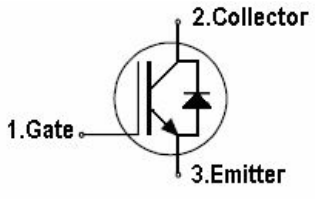
# TSG20N60

## 20A 600V high speed trench gate field-stop IGBT

DRAWING

G C E




### Features

- ＊ High speed switching
- ＊ Tight parameters distribution
- ＊ Safe paralleling
- ＊ Low thermal resistance
- ＊ Short-circuit rated
- ＊ Ultrafast soft recovery antiparallel diode

### General Description

- ＊ Package:ITO-220AB DG
- ＊ This device is an IGBT developed using an advanced proprietary trench gate and field stop structure. This IGBT series offers the optimum compromise between conduction and switching losses maximizing the efficiency of very high frequency converters. Furthermore, a positive $V_{CE}$(sat) temperature coefficient and very tight parameter distribution result in easier paralleling operation.

### Absolute Maximum Ratings

| Symbol | Parameter | Spec | Units |
|---|---|---|---|
| $V_{CES}$ | Collector-emitter voltage ($V_{GE}$=0) | 600 | V |
| $I_C$ | Continuous collector current at $T_C$=25℃ | 40(1) | A |
| $I_C$ | Continuous collector current at $T_C$=100℃ | 20(1) | A |
| $I_{CP}$(2) | Pulsed collector current | 80(1) | A |
| $V_{GE}$ | Gate-emitter voltage | ±20 | V |
| $I_F$ | Continuous forward current Tc=25℃ | 40(1) | A |
| $I_F$ | Continuous forward current Tc=100℃ | 20(1) | A |
| $I_{FP}$(2) | Pulsed forward current | 80(1) | A |
| $P_{TOT}$ | Total dissipation at $T_C$=25℃ | 37 | W |
| $T_{STG}$ | Storage Temperature range | -55 to 150 | ℃ |
| $T_J$ | Operating Junction temperature | -55 to 175 | ℃ |

**Note1：** 1.Limited by maximum junction temperature .

2.Pulse width limited by maximum junction temperature and turn-off within RBSOA

### Thermal Characteristics

| Symbol | Parameter | Spec | Units |
|---|---|---|---|
| $R_{thJC}$ | Thermal resistance junction-case IGBT | 4 | ℃/W |
| $R_{thJC}$ | Thermal resistance junction-case diode | 5.6 | ℃/W |
| $R_{thJA}$ | Thermal resistance junction-ambient | 62.5 | ℃/W |

**Electrical Characteristics** (TC=25℃ unless otherwise noted )

**Static characteristics**

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $V_{(BR)CES}$ | Collector-emitter breakdown voltage($V_{GE}$=0) | $I_C$=2mA | 600 | - | - | V |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE}$=15V,$I_C$=20A | - | 1.6 | 2.0 | V |
| | | $V_{GE}$=15V,$I_C$=20A,$T_J$=125℃ | - | 1.75 | - | |
| | | $V_{GE}$=15V,$I_C$=20A,$T_J$=175℃ | 0 | 1.8 | 1 | |
| $V_{GE(th)}$ | Gate threshold voltage | $V_{CE}$=$V_{GE}$,$I_C$=1mA | 5.0 | 6.0 | 7.0 | V |
| $I_{CES}$ | Collector cut-off current ($V_{GE}$=0) | $V_{CE}$=600V | - | - | 25 | uA |
| $I_{GES}$ | Gate-emitter leakage current ($V_{CE}$=0) | $V_{GE}$=±20V | - | - | 250 | nA |

**Dynamic characteristics**

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $C_{ies}$ | Input capacitance | $V_{CE}$=25V, | - | 2750 | - | pF |
| $C_{oes}$ | Output capacitance | f=1MHz, | - | 110 | - | pF |
| $C_{res}$ | Reverse transfer capacitance | $V_{GE}$=0 | - | 65 | - | pF |
| $Q_g$ | Total gate charge | $V_{CC}$=400V, | - | 115 | - | nC |
| $Q_{ge}$ | Gate-emitter charge | $I_C$=20A, | - | 22 | - | nC |
| $Q_{gc}$ | Gate-collector charge | $V_{GE}$=15V | - | 45 | - | nC |

**Switching characteristics(inductive load)**

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn-on delay time | $V_{CE}$=400V,$I_C$=20A, | - | 42.5 | - | ns |
| $t_r$ | Current rise time | $R_G$=10Ω,$V_{GE}$=15V | - | 11.9 | - | ns |
| (di/dt)on | Turn-on current slope | | - | 1345 | - | A/us |
| $t_{d(on)}$ | Turn-on delay time | $V_{CE}$=400V,$I_C$=20A, | - | 42.5 | - | ns |
| $t_r$ | Current rise time | $R_G$=10Ω,$V_{GE}$=15V | - | 13.4 | - | ns |
| (di/dt)on | Turn-on current slope | $T_J$=175℃ | - | 1180 | - | A/us |
| $t_{r(Voff)}$ | Off voltage rise time | $V_{CE}$=400V,$I_C$=20A, | - | 20 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | $R_G$=10Ω,$V_{GE}$=15V | - | 177 | - | ns |
| $t_f$ | Current fall time | | - | 55 | - | ns |
| $t_{r(Voff)}$ | Off voltage rise time | $V_{CE}$=400V,$I_C$=20A, | - | 26 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | $R_G$=10Ω,$V_{GE}$=15V | - | 173 | - | ns |
| $t_f$ | Current fall time | $T_J$=175℃ | - | 86 | - | ns |
| $t_{sc}$ | Short-circuit withstand time | $V_{CC}$≤360V,$V_{GE}$=15V | 3 | 5 | - | us |

**Switching energy(inductive load)**

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $E_{on}$(1) | Turn-on switching losses | $V_{CE}$=400V,$I_C$=20A $R_G$=10Ω,$V_{GE}$=15V | - | 209 | - | uJ |
| $E_{off}$(2) | Turn-off switching losses | | - | 261 | - | uJ |
| $E_{ts}$ | Total switching losses | | - | 470 | - | uJ |
| $E_{on}$(1) | Turn-on switching losses | $V_{CE}$=400V,$I_C$=20A, | - | 480 | - | uJ |
| $E_{off}$(2) | Turn-off switching losses | $R_G$=10Ω,$V_{GE}$=15V | - | 416 | - | uJ |
| $E_{ts}$ | Total switching losses | $T_J$=175℃ | - | 896 | - | uJ |

Notes: 1.Energy losses include reverse recovery of the diode .

2.Turn-off losses include also the tail of the collector current .

**Collector-emitter diode**

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $V_F$ | Forward on-voltage | $I_F$=20A | | 1.8 | 2.2 | V |
| | | $I_F$=20A, $T_J$=175℃ | | 1.3 | | |
| $t_{rr}$ | Reverse recovery time | $V_r$=60V,$I_F$=20A diF/dt = 100 A / μs | - | 90 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 110 | - | nC |
| $I_{rrm}$ | Reverse recovery current | | - | 2.4 | - | A |
| $t_{rr}$ | Reverse recovery time | $V_r$=60V,$I_F$=20A diF/dt = 100 A / μs $T_J$=175℃ | - | 188 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 466 | - | nC |
| $I_{rrm}$ | Reverse recovery current | | - | 5.2 | - | A |

## Typical Characteristics

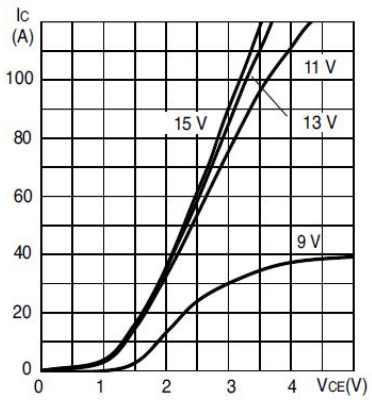



**Figure 1.** Output characteristics($T_J$=25℃)

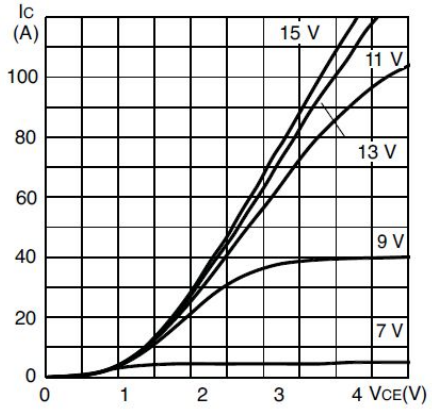



**Figure 2.** Output characteristics($T_J$=175℃)

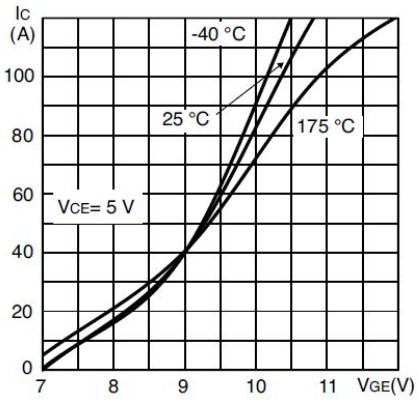



**Figure 3.** Transfer characteristics

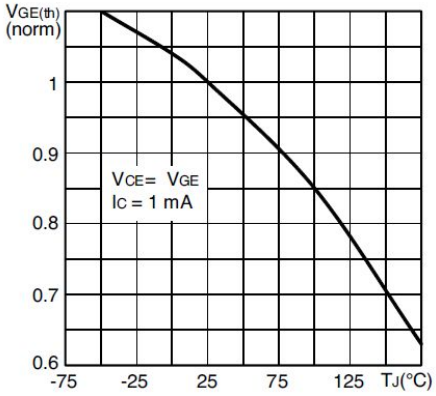



**Figure 4.** Normalized $V_{GE(th)}$ VS junction temperature

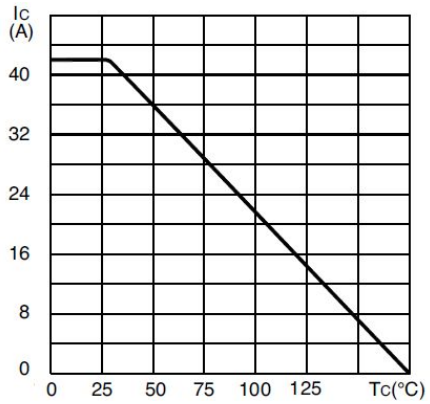



**Figure 5.** Collector current vs.case temperature

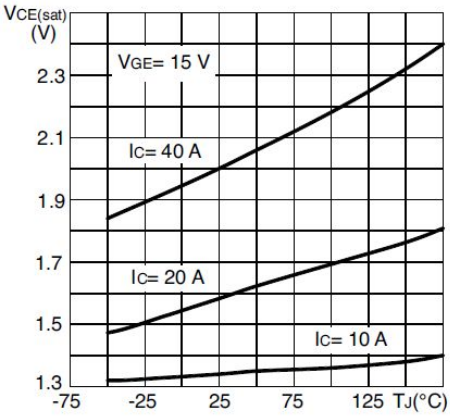



**Figure 6.** $V_{CE(sat)}$VS junction temperature

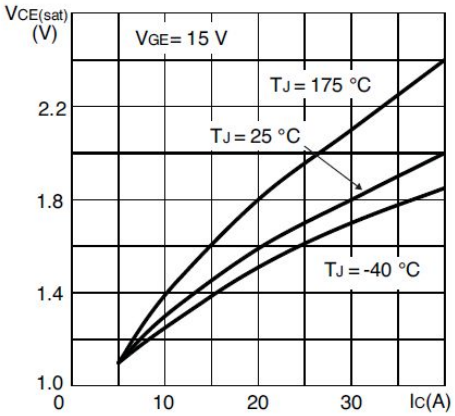



**Figure 7.**$V_{CE(sat)}$VS .collector current

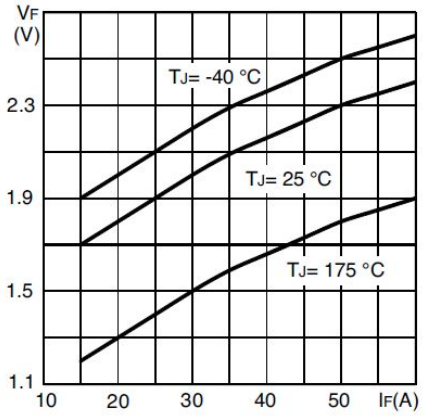



**Figure 8.** Diode VF vs.forward current

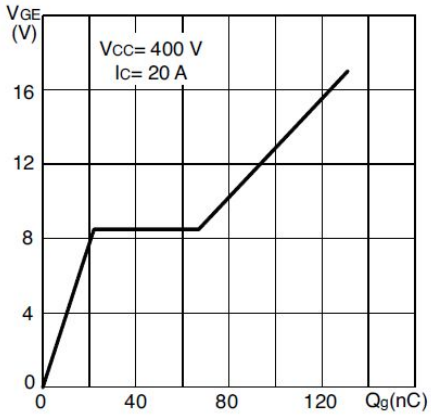



**Figure 9.** Gate charge vs.gate-emitter voltage

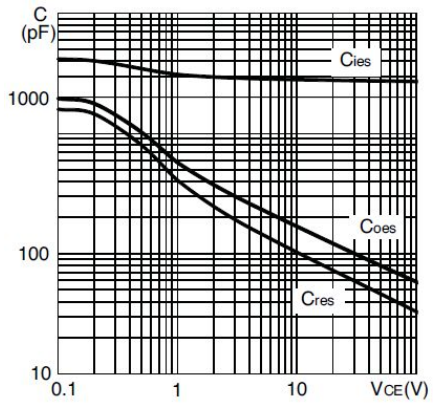



**Figure 10.** Capacitance variations vs .$V_{CE}$

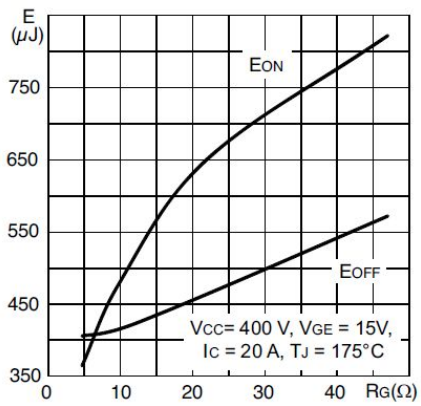



**Figure 11.** Switching losses vs.gate resisitance

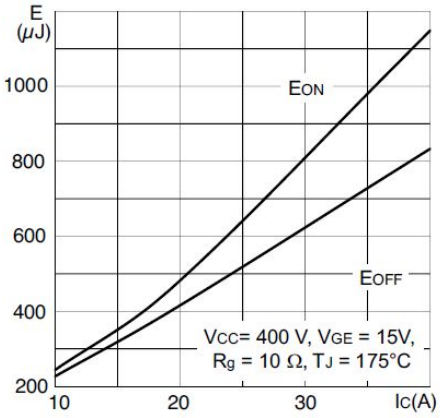



**Figure 11.** Switching losses vs.collector current

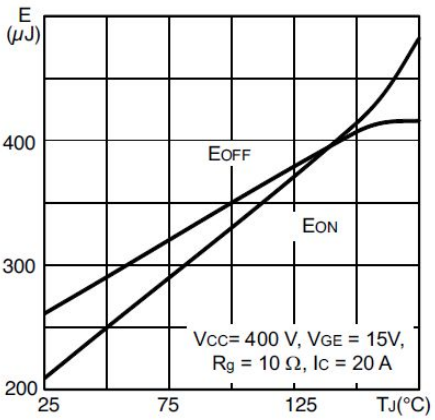



**Figure 12.** Switching losses vs.temperature

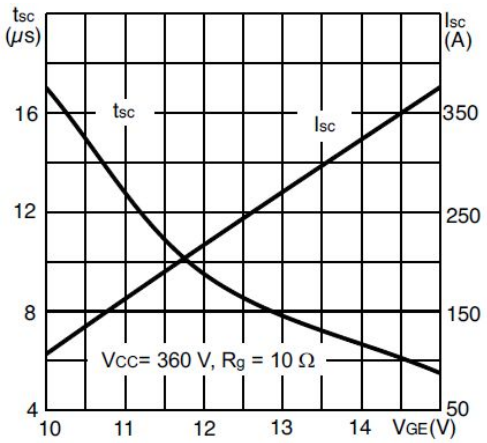



**Figure 13.** Short-circuit time and current vs.$V_{GE}$

## Test circuits and waveforms

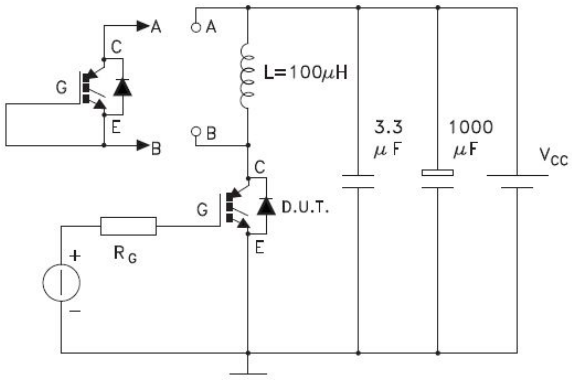



**Figure 1.** Test circuit for inductive load switching

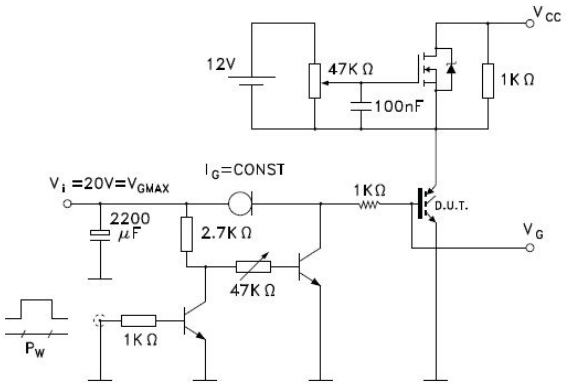



**Figure 2.** Gate charge test circuit

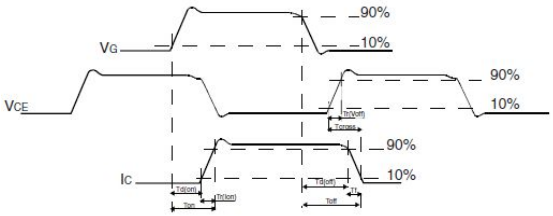



**Figure 3.** Switching waveform

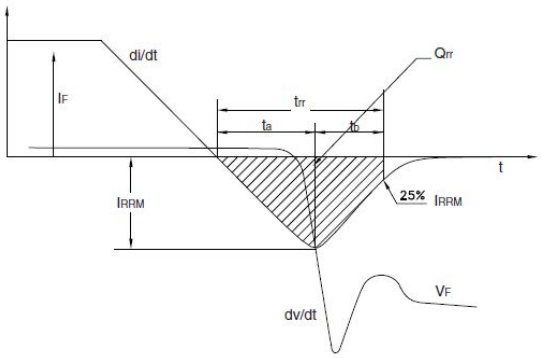



**Figure 4.** Diode recovery time waveform

## Mechanical Dimensions