



# STGW40NC60V

N-CHANNEL 50A - 600V - TO-247

Very Fast PowerMESH™ IGBT

**Table 1: General Features**

TYPE	V <sub>CES</sub>	V <sub>CE(sat)</sub> (Max) @25°C	I <sub>C</sub> @100°C
STGW40NC60V	600 V	< 2.5 V	50 A

- HIGH CURRENT CAPABILITY
- HIGH FREQUENCY OPERATION UP TO 50 KHz
- LOSSES INCLUDE DIODE RECOVERY ENERGY
- OFF LOSSES INCLUDE TAIL CURRENT
- LOWER C<sub>RES</sub> / C<sub>IES</sub> RATIO
- NEW GENERATION PRODUCTS WITH TIGHTER PARAMETER DISTRIBUTION

## DESCRIPTION

Using the latest high voltage technology based on a patented strip layout, STMicroelectronics has designed an advanced family of IGBTs, the PowerMESH™ IGBTs, with outstanding performances. The suffix "V" identifies a family optimized for high frequency.

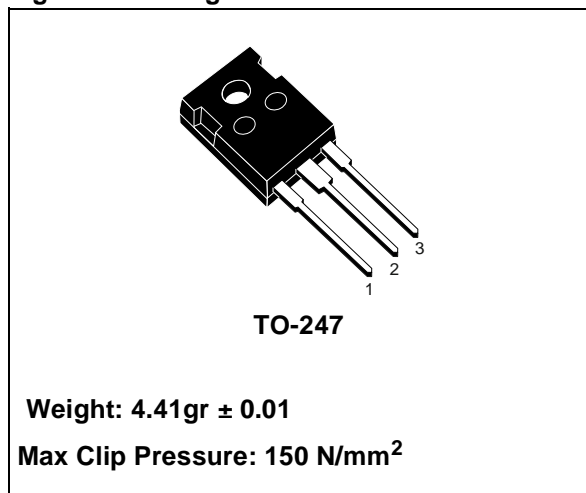
## APPLICATIONS

- HIGH FREQUENCY INVERTERS
- SMPS and PFC IN BOTH HARD SWITCH AND RESONANT TOPOLOGIES
- UPS
- MOTOR DRIVERS

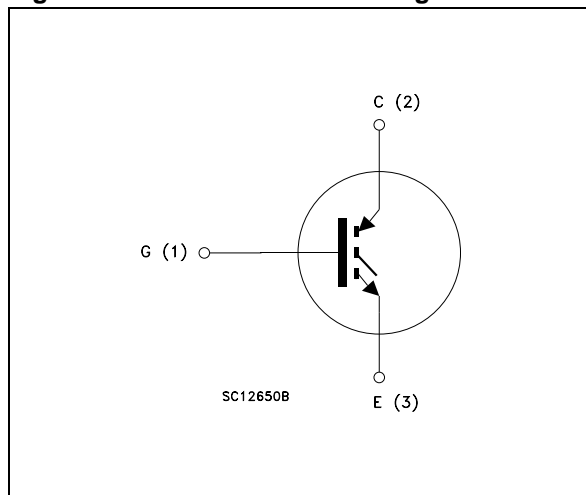
**Table 2: Order Codes**

SALES TYPE	MARKING	PACKAGE	PACKAGING
STGW40NC60V	GW40NC60V	TO-247	TUBE

**Figure 1: Package**



**Figure 2: Internal Schematic Diagram**



**Table 3: Absolute Maximum ratings**

Symbol	Parameter	Value	Symbol
V <sub>CES</sub>	Collector-Emitter Voltage (V <sub>GS</sub> = 0)	600	V
V <sub>ECR</sub>	Reverse Battery Protection	20	V
V <sub>GE</sub>	Gate-Emitter Voltage	± 20	V
I <sub>C</sub>	Collector Current (continuous) at 25°C (#)	80	A
I <sub>C</sub>	Collector Current (continuous) at 100°C (#)	50	A
I <sub>CM</sub> (1)	Collector Current (pulsed)	200	A
P <sub>TOT</sub>	Total Dissipation at T <sub>C</sub> = 25°C	260	W
	Derating Factor	2.08	W/°C
T <sub>stg</sub>	Storage Temperature	- 55 to 150	°C
T <sub>j</sub>	Operating Junction Temperature		

(1)Pulse width limited by max. junction temperature.

**Table 4: Thermal Data**

		Min.	Typ.	Max.	Unit
R <sub>thj-case</sub>	Thermal Resistance Junction-case			0.48	°C/W
R <sub>thj-amb</sub>	Thermal Resistance Junction-ambient			50	°C/W
T <sub>L</sub>	Maximum Lead Temperature for Soldering Purpose (1.6 mm from case, for 10 sec.)		300		°C

**ELECTRICAL CHARACTERISTICS (T<sub>CASE</sub> =25°C UNLESS OTHERWISE SPECIFIED)**
**Table 5: Off**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V <sub>BR(CES)</sub>	Collectro-Emitter Breakdown Voltage	I <sub>C</sub> = 1 mA, V <sub>GE</sub> = 0	600			V
I <sub>CES</sub>	Collector-Emitter Leakage Current (V <sub>CE</sub> = 0)	V <sub>GE</sub> = Max Rating T <sub>c</sub> =25°C T <sub>c</sub> =125°C			10 1	µA mA
I <sub>GES</sub>	Gate-Emitter Leakage Current (V <sub>CE</sub> = 0)	V <sub>GE</sub> = ± 20 V , V <sub>CE</sub> = 0			± 100	nA

**Table 6: On**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V <sub>GE(th)</sub>	Gate Threshold Voltage	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250 µA	3.75		5.75	V
V <sub>CE(SAT)</sub>	Collector-Emitter Saturation Voltage	V <sub>GE</sub> = 15 V, I <sub>C</sub> = 40A, T <sub>j</sub> = 25°C V <sub>GE</sub> = 15 V, I <sub>C</sub> = 40A, T <sub>j</sub> = 125°C		1.9 1.7	2.5	V V

(#) Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{JMAX} - T_C}{R_{THJ-C} \times V_{CESAT(MAX)}(T_C, I_C)}$$

## ELECTRICAL CHARACTERISTICS (CONTINUED)

Table 7: Dynamic

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$g_{fs}(1)$	Forward Transconductance	$V_{CE} = 15 \text{ V}$ , $I_C = 20 \text{ A}$		20		S
$C_{ies}$ $C_{oes}$ $C_{res}$	Input Capacitance Output Capacitance Reverse Transfer Capacitance	$V_{CE} = 25 \text{ V}$ , $f = 1 \text{ MHz}$ , $V_{GE} = 0$		4550 350 105		pF pF pF
$Q_g$ $Q_{ge}$ $Q_{gc}$	Total Gate Charge Gate-Emitter Charge Gate-Collector Charge	$V_{CE} = 390 \text{ V}$ , $I_C = 40 \text{ A}$ , $V_{GE} = 15 \text{ V}$ , (see Figure 20)		214 30 96		nC nC nC
$I_{CL}$	Turn-Off SOA Minimum Current	$V_{clamp} = 480 \text{ V}$ , $T_j = 150^\circ\text{C}$ $R_G = 100 \Omega$ , $V_{GE} = 15 \text{ V}$	200			A

Table 8: Switching On

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ $t_r$ $(di/dt)_{on}$ $E_{on}(2)$	Turn-on Delay Time Current Rise Time Turn-on Current Slope Turn-on Switching Losses	$V_{CC} = 390 \text{ V}$ , $I_C = 40 \text{ A}$ $R_G = 3.3 \Omega$ , $V_{GE} = 15 \text{ V}$ , $T_j = 25^\circ\text{C}$ (see Figure 18)		43 17 2060 330	450	ns ns A/ $\mu\text{s}$ $\mu\text{J}$
$t_{d(on)}$ $t_r$ $(di/dt)_{on}$ $E_{on}(2)$	Turn-on Delay Time Current Rise Time Turn-on Current Slope Turn-on Switching Losses	$V_{CC} = 390 \text{ V}$ , $I_C = 40 \text{ A}$ $R_G = 3.3 \Omega$ , $V_{GE} = 15 \text{ V}$ , $T_j = 125^\circ\text{C}$ (see Figure 18)		42 19 1900 640		ns ns A/ $\mu\text{s}$ $\mu\text{J}$

2)  $E_{on}$  is the turn-on losses when a typical diode is used in the test circuit in figure 2. If the IGBT is offered in a package with a co-pack diode, the co-pack diode is used as external diode. IGBTs & DIODE are at the same temperature ( $25^\circ\text{C}$  and  $125^\circ\text{C}$ )

Table 9: Switching Off

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_r(V_{off})$ $t_{d(off)}$ $t_f$ $E_{off}(3)$ $E_{ts}$	Off Voltage Rise Time Turn-off Delay Time Current Fall Time Turn-off Switching Loss Total Switching Loss	$V_{CC} = 390 \text{ V}$ , $I_C = 40 \text{ A}$ , $R_{GE} = 3.3 \Omega$ , $V_{GE} = 15 \text{ V}$ $T_j = 25^\circ\text{C}$ (see Figure 18)		25 140 45 720 1050	970 1420	ns ns ns $\mu\text{J}$ $\mu\text{J}$
$t_r(V_{off})$ $t_{d(off)}$ $t_f$ $E_{off}(3)$ $E_{ts}$	Off Voltage Rise Time Turn-off Delay Time Current Fall Time Turn-off Switching Loss Total Switching Loss	$V_{CC} = 390 \text{ V}$ , $I_C = 40 \text{ A}$ , $R_{GE} = 3.3 \Omega$ , $V_{GE} = 15 \text{ V}$ $T_j = 125^\circ\text{C}$ (see Figure 18)		60 170 77 1400 2040		ns ns ns $\mu\text{J}$ $\mu\text{J}$

(3) Turn-off losses include also the tail of the collector current.

Figure 3: Output Characteristics

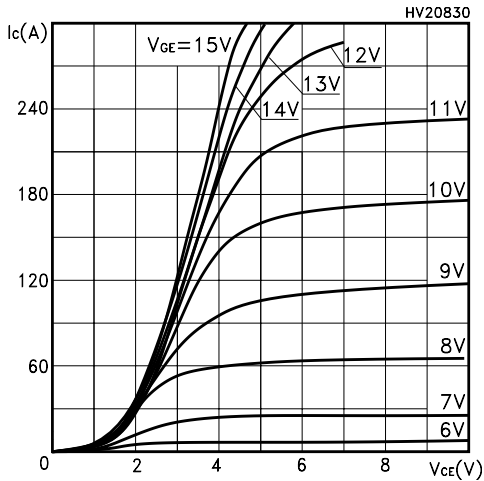


Figure 4: Transconductance

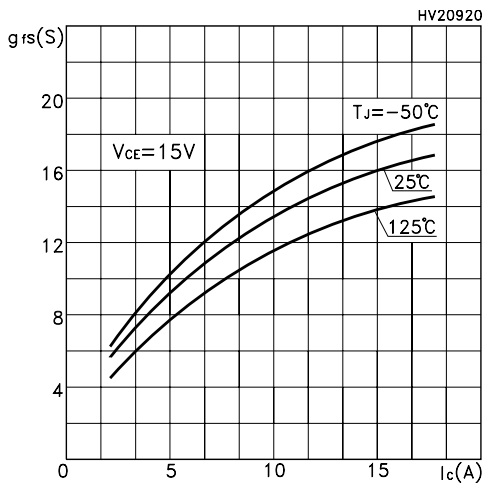


Figure 5: Collector-Emittter On Voltage vs Collector Current

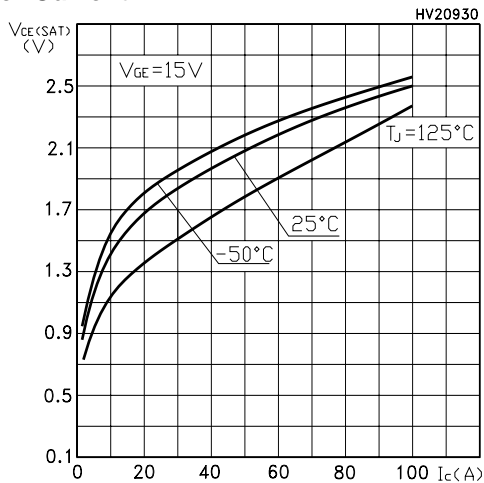


Figure 6: Transfer Characteristics

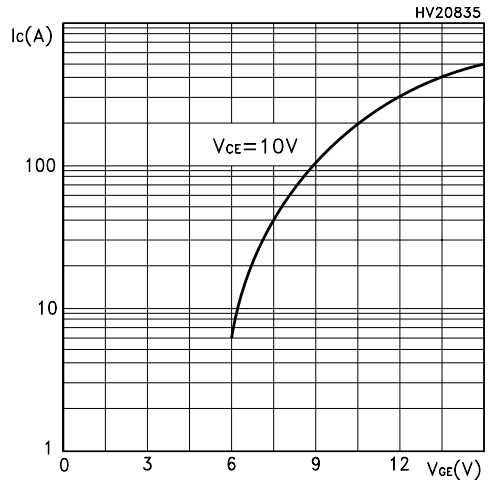


Figure 7: Collector-Emittter On Voltage vs Temperature

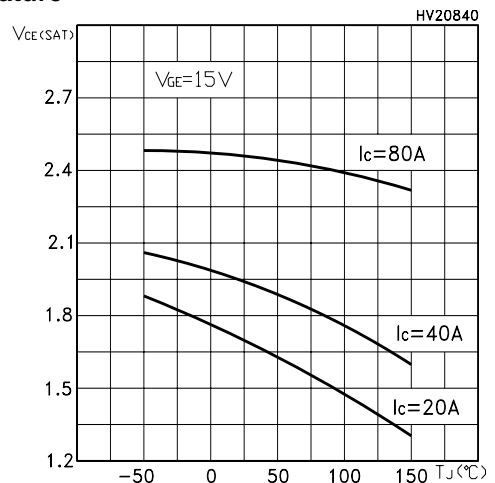
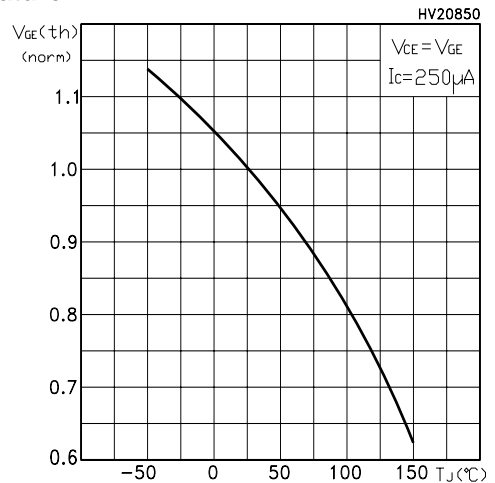
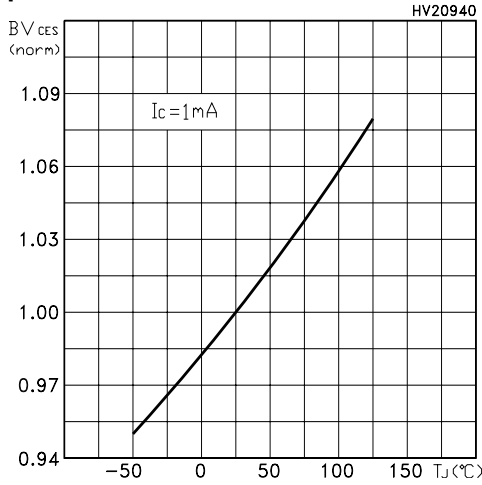


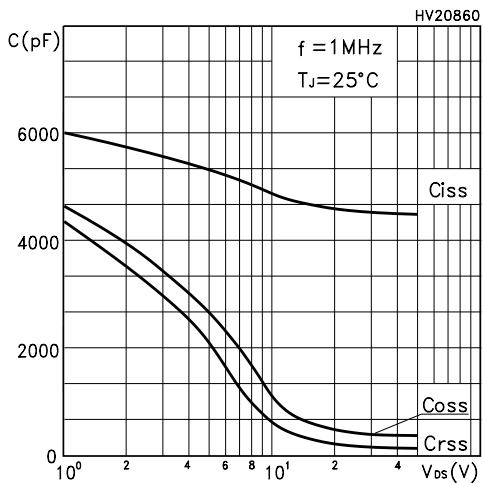
Figure 8: Normalized Gate Threshold vs Temperature



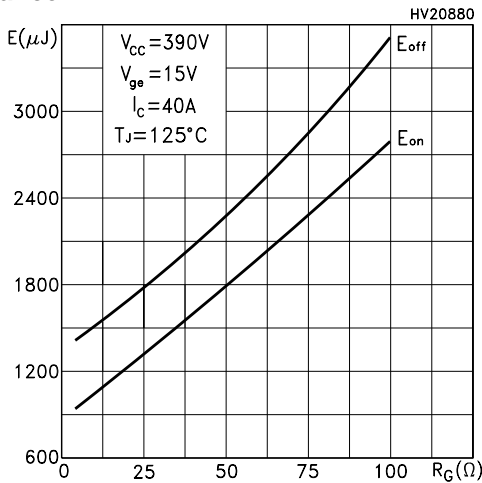
**Figure 9: Normalized Breakdown Voltage vs Temperature**



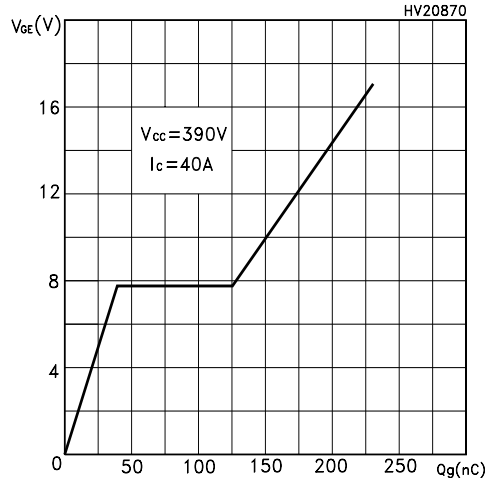
**Figure 10: Capacitance Variations**



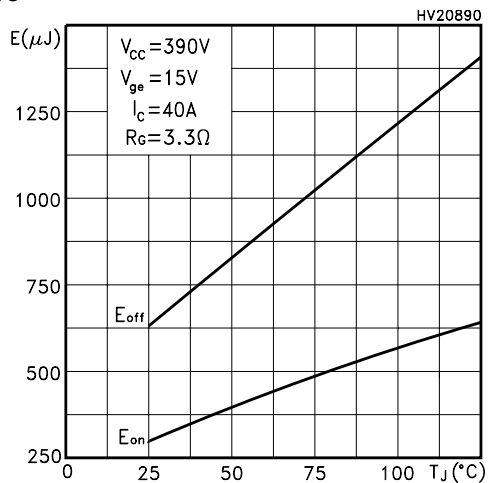
**Figure 11: Total Switching Losses vs Gate Resistance**



**Figure 12: Gate Charge vs Gate-Emitter Voltage**



**Figure 13: Total Switching Losses vs Temperature**



**Figure 14: Total Switching Losses vs Collector Current**

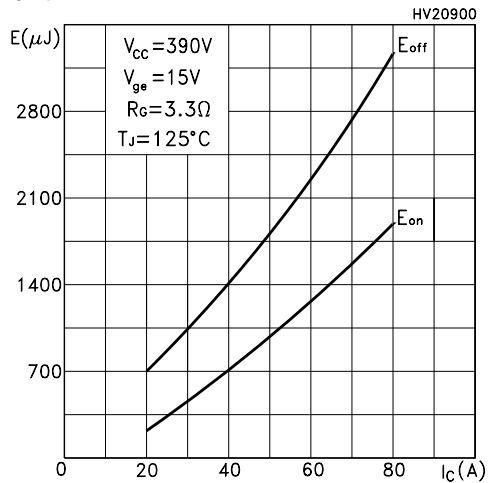


Figure 15: Thermal Impedance

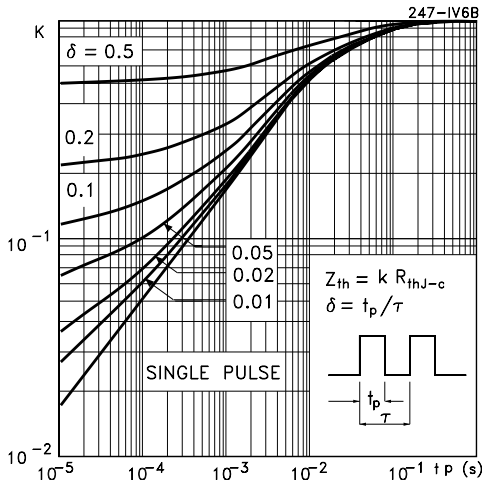


Figure 16: Turn-Off SOA

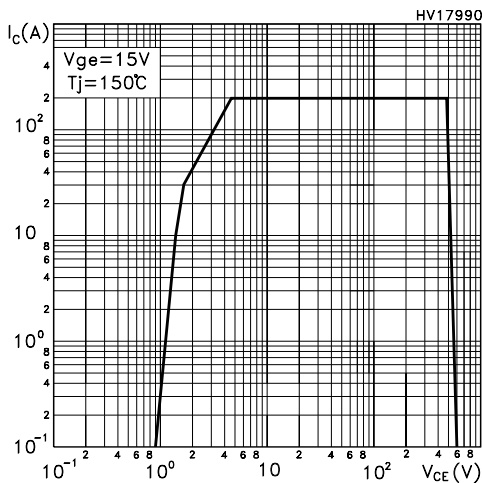
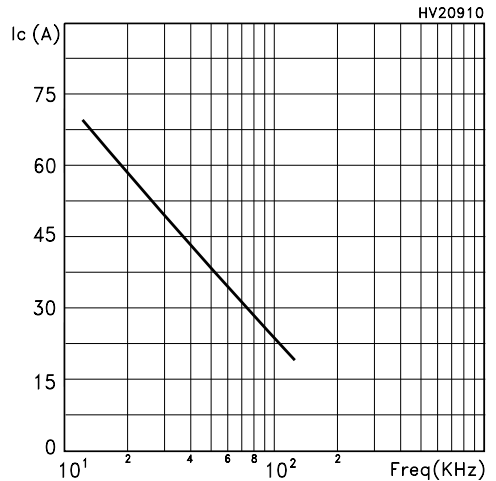


Figure 17: Ic vs Frequency



For a fast IGBT suitable for high frequency applications, the typical collector current vs. maximum operating frequency curve is reported. That frequency is defined as follows:

$$f_{MAX} = (P_D - P_C) / (E_{ON} + E_{OFF})$$

1) The maximum power dissipation is limited by maximum junction to case thermal resistance:

$$P_D = \Delta T / R_{THJ-C}$$

considering  $\Delta T = T_J - T_C = 125^\circ C - 75^\circ C = 50^\circ C$

2) The conduction losses are:

$$P_C = I_c * V_{CE(SAT)} * \delta$$

with 50% of duty cycle,  $V_{CESAT}$  typical value @  $125^\circ C$ .

3) Power dissipation during ON & OFF commutations is due to the switching frequency:

$$P_{SW} = (E_{ON} + E_{OFF}) * freq.$$

4) Typical values @  $125^\circ C$  for switching losses are used (test conditions:  $V_{CE} = 390V$ ,  $V_{GE} = 15V$ ,  $R_G = 3.3 \text{ Ohm}$ ). Furthermore, diode recovery energy is included in the  $E_{ON}$  (see note 2), while the tail of the collector current is included in the  $E_{OFF}$  measurements (see note 3).

Figure 18: Test Circuit for Inductive Load Switching

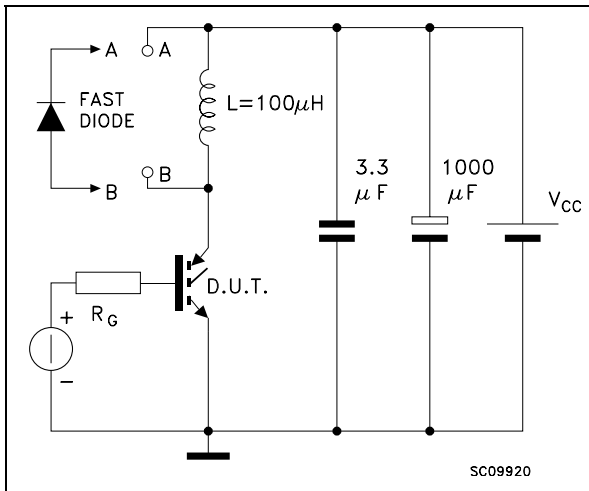


Figure 19: Switching Waveforms

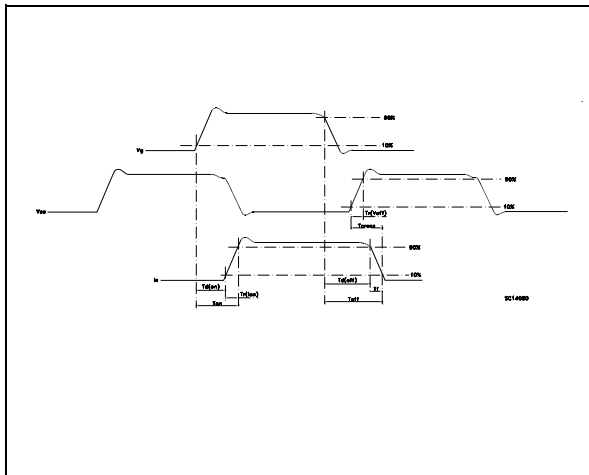
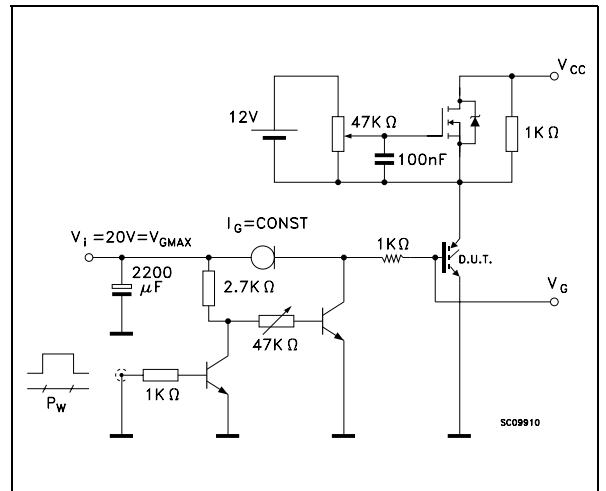
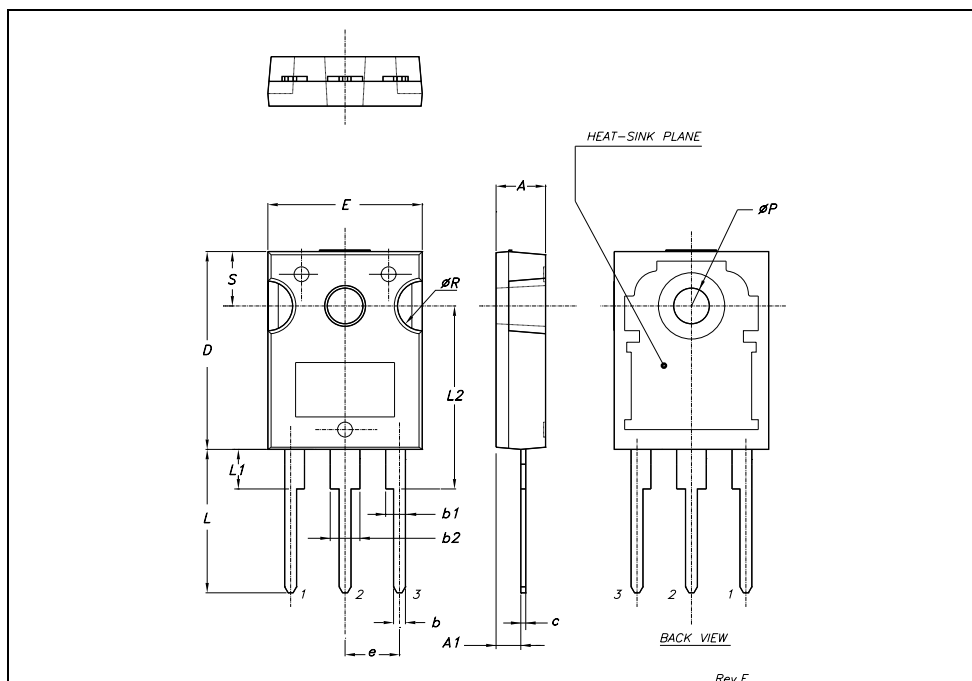


Figure 20: Gate Charge Test Circuit



## TO-247 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.85		5.15	0.19		0.20
A1	2.20		2.60	0.086		0.102
b	1.0		1.40	0.039		0.055
b1	2.0		2.40	0.079		0.094
b2	3.0		3.40	0.118		0.134
c	0.40		0.80	0.015		0.03
D	19.85		20.15	0.781		0.793
E	15.45		15.75	0.608		0.620
e		5.45			0.214	
L	14.20		14.80	0.560		0.582
L1	3.70		4.30	0.14		0.17
L2		18.50			0.728	
øP	3.55		3.65	0.140		0.143
øR	4.50		5.50	0.177		0.216
S		5.50			0.216	





**Table 10: Revision History**

Date	Revision	Description of Changes
13-Jul-2004	9	Stylesheet update. No content change
14-Jul-2004	10	Some datas have been updated

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