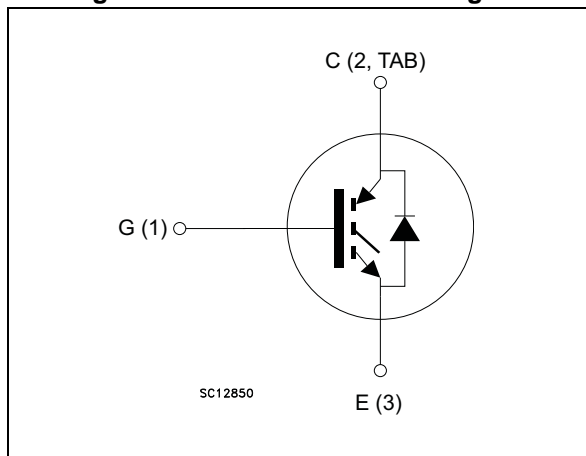


Figure 1. Internal schematic diagram



### Features

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

### Applications

- Motor control
- UPS, PFC

### Description

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.

Table 1. Device summary

Order codes	Marking	Packages	Packaging
STGW20H60DF	GW20H60DF	TO-247	Tube
STGWT20H60DF	GWT20H60DF	TO-3P	Tube

## Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ )	600	V
$I_C$	Continuous collector current at $T_C = 25\text{ °C}$	40	A
	Continuous collector current at $T_C = 100\text{ °C}$	20	A
$I_{CP}^{(1)}$	Pulsed collector current	80	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$I_F$	Continuous forward current $T_C = 25\text{ °C}$	40	A
	Continuous forward current at $T_C = 100\text{ °C}$	20	
$I_{FP}^{(2)}$	Pulsed forward current	80	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	167	W
$T_{STG}$	Storage temperature range	- 55 to 150	°C
$T_J$	Operating junction temperature	- 55 to 175	

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

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Thermal resistance junction-case IGBT	0.9	°C/W
$R_{thJC}$	Thermal resistance junction-case diode	2.5	°C/W
$R_{thJA}$	Thermal resistance junction-ambient	62.5	°C/W

## 2 Electrical characteristics

$T_J = 25\text{ °C}$  unless otherwise specified.

**Table 4. Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage ( $V_{GE} = 0$ )	$I_C = 2\text{ mA}$	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 20\text{ A}$		1.6	2.0	V
		$V_{GE} = 15\text{ V}, I_C = 20\text{ A}$ $T_J = 125\text{ °C}$		1.75		
		$V_{GE} = 15\text{ V}, I_C = 20\text{ A}$ $T_J = 175\text{ °C}$		1.8		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 1\text{ mA}$	5	6	7	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 600\text{ V}$			25	$\mu\text{A}$
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{ V}$			250	nA

**Table 5. Dynamic**

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

Table 6. Switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$		42.5	-	ns
$t_r$	Current rise time			11.9	-	ns
$(di/dt)_{on}$	Turn-on current slope			1345	-	A/ $\mu$ s
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$		42.5	-	ns
$t_r$	Current rise time			13.4		ns
$(di/dt)_{on}$	Turn-on current slope			1180		A/ $\mu$ s
$t_{r(Voff)}$	Off voltage rise time	$V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$		20	-	ns
$t_{d(off)}$	Turn-off delay time			177	-	ns
$t_f$	Current fall time			55	-	ns
$t_{r(Voff)}$	Off voltage rise time	$V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$		26	-	ns
$t_{d(off)}$	Turn-off delay time			173	-	ns
$t_f$	Current fall time			86	-	ns
$t_{sc}$	Short-circuit withstand time	$V_{CC} \leq 360\text{ V}$ , $V_{GE} = 15\text{ V}$	3	5	-	$\mu$ s

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit	
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$	-	209	-	$\mu$ J	
$E_{off}^{(2)}$	Turn-off switching losses			-	261	-	$\mu$ J
$E_{ts}$	Total switching losses			-	470	-	$\mu$ J
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$	-	480	-	$\mu$ J	
$E_{off}^{(2)}$	Turn-off switching losses			-	416	-	$\mu$ J
$E_{ts}$	Total switching losses			-	896	-	$\mu$ J

1. Energy losses include reverse recovery of the diode.
2. Turn-off losses include also the tail of the collector current.

Table 8. Collector-emitter diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_F$	Forward on-voltage	$I_F = 20\text{ A}$ $I_F = 20\text{ A}, T_J = 175\text{ °C}$	-	1.8	2.2	V
				1.3		V
$t_{rr}$	Reverse recovery time	$V_r = 60\text{ V}; I_F = 20\text{ A};$ $di_F/dt = 100\text{ A} / \mu\text{s}$	-	90	-	ns
$Q_{rr}$	Reverse recovery charge			110		nC
$I_{rrm}$	Reverse recovery current			2.4		A
$t_{rr}$	Reverse recovery time	$V_r = 60\text{ V}; I_F = 20\text{ A};$ $di_F/dt = 100\text{ A} / \mu\text{s}$ $T_J = 175\text{ °C}$	-	180	-	ns
				466	-	nC
$I_{rrm}$	Reverse recovery current		-	5.2	-	A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics ( $T_J = 25^\circ\text{C}$ )

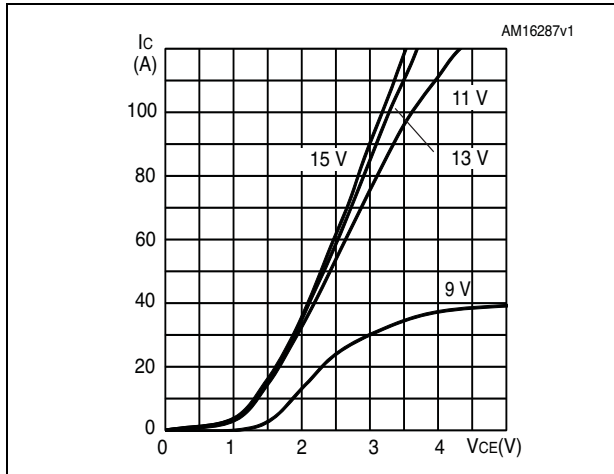


Figure 3. Output characteristics ( $T_J = 175^\circ\text{C}$ )

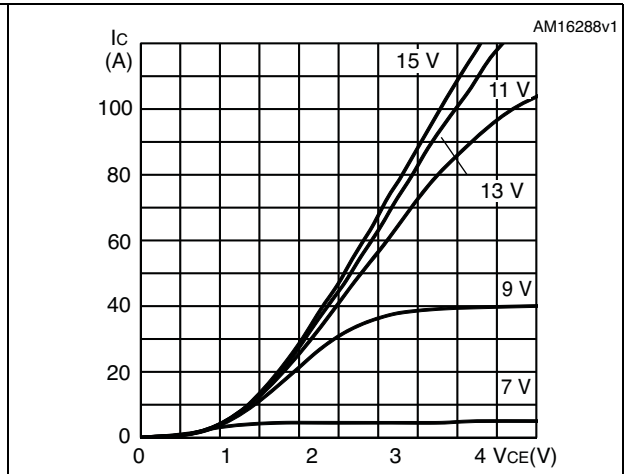


Figure 4. Transfer characteristics

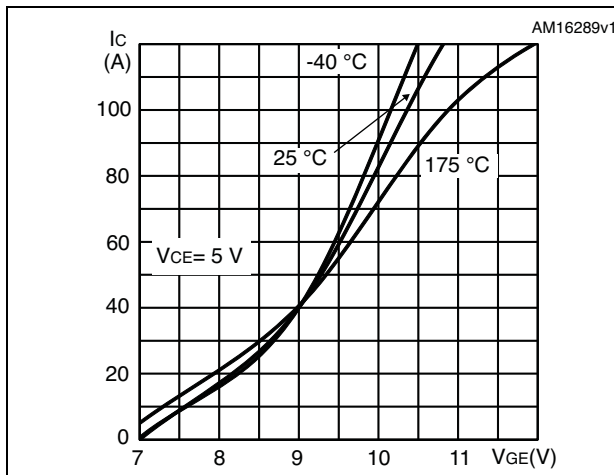


Figure 5. Normalized  $V_{GE(th)}$  vs junction temperature

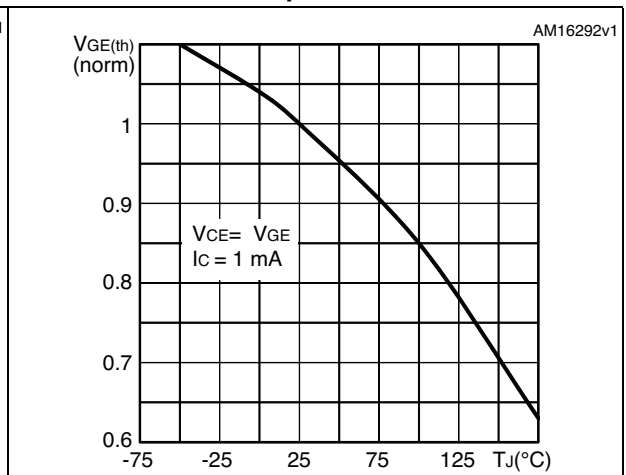


Figure 6. Collector current vs. case temperature

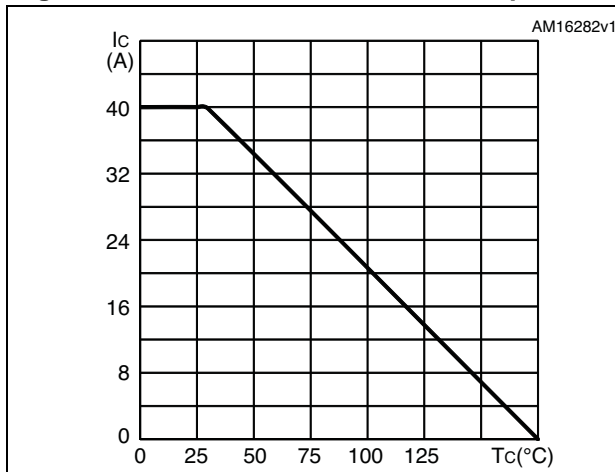


Figure 7. Collector current vs. frequency

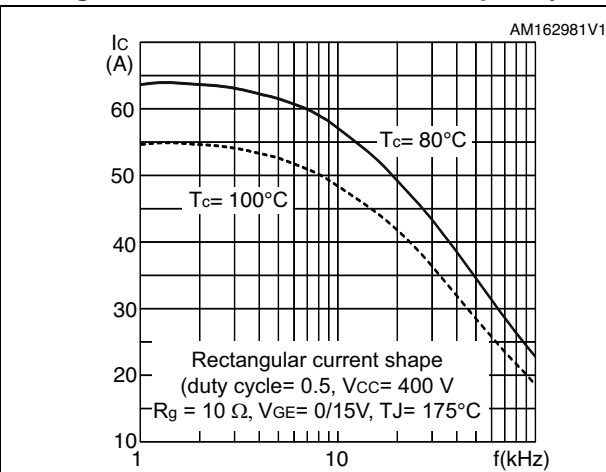


Figure 8. V<sub>CE(sat)</sub> vs. junction temperature

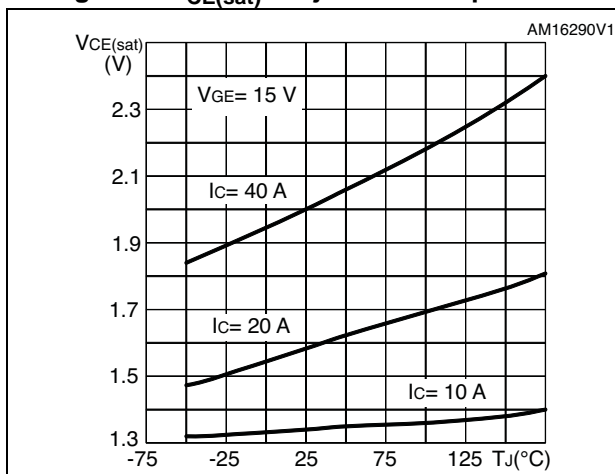


Figure 9. V<sub>CE(sat)</sub> vs. collector current

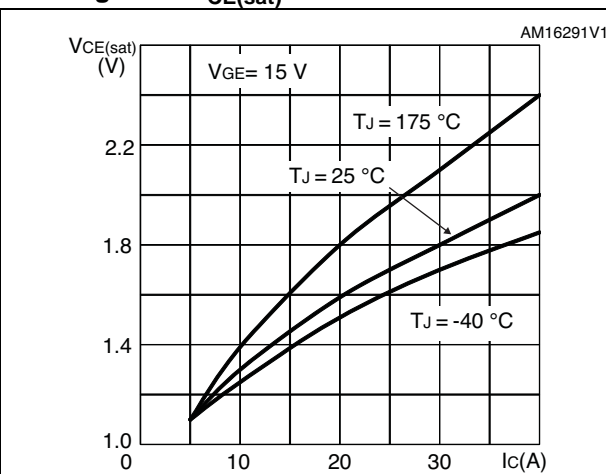


Figure 10. Forward bias safe operating area

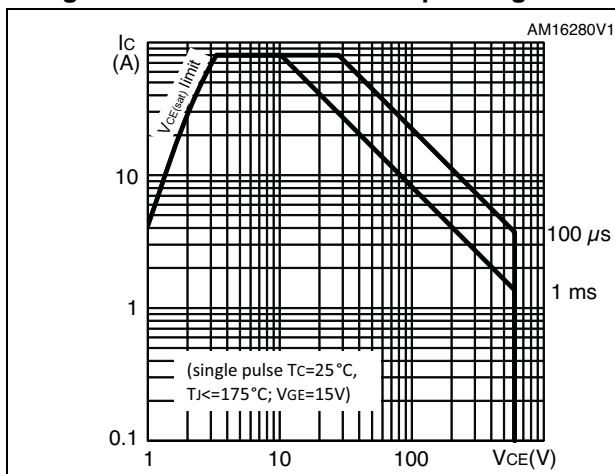


Figure 11. Thermal impedance

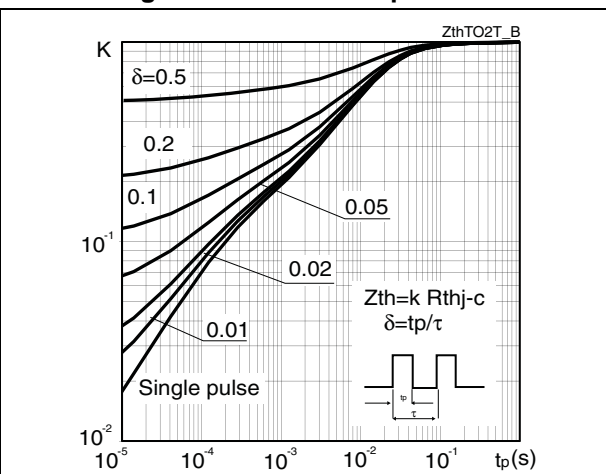




Figure 12. Diode  $V_F$  vs. forward current

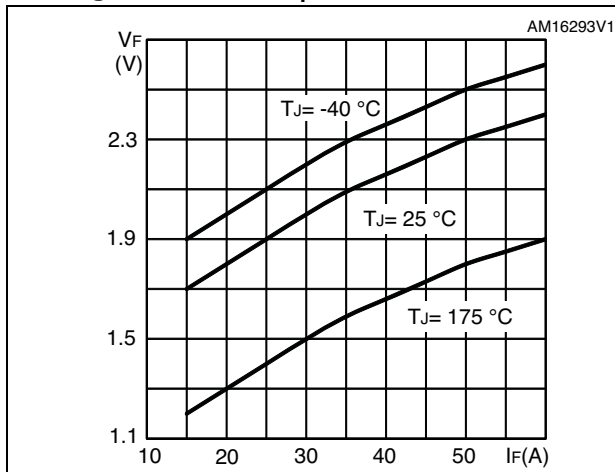


Figure 13. Gate charge vs. gate-emitter voltage

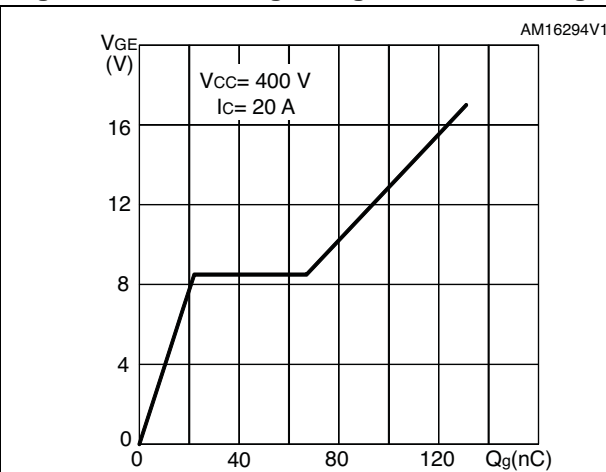


Figure 14. Capacitance variations vs.  $V_{CE}$

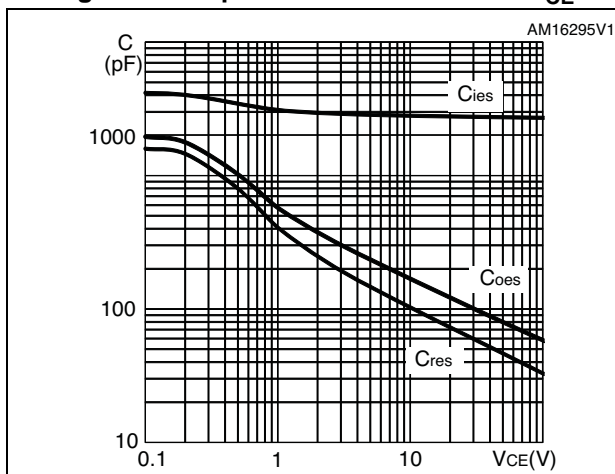


Figure 15. Switching losses vs. gate resistance

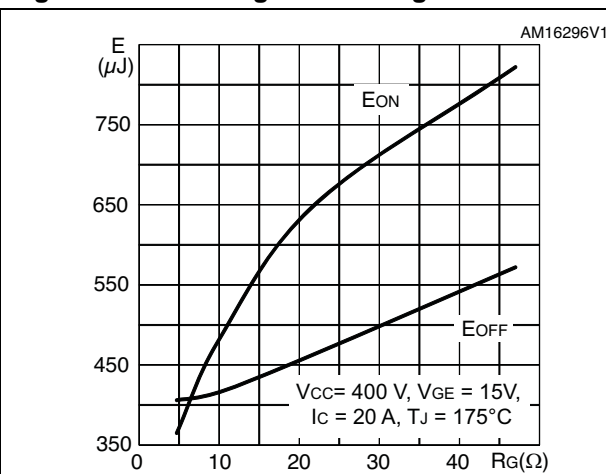


Figure 16. Switching losses vs. collector current

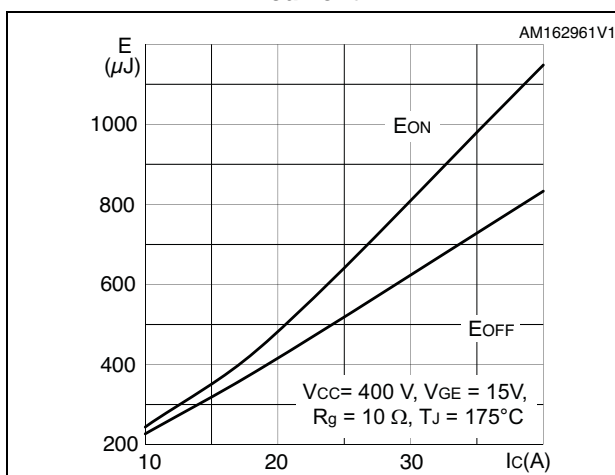


Figure 17. Switching losses vs. temperature

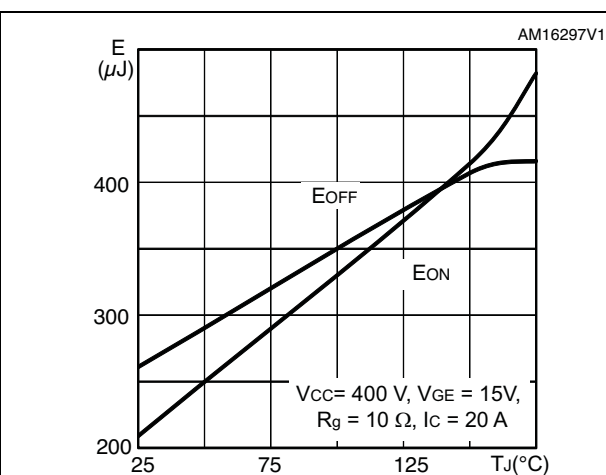


Figure 18. Short-circuit time and current vs.  $V_{GE}$

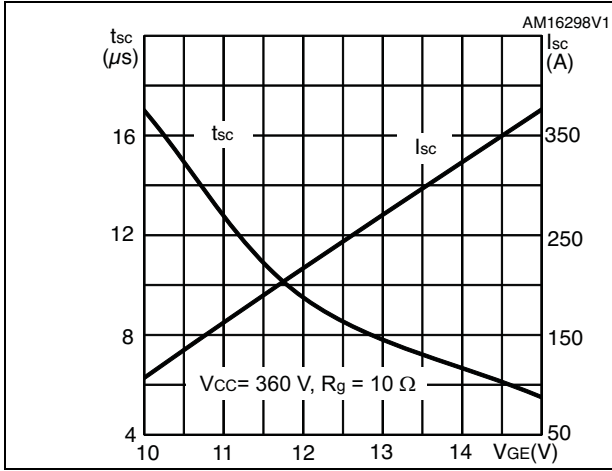
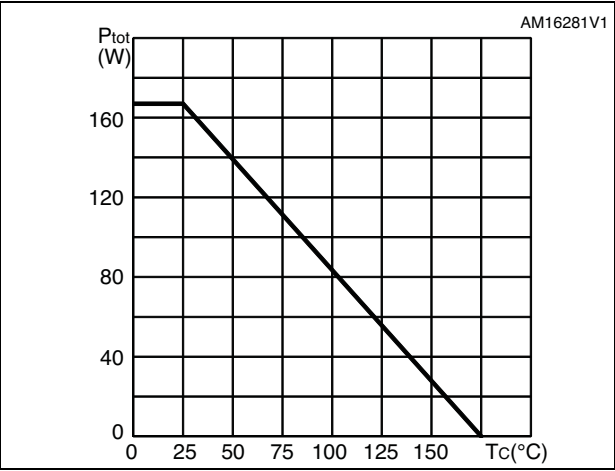


Figure 19. Power dissipation vs. case temperature



### 3 Test circuits

Figure 20. Test circuit for inductive load switching



Figure 21. Gate charge test circuit

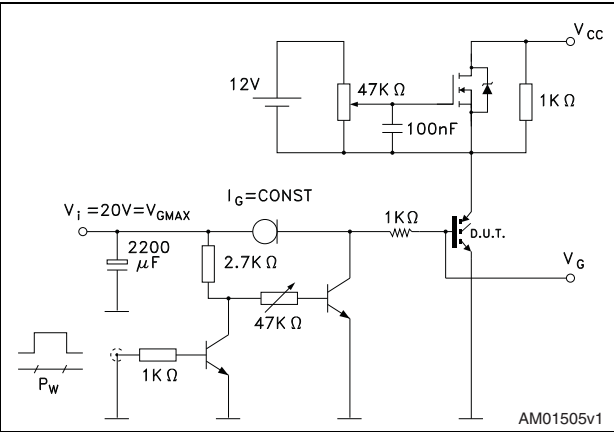


Figure 22. Switching waveform

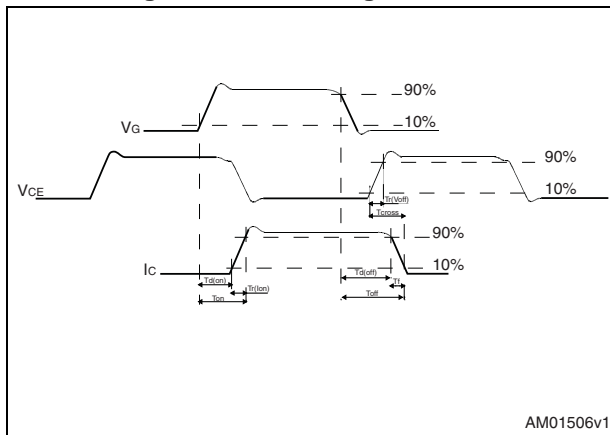
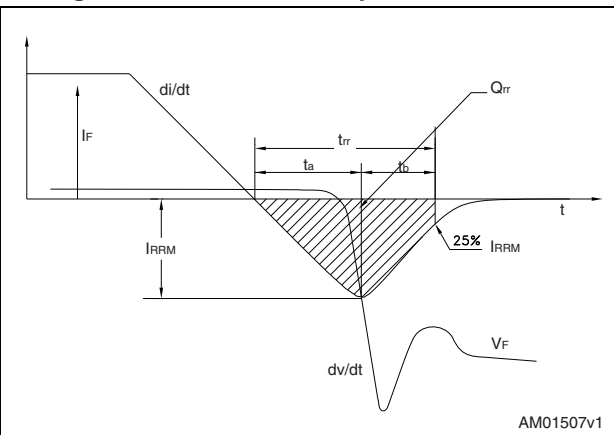


Figure 23. Diode recovery time waveform



## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK is an ST trademark.

**Table 9. TO-247 mechanical data**

Dim.	mm.		
	Min.	Typ.	Max.
A	4.85		5.15
A1	2.20		2.60
b	1.0		1.40
b1	2.0		2.40
b2	3.0		3.40
c	0.40		0.80
D	19.85		20.15
E	15.45		15.75
e	5.30	5.45	5.60
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

Figure 24. TO-247 drawing

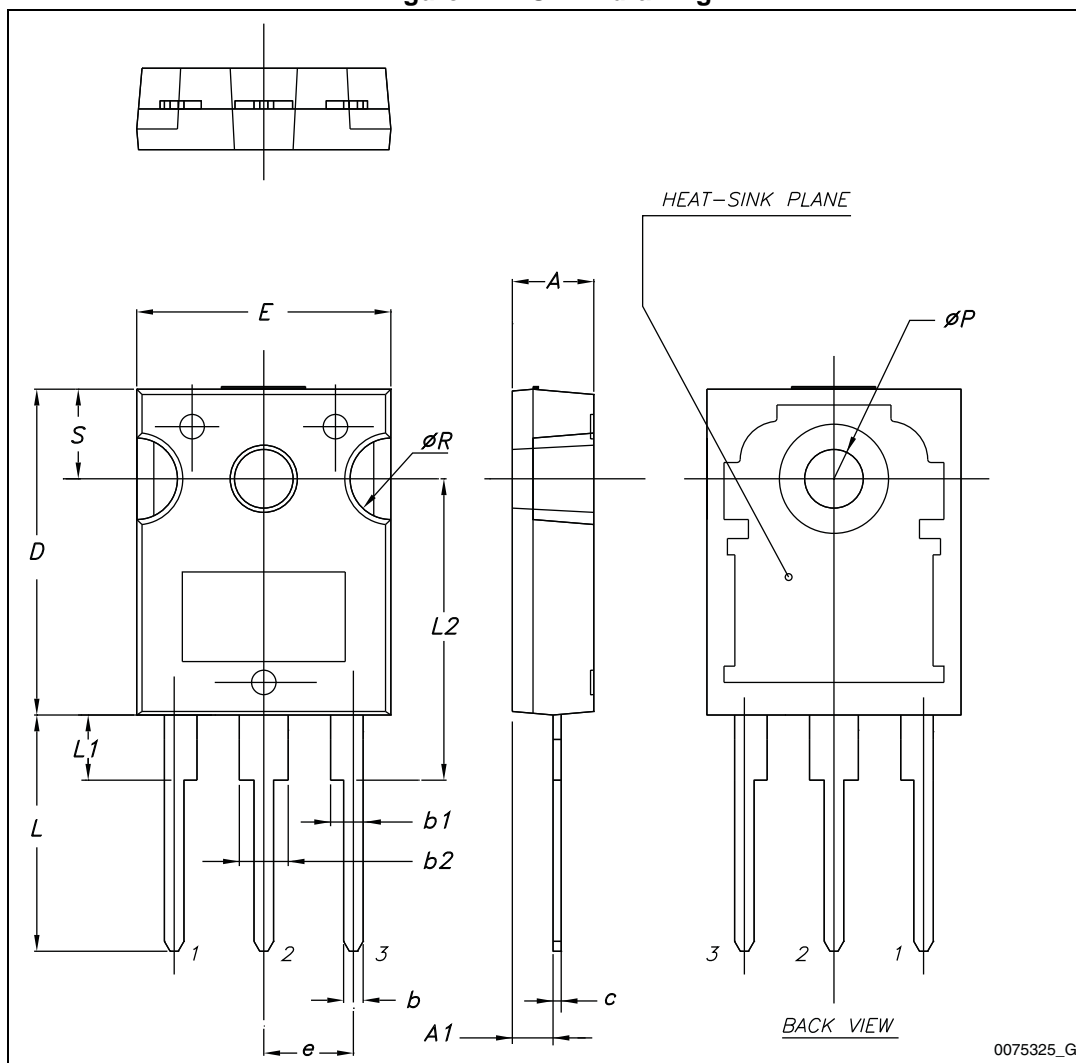
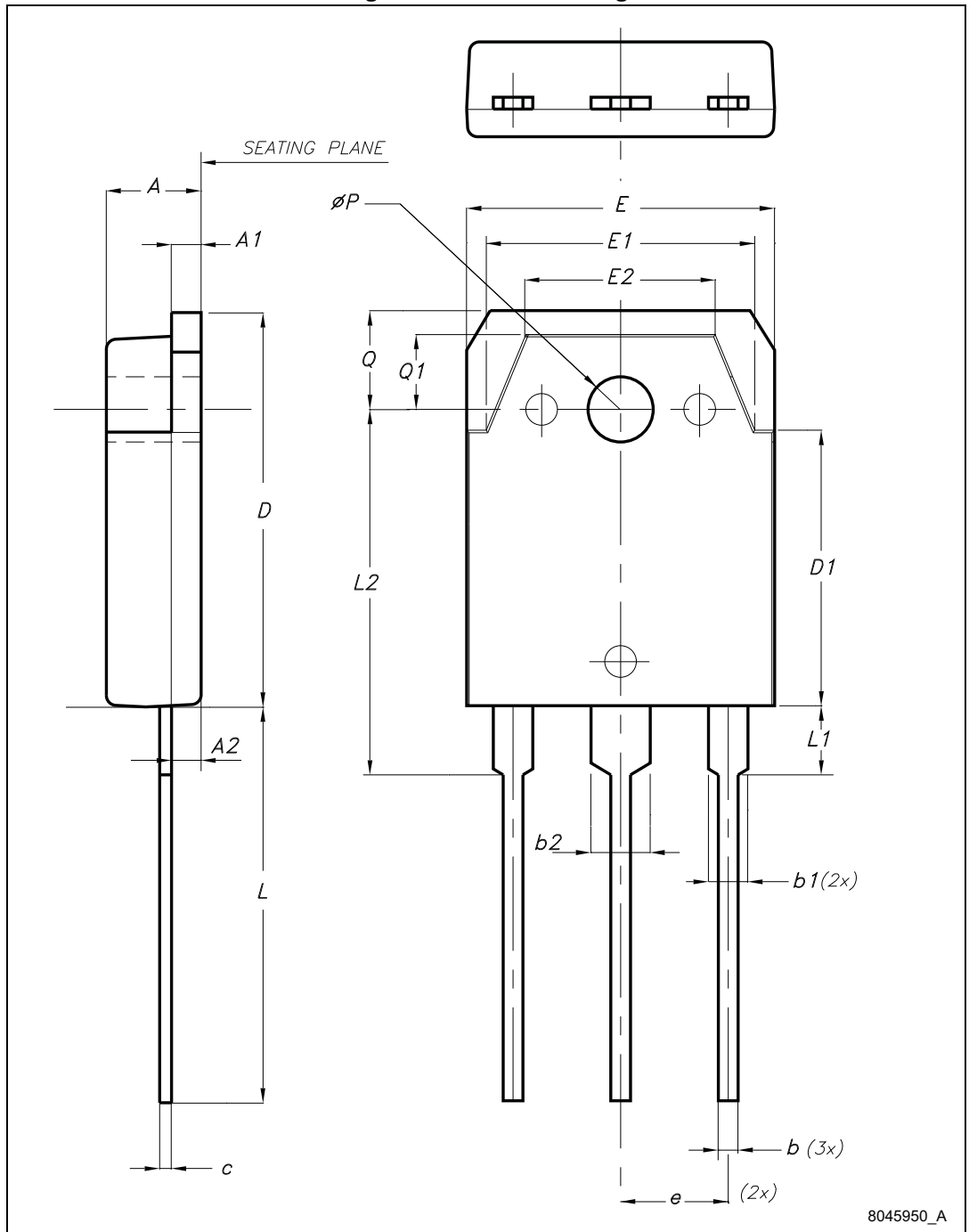


Table 10. TO-3P mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.60		5
A1	1.45	1.50	1.65
A2	1.20	1.40	1.60
b	0.80	1	1.20
b1	1.80		2.20
b2	2.80		3.20
c	0.55	0.60	0.75
D	19.70	19.90	20.10
D1		13.90	
E	15.40		15.80
E1		13.60	
E2		9.60	
e	5.15	5.45	5.75
L	19.50	20	20.50
L1		3.50	
L2	18.20	18.40	18.60
øP	3.10		3.30
Q		5	
Q1		3.80	

Figure 25. TO-3P drawing



## 5 Revision history

Table 11. Document revision history

Date	Revision	Changes
06-Jun-2013	1	Initial release.