STGY40NC60VD

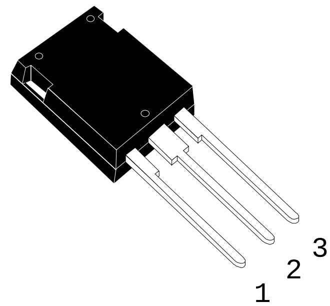
N-CHANNEL 50A - 600V - Max247
Very Fast PowerMESH™ IGBT

Table 1: General Features

TYPE	V_{CES}	$V_{CE(sat)}$ (Max) @25°C	I_C @100°C
STGY40NC60VD	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_{RES} / C_{IES} RATIO
- VERY SOFT ULTRA FAST RECOVERY ANTIPARALLEL DIODE
- NEW GENERATION PRODUCTS WITH TIGHTER PARAMETER DISTRUBUTION

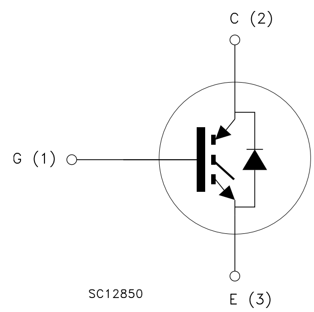
Figure 1: Package



Max247

Weight: 4.96gr ± 0.01
Max Clip Pressure: 150 N/mm²

Figure 2: Internal Schematic Diagram



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
STGY40NC60VD	GY40NC60VD	Max247	TUBE

Rev.8

Table 3: Absolute Maximum ratings

Symbol	Parameter	Value	Symbol
V_{CES}	Collector-Emitter Voltage (V_{GS} = 0)	600	V
V_{ECR}	Reverse Battery Protection	20	V
V_{GE}	Gate-Emitter Voltage	± 20	V
I_C	Collector Current (continuous) at 25°C (#)	80	A
I_C	Collector Current (continuous) at 100°C (#)	50	A
I_{CM} (1)	Collector Current (pulsed)	200	A
I_F	Diode R_{MS} Forward Current at T_C =25°C	30	A
P_{TOT}	Total Dissipation at T_C = 25°C	260	W
	Derating Factor	2.08	W/°C
T_{stg}	Storage Temperature	– 55 to 150	°C
T_j	Operating Junction Temperature		

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

Table 4: Thermal Data

		Min.	Typ.	Max.	Unit
Rthj-case	Thermal Resistance Junction-case (IGBT)	--	--	0.48	°C/W
Rthj-case	Thermal Resistance Junction-case (Diode)	--	--	1.5	°C/W
Rthj-amb	Thermal Resistance Junction-ambient	--	--	50	°C/W
T_L	Maximum Lead Temperature for Soldering Purpose (1.6 mm from case, for 10 sec.)		300		°C

ELECTRICAL CHARACTERISTICS (T_{CASE} =25°C UNLESS OTHERWISE SPECIFIED)

Table 5: Off

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{BR(CES)}$	Collectro-Emitter Breakdown Voltage	I_C = 1 mA, V_{GE} = 0	600			V
I_{CES}	Collector-Emitter Leakage Current (V_{CE} = 0)	V_{GE} = Max Rating Tc=25°C Tc=125°C			 10 1	 µA mA
I_{GES}	Gate-Emitter Leakage Current (V_{CE} = 0)	V_{GE} = ± 20 V , V_{CE} = 0			± 100	nA

Table 6: On

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{GE(th)}$	Gate Threshold Voltage	V_{CE}= V_{GE}, I_C= 250 µA	3.75		5.75	V
$V_{CE(SAT)}$	Collector-Emitter Saturation Voltage	V_{GE}= 15 V, I_C= 40A, Tj= 25°C V_{GE}= 15 V, I_C= 40A, Tj= 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 V, I_C= 20 A		20		S
C_{ies} C_{oes} C_{res}	Input Capacitance Output Capacitance Reverse Transfer Capacitance	V_{CE} = 25V, f = 1 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 V, I_C = 40 A, V_{GE} = 15V, (see Figure 21)		214 30 96		nC nC nC
I_{CL}	Turn-Off SOA Minimum Current	V_{clamp} = 480 V , Tj = 150°C R_G = 100 Ω, V_{GE}= 15V	200			A

Table 8: Switching On

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ t_r $(di/dt)_{on}$ Eon (2)	Turn-on Delay Time Current Rise Time Turn-on Current Slope Turn-on Switching Losses	V_{CC} = 390 V, I_C = 40 A R_G= 3.3Ω, V_{GE}= 15V, Tj= 25°C (see Figure 19)		43 17 2060 330	 450	ns ns A/µs µJ
$t_{d(on)}$ t_r $(di/dt)_{on}$ Eon (2)	Turn-on Delay Time Current Rise Time Turn-on Current Slope Turn-on Switching Losses	V_{CC} = 390 V, I_C = 40 A R_G= 3.3Ω, V_{GE}= 15V, Tj= 125°C (see Figure 19)		42 19 1900 640		ns ns A/µs µJ

2) Eon 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°C and 125°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 V, I_C = 40 A, R_{GE} = 3.3 Ω , V_{GE} = 15 V T_J = 25 °C (see Figure 19)		25 140 45 720 1050	 970 1420	ns ns ns µJ µJ
$t_r(V_{off})$ $t_d(_{off})$ 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 V, I_C = 40 A, R_{GE} = 3.3 Ω , V_{GE} = 15 V Tj = 125 °C (see Figure 19)		60 170 77 1400 2040		ns ns ns µJ µJ

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

Table 10: Collector-Emitter Diode

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_f	Forward On-Voltage	I_f = 20 A I_f = 20 A, Tj = 125 °C		1.5 1	2.2	V V
t_{rr} t_a Q_{rr} I_{rrm} S	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current Softness factor of the diode	I_f = 20 A ,V_R = 40 V, Tj = 25°C, di/dt = 100 A/µs (see Figure 22)		44 32 66 3 0.375		ns ns nC A
t_{rr} t_a Q_{rr} I_{rrm} S	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current Softness factor of the diode	I_f = 20 A ,V_R = 40 V, Tj =125°C, di/dt = 100 A/µs (see Figure 22)		88 56 237 5.4 0.57		ns ns nC A

Figure 3: Output Characteristics

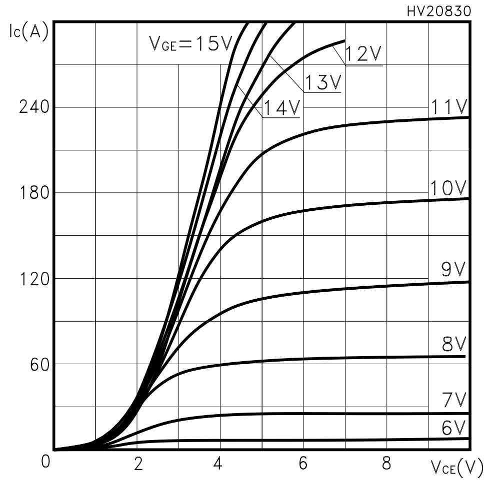


Figure 6: Transfer Characteristics

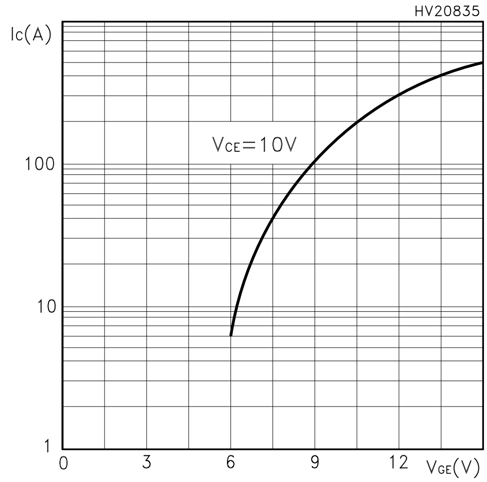


Figure 4: Transconductance

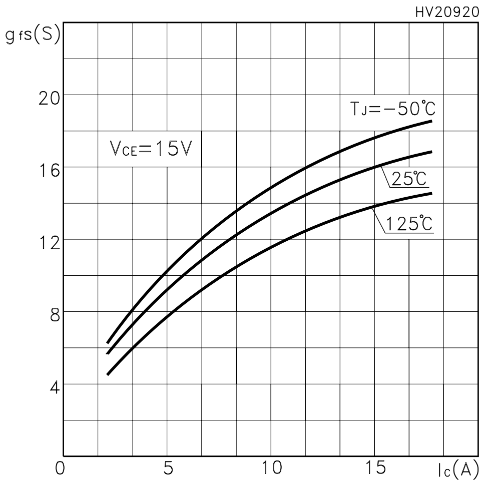


Figure 7: Collector-Emitter On Voltage vs Temperature

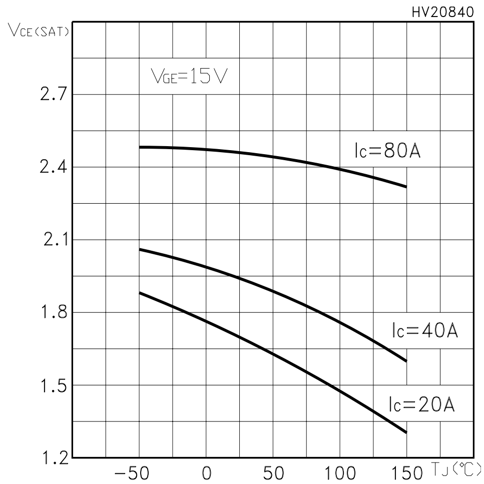


Figure 5: Collector-Emitter On Voltage vs Collector Current

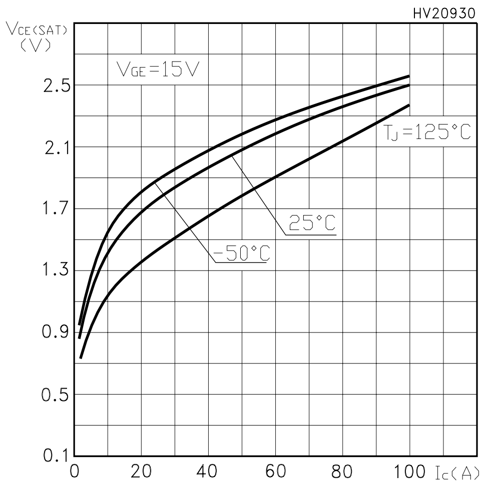


Figure 8: Normalized Gate Threshold vs Temperature

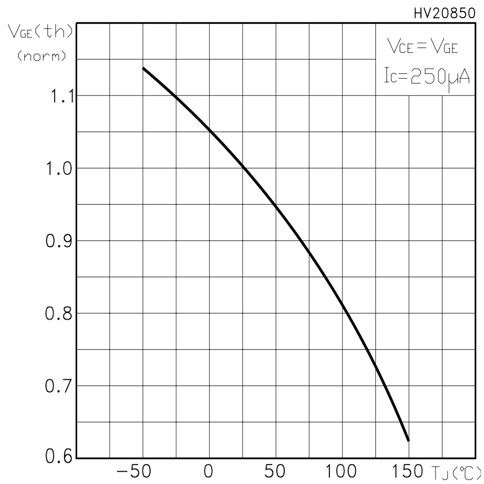


Figure 9: Normalized Breakdown Voltage vs Temperature

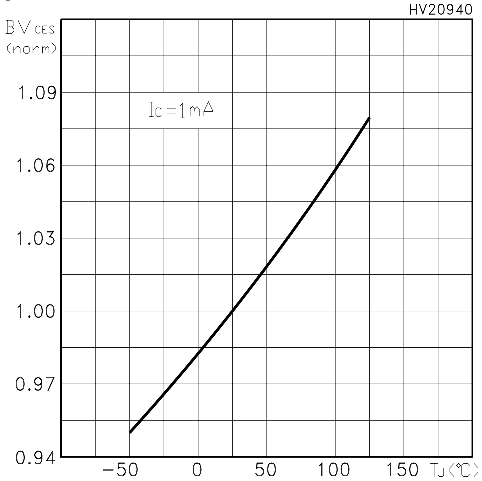


Figure 10: Capacitance Variations

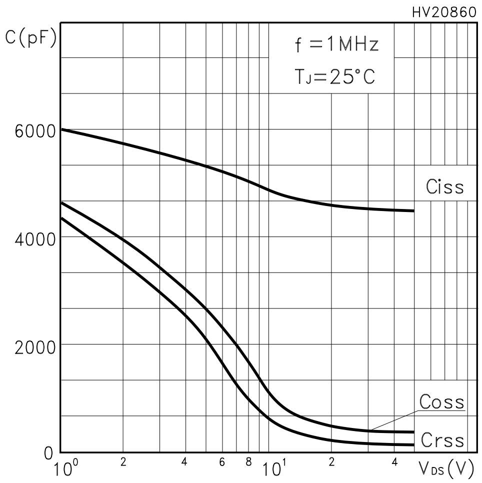


Figure 11: Total Switching Losses vs Gate Resistance

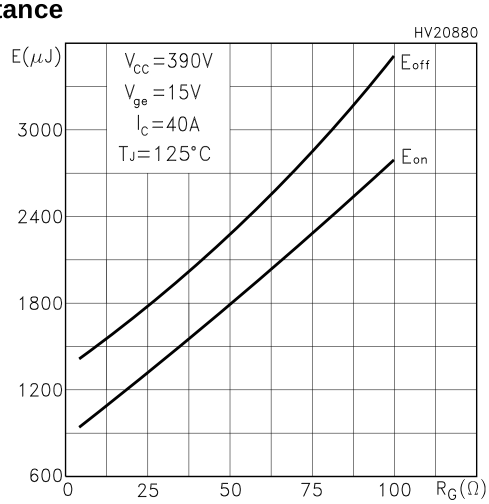


Figure 12: Gate Charge vs Gate-Emitter Voltage

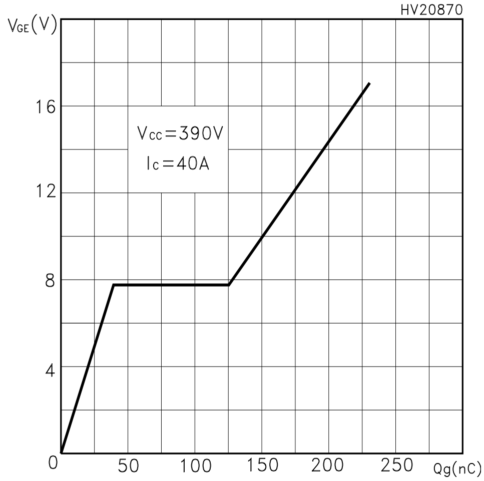


Figure 13: Total Switching Losses vs Temperature

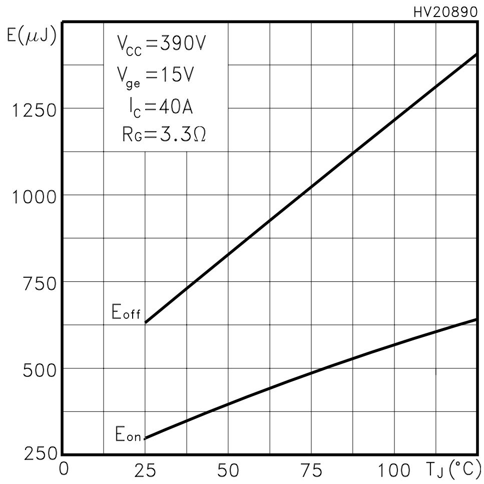


Figure 14: Total Switching Losses vs Collector Current

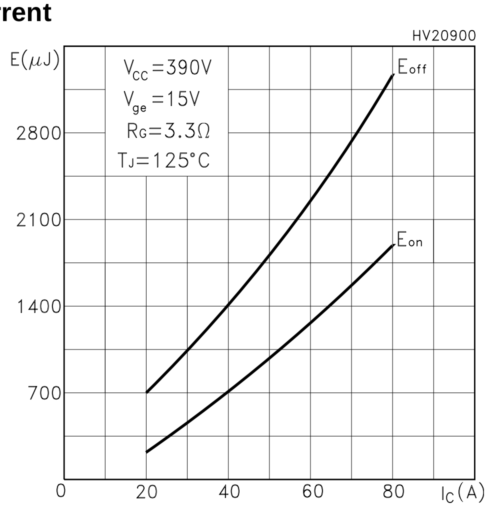


Figure 15: Thermal Impedance

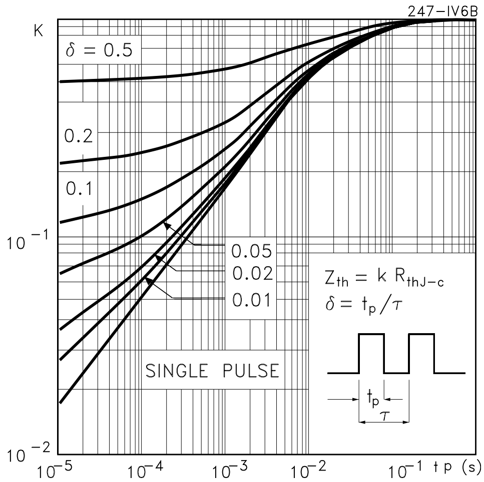


Figure 16: Turn-Off SOA

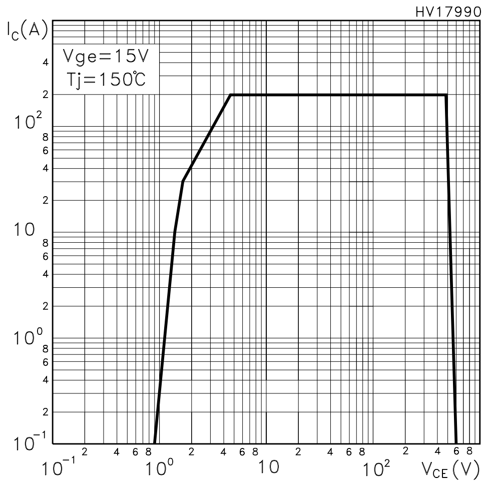


Figure 17: Emitter-Collector Diode Characteristics

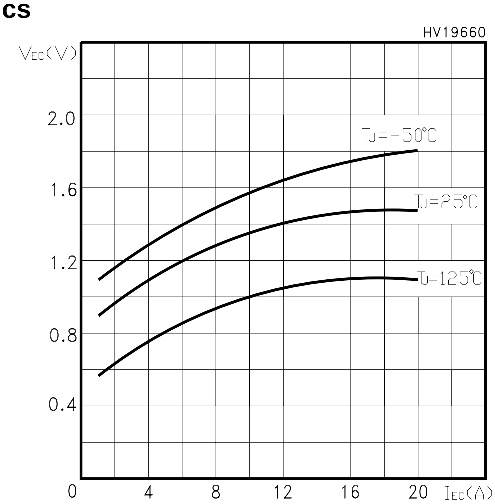
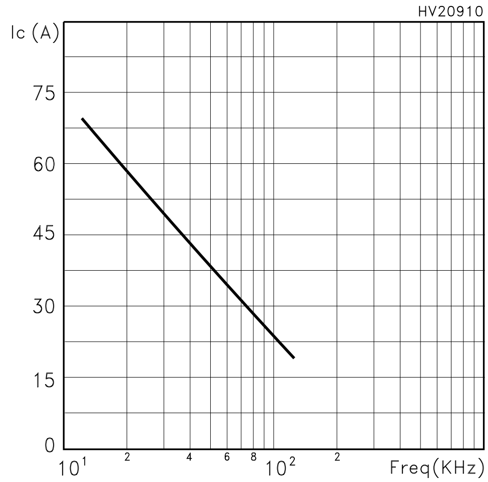


Figure 18: Ic vs Frequency



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:

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

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

2) The conduction losses are:

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

with 50% of duty cycle, V_{CESAT} typical value @125°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°C for switching losses are used (test conditions: V_{CE} = 390V, V_{GE} = 15V, R_G = 3.3 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 19: Test Circuit for Inductive Load Switching

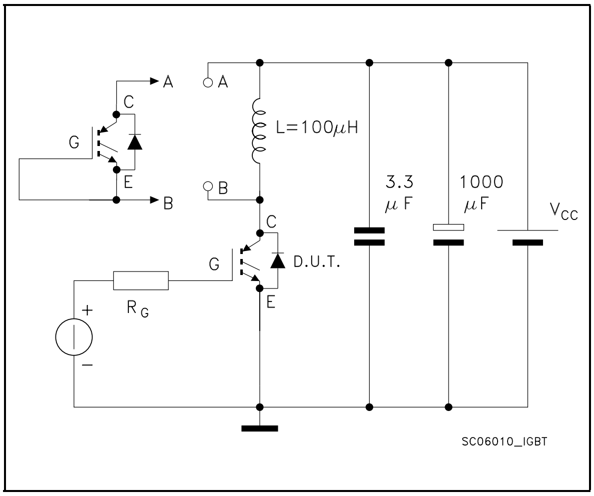


Figure 21: Gate Charge Test Circuit

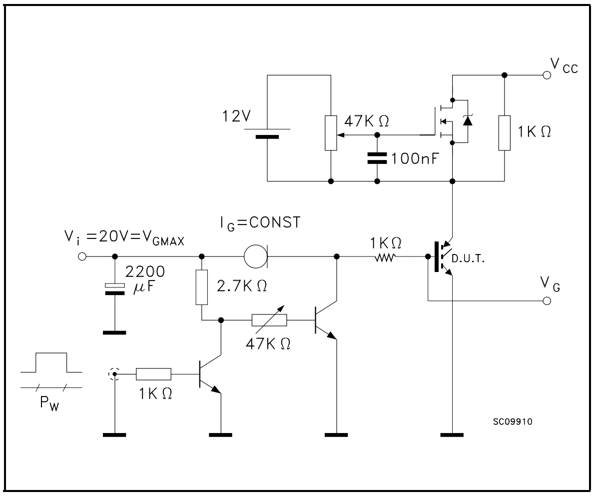


Figure 20: Switching Waveforms

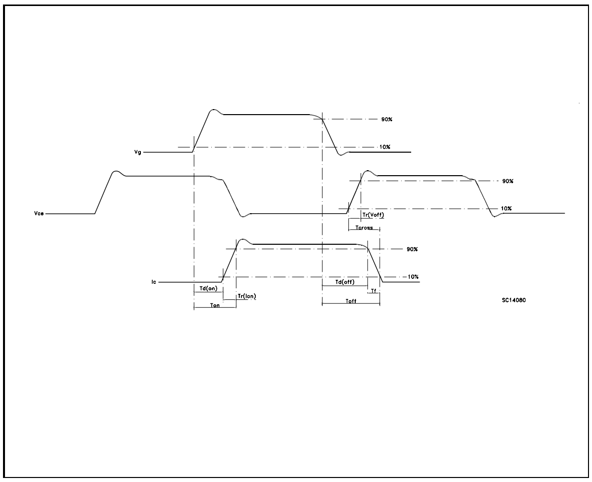


Figure 22: Diode Recovery Times Waveform

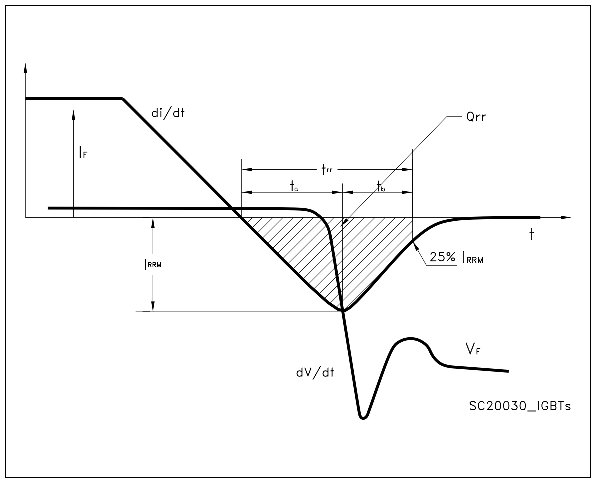


Table 11: Revision History

Date	Revision	Description of Changes
07-June-2004	7	Stylesheet update. Added Max Values see Table 8 and 9 Added Figure 22
14-Jul-2004	8	Figure 19 updated, some datas have been modified

Max247 MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.70		5.30			
A1	2.20		2.60			
b	1.00		1.40			
b1	2.00		2.40			
b2	3.00		3.40			
c	0.40		0.80			
D	19.70		20.30			
e	5.35		5.55			
E	15.30		15.90			
L	14.20		15.20			
L1	3.70		4.30