

T-39-15



Data Book No.91560A October 1991

"S" Series MOSIGBTs

High Short Circuit SOA Insulated Gate Bipolar Transistor

Features

- Guaranteed Short Circuit Capability (SCSOA)
- Optimized for 60Hz to 30kHz Switching
- Guaranteed Maximum Turn-off Energies
- Low Input Capacitances
- MOS Gate Drive Simplicity
- Low On-State Conduction Losses

Description

IGBTs combine the advantages of MOS gated drive simplicity with the high current handling capability of bipolar transistors. The "S" Series are a new class of ultra-rugged IGBTs that can survive overload and accidental short circuit currents for a guaranteed period of time. This allows the design of gating circuits that would detect these fault currents and turn-off the IGBT before device degradation.

The basic cell design characteristics of the MOSIGBT are very similar to power MOSFETs. The drive circuitry required to control up to 75A at 500V to 1000V is basically the same as a power MOSFET with 5000pF of input capacitance. During turn-on of the MOSIGBT, minority carrier injection into the N-base region modulates the body on-resistance to a level 10 to 20 times lower than an equivalently sized MOSFET, resulting in a proportionate 5 to 10 times increase in current handling capability. Minority carrier recombination during turn-off results in a current fall time t_f of 0.5-3.0μs

depending upon blocking voltage capability, similar to bipolar devices. Therefore the MOSIGBT is more suitable in low to medium frequency, high current, power switching applications ranging from 60Hz to 30kHz and where low conduction losses are essential.

The IXSH and IXSM family of high voltage MOSIGBT are members of an advanced series of N-Channel, power MOS products, which use HDMOS™, a proprietary vertical DMOS technology developed by IXYS. HDMOS™ is a planar, high density process, which incorporates new techniques to improve operating characteristics and stability at high voltages. This technology, combined with a unique polysilicon gate cell structure, gives the MOSIGBT a peak current capability of two times its 90°C current rating. This advantage makes the MOSIGBT ideal for many industrial and commercial applications in power conversion and motor control

Product Family

V _{CE} (V)	I _{C25} (cont) (A)	I _{C90} (cont) (A)	A ⁽¹⁾		STD		Part Number ⁽¹⁾	Page No.
			V _{CE(sat)} (V)	t _{fi} (μs)	V _{CE(sat)} (V)	t _{fi} (μs)		
1000	70	35	4.0	2.0	3.5	3.0	IXSH35N100/IXSM35N100	5
	50	25	4.0	1.5	3.5	3.0	IXSH25N100/IXSM25N100	9
	34	17	4.0	1.0	3.5	2.0	IXSH17N100/IXSM17N100	13
600	75	40	3.0	0.8	2.5	1.5	IXSH40N60 / IXSM40N60	15
	50	30	3.0	0.8	2.5	1.5	IXSH30N60 / IXSM30N60	19
	40	20	3.0	0.6	2.5	1.0	IXSH20N60 / IXSM20N60	23

IXYS reserves the right to change limits, test conditions, and dimensions without notice

⁽¹⁾ Note To specify the high speed "A" version add an "A" suffix to part number

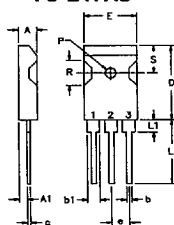
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9000-4233



Package Outlines & Pinouts

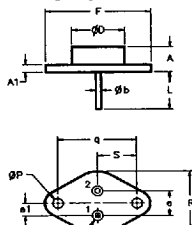
TO-247AD



PIN 1. GATE
2. COLLECTOR
3. EMITTER

Dim.	Millimeter	Inches
	Min.	Max.
A	4.70	5.30
E	4.32	5.49
D	20.80	21.45
L	15.49	16.26
L1	4.50	5.17
b1	1.65	2.13
b	1.02	1.40
c	3.33	5.59
L	16.81	20.32
A1	2.21	2.59
P	3.56	3.66

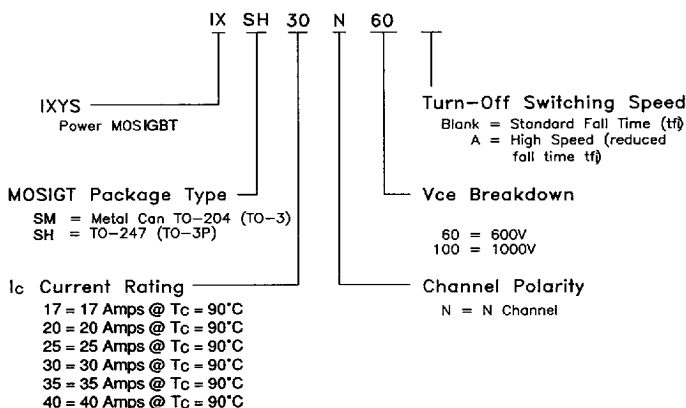
TO-204AE



PIN 1. GATE
2. EMITTER
CASE-COLLECTOR

Dim.	Millimeter	Inches
	Min.	Max.
F	38.35	39.37
A	6.35	11.43
L	1.45	1.80
A1	1.02	3.43
q	29.29	30.40
s	10.67	11.18
e1	5.21	5.72
S	16.64	17.15
L	11.18	12.19
GP	3.84	4.19
R	24.84	25.47
BU	2.54	3.69

PART NUMBER DESCRIPTION



"S" Series Advantages

A very important requirement imposed on the power switching device when used in motor control applications is that it be able to turn-off safely current due to a load or equipment short circuit. When a current overload occurs, collector current rises rapidly until it exceeds that which the device can sustain by the applied gate voltage (See Figure 1).

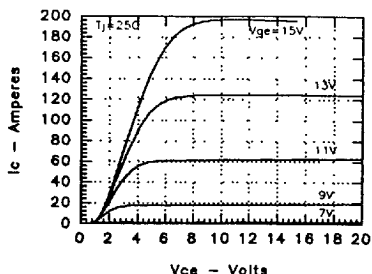


Figure 1: IGBT Output Characteristic

V_{ce} then rapidly rises until it reaches the full DC bus voltage. The key to survivability is for the power device to limit current amplitude to a safe level for a period of time that is sufficiently long for the control circuit to detect the fault and turn off the device.

The Short Circuit Capability of the "S" Series IGBTs is characterized by its Short Circuit Withstand Time t_{sc} . All members of this family have a rating of t_{sc} equal to 10 μ s, which has become an accepted industry standard. The circuit for an SCSOA tester is shown in Figure 2 with its typical test waveforms in Figure 3.

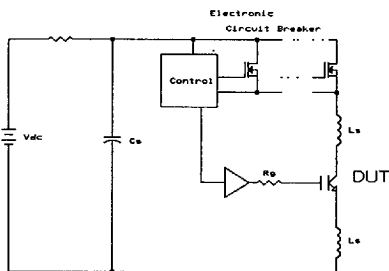


Figure 2: SCSOA Test Circuit

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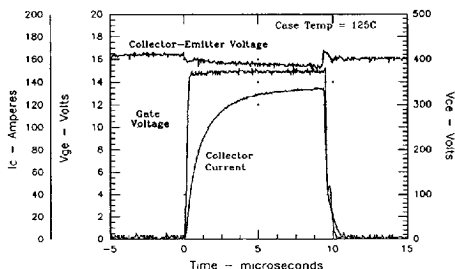


Figure 3: SCSOA Test Waveforms

The proposed JEDEC JC-25 "Short Circuit Withstand Time Test Method" stipulates that capacitor C_c must be large enough to limit V_{ce} voltage droop during the test to less than 10% of V_{ces} . IXYS tests SCSOA at 60% of V_{ces} and at a starting junction temperature of 125°C. The amount of voltage spiking during turn-off depends upon peak short-circuit current, stray inductance and the turn-off speed of the device. Consequently, a further test condition specifies that the peak voltage during turn-off cannot exceed 80% of V_{ces} .

It is also important to measure the peak let-through current of the IGBT in SCSOA testing, because this current plays an important role in the design of voltage transient suppressor circuits. The typical value of short circuit current, termed $I_{c(on)}$, now also appears in the Electrical Characteristic Tables.

The Importance of Cross-over Time t_c

IXYS continues its leadership in characterizing IGBTs by taking another step forward in specifying these parts for switching applications. Circuit designers need to know switching power losses in order to compute allowable currents in their particular application and the required heat sinking.

Figure 4 shows a typical circuit schematic for measuring switching times. The switching time definitions appear in Figure 5. While the measurement of switching times implicitly measures switching loss, there has been no explicit correlation of turn-off energy loss with switching times for IGBTs until now with the introduction of t_c specifications.

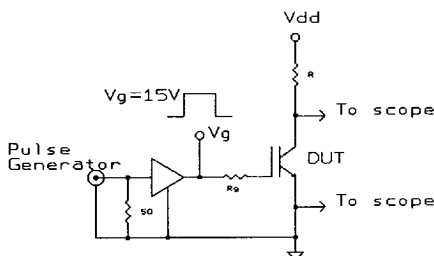


Figure 4: Switching Time Test Circuit

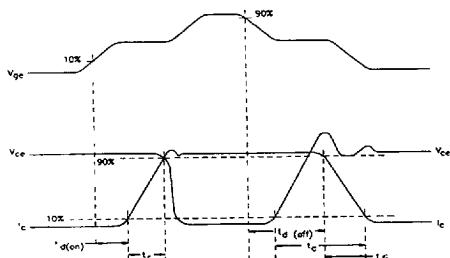


Figure 5: Switching Time Definitions

The turn-off switching energy losses, which normally predominate in IGBTs, are defined as:

$$W_{(off)} = \int t_c I_c(t) \cdot V_{ce}(t) \cdot dt$$

While there is currently a lack of fast, automated test equipment to measure $W_{(off)}$, it can be approximated by performing the integration over the time period t_c , where t_c is defined as the time from 10% of V_m rise to 90% of I_m fall, as shown in Figure 5. The period t_c has become known as "cross-over time." It also turns out that when the IGBT is operating at $T_j=125^\circ\text{C}$, the voltage and current waveforms are relatively linear so that $W_{(off)}$ can be simplified to the following:

$$W_{(off)} = \frac{V_m \cdot I_m \cdot t_c}{2}$$

Thus it can be seen that the hard-to-measure specification $W_{(off)}$ can now be guaranteed by measuring t_c . IXYS has added cross-over time to its data sheets and has instituted 100% testing of this parameter.

Design and Handling Considerations

Gating Considerations

Turn-on and turn-off delay times as well as VCE voltage rise during turn-off are dependent on the drive circuit impedance. While the IGBTs are tested with very low gate impedances as specified by the rating and characteristic tables, the user may find it advantageous to use a higher impedance drive circuit in order to reduce dV/dt and thereby also reduce EMI. In order to avoid EMI problems, it is good practice to limit dV/dt to less than 5V/ns. Stray gate inductance can lead to spurious oscillations during turn-off so that any loop inductance in the gate circuit must be minimized.

The gate threshold voltage of the S-series family is typically two volts higher than the G-series of IGBTs and require a 15V gate drive to assure full-current conduction. Consequently the substitution of an 'S' IGBT for a 'G' part may require an increase in the gate supply voltage.

Parasitic Diode

Unlike a MOSFET, an IGBT does not have a parasitic diode. A separate, fast reverse recovery diode must be connected emitter-collector to handle current flow in that direction. IXYS does offer discrete IGBTs and IGBT modules, which include this diode.

Gate Termination

Because the gate is essentially a capacitor, circuits that leave the gate open-circuited or floating can result in unwanted turn-on of the device or gate over-voltage damage. If gate drive impedance is high, it is frequently advisable to add an external Zener diode from gate-to-source to protect the gate.

Gate Protection and ESD

IXYS IGBTs do not have an internal Zener diode connected gate-to-source and can be damaged from static electricity discharge. Reasonable precautions in handling and packaging, similar to those required from MOS ICs, must be employed.



PRELIMINARY TECHNICAL INFORMATION*

Data Sheet No. 91545A

October 1991

HIGH VOLTAGE "S" Series MOSIGBT

Improved SCSOA Capability

FEATURES:

- Guaranteed Short Circuit SOA Capability
- Fast Fall Time for Switching Speeds up to 20kHz
- Low $V_{CE(sat)}$ for Low On-State Conduction Losses
- MOS Gate Turn-on Drive Simplicity

APPLICATIONS:

- Motor Control
- Uninterruptible Power Supplies
- Welding

MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit
Collector-Emitter Voltage (1)	V_{CES}	1000	V _{DC}
Collector-Gate Voltage ($R_{GE}=1\text{ } \Omega$) (1)	V_{CGR}	1000	V _{DC}
Gate- Emitter Voltage Continuous	V_{GES}	± 20	V _{DC}
Gate- Emitter Voltage Transient	V_{GEM}	± 30	V
Collector Current Continuous ($T_C=25^\circ\text{C}$)	I_{C25}	70	A _{DC}
($T_C=90^\circ\text{C}$)	I_{C90}	35	A _{DC}
Collector Current Pulsed (3)	I_{CM}	140	A
Short Circuit Withstand Time (5)	t_{SC}	10	μsec
Switching Safe Operating Area (6)	SSOA	70A @ 0.8 X V_{CES}	—
Total Power Dissipation	P_G	300	W
Power Dissipation Derating ($T_C>25^\circ\text{C}$)		2.4	W/ $^\circ\text{C}$
Operating and Storage Temperature	T_J & T_{STG}	-55 to $+150$	$^\circ\text{C}$
Thermal Resistance	$R_{\theta JC}$	0.42	$^\circ\text{C/W}$
Thermal Resistance	$R_{\theta CS}$	0.25 (typ)	$^\circ\text{C/W}$
Max Lead Temp for Soldering	T_L	300 (1.6mm for 10 sec)	$^\circ\text{C}$
Mounting Torque	M_M	10	in-lb

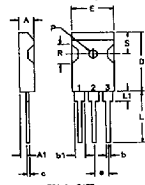
* The data supplied herein reflects the pre-production objective specification and characterization from Engineering lots. IXYS reserves the right to change limits, test conditions, and dimensions without notice.

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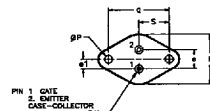
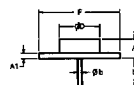
IXSH35N100, 100A**IXSM35N100, 100A**

Part Number	V_{CES}	I_{C25}	$V_{CE(sat)}$
35N100	1000V	70A	3.5 V
35N100A			4.0 V

T0-247AD (IXSH)

PN 1 GATE
2 COLLECTOR
3 EMITTER

Dim.	Millimeter	Inches
A	4.70	0.185
B	4.30	0.169
C	20.90	0.823
D	5.4	0.213
E	15.49	0.610
F	4.50	0.177
G	1.85	0.073
H	2.00	0.079
I	1.02	0.040
J	5.33	0.210
K	10.81	0.425
L	2.21	0.087
M	0.41	0.016
N	3.56	0.140

T0-204AE (IXSM)

PN 1 GATE
2 EMITTER
3 CASE-COLLECTOR

Dim.	Millimeter	Inches
A	30.35	1.21
B	20.18	0.795
C	6.35	0.250
D	4.25	0.167
E	1.52	0.060
F	28.29	1.113
G	10.67	0.420
H	2.21	0.087
I	10.81	0.425
J	11.18	0.440
K	2.54	0.100
L	2.54	0.100

IXSH35N100, 100A
IXSM35N100, 100A
ELECTRICAL CHARACTERISTICS ($T_C=25^\circ\text{C}$ unless otherwise specified)

CHARACTERISTIC	TEST CONDITION	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage (1)	$I_C=3\text{mA}$, $V_{GE}=0\text{V}$	BV_{CES}	1000	—	—	V
Gate-Emitter Threshold Voltage	$I_C=4\text{mA}$, $V_{CE}=V_{GE}$	$V_{GE(TH)}$	4	—	7	V
Gate-Emitter Leakage Current	$V_{GE}=\pm 20\text{V}$, $V_{CE}=0\text{V}$	I_{GES}	—	—	± 100	nA
Collector Leakage Current	$V_{CE}=0.8 \times V_{CES}$, $V_{GE}=0\text{V}$	I_{CES}	$T_C=25^\circ\text{C}$		250	μA
			$T_C=125^\circ\text{C}$		1	mA
Collector-Emitter Saturation Voltage	$I_C=I_{C90}$, $V_{GE}=15\text{V}$	$V_{CE(sat)}$	35N100		3.5	V
			35N100A		4.0	V
Forward Transconductance (2)	$I_C=I_{C90}$, $V_{CE}=10\text{V}$	g_{fs}	20	25	—	S
Short Circuit Current	$V_{GE}=15\text{V}$, $V_{CE}=10\text{V}$	$I_{C(on)}$	—	240	—	A
Input Capacitance	$V_{CE}=25\text{V}$, $V_{GE}=0\text{V}$, $f=1\text{MHz}$	C_{iss}	—	4400	—	pF
Output Capacitance		C_{oss}	—	325	—	pF
Reverse Transfer Capacitance		C_{res}	—	85	—	pF
Total Gate Charge	$V_{GE}=15\text{V}$, $I_C=I_{C90}$, $V_{CE}=0.5 \times V_{CES}$	$Q_{g(on)}$	—	180	260	nC
Gate-Emitter Charge		Q_{ge}	—	45	60	nC
Gate-Collector ("Miller") Charge		Q_{gc}	—	120	200	nC

SWITCHING CHARACTERISTICS

CHARACTERISTIC	TEST CONDITION	SYMBOL	MIN	TYP	MAX	UNIT	
Turn-On Delay Time	Resistive Load $I_C=I_{C90}$, $T_J=125^{\circ}\text{C}$, $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=2.7\Omega$	$t_{d(on)}$	—	80	—	ns	
Current Rise Time		t_r	—	150	—	ns	
Current Fall Time	Inductive Load $L=100\mu\text{H}$, $I_C=I_{C90}$, $T_J=25^{\circ}\text{C}$, $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=2.7\Omega$ (4)	35N100	t_{fs}	—	400	ns	
		35N100A	t_{fi}	—	200	—	ns
Turn-Off Energy	Inductive Load	35N100	$W_{(off)}$	—	6	mJ	
		35N100A	$W_{(off)}$	—	3	—	mJ
Turn-Off Delay Time	Inductive Load	35N100	$t_{d(off)}$	—	200	550	ns
		35N100A	$t_{d(off)}$	—	200	550	ns
Current Fall Time	$L=100\mu\text{H}$, $I_C=I_{C90}$, $T_J=125^{\circ}\text{C}$, $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=2.7\Omega$ (4)	35N100	t_{fi}	—	2000	3000	ns
		35N100A	t_{fi}	—	1000	2000	ns
Cross-Over Time	$R_G=2.7\Omega$ (4)	35N100A	t_c	—	1100	2200	ns
		35N100	$W_{(off)}$	—	34	—	mJ
Turn-Off Energy		35N100A	$W_{(off)}$	—	15	31	mJ

(1) $T_J=25^\circ\text{C}$ to 150°C (2) Pulse Test: Pulse width $\leq 300\mu\text{s}$, duty cycle $\leq 2\%$

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

(4) Switching times may increase for $V_{CE}(\text{Clamp}) > 0.8 \times V_{CES}$, $T_J=125^\circ\text{C}$ or $R_G > 2.7\Omega$ (5) Non-Repetitive Rating $T_C=125^\circ\text{C}$, $V_{CC}=600\text{V}$, $V_{GE}=15\text{V}$, $R_G=2.7\Omega$ (6) Turn-Off SSOA (or RBSOA), $T_C=125^\circ\text{C}$, $V_{GE}=15\text{V}$, Clamped Inductive Load, $L=30\mu\text{H}$, $R_G=2.7\Omega$



IXSH35N100 IXSM35N100

Fig. 1. Saturation Characteristics

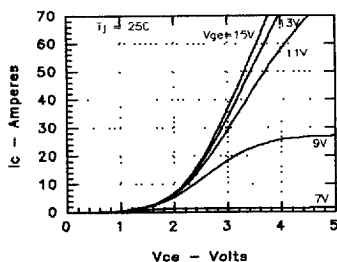


Fig. 2. Output Characteristics

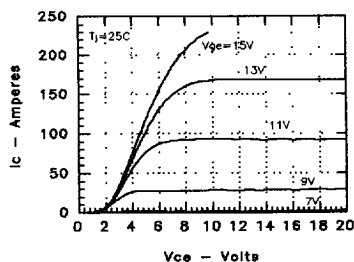


Fig. 3. Collector-Emitter Voltage vs. Gate-Emitter Voltage

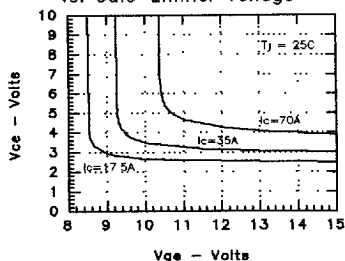


Fig. 4. Temperature Dependence of Output Saturation Voltage

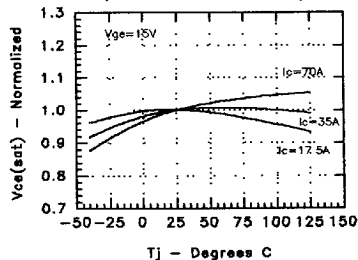


Fig. 5. Input Admittance

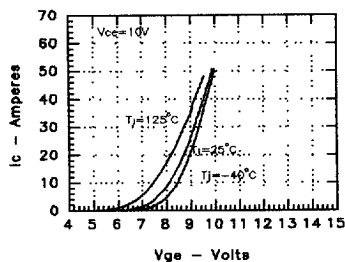
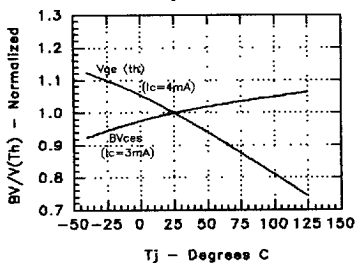


Fig. 6. Temperature Dependence of Breakdown Voltage and Threshold Voltage





IXSH35N100 IXSM35N100

Fig. 7. Dependence of Turn-Off Energy Per Pulse and Fall Time on Collector Current

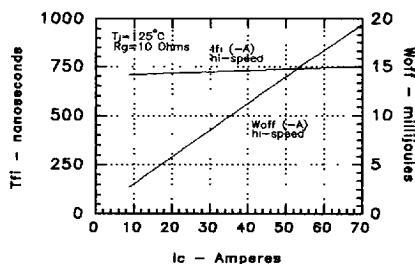
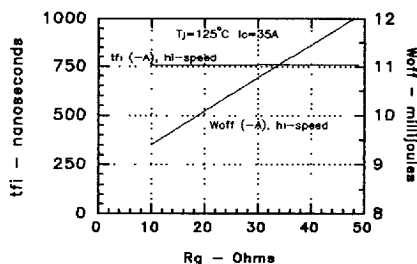
Fig. 8. Dependence of Turn-Off Energy Per Pulse and Fall Time on R_g 

Fig. 9. Gate Charge Characteristic Curve

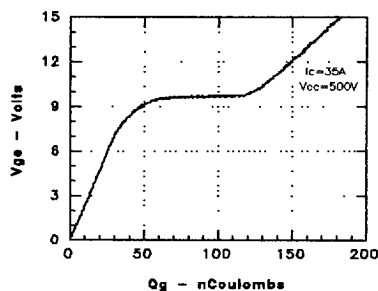


Fig. 10. Turn-Off Safe Operating Area

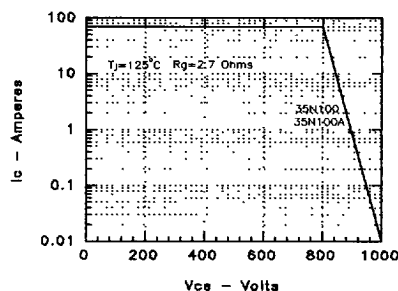
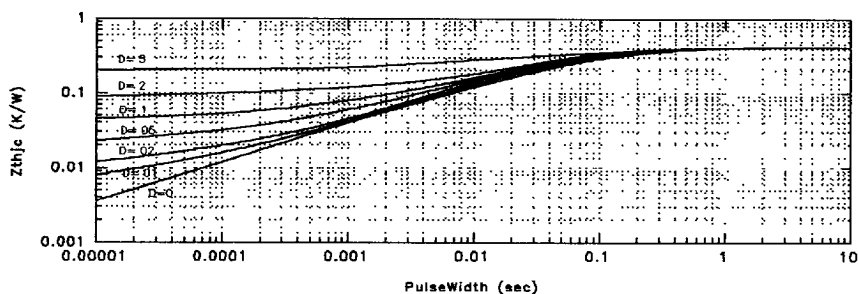


Fig. 11. Transient Thermal Impedance





PRELIMINARY TECHNICAL INFORMATION*

Data Sheet No. 91548A

October 1991

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MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit
Collector-Emitter Voltage (1)	V_{CES}	1000	V _{DC}
Collector-Gate Voltage ($R_{GE}=1.0M\Omega$) (1)	V_{CGR}	1000	V _{DC}
Gate-Emitter Voltage Continuous	V_{GES}	± 20	V _{DC}
Gate-Emitter Voltage Transient	V_{GEM}	± 30	V
Collector Current Continuous ($T_C=25^\circ C$)	I_{C25}	50	A _{DC}
($T_C=90^\circ C$)	I_{C90}	25	A _{DC}
Collector Current Pulsed (3)	I_{CM}	100	A
Short Circuit Withstand Time (5)	t_{SC}	10	μsec
Switching Safe Operating Area (6)	SSOA	50A @ 0.8 X V_{CES}	—
Total Power Dissipation	P_C	200	W
Power Dissipation Derating ($T_C>25^\circ C$)		1.67	W/ $^\circ C$
Operating and Storage Temperature	T_J & T_{STG}	-55 to $+150$	$^\circ C$
Thermal Resistance	R_{thJC}	0.625	$^\circ C/W$
Thermal Resistance	R_{thCS}	0.25 (typ)	$^\circ C/W$
Max. Lead Temp. for Soldering	T_L	300 (1.6mm for 10 sec)	$^\circ C$
Mounting Torque	M_M	10	in-lb

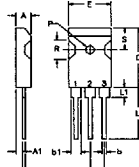
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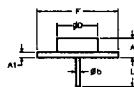
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IXSH25N100, 100A**IXSM25N100, 100A**

Part Number	V_{CES}	I_{C25}	$V_{CE(sat)}$
25N100	1000V	50A	3.5 V
25N100A			4.0 V

TO-247AD (IXSH)PIN 1: GATE
2: COLLECTOR
3: EMITTER

Dim.	Millimeter	Max.	Min.	Max.	Min.
A	4.70	5.30	165	908	
B	5.32	5.48	170	918	
C	20.60	21.48		845	
D	5.4	6.2	232	262	
E	15.48	16.28	810	840	
F	—	4.90	—	177	
G	1.68	2.13	685	684	
H	2.87	3.18	113	122	
I	1.05	1.40	260	262	
J	5.33	5.99	210	220	
K	19.81	20.37	780	800	
L	2.21	2.29	687	102	
M	0.41	79	218	531	
N	3.58	3.68	140	141	

TO-204AE (IXSM)PIN 1: GATE
2: EMITTER
3: COLLECTOR

Dim.	Millimeter	Max.	Min.	Max.	Min.
F	38.35	39.37	1.51	1.55	
G	20.18	19.84	220	225	
H	8.35	11.42	280	450	
J	1.45	1.60	587	585	
K	1.32	3.43	260	130	
L	20.28	20.40	1,177	1,171	
M	10.52	11.18	420	440	
N	5.21	5.72	205	222	
O	14.84	17.15	855	875	
P	11.15	13.15	440	450	
Q	3.84	4.18	151	155	
R	14.66	25.27	818	565	
S	2.54	3.89	100	145	

IXSH25N100, 100A
IXSM25N100, 100A
ELECTRICAL CHARACTERISTICS ($T_C=25^\circ\text{C}$ unless otherwise specified)

CHARACTERISTIC	TEST CONDITION	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage	$I_C=3\text{mA}$, $V_{GE}=0\text{V}$	BV_{CES}	1000	—	—	V
Gate-Emitter Threshold Voltage	$I_C=2.5\text{mA}$, $V_{GE}=V_{CE}$	$V_{GE(th)}$	4	—	7	V
Gate-Emitter Leakage Current	$V_{GE}=\pm 20\text{V}$, $V_{CE}=0\text{V}$	I_{GES}	—	—	± 100	nA
Collector Leakage Current	$V_{CE}=0.8 \times V_{CES}$, $V_{GE}=0\text{V}$	$T_C=25^\circ\text{C}$	—	—	250	μA
		$T_C=125^\circ\text{C}$	—	—	1	mA
Collector-Emitter Saturation Voltage	$I_C=I_{CS0}$, $V_{GE}=15\text{V}$	25N100	—	—	3.5	V
		25N100A	—	—	4.0	V
Forward Transconductance (2)	$I_C=I_{CS0}$, $V_{CE}=10\text{V}$	g_{fs}	10	17	—	S
Short Circuit Current	$V_{GE}=15\text{V}$, $V_{CE}=10\text{V}$	$I_{C(on)}$	—	140	—	A
Input Capacitance	$V_{CE}=25\text{V}$, $V_{GE}=0\text{V}$, $f=1\text{MHz}$	C_{iss}	—	2850	—	pF
Output Capacitance		C_{oss}	—	210	—	pF
Reverse Transfer Capacitance		C_{res}	—	50	—	pF
Total Gate Charge	$V_{GE}=15\text{V}$, $I_C=I_{CS0}$, $V_{CE}=0.5 \times V_{CES}$	$Q_{g(on)}$	—	112	130	nC
Gate-Emitter Charge		Q_{ge}	—	28	40	nC
Gate-Collector ("Miller") Charge		Q_{gc}	—	50	75	nC

SWITCHING CHARACTERISTICS

CHARACTERISTIC	TEST CONDITION	SYMBOL	MIN	TYP	MAX	UNIT
Turn-On Delay Time	Resistive Load $I_C=I_{CS0}$, $T_J=125^\circ\text{C}$, $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=4.7\Omega$	$t_{d(on)}$	—	70	—	ns
Current Rise Time		t_r	—	580	—	ns
Current Fall Time	Inductive Load $L=100\mu\text{H}$, $I_C=I_{CS0}$, $T_J=25^\circ\text{C}$, $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=4.7\Omega$ (4)	25N100 t_{fi}	—	400	—	ns
Turn-Off Energy		25N100A t_{fi}	—	200	—	ns
Turn-Off Delay Time	Inductive Load $L=100\mu\text{H}$, $I_C=I_{CS0}$, $T_J=125^\circ\text{C}$, $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=4.7\Omega$ (4)	25N100 $W_{(off)}$	—	4.5	—	mJ
		25N100A $W_{(off)}$	—	2.5	—	mJ
Current Fall Time	Inductive Load $L=100\mu\text{H}$, $I_C=I_{CS0}$, $T_J=125^\circ\text{C}$, $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=4.7\Omega$ (4)	25N100 $t_{d(off)}$	—	110	550	ns
		25N100A $t_{d(off)}$	—	110	550	ns
Cross-Over Time	Inductive Load $L=100\mu\text{H}$, $I_C=I_{CS0}$, $T_J=125^\circ\text{C}$, $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=4.7\Omega$ (4)	25N100 t_{tr}	—	1300	3000	ns
		25N100A t_{tr}	—	—	1500	ns
Turn-Off Energy	Inductive Load $L=100\mu\text{H}$, $I_C=I_{CS0}$, $T_J=125^\circ\text{C}$, $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=4.7\Omega$ (4)	25N100 t_c	—	1500	—	ns
		25N100A t_c	—	1100	—	ns
Turn-Off Energy	Inductive Load $L=100\mu\text{H}$, $I_C=I_{CS0}$, $T_J=125^\circ\text{C}$, $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=4.7\Omega$ (4)	25N100 $W_{(off)}$	—	15	—	mJ
		25N100A $W_{(off)}$	—	11	—	ns

(1) $T_J=25^\circ\text{C}$ to 150°C (2) Pulse Test Pulse width $\leq 300\mu\text{s}$, duty cycle $\leq 2\%$

(3) Repetitive Rating Pulse width limited by max junction temperature

(4) Switching times may increase for $V_{CE}(\text{Clamp}) > 0.8 \times V_{CES}$, $T_J=125^\circ\text{C}$ or $R_G \geq 4.7\Omega$ (5) Non-Repetitive Rating $T_C=125^\circ\text{C}$, $V_{CC}=600\text{V}$, $V_{GE}=15\text{V}$, $R_G=4.7\Omega$ (6) Turn-Off SSOA (or RBSOA), $T_C=125^\circ\text{C}$, $V_{GE}=15\text{V}$, Clamped Inductive Load, $L=30\mu\text{H}$, $R_G=4.7\Omega$



IXSH25N100 IXSM25N100

Fig. 1. Saturation Characteristics

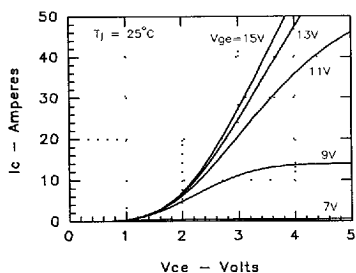


Fig. 2. Output Characteristics

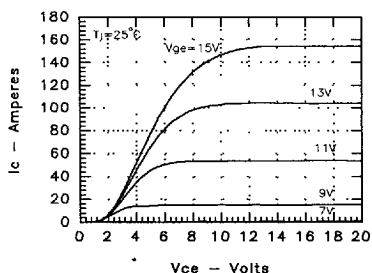


Fig. 3. Collector-Emitter Voltage vs. Gate-Emitter Voltage

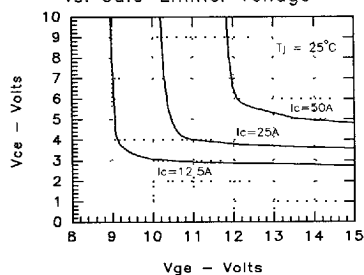


Fig. 4. Temperature Dependence of Output Saturation Voltage

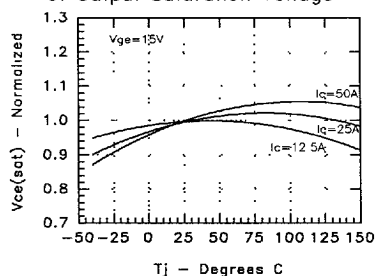


Fig. 5. Input Admittance

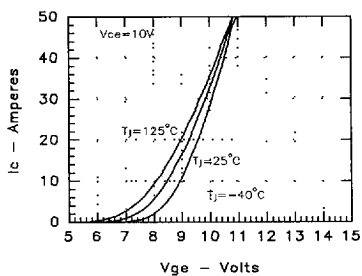


Fig. 6. Temperature Dependence of Breakdown Voltage and Threshold Voltage

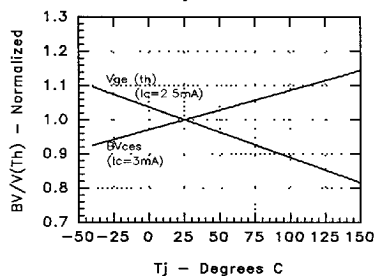




Fig. 7. Dependence of Turn-Off Energy per Pulse and Fall Time on Collector Current

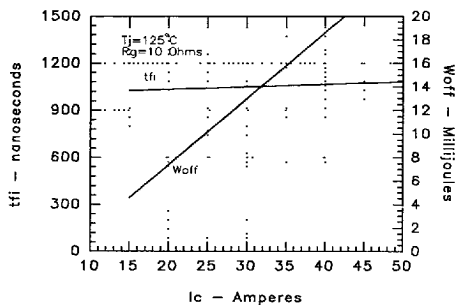
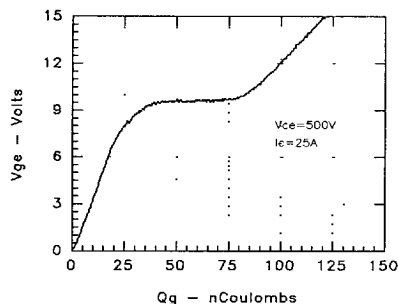


Fig. 9. Gate Charge Characteristic Curve



IXSH25N100 IXSM25N100

Fig. 8. Dependence of Turn-Off Energy Per Pulse and Fall Time on Rg

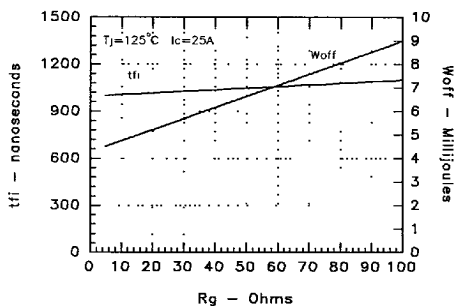


Fig. 10. Turn-Off Safe Operating Area

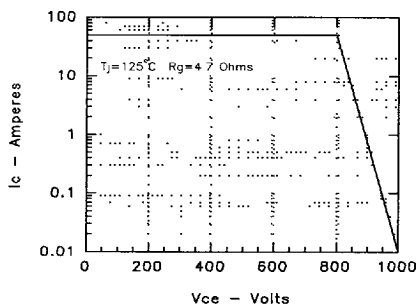
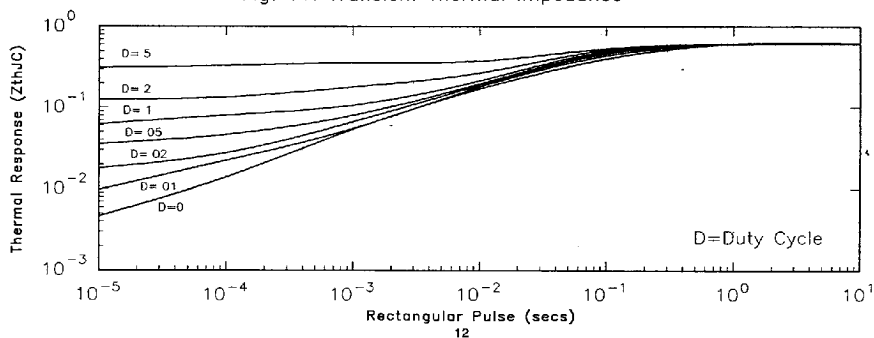


Fig. 11. Transient Thermal Impedance





ADVANCE TECHNICAL INFORMATION*

Data Sheet No. 91550A

October 1991

HIGH VOLTAGE "S" Series MOSIGBT

Improved SCSOA Capability

FEATURES:

- Guaranteed Short Circuit SOA Capability
- Fast Fall Time for Switching Speeds up to 20kHz
- Low $V_{CE(sat)}$ for Low On-State Conduction Losses
- MOS Gate Turn-on Drive Simplicity

APPLICATIONS:

- Motor Control
- Uninterruptible Power Supplies
- Welding

MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit
Collector-Emitter Voltage (1)	V_{CES}	1000	V _{DC}
Collector-Gate Voltage($R_{GE}=1.0M\Omega$) (1)	V_{CGR}	1000	V _{DC}
Gate-Emitter Voltage Continuous	V_{GES}	± 20	V _{DC}
Gate-Emitter Voltage Transient	V_{GET}	± 30	V
Collector Current Continuous ($T_C=25^\circ C$)	I_{C25}	34	A _{DC}
($T_C=90^\circ C$)	I_{C90}	17	A _{DC}
Collector Current Pulsed (3)	I_{CM}	68	A
Short Circuit Withstand Time (5)	t_{SC}	10	μsec
Switching Safe Operating Area (6)	SSOA	34A @ 0.8 X V_{CES}	—
Total Power Dissipation	P_C	150	W
Power Dissipation Derating ($T_C > 25^\circ C$)		1.2	W/ $^\circ C$
Operating and Storage Temperature	T_J & T_{STG}	-55 to +150	$^\circ C$
Thermal Resistance	$R_{\theta JC}$	0.83	$^\circ C/W$
Thermal Resistance	$R_{\theta CS}$	0.25 (typ)	$^\circ C/W$
Max. Lead Temp. for Soldering	T_L	300 (1.6mm for 10 sec)	$^\circ C$
Mounting Torque	M_M	10	in-lb

*The data supplied herein reflects the Design Technical Objective Specification. The subject products are in Product Development. IXYS reserves the right to change limits, test conditions, and dimensions without notice.

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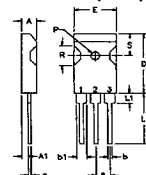
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IXSH17N100, 100A

IXSM17N100, 100A

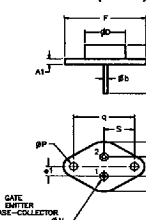
Part Number	V_{CES}	I_{C25}	$V_{CE(SAT)}$
17N100	1000V	34A	3.5 V
17N100A			4.0 V

TO-247AD (IXSH)



Dim.	Millimeter	Inches
A	4.70 2.30 188 208	
B	4.25 3.48 170 218	
C	10.80 21.48 418 445	
D	9.4 8.2 232 252	
E	15.48 18.50 810 440	
F	1.65 2.13 285 284	
G	2.67 2.13 113 133	
H	1.02 1.40 340 350	
I	5.33 5.89 210 220	
J	18.81 20.32 780 800	
K	2.21 2.89 287 102	
L	2.41 2.9 216 231	
M	3.58 3.68 140 144	

TO-204AE (IXSM)



Dim.	Millimeter	Inches
A	38.35 38.37 1.51 1.58	
B	18.18 18.24 0.75 0.76	
C	6.35 11.43 0.25 0.45	
D	1.42 1.46 0.07 0.08	
E	1.52 2.42 0.06 0.10	
F	28.29 30.40 1.12 1.21	
G	10.87 11.18 0.43 0.44	
H	5.21 5.72 0.20 0.23	
I	16.84 17.15 0.66 0.67	
J	11.18 12.18 0.44 0.48	
K	3.84 4.19 0.15 0.16	
L	24.86 25.47 0.98 0.99	
M	2.54 3.59 0.10 0.14	

IXSH17N100, 100A
IXSM17N100, 100AELECTRICAL CHARACTERISTICS ($T_C=25^\circ\text{C}$ unless otherwise specified)

CHARACTERISTIC	TEST CONDITION	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage	$I_C=3\text{mA}$, $V_{GE}=0\text{V}$	BV_{CES}	1000	—	—	V
Gate-Emitter Threshold Voltage	$I_C=1.5\text{mA}$, $V_{CE}=V_{GE}$	$V_{GE(th)}$	4	—	7	V
Gate-Emitter Leakage Current	$V_{GE}=\pm 20\text{V}$, $V_{CE}=0\text{V}$	I_{GES}	—	—	± 100	nA
Collector Leakage Current	$V_{CE}=0.8 \times V_{CES}$, $V_{GE}=0\text{V}$	$T_C=25^\circ\text{C}$	—	—	250	μA
		$T_C=125^\circ\text{C}$	—	—	1	mA
Collector-Emitter Saturation Voltage	$I_C=I_{CS0}$, $V_{GE}=15\text{V}$	17N100	—	—	3.5	V
		17N100A	—	—	4.0	V
Forward Transconductance (2)	$I_C=I_{CS0}$, $V_{CE}=10\text{V}$	g_{fs}	6	—	—	S
Short Circuit Current	$V_{GE}=15\text{V}$, $V_{CE}=10\text{V}$	$I_{C(on)}$	—	65	—	A
Input Capacitance	$V_{CE}=25\text{V}$, $V_{GE}=0\text{V}$, $f=1\text{MHz}$	C_{iss}	—	1800	—	pF
Output Capacitance		C_{oss}	—	160	—	pF
Reverse Transfer Capacitance		C_{res}	—	45	—	pF
Total Gate Charge	$V_{GE}=15\text{V}$, $I_C=I_{CS0}$, $V_{CE}=0.5 \times V_{CES}$	$Q_{g(on)}$	—	75	—	nC
Gate-Emitter Charge		Q_{ge}	—	20	—	nC
Gate-Collector ("Miller") Charge		Q_{gc}	—	35	—	nC

SWITCHING CHARACTERISTICS

CHARACTERISTIC	TEST CONDITION	SYMBOL	MIN	TYP	MAX	UNIT
Turn-On Delay Time	Resistive Load $I_C=I_{CS0}$, $T_J=125^\circ\text{C}$, $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=10\Omega$	$t_{d(on)}$	—	80	—	ns
Current Rise Time		t_r	—	150	—	ns
Current Fall Time	Inductive Load $L=100\mu\text{H}$, $I_C=I_{CS0}$, $T_J=25^\circ\text{C}$, $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=10\Omega$ (4)	17N100	t_{fi}	—	400	ns
		17N100A	t_{fi}	—	200	ns
Turn-Off Energy		17N100	$W_{f(off)}$	—	3.5	mJ
		17N100A	$W_{f(off)}$	—	2	mJ
Turn-Off Delay Time	Inductive Load	17N100	$t_{d(off)}$	—	550	ns
		17N100A	$t_{d(off)}$	—	550	ns
Current Fall Time	$L=100\mu\text{H}$, $I_C=I_{CS0}$, $T_J=125^\circ\text{C}$, $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=10\Omega$ (4)	17N100	t_{fi}	—	2000	ns
		17N100A	t_{fi}	—	1000	ns
Cross-Over Time		17N100	t_c	—	2300	ns
		17N100A	t_c	—	1100	ns
Turn-Off Energy		17N100	$W_{f(off)}$	—	17	mJ
		17N100A	$W_{f(off)}$	—	8	mJ

(1) $T_J=25^\circ\text{C}$ to 150°C (2) Pulse Test: Pulse width $\leq 300\mu\text{s}$, duty cycle $\leq 2\%$

(3) Repetitive Rating, Pulse width limited by max. junction temperature

(4) Switching times may increase for $V_{CE}(\text{Clamp}) > 0.8 \times V_{CES}$, $T_J > 125^\circ\text{C}$ or $R_G > 10\Omega$ (5) Non-Repetitive Rating, $T_C=125^\circ\text{C}$, $V_{CC}=600\text{V}$, $V_{GE}=15\text{V}$, $R_G=10\Omega$ (6) Turn-Off SSOA (or RBSOA), $T_C=125^\circ\text{C}$, $V_{GE}=15\text{V}$, Clamped Inductive Load, $L=100\mu\text{H}$, $R_G=10\Omega$



PRELIMINARY TECHNICAL INFORMATION*

Data Sheet No. 91546A

October 1991

HIGH VOLTAGE "S" Series MOSIGBT

Improved SCSOA Capability

FEATURES:

- Guaranteed Short Circuit SOA Capability
- Fast Fall Time for Switching Speeds up to 30kHz
- Low $V_{CE(sat)}$ for Low On-State Conduction Losses
- MOS Gate Turn-on Drive Simplicity

APPLICATIONS:

- Motor Control
- Uninterruptible Power Supplies
- Welding

MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit
Collector-Emitter Voltage (1)	V_{CES}	600	V _{DC}
Collector-Gate Voltage ($R_{GE}=1\text{ M}\Omega$) (1)	V_{CGR}	600	V _{DC}
Gate-Emitter Voltage Continuous	V_{GES}	± 20	V _{DC}
Gate-Emitter Voltage Transient	V_{GEM}	± 30	V
Collector Current Continuous ($T_C=25^\circ\text{C}$)	I_{C25}	75	A _{DC}
($T_C=90^\circ\text{C}$)	I_{C90}	40	A _{DC}
Collector Current Pulsed (3)	I_{CM}	150	A
Short Circuit Withstand Time (5)	t_{SC}	10	μsec
Switching Safe Operating Area (6)	SSOA	80A @ 0.8 X V_{CES}	—
Total Power Dissipation	P_C	300	W
Power Dissipation Derating ($T_C>25^\circ\text{C}$)		2.4	W/ $^\circ\text{C}$
Operating and Storage Temperature	T_J & T_{STG}	-55 to $+150$	$^\circ\text{C}$
Thermal Resistance	R_{thJC}	0.42	$^\circ\text{C}/\text{W}$
Thermal Resistance	R_{thCS}	0.25 (typ)	$^\circ\text{C}/\text{W}$
Max. Lead Temp for Soldering	T_L	300 (1.6mm for 10 sec)	$^\circ\text{C}$
Mounting Torque	M_M	10	in-lb

* The data supplied herein reflects the pre-production specification and characterization measurements from Engineering lots. IXYS reserves the right to change limits, test conditions, and dimensions without notice.

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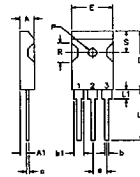
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IXSH40N60, 60A

IXSM40N60, 60A

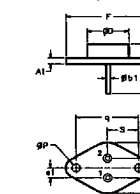
Part Number	V_{CES}	I_{C25}	$V_{CE(sat)}$
40N60	600V	75A	2.5 V
40N60A			3.0 V

TO-247AD (IXSH)



Dim.	Min.	Max.	Min.	Max.
A	4.70	5.30	183	200
B	4.32	5.48	170	218
C	20.50	21.50	819	863
D	5.4	6.5	232	257
E	18.48	18.78	740	749
F	4.50	—	177	—
G	1.85	2.13	658	684
H	2.87	3.12	113	132
I	1.02	1.40	400	558
J	5.33	5.50	210	220
K	19.81	20.35	780	800
L	2.81	2.59	107	107
M	0.81	0.9	31.8	33.1
N	3.58	3.65	140	144

TO-204AE (IXSM)



Dim.	Min.	Max.	Min.	Max.
A	38.25	38.57	1.51	1.55
B	19.15	19.94	0.75	0.80
C	6.35	11.43	0.250	0.450
D	1.43	1.80	0.057	0.083
E	1.50	3.43	0.060	0.133
F	28.25	30.40	1.177	1.193
G	10.91	11.18	0.430	0.445
H	5.21	5.72	0.205	0.228
I	16.66	17.18	0.655	0.675
J	11.18	12.19	0.440	0.480
K	3.30	4.19	0.131	0.165
L	2.45	2.62	0.072	0.080


IXSH40N60,60A
IXSM40N60,60A
ELECTRICAL CHARACTERISTICS ($T_C=25^\circ\text{C}$ unless otherwise specified)

CHARACTERISTIC	TEST CONDITION	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage	$I_C=250\ \mu\text{A}$, $V_{GE}=0\text{V}$	BV_{CES}	600	—	—	V
Gate-Emitter Threshold Voltage	$I_C=4\ \text{mA}$, $V_{CE}=V_{GE}$	$V_{GE(TH)}$	4	—	7	V
Gate-Emitter Leakage Current	$V_{GE}=\pm 20\text{V}$, $V_{CE}=0\text{V}$	I_{GES}	—	—	± 100	nA
Collector Leakage Current	$V_{CE}=0.8 \times V_{CES}$, $V_{GE}=0\text{V}$	I_{CES}	$T_C=25^\circ\text{C}$		—	50
			$T_C=125^\circ\text{C}$		—	1
Collector-Emitter Saturation Voltage	$I_C=I_{CS}$, $V_{GE}=15\text{V}$	$V_{CE(sat)}$	40N60		—	2.5
			40N60A		—	3.0
Forward Transconductance (2)	$I_C=I_{CS}$, $V_{CE}=10\text{V}$	g_{fs}	20	23	—	S
Short Circuit Current	$V_{GE}=15\text{V}$, $V_{CE}=10\text{V}$	$I_{C(on)}$	—	200	—	A
Input Capacitance	$V_{CE}=25\text{V}$, $V_{GE}=0\text{V}$, $f=1\text{MHz}$	C_{iss}	—	4500	—	pF
Output Capacitance		C_{oss}	—	350	—	pF
Reverse Transfer Capacitance		C_{res}	—	90	—	pF
Total Gate Charge	$V_{GE}=15\text{V}$, $I_C=I_{CS}$, $V_{CE}=0.5 \times V_{CES}$	$Q_{g(on)}$	—	190	260	nC
Gate-Emitter Charge		Q_{ge}	—	45	60	nC
Gate-Collector ("Miller") Charge		Q_{gc}	—	88	120	nC

SWITCHING CHARACTERISTICS

CHARACTERISTIC	TEST CONDITION	SYMBOL	MIN	TYP	MAX	UNIT
Turn-On Delay Time	Resistive Load $I_C=I_{CS}$, $T_J=125^{\circ}\text{C}$, $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=2.7\Omega$	$t_{d(on)}$	—	55	—	ns
Current Rise Time		t_r	—	170	—	ns
Current Fall Time	Inductive Load $L=100\ \mu\text{H}$, $I_C=I_{CS}$, $T_J=25^{\circ}\text{C}$, $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=2.7\Omega$ (4)	40N60 t_{ff}	—	400	—	ns
Turn-Off Energy		40N60A t_{ff}	—	200	—	ns
	40N60 $W_{(off)}$	—	5	—	mJ	
Turn-Off Delay Time	Inductive Load	40N60A $W_{(off)}$	—	2.5	—	mJ
		40N60 $t_{d(off)}$	—	—	—	ns
Current Fall Time	Inductive Load $L=100\ \mu\text{H}$, $I_C=I_{CS}$, $T_J=125^{\circ}\text{C}$, $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=2.7\Omega$ (4)	40N60A $t_{d(off)}$	—	340	525	ns
		40N60 t_{cs}	—	600	1500	ns
Cross-Over Time		40N60A t_{cs}	—	340	700	ns
Turn-Off Energy		40N60A t_c	—	600	800	ns
	40N60 $W_{(off)}$	—	12	—	mJ	
	40N60A $W_{(off)}$	—	6	—	mJ	

(1) $T_J=25^\circ\text{C}$ to 150°C (2) Pulse Test: Pulse width $\leq 300\ \mu\text{s}$, duty cycle $\leq 2\%$

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

(4) Switching times may increase for V_{GE} (Clamp) $> 0.8 \times V_{CES}$, $T_J=125^\circ\text{C}$ or $R_G>2.7\Omega$ (5) Non-Repetitive Rating: $T_C=125^\circ\text{C}$, $V_{CC}=360\text{V}$, $V_{GE}=15\text{V}$, $R_G=2.7\Omega$ (6) Turn-Off SSOA (or RBSOA), $T_C=125^\circ\text{C}$, $V_{GE}=15\text{V}$, Clamped Inductive Load, $L=100\ \mu\text{H}$, $R_G=2.7\Omega$

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Fig. 1. Saturation Characteristics

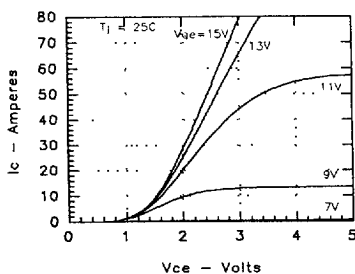


Fig. 3. Collector-Emitter Voltage vs. Gate-Emitter Voltage

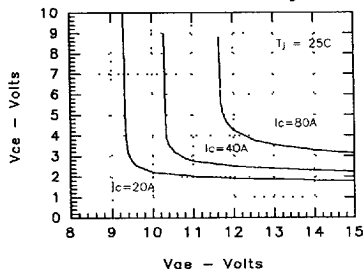
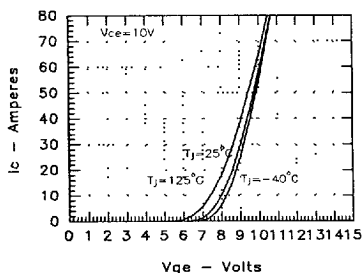


Fig. 5. Input Admittance



IXSH40N60 IXSM40N60

Fig. 2. Output Characteristics

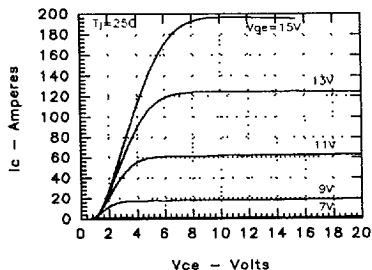


Fig. 4. Temperature Dependence of Output Saturation Voltage

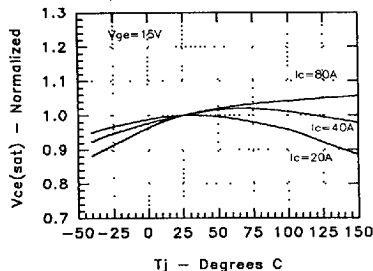


Fig. 6. Temperature Dependence of Breakdown Voltage and Threshold Voltage

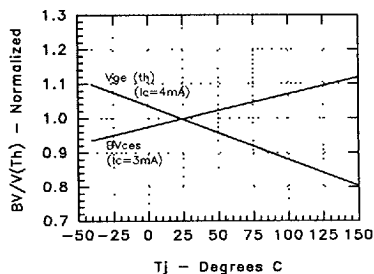
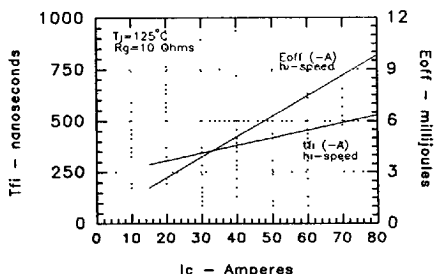




Fig. 7. Dependence of Turn-Off Energy Per Pulse and Fall Time on Collector Current



IXSH40N60 IXSM40N60

Fig. 8. Dependence of Turn-Off Energy Per Pulse and Fall Time on R_g

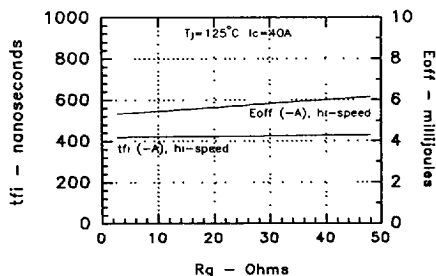


Fig. 9. Gate Charge Characteristic Curve

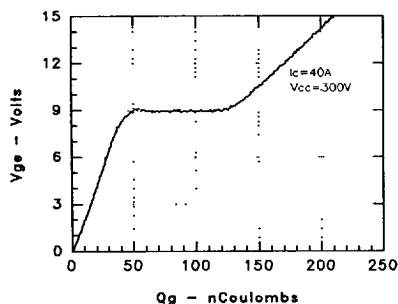


Fig. 10. Turn-Off Safe Operating Area

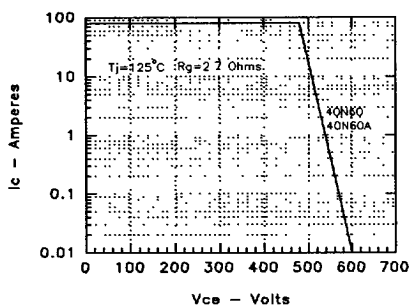
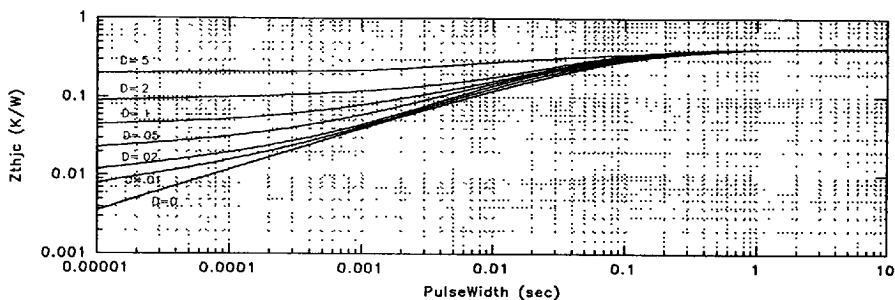


Fig. 11. Transient Thermal Impedance





PRELIMINARY TECHNICAL INFORMATION*

Data Sheet No 91549A

October 1991

HIGH VOLTAGE "S" Series MOSIGBT

Improved SCSOA Capability

FEATURES:

- Guaranteed Short Circuit SOA Capability
- Fast Fall Time for Switching Speeds up to 30kHz
- Low $V_{CE(sat)}$ for Low On-State Conduction Losses
- MOS Gate Turn-on Drive Simplicity

APPLICATIONS:

- Motor Control
- Uninterruptible Power Supplies
- Welding

MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit
Collector-Emitter Voltage (1)	V_{CES}	600	V _{DC}
Collector-Gate Voltage ($R_{GE}=1\text{ M}\Omega$) (1)	V_{DGR}	600	V _{DC}
Gate-Emitter Voltage Continuous	V_{GES}	± 20	V _{DC}
Gate-Emitter Voltage Transient	V_{GEM}	± 30	V
Collector Current Continuous ($T_C=25^\circ\text{C}$)	I_{C25}	50	A _{DC}
($T_C=90^\circ\text{C}$)	I_{C90}	30	A _{DC}
Collector Current Pulsed (3)	I_{CM}	100	A
Short Circuit Withstand Time (5)	t_{SC}	10	μsec
Switching Safe Operating Area (6)	SSOA	60A @ 0.8 V_{CES}	—
Total Power Dissipation	P_C	200	W
Power Dissipation Derating ($T_C>25^\circ\text{C}$)		1.6	W/ $^\circ\text{C}$
Operating and Storage Temperature	T_J & T_{STG}	-55 to $+150$	$^\circ\text{C}$
Thermal Resistance	R_{thJC}	0.625	$^\circ\text{C}/\text{W}$
Thermal Resistance	R_{thCS}	0.25 (typ)	$^\circ\text{C}/\text{W}$
Max. Lead Temp for Soldering	T_L	300 (1.6mm for 10 sec)	$^\circ\text{C}$
Mounting Torque	M_M	10	in-lb

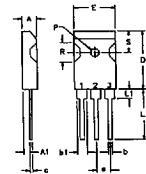
* The data supplied herein reflects the pre-production specification and characterization measurements from Engineering lots. IXYS reserves the right to change limits, test conditions, and dimensions without notice.

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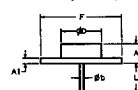
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IXSH30N60, 60A**IXSM30N60, 60A**

Part Number	V_{CES}	I_{C25}	$V_{CE(SAT)}$
30N60	600V	50A	2.5 V
30N60A			3.0 V

TO-247AD (IXSH)

Dim.	Millimeter	Max.	Min.	Inches	Max.
A	2.70	5.30	188	208	
B	4.32	5.49	170	218	
C	20.80	21.46	219	245	
D	5.34	6.35	232	255	
E	15.48	16.28	610	640	
F	1.27	4.00	—	1.97	
G1	1.85	3.13	065	084	
G2	2.87	3.12	113	133	
H	1.02	1.40	243	260	
I	3.33	3.59	210	220	
J	18.41	20.35	705	800	
K1	2.21	2.59	087	102	
K2	0.51	2.91	—	0.51	
L	3.58	3.65	140	144	

TO-204AE (IXSM)

Dim.	Millimeter	Max.	Min.	Inches	Max.
A	8.25	11.43	230	450	
B1	1.40	1.80	027	063	
A1	1.50	3.43	040	130	
G	28.28	30.40	1177	1179	
H	10.20	11.18	420	440	
A1	5.11	6.35	206	225	
S	18.62	17.15	625	675	
L	11.18	12.19	440	480	
GP	3.81	4.18	151	169	
R	24.84	25.47	878	980	
B1	2.54	3.09	100	140	


IXSH30N60,60A
IXSM30N60,60A
ELECTRICAL CHARACTERISTICS ($T_C=25^\circ\text{C}$ unless otherwise specified)

CHARACTERISTIC	TEST CONDITION		SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage	I _C =250 μA, V _{GE} =0V		BV _{CES}	600	—	—	V
Gate-Emitter Threshold Voltage	I _C =2.5 mA, V _{CE} =V _{GE}		V _{GE(th)}	4	—	7	V
Gate-Emitter Leakage Current	V _{GE} = ± 20V, V _{CE} =0V		I _{GES}	—	—	± 100	nA
Collector Leakage Current	V _{CE} = 0.8 x V _{CES} , V _{GE} = 0V	T _C =25°C	I _{CES}	—	—	50	μA
		T _C =125°C		—	—	1	mA
Collector-Emitter Saturation Voltage	I _C = I _{C90} , V _{GE} =15V	30N60	V _{CE(sat)}	—	—	2.5	V
		30N60A		—	—	3.0	
Forward Transconductance (2)	I _C = I _{C90} , V _{CE} =10V		g _{fs}	7	13	—	S
Short Circuit Current	V _{GE} =15V, V _{CE} =10V		I _{C(on)}	—	100	—	A
Input Capacitance	V _{CE} =25V, V _{GE} =0V, f=1MHz		C _{iss}	—	2760	—	pF
Output Capacitance			C _{oss}	—	240	—	pF
Reverse Transfer Capacitance			C _{res}	—	51	—	pF
Total Gate Charge	V _{GE} =15V, I _C = I _{C90} , V _{CE} =0.5 x V _{CES}		Q _{g(on)}	—	110	—	nC
Gate-Emitter Charge			Q _{ge}	—	34	—	nC
Gate-Collector ("Miller") Charge			Q _{gc}	—	47	—	nC

SWITCHING CHARACTERISTICS

CHARACTERISTIC	TEST CONDITION	SYMBOL	MIN	TYP	MAX	UNIT
Turn-On Delay Time	Resistive Load $I_C=I_{C90}$, $T_J=125^{\circ}\text{C}$, $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=4.7\ \Omega$	$t_{d(on)}$	—	60	—	ns
Current Rise Time		t_r	—	130	—	ns
Current Fall Time	Inductive Load $L=100\ \mu\text{H}$, $I_C=I_{C90}$, $T_J=25^{\circ}\text{C}$, $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=4.7\ \Omega$ (4)	30N60 t_{th}	—	400	—	ns
Turn-Off Energy		30N60A t_{th}	—	200	—	ns
	30N60 $W_{(off)}$	—	5	—	mJ	
Turn-Off Delay Time	30N60A $W_{(off)}$	—	2.5	—	mJ	
	Inductive Load	30N60 $t_{d(off)}$	—	340	—	ns
30N60A $t_{d(off)}$		—	340	525	ns	
Current Fall Time	$L=100\ \mu\text{H}$, $I_C=I_{C90}$, $T_J=125^{\circ}\text{C}$, $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=4.7\ \Omega$ (4)	30N60 t_{th}	—	600	1500	ns
Cross-Over Time		30N60A t_{th}	—	340	700	ns
	Turn-Off Energy	30N60 t_c	—	1400	—	ns
30N60A t_c		—	600	800	ns	
Turn-Off Energy	30N60 $W_{(off)}$	—	12	—	mJ	
	30N60A $W_{(off)}$	—	5	—	mJ	

(1) $T_J=25^\circ\text{C}$ to 150°C (2) Pulse Test: Pulse width $\leq 300\ \mu\text{s}$, duty cycle $\leq 2\%$

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

(4) Switching times may increase for $V_{CE}(\text{Clamp}) > 0.8 \times V_{CES}$, $T_J=125^\circ\text{C}$ or $R_G > 4.7\ \Omega$ (5) Non-Repetitive Rating: $T_C=125^\circ\text{C}$, $V_{CC}=360\text{V}$, $V_{GE}=15\text{V}$, $R_G=4.7\ \Omega$ (6) Turn-Off SSOA (or RBSOA), $T_C=125^\circ\text{C}$, $V_{GE}=15\text{V}$, Clamped Inductive Load, $L=100\ \mu\text{H}$, $R_G=4.7\ \Omega$
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IXSH30N60 IXSM30N60

Fig. 1. Saturation Characteristics

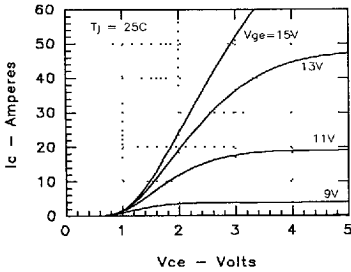


Fig. 2. Output Characteristics

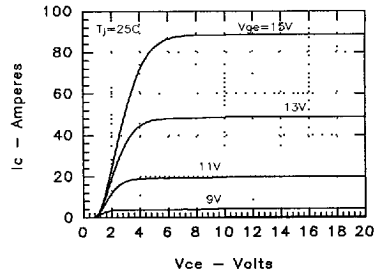


Fig. 3. Collector-Emitter Voltage vs. Gate-Emitter Voltage

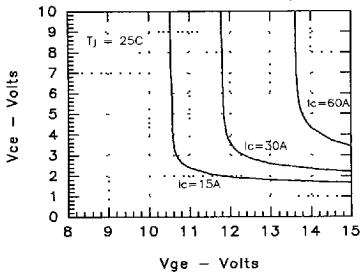


Fig. 4. Temperature Dependence of Output Saturation Voltage

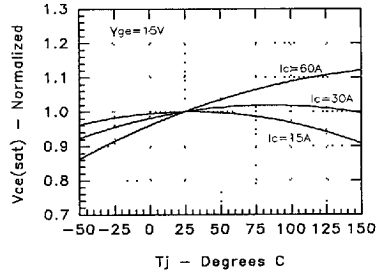


Fig. 5. Input Admittance

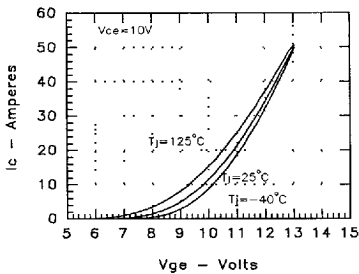


Fig. 6. Temperature Dependence of Breakdown Voltage and Threshold Voltage

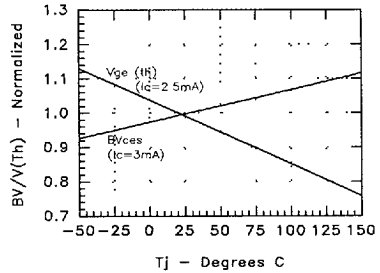
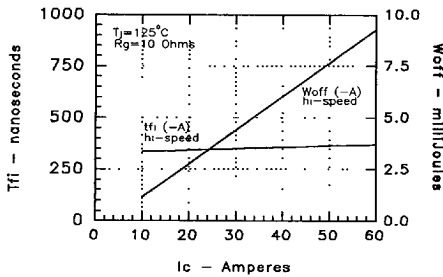




Fig. 7. Dependence of Turn-Off Energy Per Pulse and Fall Time on Collector Current



IXSH30N60 IXSM30N60

Fig. 8. Dependence of Turn-Off Energy Per Pulse and Fall Time on R_g

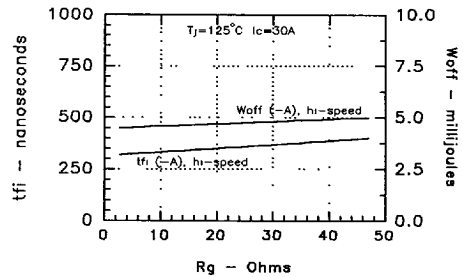


Fig. 9. Gate Charge Characteristic Curve

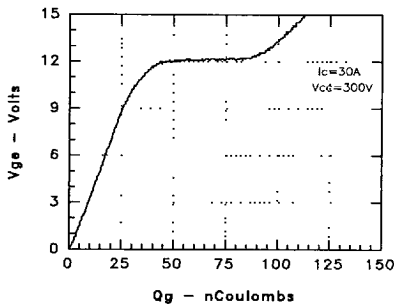


Fig. 10. Turn-Off Safe Operating Area

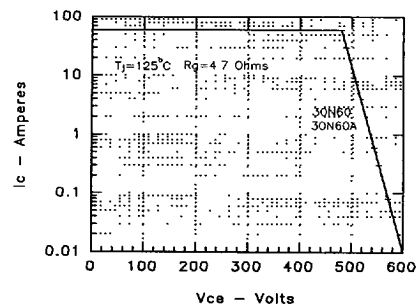
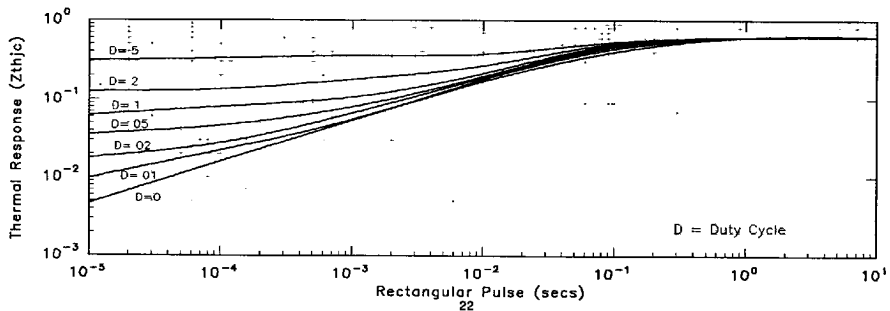


Fig. 11. Transient Thermal Impedance





PRELIMINARY TECHNICAL INFORMATION*

Data Sheet No 91547A

October 1991

HIGH VOLTAGE "S" Series MOSIGBT

Improved SCSOA Capability

FEATURES:

- Guaranteed Short Circuit SOA Capability
- Fast Fall Time for Switching Speeds up to 30kHz
- Low $V_{CE(sat)}$ for Low On-State Conduction Losses
- MOS Gate Turn-on Drive Simplicity

APPLICATIONS:

- Motor Control
- Uninterruptible Power Supplies
- Welding

MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit
Collector-Emitter Voltage (1)	V_{CES}	600	V _{DC}
Collector-Gate Voltage ($R_{GE}=10\Omega$) (1)	V_{CGR}	600	V _{DC}
Gate-Emitter Voltage Continuous	V_{GES}	± 20	V _{DC}
Gate-Emitter Voltage Transient	V_{GEM}	± 30	V
Collector Current Continuous ($T_C=25^\circ\text{C}$)	I_{C25}	40	A _{DC}
($T_C=90^\circ\text{C}$)	I_{C90}	20	A _{DC}
Collector Current Pulsed (3)	I_{CM}	75	A
Short Circuit Withstand Time (5)	t_{SC}	10	μsec
Switching Safe Operating Area (6)	SSOA	40A @ 0.8 X V_{CES}	—
Total Power Dissipation	P_C	150	W
Power Dissipation Derating ($T_C>25^\circ\text{C}$)		1.25	W/ $^\circ\text{C}$
Operating and Storage Temperature	T_J & T_{STG}	-55 to +150	$^\circ\text{C}$
Thermal Resistance	R_{thJC}	0.8	$^\circ\text{C/W}$
Thermal Resistance	R_{thCS}	0.25 (typ)	$^\circ\text{C/W}$
Max. Lead Temp. for Soldering	T_L	300 (1.6mm for 10 sec)	$^\circ\text{C}$
Mounting Torque	M_M	10	in-lb

* The data supplied herein reflects the pre-production objective specification and characterization measurements from Engineering lots. IXYS reserves the right to change limits, test conditions, and dimensions without notice.

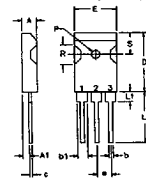
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IXSH20N60, 60A IXSM20N60, 60A

Part Number	V_{CES}	I_{C25}	$V_{CE(SAT)}$
20N60	600V	20A	2.5 V
20N60A			3.0 V

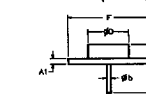
TO-247AD (IXSH)



PIN 1 GATE
2. COLLECTOR
3. EMITTER

Dim.	Millimeter	Inches
A	4.70 5.30	186 209
B	4.32 5.49	170 218
C	20.80 21.48	.819 .845
D	8.14 8.52	.322 .335
E	15.49 16.28	.610 .645
F	4.30	.172
G	1.68 2.13	.066 .084
H	2.67 3.12	.113 .123
I	1.00 1.45	.040 .057
J	5.33 5.98	.210 .235
K	10.81 10.33	.426 .409
L	2.01 3.24	.080 .127
M	0.41 0.76	.016 .031
N	3.56 3.66	.140 .144

TO-204AE (IXSM)



PIN 1 GATE
2. EMITTER
3. COLLECTOR

Dim.	Millimeter	Inches
A	38.30 38.30	1.51 1.51
B	18.18 18.18	.715 .715
C	6.35 11.43	.250 .450
D	1.25 1.60	.050 .063
E	1.52 3.43	.060 .135
F	29.28 30.40	1.153 1.197
G	10.87 11.18	.428 .440
H	9.14 9.75	.359 .385
I	16.64 17.13	.655 .674
J	11.18 12.18	.440 .480
K	3.84 4.19	.151 .165
L	24.84 25.47	.978 .995
M	2.34 3.18	.092 .125



IXSH20N60,60A
IXSM20N60,60A

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

CHARACTERISTIC	TEST CONDITION	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage	$I_C=250\ \mu\text{A}$, $V_{GE}=0\text{V}$	BV_{CES}	600	—	—	V
Gate-Emitter Threshold Voltage	$I_C=5\ \text{mA}$, $V_{CE}=V_{GE}$	$V_{GE(TH)}$	3	—	6	V
Gate-Emitter Leakage Current	$V_{GE}=\pm 20\text{V}$, $V_{CE}=0\text{V}$	I_{GES}	—	—	± 100	nA
Collector Leakage Current	$V_{CE}=0.8 \times V_{CES}$, $V_{GE}=0\text{V}$	$T_C=25^\circ\text{C}$	—	—	200	μA
		$T_C=125^\circ\text{C}$	—	—	1	mA
Collector-Emitter Saturation Voltage	$I_C=I_{C90}$, $V_{GE}=15\text{V}$	non-A	—	—	2.5	V
		A	—	—	3.0	V
Forward Transconductance (2)	$I_C=I_{C90}$, $V_{CE}=10\text{V}$	g_{fs}	6	7	—	S
Short Circuit Current	$V_{GE}=15\text{V}$, $V_{CE}=10\text{V}$	$I_{C(ON)}$	—	65	—	A
Input Capacitance	$V_{CE}=25\text{V}$, $V_{GE}=0\text{V}$, $f=1\text{MHz}$	C_{iss}	—	1800	—	pF
Output Capacitance		C_{oss}	—	160	—	pF
Reverse Transfer Capacitance		C_{res}	—	45	—	pF
Total Gate Charge	$V_{GE}=15\text{V}$, $I_C=I_{C90}$, $V_{CE}=0.5 \times V_{CES}$	$Q_{g(on)}$	—	75	—	nC
Gate-Emitter Charge		Q_{ge}	—	20	—	nC
Gate-Collector ("Miller") Charge		Q_{gc}	—	35	—	nC

SWITCHING CHARACTERISTICS

CHARACTERISTIC	TEST CONDITION	SYMBOL	MIN	TYP	MAX	UNIT
Turn-On Delay Time	Resistive Load $I_C=I_{C90}$, $T_J=125^{\circ}\text{C}$, $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=10\Omega$	$t_{d(on)}$	—	100	—	ns
Current Rise Time		t_r	—	200	—	ns
Turn-Off Delay Time	Inductive Load $L=100\ \mu\text{H}$ $I_C=I_{C90}$, $T_J=125^{\circ}\text{C}$ $V_{CC}=0.8 \times V_{CES}$, $V_{GE}=15\text{V}$, $R_G=10\ \Omega$ (4)	$t_{d(off)}$	—	—	1000	ns
Current Fall Time		20N60 t_f	—	—	1000	ns
Turn-On Energy		20N60A t_{th}	—	—	600	ns
Turn-Off Energy		All Types $W_{(on)}$	—	—	—	mJ
		20N60 $W_{(off)}$	—	9	—	mJ
		20N60A $W_{(off)}$	—	3	—	mJ

(1) $T_J=25^\circ\text{C}$ to 150°C (2) Pulse Test. Pulse width $\leq 300\ \mu\text{s}$, duty cycle $\leq 2\%$

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

(4) Switching times may increase for $V_{CE}(\text{Clamp}) > 0.8 \times V_{CES}$, $T_J=125^\circ\text{C}$ or $R_G > 10\ \Omega$ (5) Non-Repetitive Rating. $T_C=125^\circ\text{C}$, $V_{CC}=360\text{V}$, $V_{GE}=15\text{V}$, $R_G=10\ \Omega$ (6) Turn-Off SSOA (or RBSOA), $T_C=125^\circ\text{C}$, $V_{GE}=15\text{V}$, Clamped Inductive Load, $L=100\ \mu\text{H}$, $R_G=10\ \Omega$

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IXSH20N60 IXSM20N60

Fig. 1. Saturation Characteristics

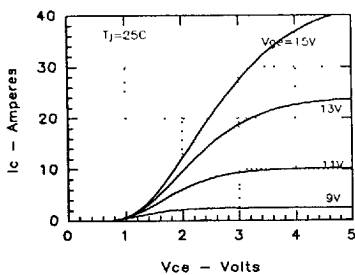


Fig. 2. Output Characteristics

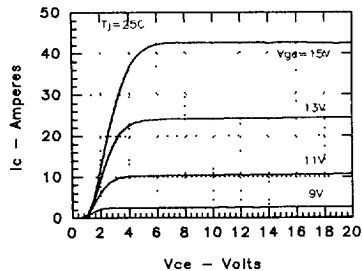


Fig. 3. Collector-Emitter Voltage vs. Gate-Emittor Voltage

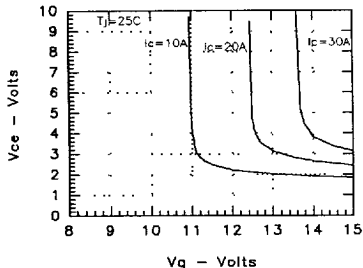


Fig. 4. Temperature Dependence of Output Saturation Voltage

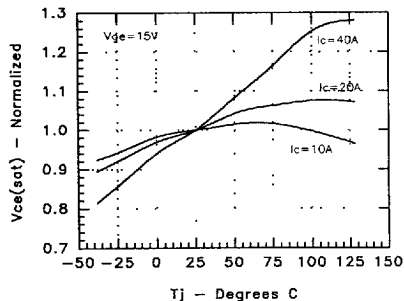


Fig. 5. Input Admittance

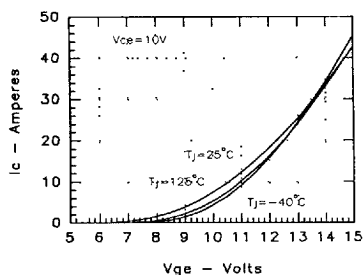


Fig. 6. Temperature Dependence of Breakdown Voltage and Threshold Voltage

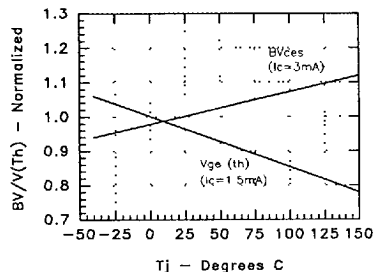




Fig. 7. Dependence of Turn-Off Energy Per Pulse and Fall Time on Collector Current

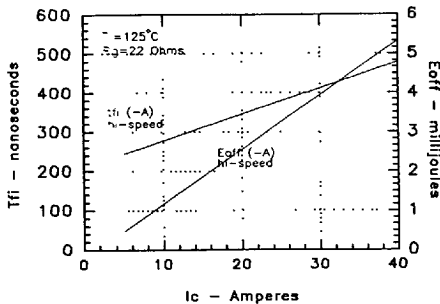
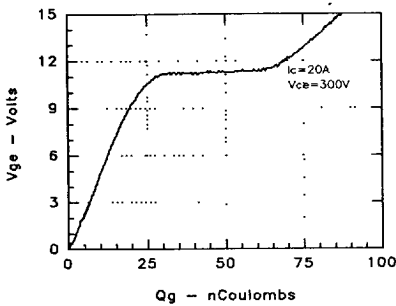


Fig. 9. Gate Charge Characteristic Curve



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Fig. 8. Dependence of Turn-Off Energy Per Pulse and Fall Time on R_g

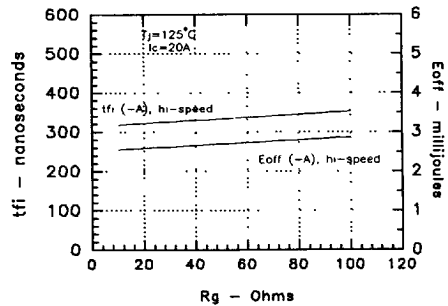


Fig. 10. Turn-Off Safe Operating Area

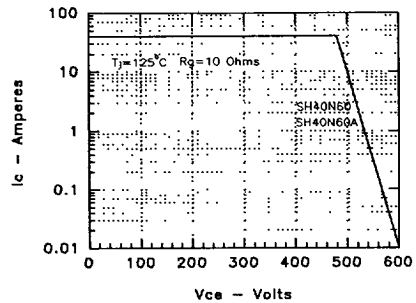


Fig. 11. Transient Thermal Impedance

