitance                        | 1.9                | nF              |
| ALFA   | Drift Coeficient                               | 1E <sup>-3</sup>   | V <sup>-1</sup> |
| RGN    | Negative Bias Resistance                       | 10                 | KΩ              |

#### DIODE DRAIN GATE (Depletion Capacitance)

| Symbol | Parameter                 | Value | Unit |
|--------|---------------------------|-------|------|
| CJO    | Zero Bias p-n Capacitance | 2.7   | nF   |
| VJ     | p-n Potential             | 0.35  | V    |
| M      | p-n Grading Coefficient   | 0.55  |      |

#### DIODE DRAIN SOURCE

| Symbol | Parameter                 | Value | Unit |
|--------|---------------------------|-------|------|
| CJO    | Zero Bias p-n Capacitance | 10    | nF   |
| VJ     | p-n Potential             | 0.35  | V    |
| M      | p-n Grading Coefficient   | 0.55  |      |
| TT     | Transit Time              | 20    | nsec |

#### N MOSFET

| Symbol | Parameter                     | Value | Unit                |
|--------|-------------------------------|-------|---------------------|
| L      | Channel Length                | 1     | μMeter              |
| W      | Channel Width                 | 1     | μMeter              |
| LEVEL  | Model Index                   | 3     |                     |
| TOX    | Oxide Thickness               | 1     | Meter               |
| VTO    | Zero Bias Threshold Voltage   | 3.25  | V                   |
| U0     | Surface Mobility              | 600   | cm <sup>2</sup> /VS |
| THETA  | Mobility Modulation           | 0.005 | V <sup>-1</sup>     |
| Vmax   | Maximum Drift Velocity        | 0     | Meter/sec           |
| KP     | Trans Conductance Coefficient | 15    | Amp/V <sup>2</sup>  |

For Transient Simulation Applicate U.I.C. (Use Initial Condition) Option

**PSPICE NETLIST OF THE SUBCIRCUIT**

.SUBCKT STP40N03L-20 1 2 3  
 \*VALUE OF THE PACKAGE INDUCTANCES  
 LS 1 11 10n  
 LG 2 12 10n  
 LD 3 13 7n

\*RESISTANCE OF THE GATE  
 POLYSILICON  
 RG 12 16 1

\*EPY AND DRIFT RESISTANCES  
 RD 13 14 1.9e-02  
 EDRI 14 15 POLY(2) (13 14) (13 11) 0 0 0 0  
 1e-3

\*CAPACITANCE GATE SOURCE  
 CGS 16 11 1.90n

\*OPTIONAL FOR NEGATIVE GATE BIAS  
 \*S2 51 11 11 16 SWITCH  
 \*CGN 51 16 3.92n  
 \*RGN 51 16 10k

\*MILLER CAPACITANCE  
 CGD 16 17 3.92n

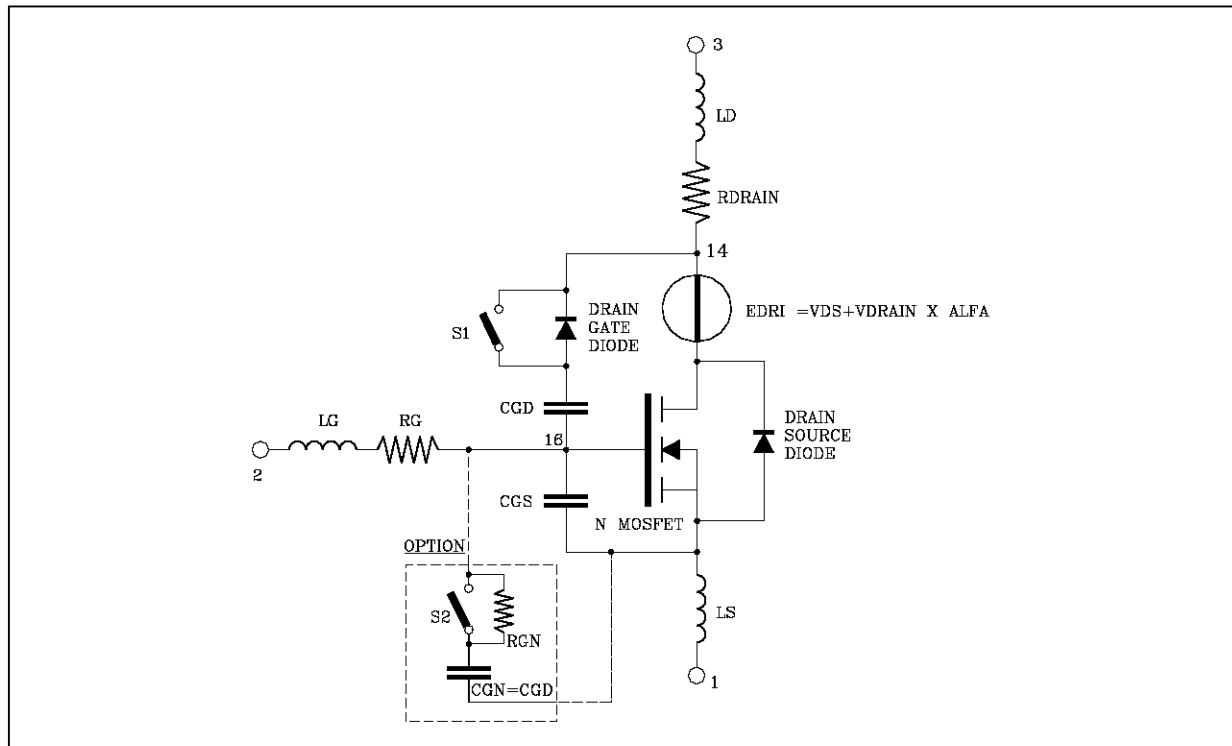
\* DEPLETION CAPACITANCE  
 DGD 17 14 DGD  
 S1 17 14 16 14 SWITCH  
 .MODEL DGD D +IS=  
 +CJO=2.6n  
 +Vj=.1  
 +M=.6

.MODEL SWITCH VSWITCH  
 +RON=1m  
 +ROFF=1MEG  
 +VON=0.1

\* OUTPUT CAPACITANCE AND BODY DRAIN DIODE  
 DBD 11 14 DBD  
 .MODEL DBD D  
 +TT=20n  
 +CJO=7.8n  
 +VJ=.1  
 +M=.6

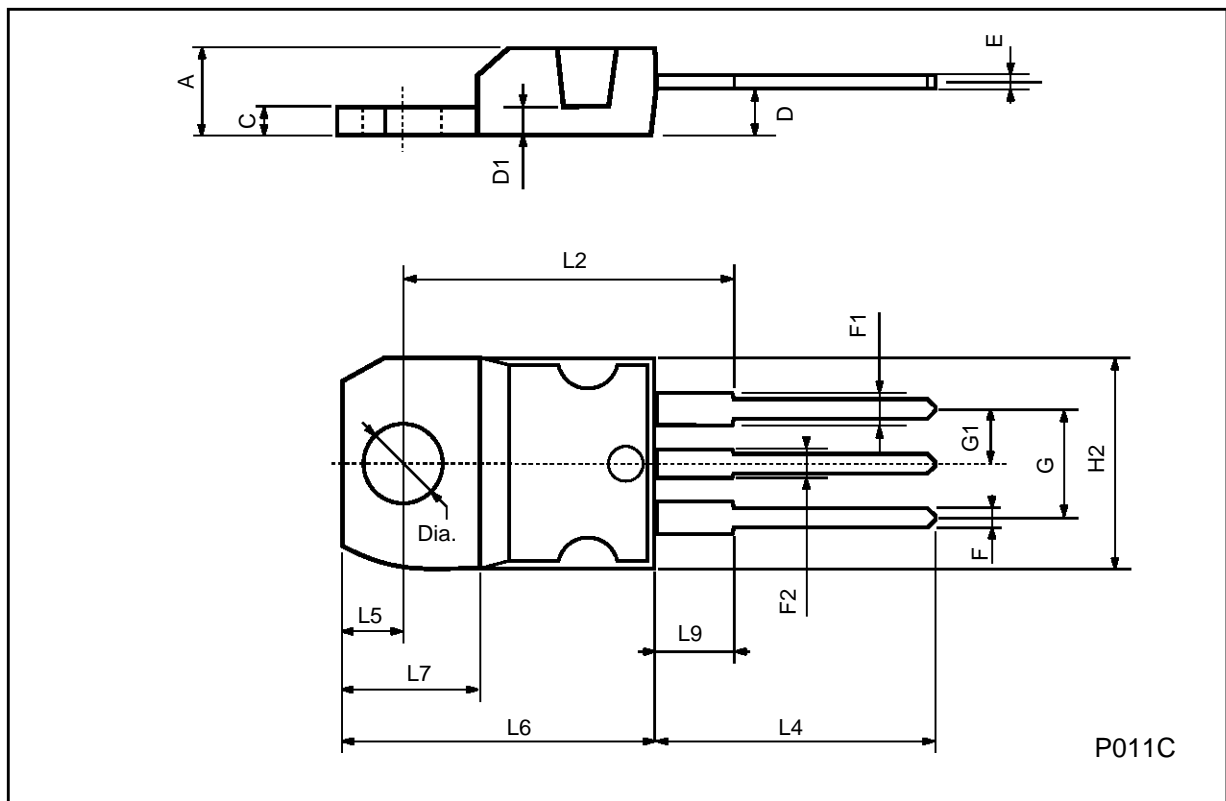
\* MODEL OF THE MOSFET  
 MMAIN 15 16 11 11 MMAIN L=1u W=1u  
 .MODEL MMAIN NMOS  
 +LEVEL=3  
 +TOX=1  
 +VTO=3.25  
 +uo=600  
 +THETA=0.005  
 +VMAX=5e7  
 +KP=28  
 .ENDS

Power Mosfet Model Subcircuit



**TO-220 MECHANICAL DATA**

| DIM. | mm    |      |       | inch  |       |       |
|------|-------|------|-------|-------|-------|-------|
|      | MIN.  | TYP. | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 4.40  |      | 4.60  | 0.173 |       | 0.181 |
| C    | 1.23  |      | 1.32  | 0.048 |       | 0.051 |
| D    | 2.40  |      | 2.72  | 0.094 |       | 0.107 |
| D1   |       | 1.27 |       |       | 0.050 |       |
| E    | 0.49  |      | 0.70  | 0.019 |       | 0.027 |
| F    | 0.61  |      | 0.88  | 0.024 |       | 0.034 |
| F1   | 1.14  |      | 1.70  | 0.044 |       | 0.067 |
| F2   | 1.14  |      | 1.70  | 0.044 |       | 0.067 |
| G    | 4.95  |      | 5.15  | 0.194 |       | 0.203 |
| G1   | 2.4   |      | 2.7   | 0.094 |       | 0.106 |
| H2   | 10.0  |      | 10.40 | 0.393 |       | 0.409 |
| L2   |       | 16.4 |       |       | 0.645 |       |
| L4   | 13.0  |      | 14.0  | 0.511 |       | 0.551 |
| L5   | 2.65  |      | 2.95  | 0.104 |       | 0.116 |
| L6   | 15.25 |      | 15.75 | 0.600 |       | 0.620 |
| L7   | 6.2   |      | 6.6   | 0.244 |       | 0.260 |
| L9   | 3.5   |      | 3.93  | 0.137 |       | 0.154 |
| DIA. | 3.75  |      | 3.85  | 0.147 |       | 0.151 |



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