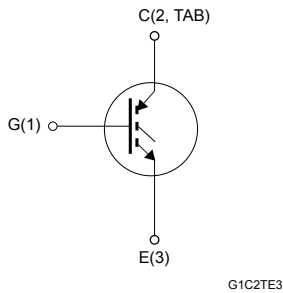
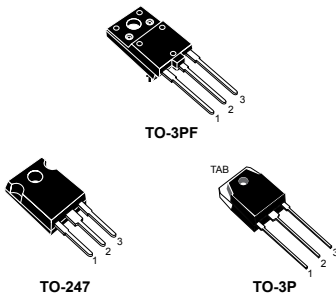


## Trench gate field-stop 650 V, 20 A high speed HB series IGBT



### Features

- Maximum junction temperature:  $T_J = 175\text{ }^\circ\text{C}$
- High speed switching series
- Minimized tail current
- $V_{CE(sat)} = 1.55\text{ V (typ.) @ } I_C = 20\text{ A}$
- Tight parameters distribution
- Safe paralleling
- Low thermal resistance

### Applications

- Photovoltaic inverters
- Power factor correction
- Welding
- High-frequency converters

### Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is part of the new HB series of IGBTs, which represents an optimum compromise between conduction and switching loss to maximize the efficiency of any frequency converter. Furthermore, the slightly positive  $V_{CE(sat)}$  temperature coefficient and very tight parameter distribution result in safer paralleling operation.

#### Product status links

[STGFW20H65FB](#)

[STGW20H65FB](#)

[STGWT20H65FB](#)

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-247, TO-3P	TO-3PF	
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0\text{ V}$ )	650		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	±20		V
$V_{ISO}$	Insulation withstand voltage (RMS) from all three leads to external heat sink ( $t = 1\text{ s}$ , $T_C = 25\text{ °C}$ )		3.5	kV
$P_{TOT}$	Total power dissipation at $T_C = 25\text{ °C}$	168	86.7	W
$T_{STG}$	Storage temperature range	-55 to 150		°C
$T_J$	Operating junction temperature range	-55 to 175		°C

1. Pulse width is limited by maximum junction temperature.

**Table 2. Thermal data**

Symbol	Parameter	Value		Unit
		TO-247, TO-3P	TO-3PF	
$R_{thJC}$	Thermal resistance, junction-to-case	0.9	1.73	°C/W
$R_{thJA}$	Thermal resistance, junction-to-ambient	50		°C/W

## 2 Electrical characteristics

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

**Table 3. Static characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	$V_{GE} = 0\text{ V}$ , $I_C = 2\text{ mA}$	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}$ , $I_C = 20\text{ A}$		1.55	2.00	V
		$V_{GE} = 15\text{ V}$ , $I_C = 20\text{ A}$ , $T_J = 125\text{ °C}$		1.65		
		$V_{GE} = 15\text{ V}$ , $I_C = 20\text{ A}$ , $T_J = 175\text{ °C}$		1.75		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}$ , $I_C = 1\text{ mA}$	5	6	7	V
$I_{CES}$	Collector cut-off current	$V_{GE} = 0\text{ V}$ , $V_{CE} = 650\text{ V}$			25	$\mu\text{A}$
$I_{GES}$	Gate-emitter leakage current	$V_{CE} = 0\text{ V}$ , $V_{GE} = \pm 20\text{ V}$			250	nA

**Table 4. Dynamic characteristics**

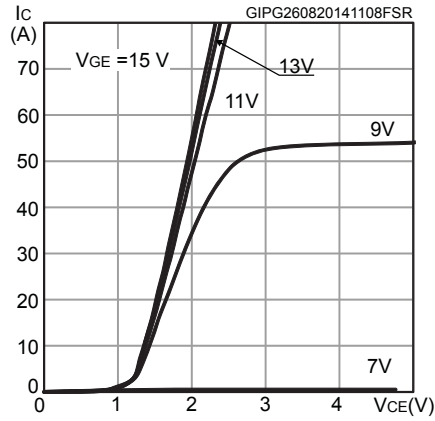
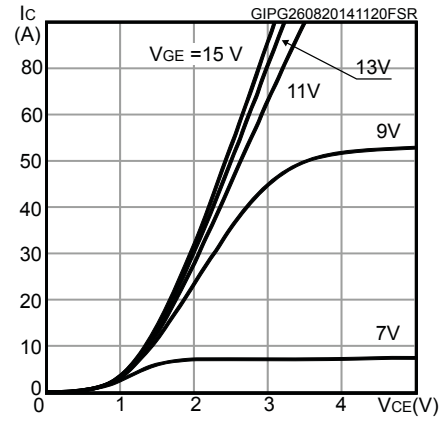
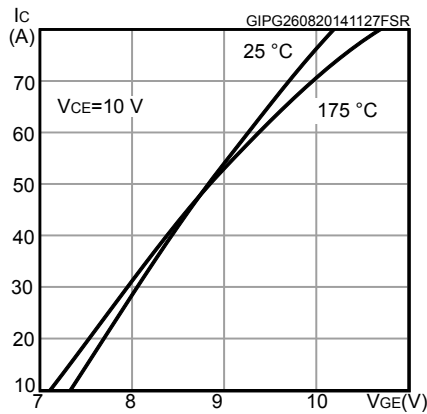
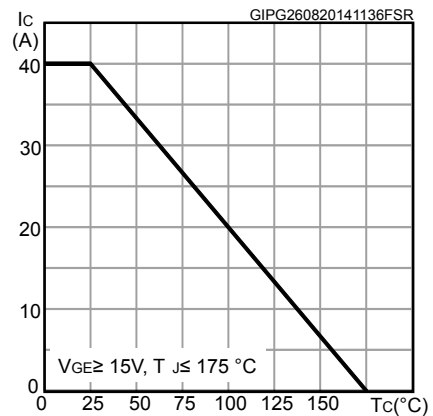
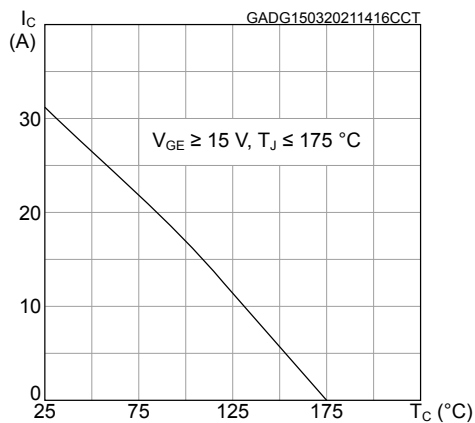
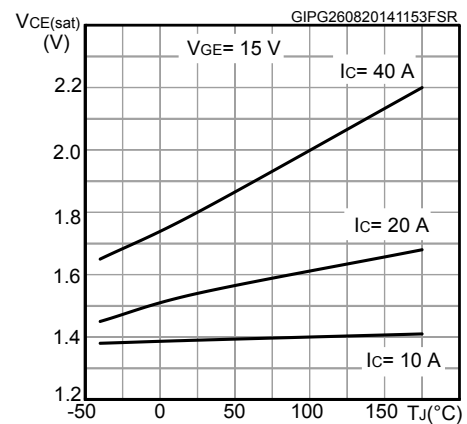
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0\text{ V}$	-	2764	-	pF
$C_{oes}$	Output capacitance		-	80	-	pF
$C_{res}$	Reverse transfer capacitance		-	60	-	pF
$Q_g$	Total gate charge	$V_{CC} = 520\text{ V}$ , $I_C = 20\text{ A}$ , $V_{GE} = 0\text{ to }15\text{ V}$ (see Figure 26. Gate charge test circuit)	-	120	-	nC
$Q_{ge}$	Gate-emitter charge		-	20	-	nC
$Q_{gc}$	Gate-collector charge		-	50	-	nC

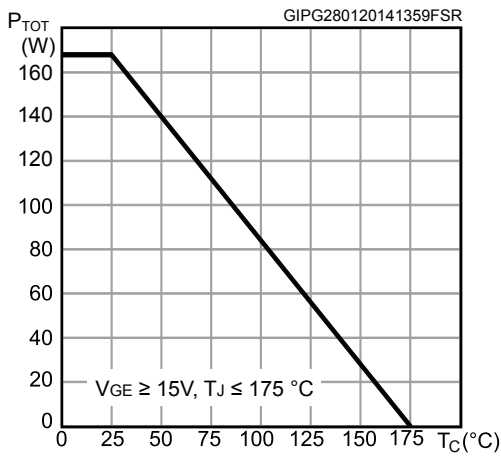
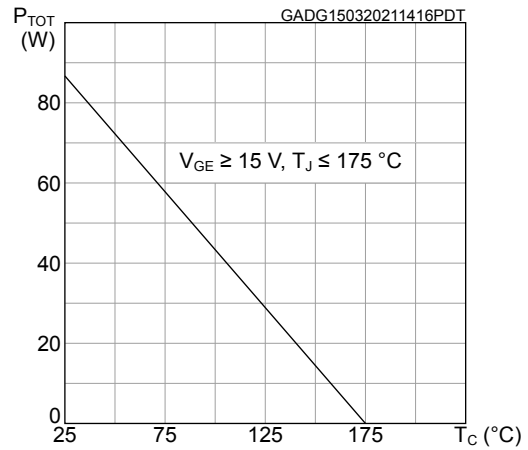
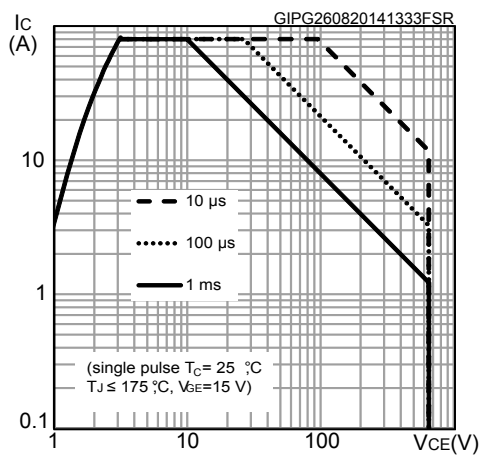
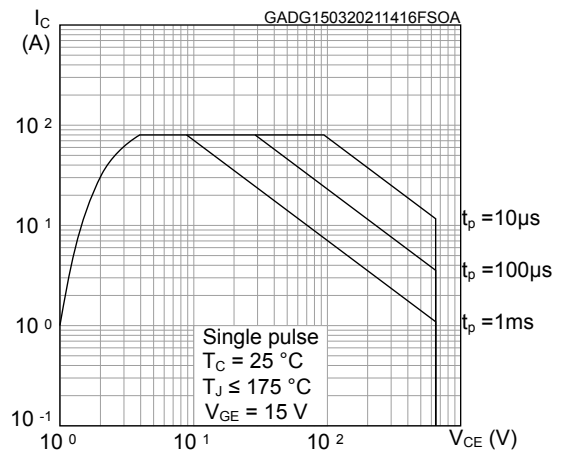
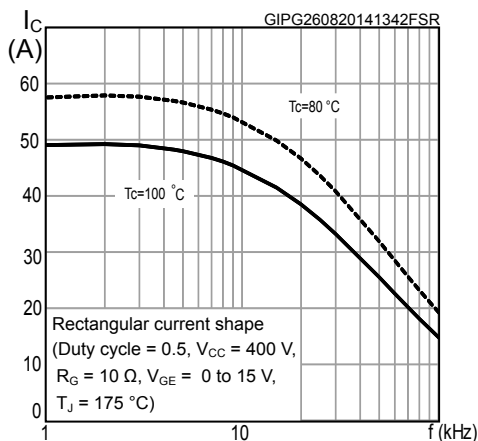
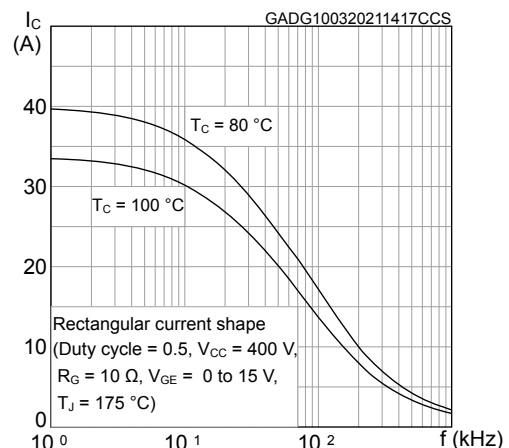
**Table 5. Switching characteristics (inductive load)**

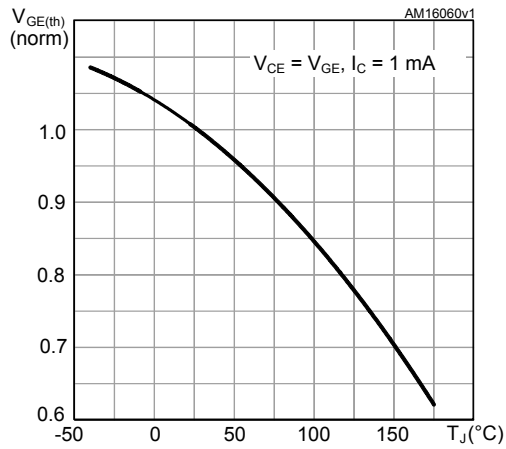
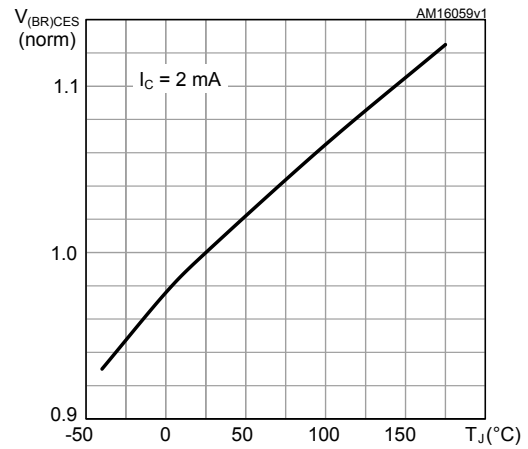
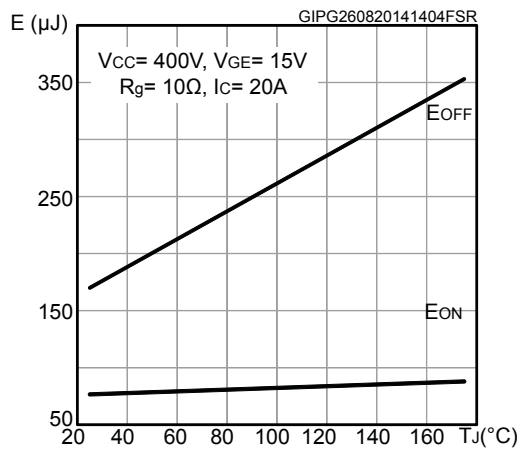
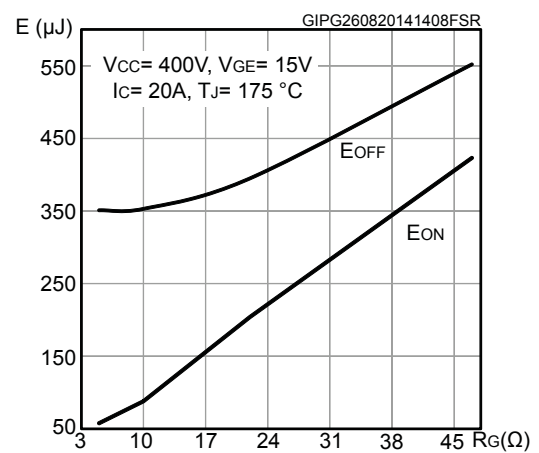
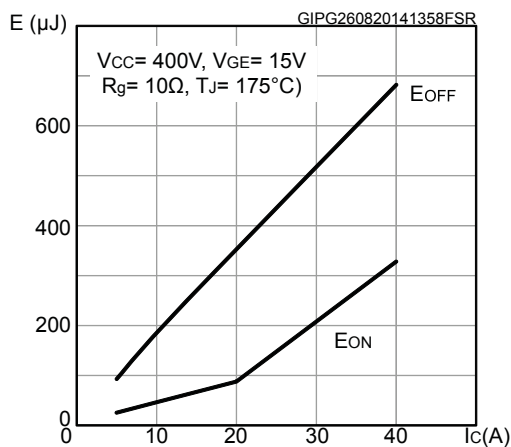
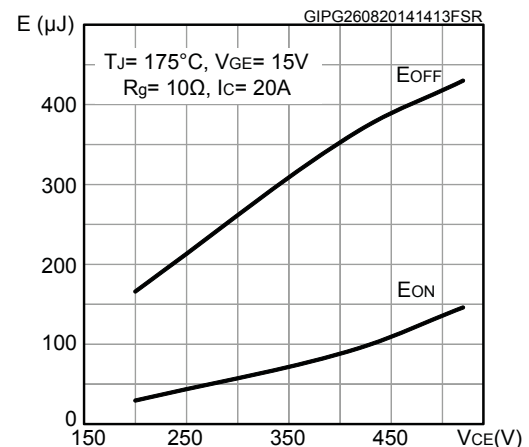
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ (see Figure 25. Test circuit for inductive load switching)	-	30	-	ns
$t_r$	Current rise time		-	11	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1400	-	A/ $\mu$ s
$t_{d(off)}$	Turn-off delay time		-	139	-	ns
$t_f$	Current fall time		-	20	-	ns
$E_{on}^{(1)}$	Turn-on switching energy		-	77	-	$\mu$ J
$E_{off}^{(2)}$	Turn-off switching energy		-	170	-	$\mu$ J
$E_{ts}$	Total switching energy		-	247	-	$\mu$ J
$t_{d(on)}$	Turn-on delay time		$V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$ (see Figure 25. Test circuit for inductive load switching)	-	29	-
$t_r$	Current rise time	-		12	-	ns
$(di/dt)_{on}$	Turn-on current slope	-		1352	-	A/ $\mu$ s
$t_{d(off)}$	Turn-off-delay time	-		147	-	ns
$t_f$	Current fall time	-		38	-	ns
$E_{on}^{(1)}$	Turn-on switching energy	-		88	-	$\mu$ J
$E_{off}^{(2)}$	Turn-off switching energy	-		353	-	$\mu$ J
$E_{ts}$	Total switching energy	-		441	-	$\mu$ J

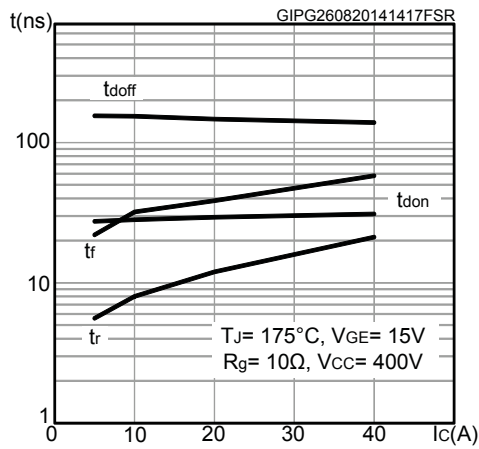
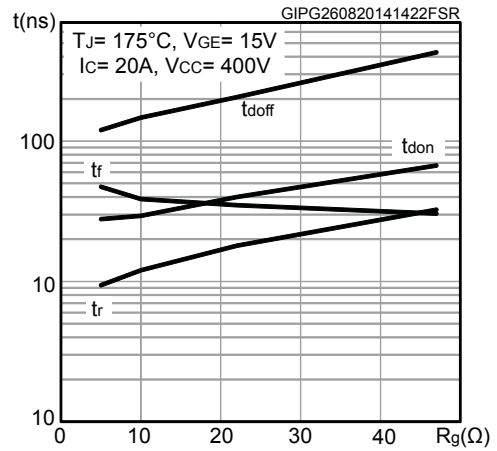
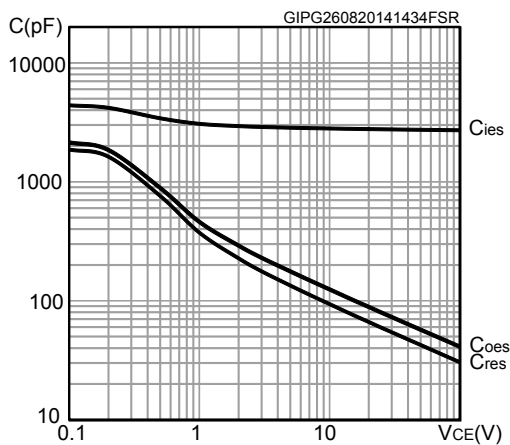
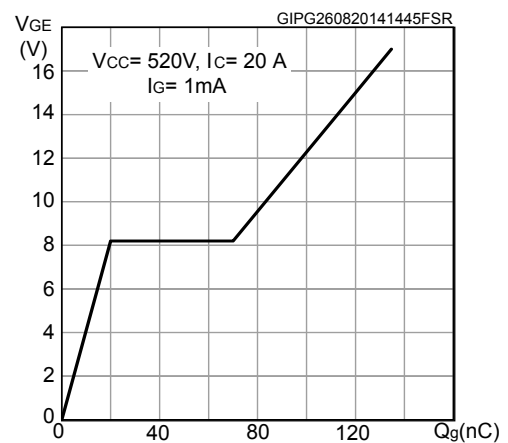
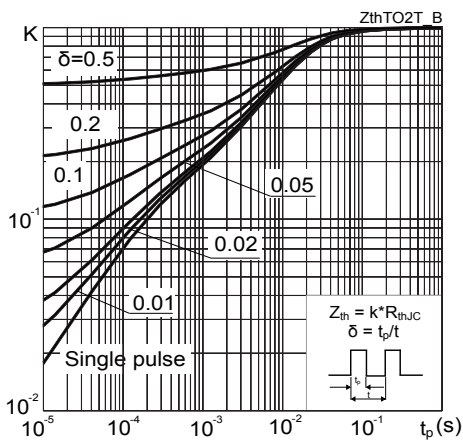
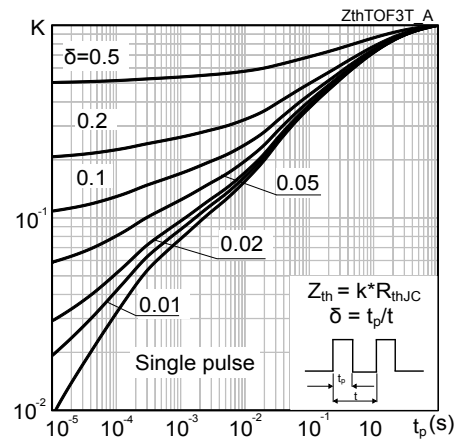
1. Including the reverse recovery of the external SiC diode STPSC206W.

2. Including the tail of the collector current.

**2.1 Electrical characteristics (curves)**
**Figure 1. Output characteristics ( $T_J = 25^\circ\text{C}$ )**

**Figure 2. Output characteristics ( $T_J = 175^\circ\text{C}$ )**

**Figure 3. Transfer characteristics**

**Figure 4. Collector current vs case temperature for TO-247 and TO-3P**

**Figure 5. Collector current vs case temperature for TO-3PF**

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


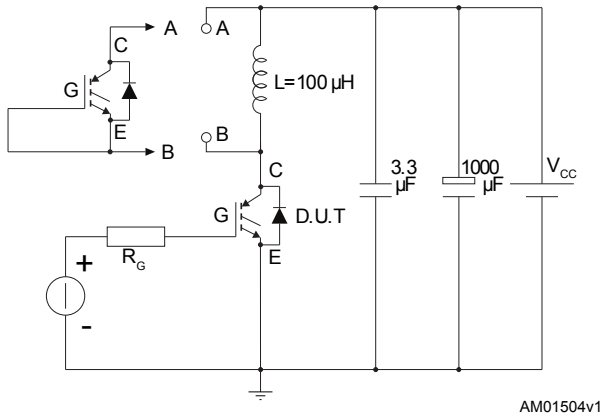
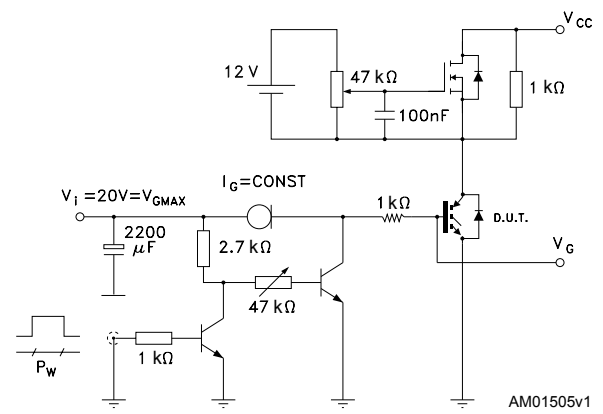
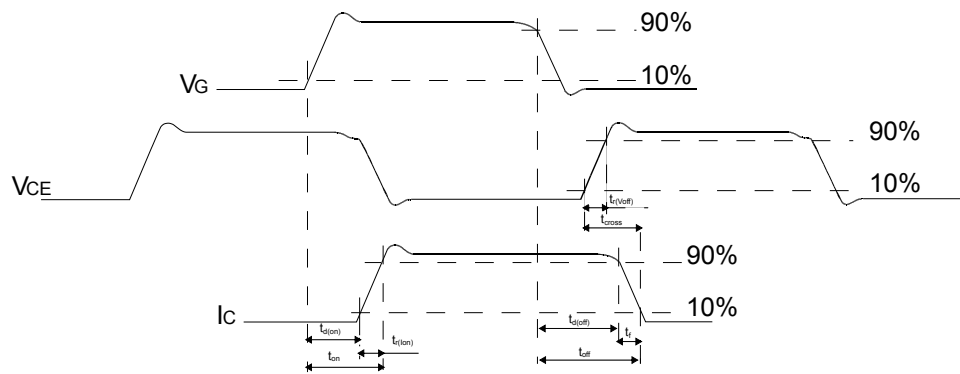
**Figure 7. Power dissipation vs case temperature for TO-247 and TO-3P**

**Figure 8. Power dissipation vs case temperature for TO-3PF**

**Figure 9. Forward bias safe operating area for TO-247 and TO-3P**

**Figure 10. Forward bias safe operating area for TO-3PF**

**Figure 11. Collector current vs. switching frequency for TO-247 and TO-3P**

**Figure 12. Collector current vs. switching frequency for TO-3PF**


**Figure 13. Normalized  $V_{GE(th)}$  vs junction temperature**

**Figure 14. Normalized  $V_{(BR)CES}$  vs junction temperature**

**Figure 15. Switching energy vs temperature**

**Figure 16. Switching energy vs gate resistance**

**Figure 17. Switching energy vs collector current**

**Figure 18. Switching energy vs collector emitter voltage**


**Figure 19. Switching times vs collector current**

**Figure 20. Switching times vs gate resistance**

**Figure 21. Capacitance variations**

**Figure 22. Gate charge vs gate-emitter voltage**

**Figure 23. Thermal impedance for TO-247 and TO-3P**

**Figure 24. Thermal impedance for in TO-3PF**




### 3 Test circuits

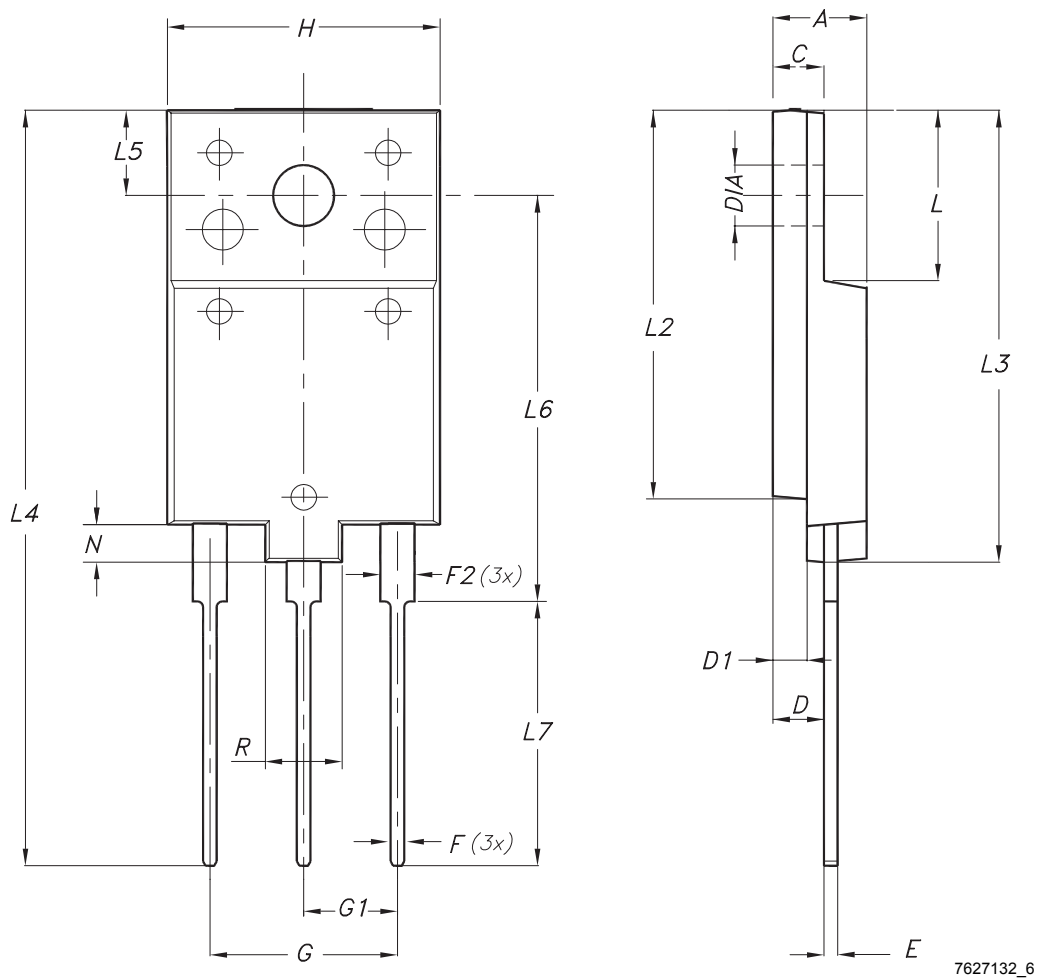
**Figure 25. Test circuit for inductive load switching**

**Figure 26. Gate charge test circuit**

**Figure 27. Switching waveform**


## 4 Package information

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

### 4.1 TO-3PF package information

Figure 28. TO-3PF package outline



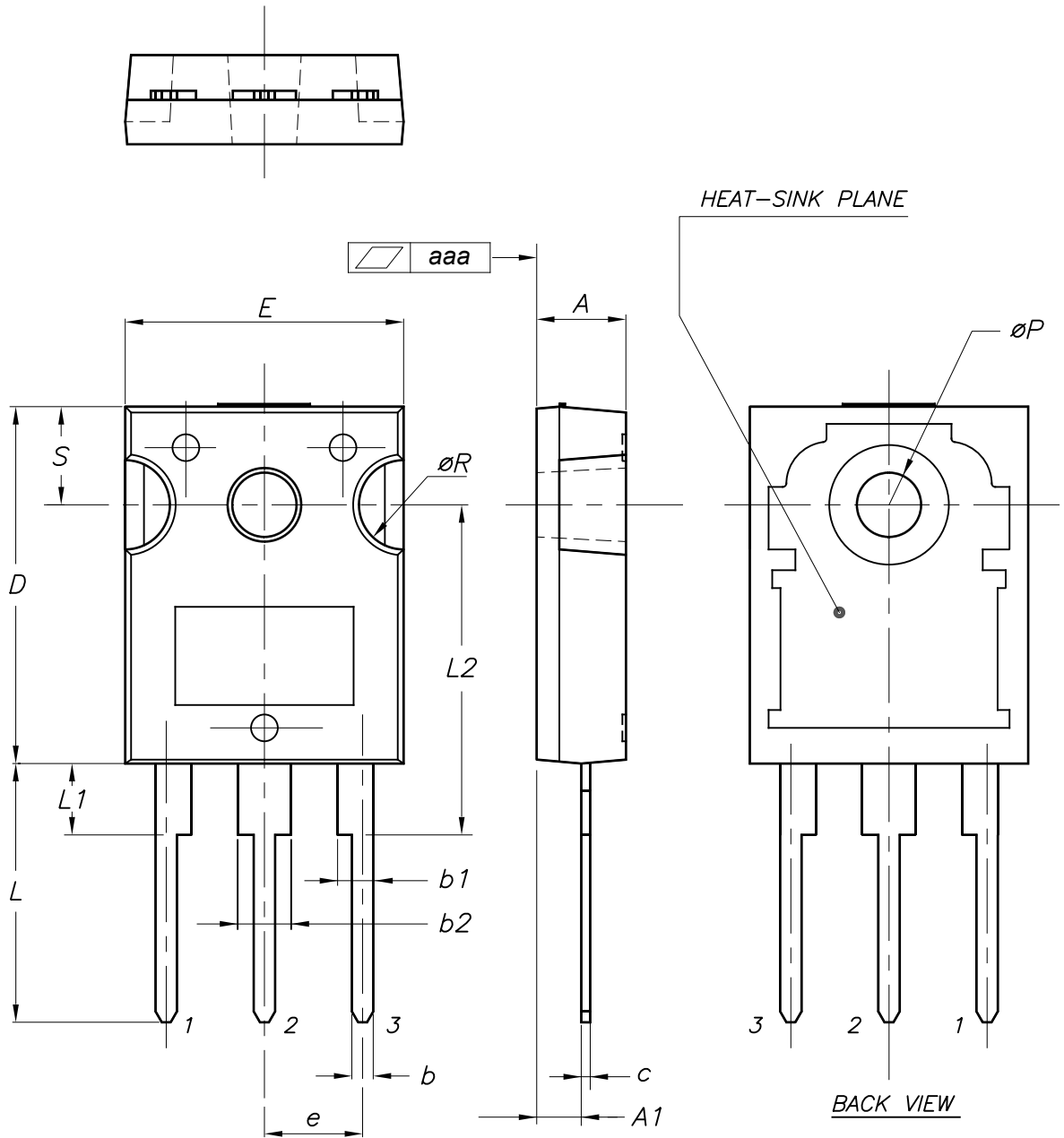
7627132\_6

**Table 6. TO-3PF mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	5.30		5.70
C	2.80		3.20
D	3.10		3.50
D1	1.80		2.20
E	0.80		1.10
F	0.65		0.95
F2	1.80		2.20
G	10.30		11.50
G1		5.45	
H	15.30		15.70
L	9.80	10.00	10.20
L2	22.80		23.20
L3	26.30		26.70
L4	43.20		44.40
L5	4.30		4.70
L6	24.30		24.70
L7	14.60		15.00
N	1.80		2.20
R	3.80		4.20
Dia	3.40		3.80

## 4.2 TO-247 package information

Figure 29. TO-247 package outline



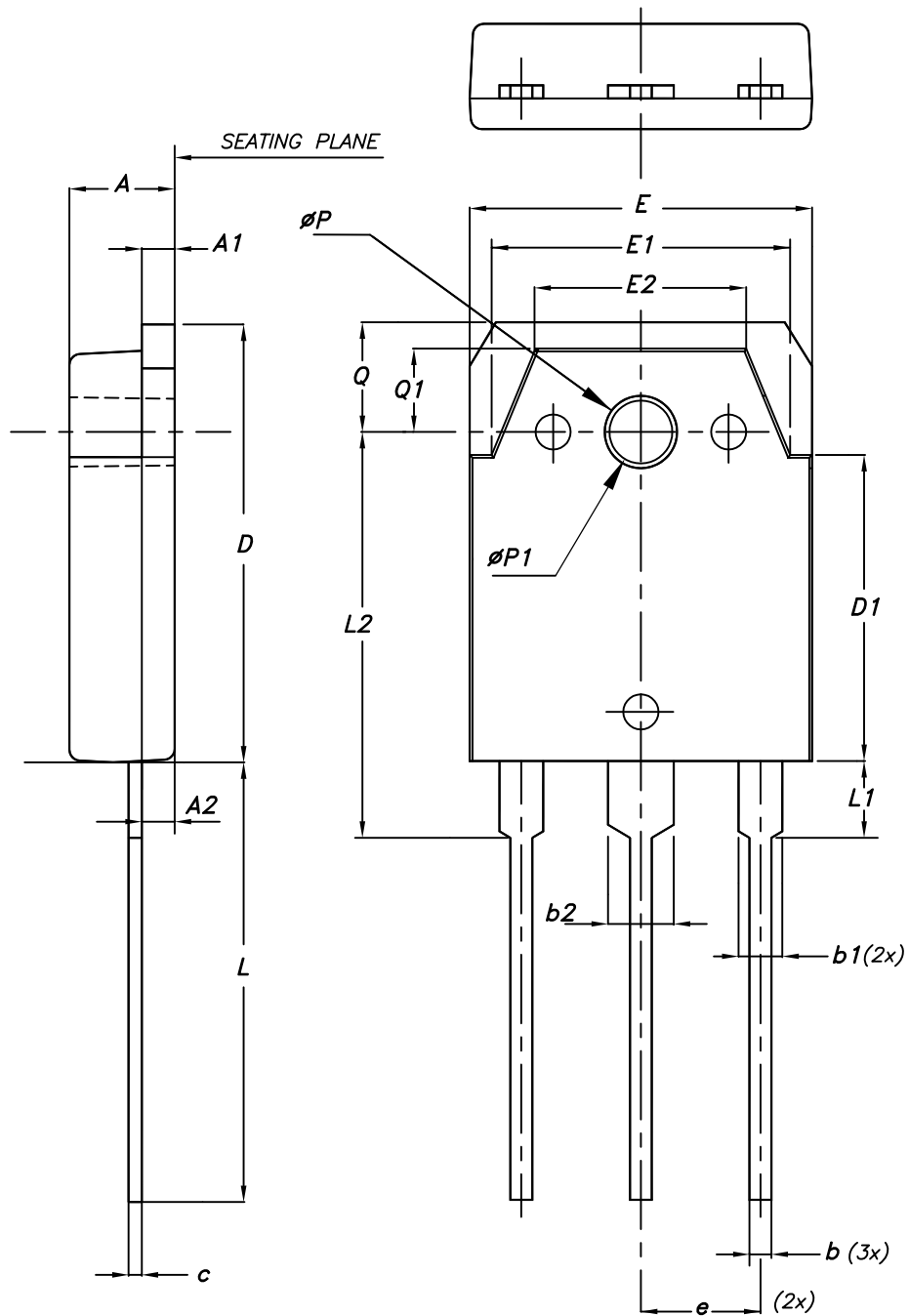
0075325\_10

**Table 7. TO-247 package 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
aaa		0.04	0.10

### 4.3 TO-3P package information

Figure 30. TO-3P package outline



8045950\_3

**Table 8. TO-3P package mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.60	4.80	5.00
A1	1.45	1.50	1.65
A2	1.20	1.40	1.60
b	0.80	1.00	1.20
b1	1.80	2.00	2.20
b2	2.80	3.00	3.20
c	0.55	0.60	0.75
D	19.70	19.90	20.10
D1	13.70	13.90	14.10
E	15.40	15.60	15.80
E1	13.40	13.60	13.80
E2	9.40	9.60	9.90
e	5.15	5.45	5.75
L	19.80	20.00	20.20
L1	3.30	3.50	3.70
L2	18.20	18.40	18.60
ØP	3.30	3.40	3.50
ØP1	3.10	3.20	3.30
Q	4.80	5.00	5.20
Q1	3.60	3.80	4.00



## 5 Ordering information

Table 9. Order codes

Order code	Marking	Package	Packing
STGFW20H65FB	G20H65FB	TO-3PF	Tube
STGW20H65FB	GW20H65FB	TO-247	
STGWT20H65FB	GWT20H65FB	TO-3P	



## Revision history

**Table 10. Document revision history**

Date	Revision	Changes
28-Aug-2014	1	Initial release.
15-Apr-2020	2	Updated applications in cover page. Updated <i>Table 9. Order codes</i> . Minor text changes.
16-Mar-2021	3	Updated <i>Section 1 Electrical ratings</i> . Updated <i>Figure 5. Collector current vs case temperature for TO-3PF</i> , <i>Figure 8. Power dissipation vs case temperature for TO-3PF</i> , <i>Figure 10. Forward bias safe operating area for TO-3PF</i> and <i>Figure 12. Collector current vs. switching frequency for TO-3PF</i> . Updated <i>Section 4.2 TO-247 package information</i> . Minor text changes.



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