

**N - CHANNEL ENHANCEMENT MODE  
POWER MOS TRANSISTORS**

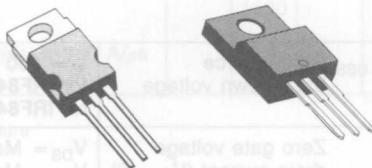
TYPE	V <sub>DSS</sub>	R <sub>DS(on)</sub>	I <sub>D</sub> ■
IRF840	500 V	0.85 Ω	8 A
IRF840FI	500 V	0.85 Ω	4.5 A
IRF841	450 V	0.85 Ω	8 A
IRF841FI	450 V	0.85 Ω	4.5 A
IRF842	500 V	1.1 Ω	7 A
IRF842FI	500 V	1.1 Ω	4 A
IRF843	450 V	1.1 Ω	7 A
IRF843FI	450 V	1.1 Ω	4 A

- HIGH VOLTAGE - 450 V FOR OFF LINE SMPS
- ULTRA FAST SWITCHING - FOR OPERATION AT > 100KHz
- EASY DRIVE - FOR REDUCED COST AND SIZE
- COST EFFECTIVE PLASTIC PACKAGE

**INDUSTRIAL APPLICATIONS:**

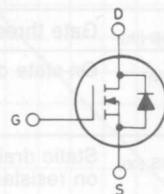
- SWITCHING POWER SUPPLIES
- MOTOR CONTROLS

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.



TO-220

ISOWATT220

**INTERNAL SCHEMATIC  
DIAGRAM**

**ABSOLUTE MAXIMUM RATINGS**

 TO-220  
 ISOWATT220

V <sub>DS</sub> *	Drain-source voltage (V <sub>GS</sub> = 0)
V <sub>DGR</sub> *	Drain-gate voltage (R <sub>GS</sub> = 20 kΩ)
V <sub>GS</sub>	Gate-source voltage
I <sub>DM</sub> (*)	Drain current (pulsed)
I <sub>DLM</sub>	Drain inductive current, clamped (L = 100 μH)
I <sub>D</sub>	Drain current (cont.) at T <sub>c</sub> = 25°C
I <sub>D</sub>	Drain current (cont.) at T <sub>c</sub> = 100°C
I <sub>D</sub> ■	Drain current (cont.) at T <sub>c</sub> = 25°C
I <sub>D</sub> ■	Drain current (cont.) at T <sub>c</sub> = 100°C
P <sub>tot</sub> ■	Total dissipation at T <sub>c</sub> < 25°C
■	Derating factor
T <sub>stg</sub>	Storage temperature
T <sub>j</sub>	Max. operating junction temperature

 IRF  
 840 841 842 843  
 840FI 841FI 842FI 843FI

 500 450 500 450 V  
 500 450 500 450 V  
 ±20 V  
 32 32 28 28 A  
 32 32 28 28 A

 840 841 842 843  
 840FI 841FI 842FI 843FI  
 8 8 7 7 A  
 5.1 5.1 4.4 4.4 A

 4.5 4.5 4 4 A  
 2.8 2.8 2.5 2.5 A

 TO-220 ISOWATT220  
 125 40 W  
 1 0.32 W/C  
 – 55 to 150 °C  
 150 °C

 \* T<sub>c</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	$^{\circ}\text{C}/\text{W}$
$R_{thc-s}$	Thermal resistance case-sink	typ	0.5	$^{\circ}\text{C}/\text{W}$	$^{\circ}\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient	max	80	$^{\circ}\text{C}/\text{W}$	$^{\circ}\text{C}/\text{W}$
$T_I$	Maximum lead temperature for soldering purpose		300		$^{\circ}\text{C}$

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

Parameters	Test Conditions	Min.	Typ.	Max.	Unit
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## OFF

$V_{(BR) DSS}$	Drain-source breakdown voltage	$I_D = 250 \mu\text{A}$ for IRF840/842/840FI/842FI for IRF841/843/841FI/843FI	$V_{GS} = 0$	500		V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = \text{Max Rating}$ $V_{DS} = \text{Max Rating} \times 0.8$	$T_c = 125^{\circ}\text{C}$		250 1000	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate-body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 20 \text{ V}$			$\pm 500$	nA

## ON \*\*

$V_{GS(\text{th})}$	Gate threshold voltage	$V_{DS} = V_{GS}$	$I_D = 250 \mu\text{A}$	2	4	V
$I_{D(\text{on})}$	On-state drain current	$V_{DS} > I_{D(\text{on})} \times R_{DS(\text{on}) \text{ max}}$ for IRF840/841/840FI/841FI for IRF842/843/842FI/843FI	$V_{GS} = 10 \text{ V}$	8		A
$R_{DS(\text{on})}$	Static drain-source on resistance	$V_{GS} = 10 \text{ V}$ for IRF840/841/840FI/841FI for IRF842/843/842FI/843FI	$I_D = 4.4 \text{ A}$		0.85 1.1	$\Omega$ $\Omega$

## DYNAMIC

$g_{fs}^{**}$	Forward transconductance	$V_{DS} > I_{D(\text{on})} \times R_{DS(\text{on}) \text{ max}}$ $I_D = 4.4 \text{ A}$	4.9			mho
$C_{iss}$	Input capacitance				1600	pF
$C_{oss}$	Output capacitance				350	pF
$C_{rss}$	Reverse transfer capacitance	$V_{DS} = 25 \text{ V}$ $V_{GS} = 0$	$f = 1 \text{ MHz}$		150	pF

## SWITCHING

$t_d(\text{on})$	Turn-on time	$V_{DD} = 200 \text{ V}$	$I_D = 4.0 \text{ A}$		35	ns
$t_r$	Rise time	$R_i = 4.7 \Omega$			15	ns
$t_d(\text{off})$	Turn-off delay time		(see test circuit)		90	ns
$t_f$	Fall time				30	ns
$Q_g$	Total Gate Charge	$V_{GS} = 10 \text{ V}$ $V_{DS} = \text{Max Rating} \times 0.8$	$I_D = 8 \text{ A}$		63	nC

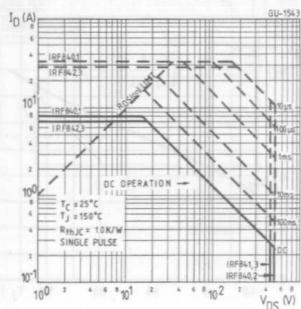
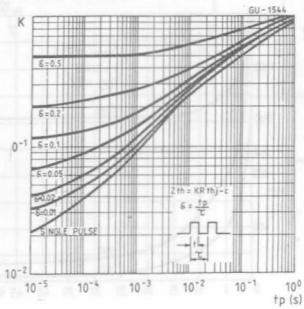
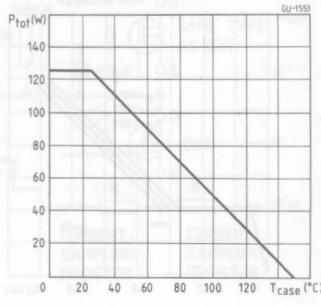
## ELECTRICAL CHARACTERISTICS (Continued)

Parameters	Test Conditions	Min.	Typ.	Max.	Unit
$I_{SD}$				8	A
$I_{SDM}^*$	Source-drain current (pulsed)			32	A
$V_{SD}^{**}$	Forward on voltage	$I_{SD} = 8 \text{ A}$	$V_{GS} = 0$		V
$t_{rr}$	Reverse recovery time	$T_j = 150^\circ\text{C}$		1100	ns
$Q_{rr}$	Reverse recovered charge	$I_{SD} = 8.0 \text{ A}$	$di/dt = 100 \text{ A}/\mu\text{s}$	6.4	$\mu\text{C}$

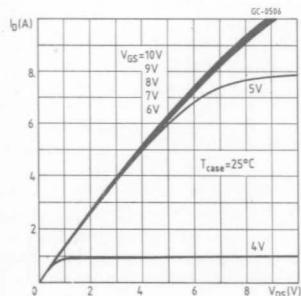
\*\* Pulsed: Pulse duration  $\leq 300 \mu\text{s}$ , duty cycle  $\leq 1.5\%$ 

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

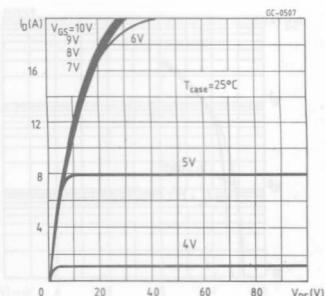
■ See note on ISOWATT220 in this datasheet

Safe operating areas  
(standard package)Thermal impedance  
(standard package)Derating curve  
(standard package)

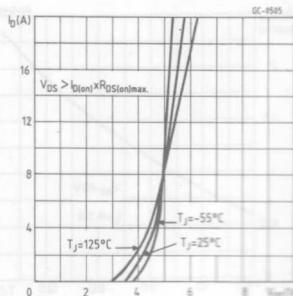
## Output characteristics



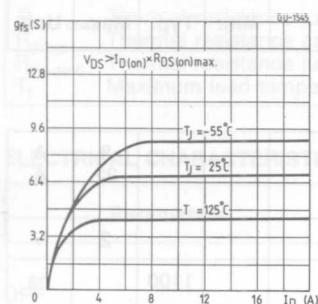
## Output characteristics



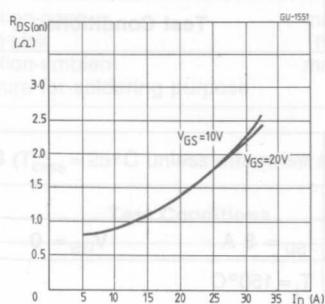
## Transfer characteristics



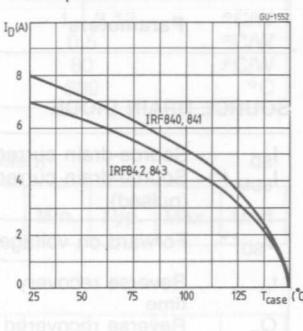
## Transconductance



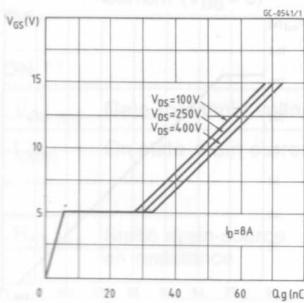
## Static drain-source on resistance



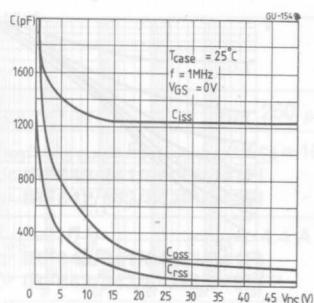
## Maximum drain current vs temperature



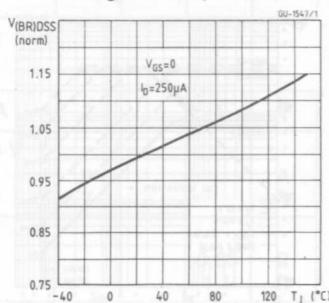
## Zero gate voltage



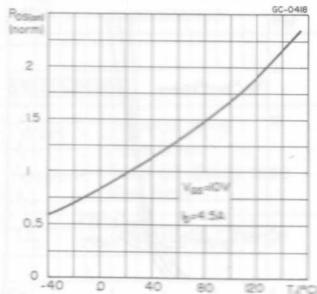
## Capacitance variation



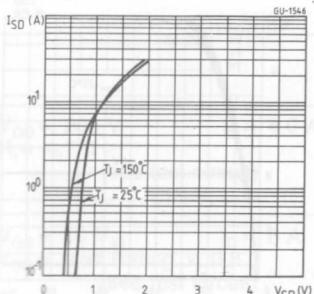
## Normalized breakdown voltage vs temperature



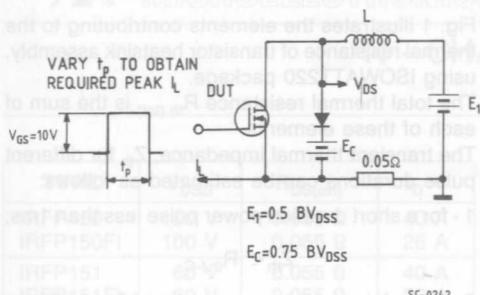
## Normalized on resistance vs temperature



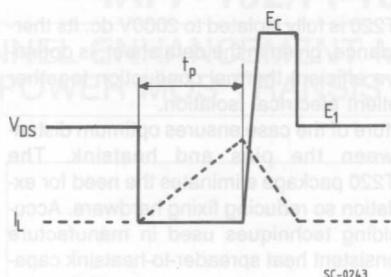
## Source-drain diode forward characteristics



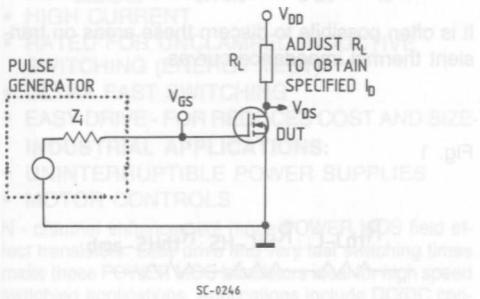
## Clamped inductive test circuit



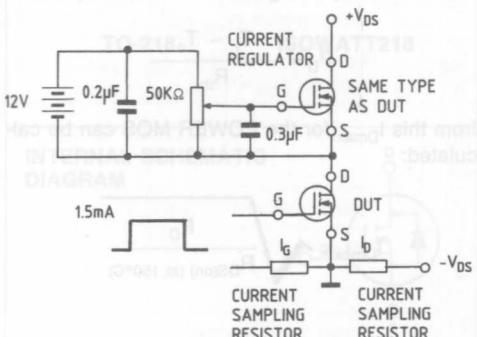
## Clamped inductive waveforms



## Switching times test circuit



## Gate charge test circuit



## ABSOLUTE MAXIMUM RATINGS

	TO-218	ISOWATT218	TO-218	150	151	152	153
$V_{DS}$ *	Drain-source voltage ( $V_{GS} = 0$ )			100	80	100	100
$V_{DSS}$ *	Drain-gate voltage ( $I_D = 20$ mA)			100	80	100	100
$V_{GS}$	Gate-source voltage						
$I_{DS} (\star)$	Drain current (drained)			100	80	100	100
	Drain current (cont.) at $T_c = 25^\circ C$			180	151	152	153
	Drain current (cont.) at $T_c = 70^\circ C$			40	40	34	34
	Drain current (cont.) at $T_c = 100^\circ C$			25	25	25	25
	Drain current (cont.) at $T_c = 150^\circ C$			150	150	150	150
	Drain current (cont.) at $T_c = 200^\circ C$			20	20	20	20
	Drain current (cont.) at $T_c = 250^\circ C$			10	10	10	10
	Drain current (cont.) at $T_c = 300^\circ C$			5	5	5	5
	Drain current (cont.) at $T_c = 350^\circ C$			2	2	2	2
	Drain current (cont.) at $T_c = 400^\circ C$			1	1	1	1
	Drain current (cont.) at $T_c = 450^\circ C$			0.5	0.5	0.5	0.5
	Drain current (cont.) at $T_c = 500^\circ C$			0.2	0.2	0.2	0.2
	Drain current (cont.) at $T_c = 550^\circ C$			0.1	0.1	0.1	0.1
	Drain current (cont.) at $T_c = 600^\circ C$			0.05	0.05	0.05	0.05
	Drain current (cont.) at $T_c = 650^\circ C$			0.02	0.02	0.02	0.02
	Drain current (cont.) at $T_c = 700^\circ C$			0.01	0.01	0.01	0.01
	Drain current (cont.) at $T_c = 750^\circ C$			0.005	0.005	0.005	0.005
	Drain current (cont.) at $T_c = 800^\circ C$			0.002	0.002	0.002	0.002
	Drain current (cont.) at $T_c = 850^\circ C$			0.001	0.001	0.001	0.001
	Drain current (cont.) at $T_c = 900^\circ C$			0.0005	0.0005	0.0005	0.0005
	Drain current (cont.) at $T_c = 950^\circ C$			0.0002	0.0002	0.0002	0.0002
	Drain current (cont.) at $T_c = 1000^\circ C$			0.0001	0.0001	0.0001	0.0001
	Drain current (cont.) at $T_c = 1050^\circ C$			0.00005	0.00005	0.00005	0.00005
	Drain current (cont.) at $T_c = 1100^\circ C$			0.00002	0.00002	0.00002	0.00002
	Drain current (cont.) at $T_c = 1150^\circ C$			0.00001	0.00001	0.00001	0.00001
	Drain current (cont.) at $T_c = 1200^\circ C$			0.000005	0.000005	0.000005	0.000005
	Drain current (cont.) at $T_c = 1250^\circ C$			0.000002	0.000002	0.000002	0.000002
	Drain current (cont.) at $T_c = 1300^\circ C$			0.000001	0.000001	0.000001	0.000001
	Drain current (cont.) at $T_c = 1350^\circ C$			0.0000005	0.0000005	0.0000005	0.0000005
	Drain current (cont.) at $T_c = 1400^\circ C$			0.0000002	0.0000002	0.0000002	0.0000002
	Drain current (cont.) at $T_c = 1450^\circ C$			0.0000001	0.0000001	0.0000001	0.0000001
	Drain current (cont.) at $T_c = 1500^\circ C$			0.00000005	0.00000005	0.00000005	0.00000005
	Drain current (cont.) at $T_c = 1550^\circ C$			0.00000002	0.00000002	0.00000002	0.00000002
	Drain current (cont.) at $T_c = 1600^\circ C$			0.00000001	0.00000001	0.00000001	0.00000001
	Drain current (cont.) at $T_c = 1650^\circ C$			0.000000005	0.000000005	0.000000005	0.000000005
	Drain current (cont.) at $T_c = 1700^\circ C$			0.000000002	0.000000002	0.000000002	0.000000002
	Drain current (cont.) at $T_c = 1750^\circ C$			0.000000001	0.000000001	0.000000001	0.000000001
	Drain current (cont.) at $T_c = 1800^\circ C$			0.0000000005	0.0000000005	0.0000000005	0.0000000005
	Drain current (cont.) at $T_c = 1850^\circ C$			0.0000000002	0.0000000002	0.0000000002	0.0000000002
	Drain current (cont.) at $T_c = 1900^\circ C$			0.0000000001	0.0000000001	0.0000000001	0.0000000001
	Drain current (cont.) at $T_c = 1950^\circ C$			0.00000000005	0.00000000005	0.00000000005	0.00000000005
	Drain current (cont.) at $T_c = 2000^\circ C$			0.00000000002	0.00000000002	0.00000000002	0.00000000002
	Drain current (cont.) at $T_c = 2050^\circ C$			0.00000000001	0.00000000001	0.00000000001	0.00000000001
	Drain current (cont.) at $T_c = 2100^\circ C$			0.000000000005	0.000000000005	0.000000000005	0.000000000005
	Drain current (cont.) at $T_c = 2150^\circ C$			0.000000000002	0.000000000002	0.000000000002	0.000000000002
	Drain current (cont.) at $T_c = 2200^\circ C$			0.000000000001	0.000000000001	0.000000000001	0.000000000001
	Drain current (cont.) at $T_c = 2250^\circ C$			0.0000000000005	0.0000000000005	0.0000000000005	0.0000000000005
	Drain current (cont.) at $T_c = 2300^\circ C$			0.0000000000002	0.0000000000002	0.0000000000002	0.0000000000002
	Drain current (cont.) at $T_c = 2350^\circ C$			0.0000000000001	0.0000000000001	0.0000000000001	0.0000000000001
	Drain current (cont.) at $T_c = 2400^\circ C$			0.00000000000005	0.00000000000005	0.00000000000005	0.00000000000005
	Drain current (cont.) at $T_c = 2450^\circ C$			0.00000000000002	0.00000000000002	0.00000000000002	0.00000000000002
	Drain current (cont.) at $T_c = 2500^\circ C$			0.00000000000001	0.00000000000001	0.00000000000001	0.00000000000001
	Drain current (cont.) at $T_c = 2550^\circ C$			0.000000000000005	0.000000000000005	0.000000000000005	0.000000000000005
	Drain current (cont.) at $T_c = 2600^\circ C$			0.000000000000002	0.000000000000002	0.000000000000002	0.000000000000002
	Drain current (cont.) at $T_c = 2650^\circ C$			0.000000000000001	0.000000000000001	0.000000000000001	0.000000000000001
	Drain current (cont.) at $T_c = 2700^\circ C$			0.0000000000000005	0.0000000000000005	0.0000000000000005	0.0000000000000005
	Drain current (cont.) at $T_c = 2750^\circ C$			0.0000000000000002	0.0000000000000002	0.0000000000000002	0.0000000000000002
	Drain current (cont.) at $T_c = 2800^\circ C$			0.0000000000000001	0.0000000000000001	0.0000000000000001	0.0000000000000001
	Drain current (cont.) at $T_c = 2850^\circ C$			0.00000000000000005	0.00000000000000005	0.00000000000000005	0.00000000000000005
	Drain current (cont.) at $T_c = 2900^\circ C$			0.00000000000000002	0.00000000000000002	0.00000000000000002	0.00000000000000002
	Drain current (cont.) at $T_c = 2950^\circ C$			0.00000000000000001	0.00000000000000001	0.00000000000000001	0.00000000000000001
	Drain current (cont.) at $T_c = 3000^\circ C$			0.000000000000000005	0.000000000000000005	0.000000000000000005	0.000000000000000005
	Drain current (cont.) at $T_c = 3050^\circ C$			0.000000000000000002	0.000000000000000002	0.000000000000000002	0.000000000000000002
	Drain current (cont.) at $T_c = 3100^\circ C$			0.000000000000000001	0.000000000000000001	0.000000000000000001	0.000000000000000001
	Drain current (cont.) at $T_c = 3150^\circ C$			0.0000000000000000005	0.0000000000000000005	0.0000000000000000005	0.0000000000000000005
	Drain current (cont.) at $T_c = 3200^\circ C$			0.0000000000000000002	0.0000000000000000002	0.0000000000000000002	0.0000000000000000002
	Drain current (cont.) at $T_c = 3250^\circ C$			0.0000000000000000001	0.0000000000000000001	0.0000000000000000001	0.0000000000000000001
	Drain current (cont.) at $T_c = 3300^\circ C$			0.00000000000000000005	0.00000000000000000005	0.00000000000000000005	0.00000000000000000005
	Drain current (cont.) at $T_c = 3350^\circ C$			0.00000000000000000002	0.00000000000000000002	0.00000000000000000002	0.00000000000000000002
	Drain current (cont.) at $T_c = 3400^\circ C$			0.00000000000000000001	0.00000000000000000001	0.00000000000000000001	0.00000000000000000001
	Drain current (cont.) at $T_c = 3450^\circ C$			0.000000000000000000005	0.000000000000000000005	0.000000000000000000005	0.000000000000000000005
	Drain current (cont.) at $T_c = 3500^\circ C$			0.000000000000000000002	0.000000000000000000002	0.000000000000000000002	0.000000000000000000002
	Drain current (cont.) at $T_c = 3550^\circ C$			0.000000000000000000001	0.000000000000000000001	0.000000000000000000001	0.000000000000000000001
	Drain current (cont.) at $T_c = 3600^\circ C$			0.0000000000000000000005	0.0000000000000000000005	0.0000000000000000000005	0.0000000000000000000005
	Drain current (cont.) at $T_c = 3650^\circ C$			0.0000000000000000000002	0.0000000000000000000002	0.0000000000000000000002	0.0000000000000000000002
	Drain current (cont.) at $T_c = 3700^\circ C$			0.0000000000000000000001	0.0000000000000000000001	0.0000000000000000000001	0.0000000000000000000001
	Drain current (cont.) at $T_c = 3750^\circ C$			0.00000000000000000000005	0.00000000000000000000005	0.00000000000000000000005	0.00000000000000000000005
	Drain current (cont.) at $T_c = 3800^\circ C$			0.00000000000000000000002	0.00000000000000000000002	0.00000000000000000000002	0.00000000000000000000002
	Drain current (cont.) at $T_c = 3850^\circ C$			0.00000000000000000000001	0.00000000000000000000001	0.00000000000000000000001	0.00000000000000000000001
	Drain current (cont.) at $T_c = 3900^\circ C$			0.000000000000000000000005	0.000000000000000000000005	0.000000000000000000000005	0.000000000000000000000005
	Drain current (cont.) at $T_c = 3950^\circ C$			0.000000000000000000000002	0.000000000000000000000002	0.000000000000000000000002	0.000000000000000000000002
	Drain current (cont.) at $T_c = 4000^\circ C$			0.000000000000000000000001	0.000000000000000000000001	0.000000000000000000000001	0.000000000000000000000001
	Drain current (cont.) at $T_c = 4050^\circ C$			0.0000000000000000000000005	0.0000000000000000000000005	0.0000000000000000000000005	0.0000000000000000000000005
	Drain current (cont.) at $T_c = 4100^\circ C$			0.0000000000000000000000002	0.0000000000000000000000002	0.0000000000000000000000002	0.0000000000000000000000002
	Drain current (cont.) at $T_c = 4150^\circ C$			0.0000000000000000000000001	0.0000000000000000000000001	0.0000000000000000000000001	0.0000000000000000000000001
	Drain current (cont.) at $T_c = 4200^\circ C$			0.00000000000000000000000005	0.00000000000000000000000005	0.00000000000000000000000005	0.00000000000000000000000005
	Drain current (cont.) at $T_c = 4250^\circ C$			0.00000000000000000000000002	0.00000000000000000000000002	0.00000000000000000000000002	0.00000000000000000000000002
	Drain current (cont.) at $T_c = 4300^\circ C$			0.00000000000000000000000001	0.00000000000000000000000001	0.00000000000000000000000001	0.00000000000000000000000001
	Drain current (cont.) at $T_c = 4350^\circ C$			0.000000000000000000000000005	0.000000000000000000000000005	0.000000000000000000000000005	0.000000000000000000000000005

## 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:

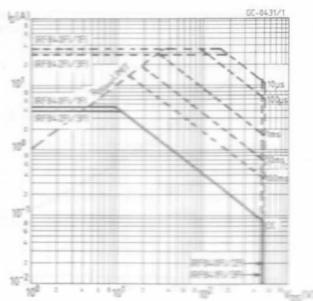
$$P_D = \frac{T_j - T_c}{R_{th}}$$

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

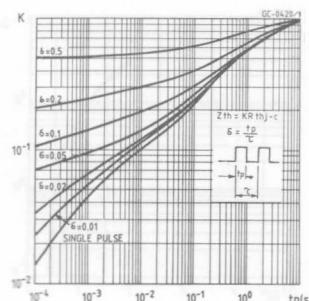
$$I_{Dmax} \leq \sqrt{\frac{P_D}{R_{DS(on)} \text{ (at } 150^\circ\text{C)}}}$$

## ISOWATT DATA

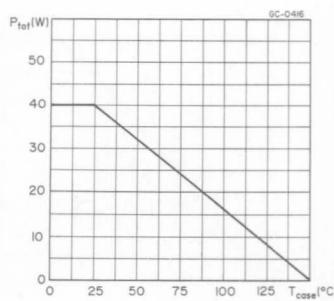
### Safe operating areas



### Thermal impedance characteristics



### Derating curve



## 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  $R_{th(\text{tot})}$  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;

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

2 - for an intermediate power pulse of 5ms to 50ms:

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

3 - for long power pulses of the order of 500ms or greater:

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

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

Fig. 1

