



### N - CHANNEL ENHANCEMENT MODE POWER MOS TRANSISTORS

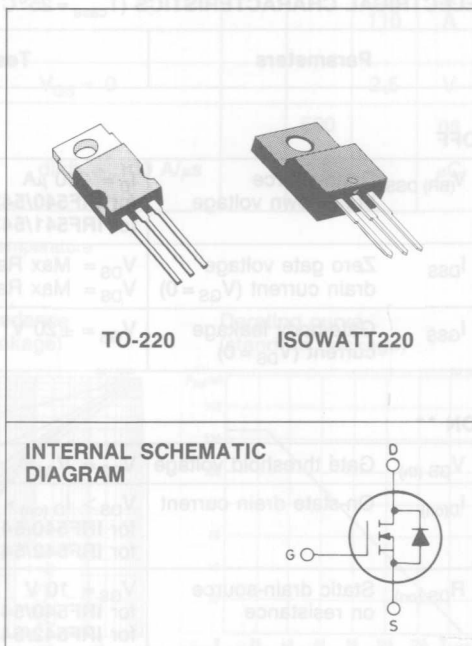
| TYPE     | V <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> ■ |
|----------|------------------|---------------------|------------------|
| IRF540   | 100 V            | 0.077 Ω             | 28 A             |
| IRF540FI | 100 V            | 0.077 Ω             | 15 A             |
| IRF541   | 80 V             | 0.077 Ω             | 28 A             |
| IRF541FI | 80 V             | 0.077 Ω             | 15 A             |
| IRF542   | 100 V            | 0.100 Ω             | 25 A             |
| IRF542FI | 100 V            | 0.100 Ω             | 14 A             |
| IRF543   | 80 V             | 0.100 Ω             | 25 A             |
| IRF543FI | 80 V             | 0.100 Ω             | 14 A             |

- 80-100 VOLTS - FOR DC/DC CONVERTERS
- HIGH CURRENT
- ULTRA FAST SWITCHING
- EASY DRIVE- FOR REDUCED COST AND SIZE

#### INDUSTRIAL APPLICATIONS:

- UNINTERRUPTIBLE POWER SUPPLIES
- MOTOR CONTROLS

N - channel enhancement mode POWER MOS field effect transistors. Easy drive and very fast switching times make these POWER MOS transistors ideal for high speed switching applications. Applications include DC/DC converters, UPS, battery chargers, secondary regulators, servo control, power-audio amplifiers and robotics.



#### ABSOLUTE MAXIMUM RATINGS

|                     |                                                 | TO-220<br>ISOWATT220 |              | IRF          |              |  |      |
|---------------------|-------------------------------------------------|----------------------|--------------|--------------|--------------|--|------|
|                     |                                                 | 540<br>540FI         | 541<br>541FI | 542<br>542FI | 543<br>543FI |  |      |
| V <sub>DS</sub> *   | Drain-source voltage (V <sub>GS</sub> = 0)      | 100                  | 80           | 100          | 80           |  | V    |
| V <sub>DGR</sub> *  | Drain-gate voltage (R <sub>GS</sub> = 20 KΩ)    | 100                  | 80           | 100          | 80           |  | V    |
| V <sub>GS</sub>     | Gate-source voltage                             | ± 20                 |              |              |              |  | V    |
| I <sub>DM</sub> (●) | Drain current (pulsed)                          | 110                  | 110          | 100          | 100          |  | A    |
| I <sub>DLM</sub>    | Drain inductive current, clamped (L = 100 μH)   | 110                  | 110          | 100          | 100          |  | A    |
| I <sub>D</sub>      | Drain current (cont.) at T <sub>c</sub> = 25°C  | 28                   | 28           | 25           | 25           |  | A    |
| I <sub>D</sub>      | Drain current (cont.) at T <sub>c</sub> = 100°C | 20                   | 20           | 17           | 17           |  | A    |
| I <sub>D</sub> ■    | Drain current (cont.) at T <sub>c</sub> = 25°C  | 15                   | 15           | 14           | 14           |  | A    |
| I <sub>D</sub> ■    | Drain current (cont.) at T <sub>c</sub> = 100°C | 9                    | 9            | 8            | 8            |  | A    |
| P <sub>tot</sub> ■  | Total dissipation at T <sub>c</sub> < 25°C      | 125                  |              | 40           |              |  | W    |
| ■                   | Derating factor                                 | 1                    |              | 0.32         |              |  | W/°C |
| T <sub>stg</sub>    | Storage temperature                             | - 55 to 150          |              |              |              |  | °C   |
| T <sub>j</sub>      | Max. operating junction temperature             | 150                  |              |              |              |  | °C   |

\* T<sub>j</sub> = 25°C to 125°C

(●) Repetitive Rating: Pulse width limited by max junction temperature.

■ See note on ISOWATT220 on this datasheet.

**THERMAL DATA \***

|                  |                                                |     | TO-220 | ISOWATT220 |      |
|------------------|------------------------------------------------|-----|--------|------------|------|
| $R_{thj - case}$ | Thermal resistance junction-case               | max | 1      | 3.12       | °C/W |
| $R_{thc-s}$      | Thermal resistance case-sink                   | typ | 0.5    |            | °C/W |
| $R_{thj-amb}$    | Thermal resistance junction-ambient            | max | 80     |            | °C/W |
| $T_l$            | Maximum lead temperature for soldering purpose |     | 300    |            | °C   |

**ELECTRICAL CHARACTERISTICS** ( $T_{case} = 25^\circ\text{C}$  unless otherwise specified)

| Parameters | Test Conditions | Min. | Typ. | Max. | Unit |
|------------|-----------------|------|------|------|------|
|------------|-----------------|------|------|------|------|

**OFF**

|                |                                                  |                                                                                                   |                           |             |                                |
|----------------|--------------------------------------------------|---------------------------------------------------------------------------------------------------|---------------------------|-------------|--------------------------------|
| $V_{(BR) DSS}$ | Drain-source breakdown voltage                   | $I_D = 250 \mu\text{A}$<br>for <b>IRF540/542/540FI/542FI</b><br>for <b>IRF541/543/541FI/543FI</b> | $V_{GS} = 0$              | 100<br>80   | V<br>V                         |
| $I_{DSS}$      | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = \text{Max Rating}$<br>$V_{DS} = \text{Max Rating} \times 0.8$                           | $T_c = 125^\circ\text{C}$ | 250<br>1000 | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$      | Gate-body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20 \text{ V}$                                                                       |                           | $\pm 500$   | nA                             |

**ON \*\***

|              |                                   |                                                                                                                              |                         |          |                |                      |
|--------------|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------|-------------------------|----------|----------------|----------------------|
| $V_{GS(th)}$ | Gate threshold voltage            | $V_{DS} = V_{GS}$                                                                                                            | $I_D = 250 \mu\text{A}$ | 2        | 4              | V                    |
| $I_{D(on)}$  | On-state drain current            | $V_{DS} > I_{D(on)} \times R_{DS(on) \text{ max}}$<br>for <b>IRF540/541/540FI/541FI</b><br>for <b>IRF542/543/542FI/543FI</b> | $V_{GS} = 10 \text{ V}$ | 28<br>25 |                | A<br>A               |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS} = 10 \text{ V}$<br>for <b>IRF540/541/540FI/541FI</b><br>for <b>IRF542/543/542FI/543FI</b>                            | $I_D = 17 \text{ A}$    |          | 0.077<br>0.100 | $\Omega$<br>$\Omega$ |

**DYNAMIC**

|               |                              |                                                                            |     |  |      |     |
|---------------|------------------------------|----------------------------------------------------------------------------|-----|--|------|-----|
| $g_{fs}^{**}$ | Forward transconductance     | $V_{DS} > I_{D(on)} \times R_{DS(on) \text{ max}}$<br>$I_D = 17 \text{ A}$ | 8.7 |  |      | mho |
| $C_{iss}$     | Input capacitance            | $V_{DS} = 25 \text{ V}$<br>$V_{GS} = 0$                                    |     |  | 1600 | pF  |
| $C_{oss}$     | Output capacitance           | $f = 1 \text{ MHz}$                                                        |     |  | 800  | pF  |
| $C_{rss}$     | Reverse transfer capacitance |                                                                            |     |  | 300  | pF  |

**SWITCHING**

|              |                     |                                                                                          |                      |  |    |    |
|--------------|---------------------|------------------------------------------------------------------------------------------|----------------------|--|----|----|
| $t_{d(on)}$  | Turn-on time        | $V_{DD} = 30 \text{ V}$<br>$R_l = 4.7 \Omega$                                            | $I_D = 15 \text{ A}$ |  | 30 | ns |
| $t_r$        | Rise time           | (see test circuit)                                                                       |                      |  | 60 | ns |
| $t_{d(off)}$ | Turn-off delay time |                                                                                          |                      |  | 80 | ns |
| $t_f$        | Fall time           |                                                                                          |                      |  | 30 | ns |
| $Q_g$        | Total Gate Charge   | $V_{GS} = 10 \text{ V}$<br>$V_{DS} = \text{Max Rating} \times 0.8$<br>(see test circuit) | $I_D = 28 \text{ A}$ |  | 59 | nC |

# ELECTRICAL CHARACTERISTICS (Continued)

| Parameters | Test Conditions | Min. | Typ. | Max. | Unit |
|------------|-----------------|------|------|------|------|
|------------|-----------------|------|------|------|------|

## SOURCE DRAIN DIODE

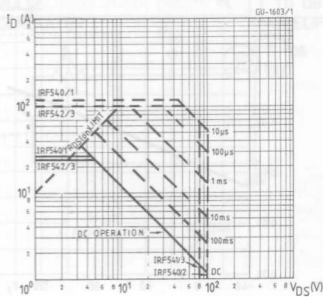
|                 |                               |                           |                                    |     |               |
|-----------------|-------------------------------|---------------------------|------------------------------------|-----|---------------|
| $I_{SD}$        | Source-drain current          |                           |                                    | 28  | A             |
| $I_{SDM}^{(*)}$ | Source-drain current (pulsed) |                           |                                    | 110 | A             |
| $V_{SD}^{**}$   | Forward on voltage            | $I_{SD} = 28\text{ A}$    | $V_{GS} = 0$                       | 2.5 | V             |
| $t_{rr}$        | Reverse recovery time         | $T_J = 150^\circ\text{C}$ |                                    | 500 | ns            |
| $Q_{rr}$        | Reverse recovered charge      | $I_{SD} = 28\text{ A}$    | $di/dt = 100\text{ A}/\mu\text{s}$ | 2.9 | $\mu\text{C}$ |

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

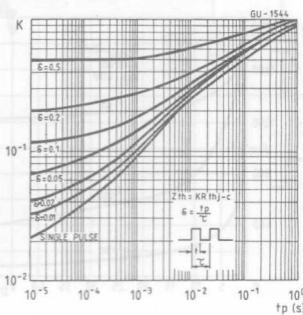
(\*) Repetitive Rating: Pulse width limited by max junction temperature

■ See note on ISOWATT220 in this datasheet

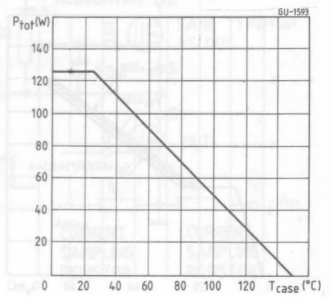
Safe operating areas  
(standard package)



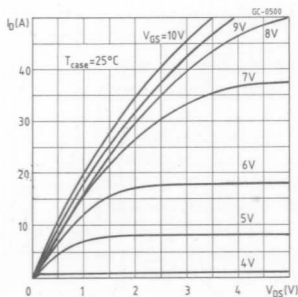
Thermal impedance  
(standard package)



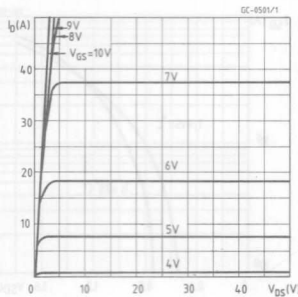
Derating curve  
(standard package)



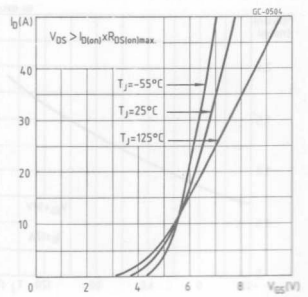
Output characteristics



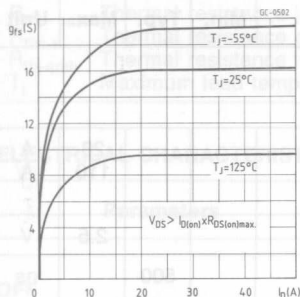
Output characteristics



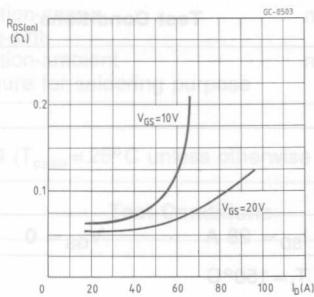
Transfer characteristics



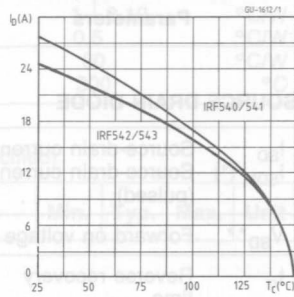
Transconductance



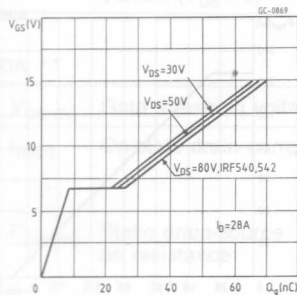
Static drain-source on resistance



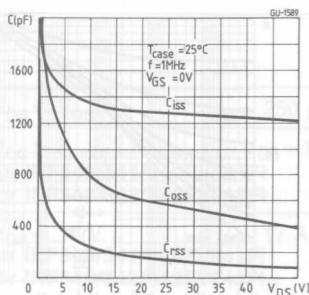
Maximum drain current vs temperature



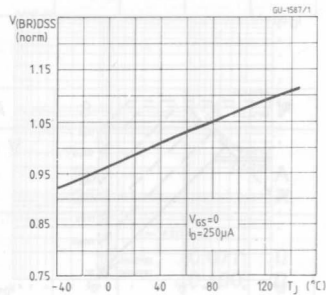
Gate charge vs gate-source voltage



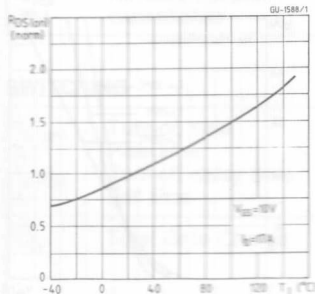
Capacitance variation



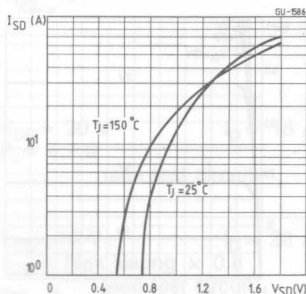
Normalized breakdown voltage vs temperature



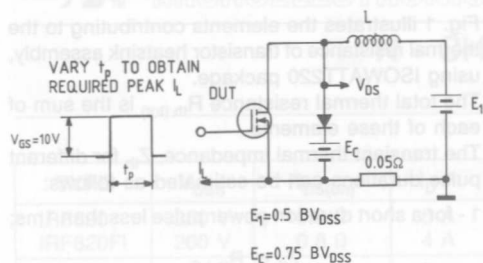
Normalized on resistance vs temperature



Source-drain diode forward characteristics

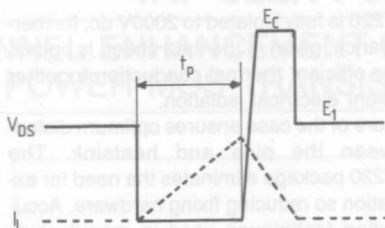


### Clamped inductive test circuit



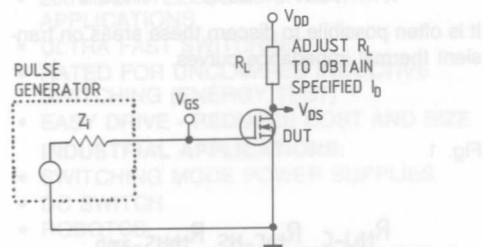
SC-0242

### Clamped inductive waveforms



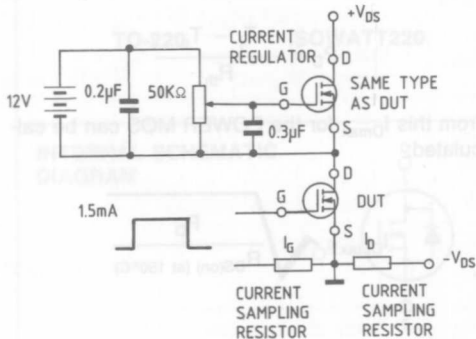
SC-0243

### Switching times test circuit



SC-0246

### Gate charge test circuit



SC-0244

ISOWATT220 PACKAGE CHARACTERISTICS AND APPLICATION.

ISOWATT220 is fully isolated to 2000V dc. Its thermal impedance, given in the data sheet, is optimised to give efficient thermal conduction together with excellent electrical isolation. The structure of the case ensures optimum distances between the pins and heatsink. The ISOWATT220 package eliminates the need for external isolation so reducing fixing hardware. Accurate moulding techniques used in manufacture assure consistent heat spreader-to-heatsink capacitance. ISOWATT220 thermal performance is better than that of the standard part, mounted with a 0.1mm mica washer. The thermally conductive plastic has a higher breakdown rating and is less fragile than mica or plastic sheets. Power derating for ISOWATT220 packages is determined by:

$$P_D = \frac{T_j - T_c}{R_{th}}$$

from this  $I_{Dmax}$  for the POWER MOS can be calculated:

$$I_{Dmax} \leq \sqrt{\frac{P_D}{R_{DS(on)} \text{ (at } 150^{\circ}\text{C)}}}$$

THERMAL IMPEDANCE OF ISOWATT220 PACKAGE

Fig. 1 illustrates the elements contributing to the thermal resistance of transistor heatsink assembly, using ISOWATT220 package. The total thermal resistance  $R_{th (tot)}$  is the sum of each of these elements. The transient thermal impedance,  $Z_{th}$  for different pulse durations can be estimated as follows:

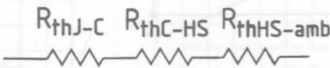
- 1 - for a short duration power pulse less than 1ms;
- 2 - for an intermediate power pulse of 5ms to 50ms;
- 3 - for long power pulses of the order of 500ms or greater;

$$Z_{th} < R_{thJ-C}$$
$$Z_{th} = R_{thJ-C}$$

$$Z_{th} = R_{thJ-C} + R_{thC-HS} + R_{thHS-amb}$$

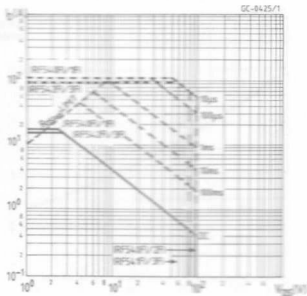
It is often possible to discern these areas on transient thermal impedance curves.

Fig. 1

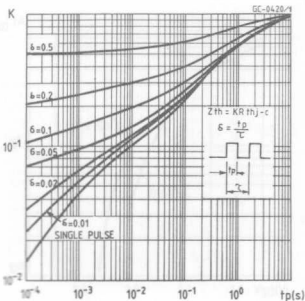


ISOWATT DATA

Safe operating areas



Thermal impedance



Derating curve

