45 A, 600 V ultra fast IGBT with low drop diode

Features

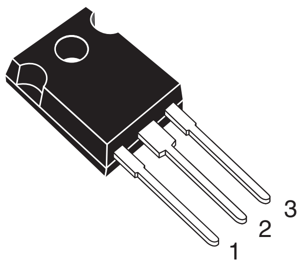
- Improved E_{off} at elevated temperature
- Low V_F soft recovery antiparallel diode

Applications

- Welding
- Induction heating
- Resonant converters

Description

The STGW45HF60WDI is based on a new advanced planar technology concept to yield an IGBT with more stable switching performance (E_{off}) versus temperature, as well as lower conduction losses. The device is tailored to high switching frequency operation (over 100 kHz).



TO-247

Figure 1. Internal schematic diagram

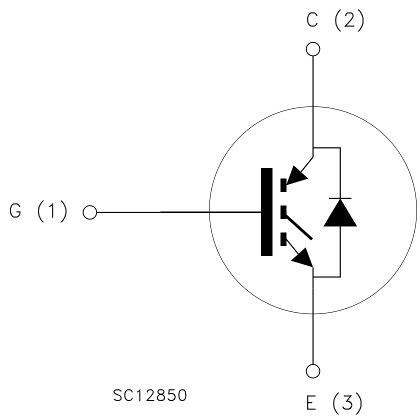


Table 1. Device summary

Order code	Marking	Package	Packaging
STGW45HF60WDI	GW45HF60WDI	TO-247	Tube
STGWA45HF60WDI	45HF60WDI	TO-247 long leads	

Content

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-247	TO-247 long leads	
V_{CES}	Collector-emitter voltage (V_{GE} = 0)	600		V
I_C (1)	Continuous collector current at T_C = 25 °C	70	80	A
I_C (1)	Continuous collector current at T_C = 100 °C	45	50	A
I_{CP} (2)	Pulsed collector current	150		A
I_{CL} (3)	Turn-off latching current	80		A
V_{GE}	Gate-emitter voltage	± 20		V
I_F	Diode RMS forward current at T_C = 25 °C	30		A
I_{FSM}	Surge not repetitive forward current t_p= 10 ms sinusoidal	130		A
P_{TOT}	Total dissipation at T_C = 25 °C	250	310	W
T_{stg}	Storage temperature	– 55 to 150		°C
T_j	Operating junction temperature			

1. Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{j(max)} - T_C}{R_{thj-c} \times V_{CE(sat)(max)}(T_{j(max)}, I_C(T_C))}$$

2. Pulse width limited by maximum junction temperature and turn-off within RBSOA
3. V_{CLAMP} = 80% (V_{CES}), V_{GE} = 15 V, R_G = 10 Ω, T_J = 150 °C

Table 3. Thermal data

Symbol	Parameter	Value		Unit
		TO-247	TO-247 long leads	
$R_{thj\text{-}case}$	Thermal resistance junction-case IGBT	0.5	0.4	°C/W
	Thermal resistance junction-case diode	1.5		°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient	50		°C/W

2 Electrical characteristics

(T_J = 25 °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 = 1 mA	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C= 30 A V_{GE} = 15V, I_C = 30 A,T_J= 125 °C		1.9 1.65	2.5	V V
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 1 mA	3.75		5.75	V
I_{CES}	Collector cut-off current (V_{GE} = 0)	V_{CE} = 600 V V_{CE} = 600 V, T_J = 125 °C			500 5	µA mA
I_{GES}	Gate-emitter leakage current (V_{CE} = 0)	V_{GE} = ±20 V			± 100	nA

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies} C_{oes} C_{res}	Input capacitance Output capacitance Reverse transfer capacitance	V_{CE} = 25 V, f = 1 MHz, V_{GE} = 0	-	2900 260 55	-	pF pF pF
Q_g Q_{ge} Q_{gc}	Total gate charge Gate-emitter charge Gate-collector charge	V_{CE} = 400 V, I_C = 30 A, V_{GE} = 15 V *Figure 18*	-	160 17 65	-	nC nC nC

Table 6. Switching off (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_r(V_{off})$ $t_d(_{off})$ t_f	Off voltage rise time Turn-off delay time Current fall time	V_{CC} = 400 V, I_C = 30 A, R_{GE} = 4.7 Ω, V_{GE} = 15 V *Figure 17*	-	30 145 50	-	ns ns ns
$t_r(V_{off})$ $t_d(_{off})$ t_f	Off voltage rise time Turn-off delay time Current fall time	V_{CC} = 400 V, I_C = 30 A, R_{GE} = 4.7 Ω, V_{GE} =15 V, T_J = 125 °C *Figure 17*	-	47 185 65	-	ns ns ns

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
E_{off}	Turn-off switching losses	V_{CC} = 400 V, I_C = 30 A R_G = 4.7 Ω, V_{GE} = 15 V, *Figure 19*	-	330		µJ
E_{off}	Turn-off switching losses	V_{CC} = 400 V, I_C = 30 A R_G = 4.7 Ω, V_{GE} = 15 V, T_J = 125 °C, *Figure 19*	-	550	800	µJ

Table 8. Collector-emitter diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_F	Forward on-voltage	I_F = 30 A I_F = 30 A, T_J = 125 °C	-	1.4 1.2	1.8	V V
t_{rr} Q_{rr} I_{rrm}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_F = 30 A,V_R = 50 V, di/dt = 100 A/µs *Figure 20*	-	90 305 5.2	-	ns nC A
t_{rr} Q_{rr} I_{rrm}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_F = 30 A,V_R = 50 V, T_J =125 °C, di/dt = 100 A/µs *Figure 20*	-	235 1100 9	-	ns nC A

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

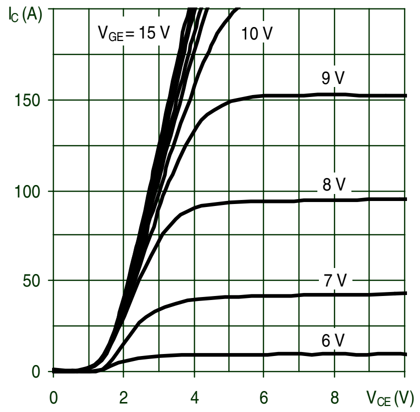


Figure 3. Transfer characteristics

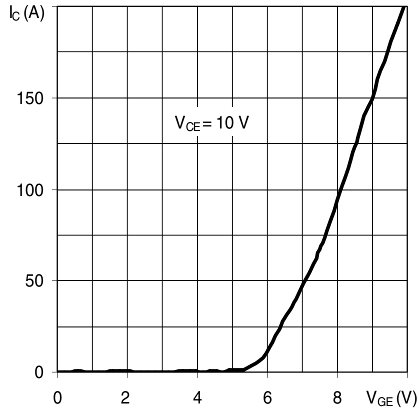


Figure 4. Normalized $V_{CE(sat)}$ vs. I_C

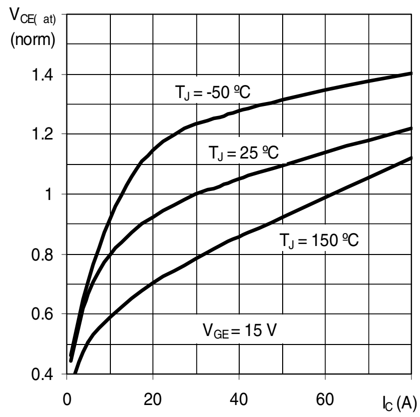


Figure 5. Normalized $V_{CE(sat)}$ vs. temperature

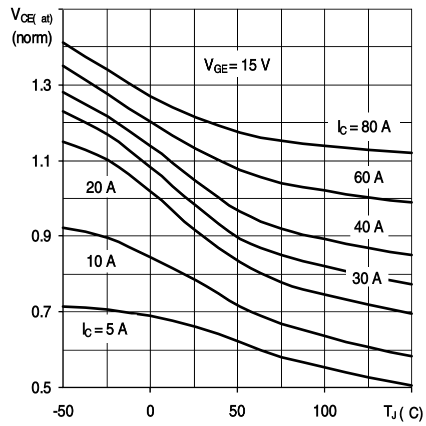


Figure 6. Normalized breakdown voltage vs. temperature

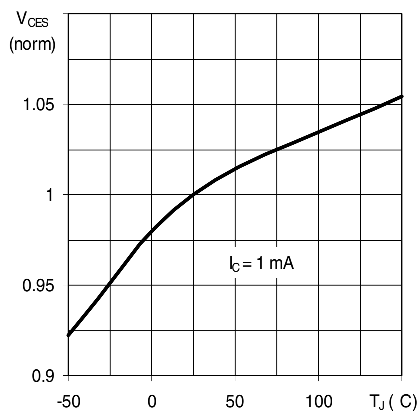


Figure 7. Normalized gate threshold voltage vs. temperature

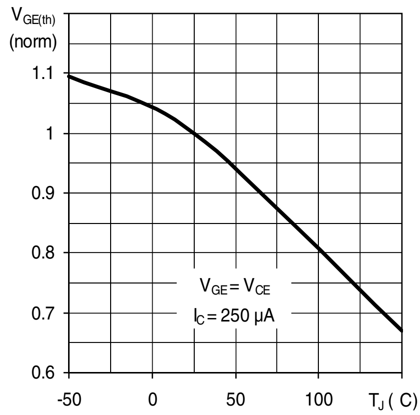


Figure 8. Gate charge vs. gate-emitter voltage

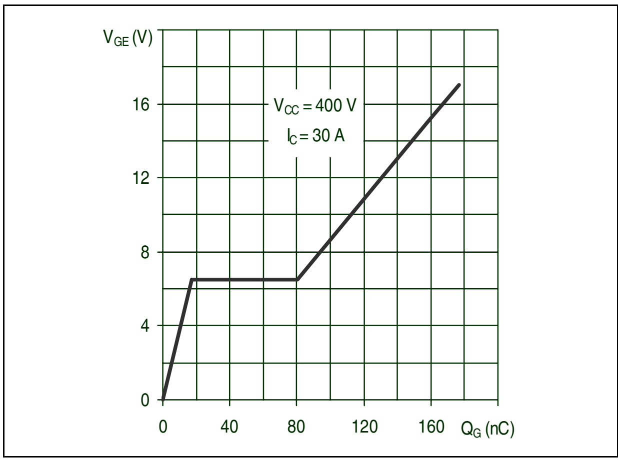


Figure 9. Capacitances variations

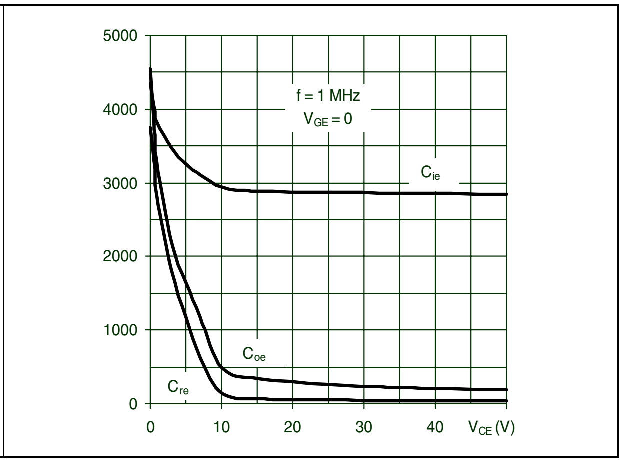


Figure 10. Switching losses vs. temperature

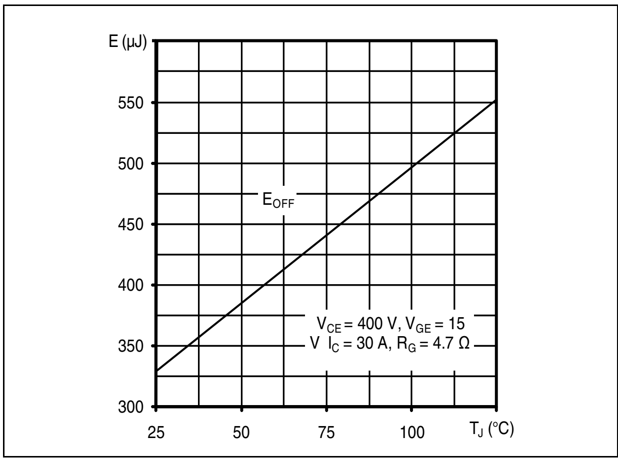


Figure 11. Switching losses vs. gate resistance

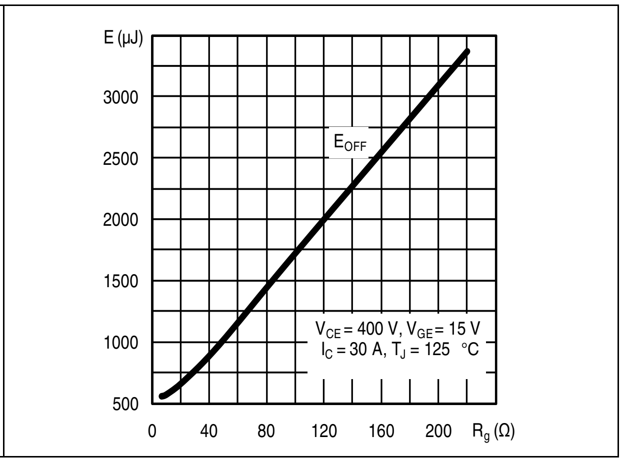


Figure 12. Switching losses vs. collector current

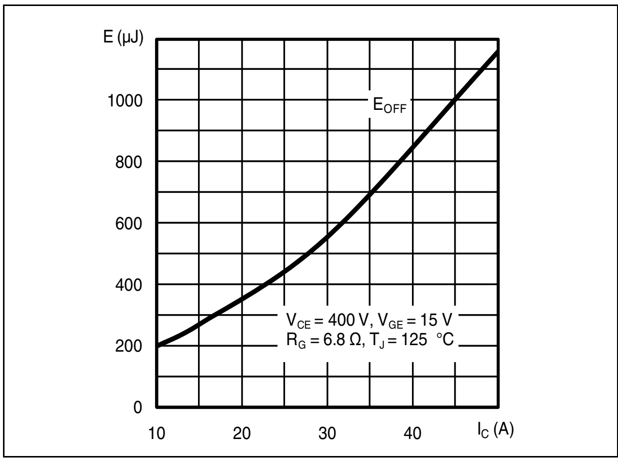


Figure 13. Turn-off SOA

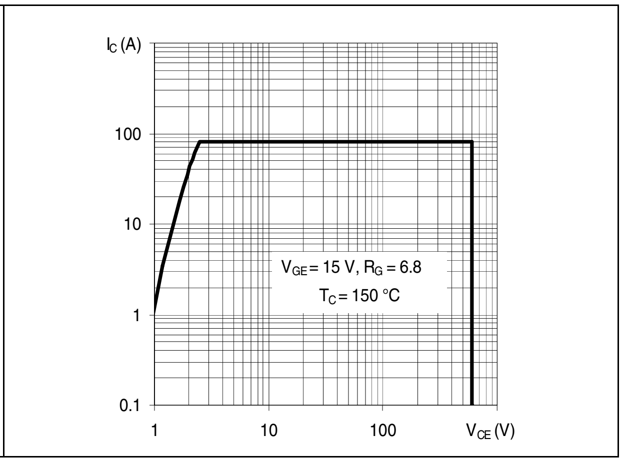


Figure 14. Diode forward on voltage

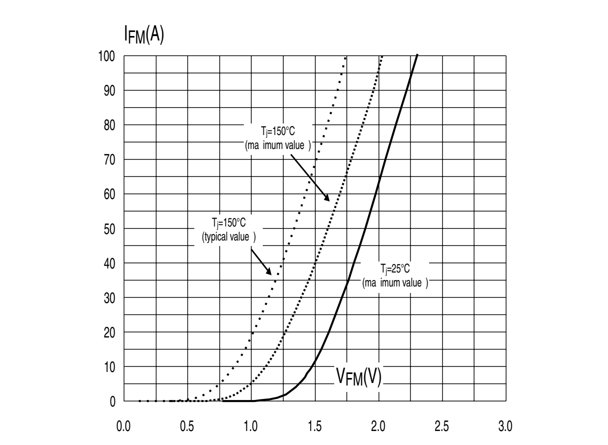


Figure 15. Thermal impedance for TO-247

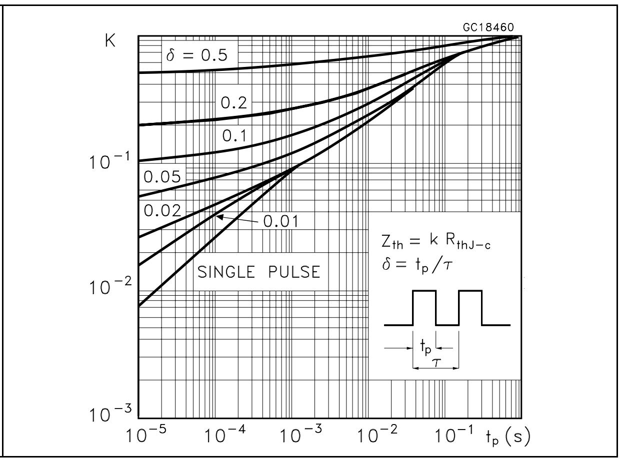
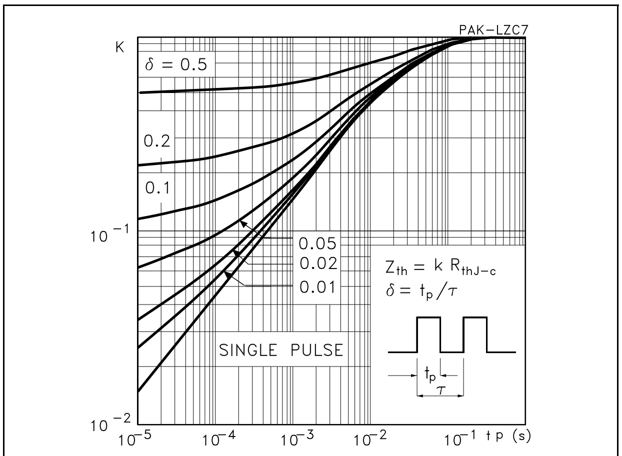


Figure 16. Thermal impedance for TO-247 narrow leads



3 Test circuits

Figure 17. Test circuit for inductive load switching

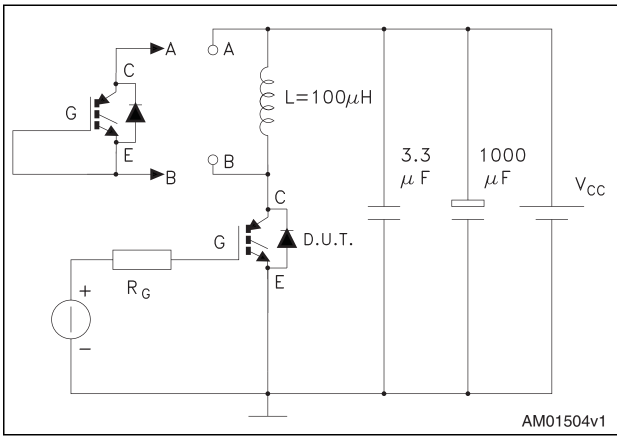


Figure 18. Gate charge test circuit

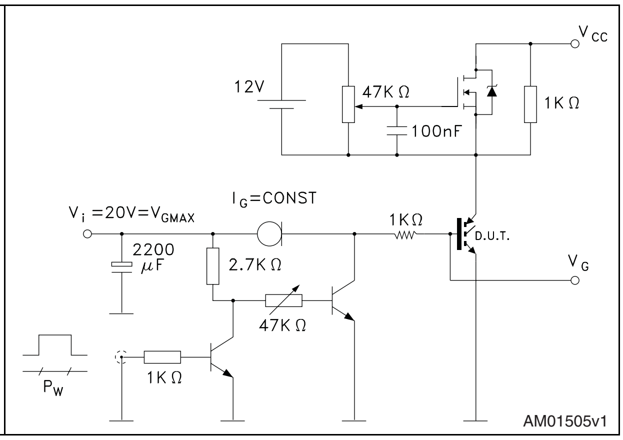


Figure 19. Switching waveform

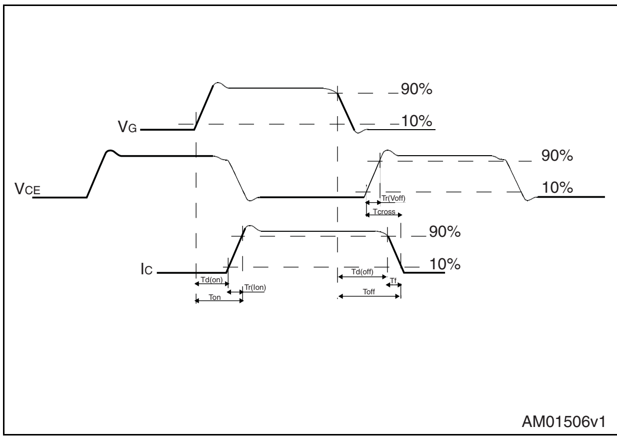
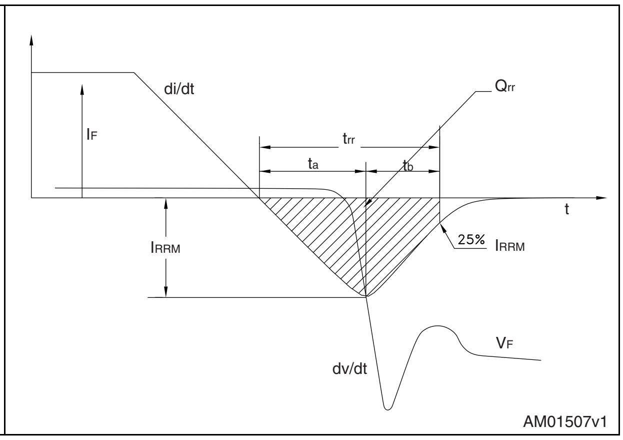


Figure 20. Diode recovery time waveform



4 Package mechanical data

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. 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		5.45	
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
∅P	3.55		3.65
∅R	4.50		5.50
S		5.50	

Figure 21. TO-247 drawing

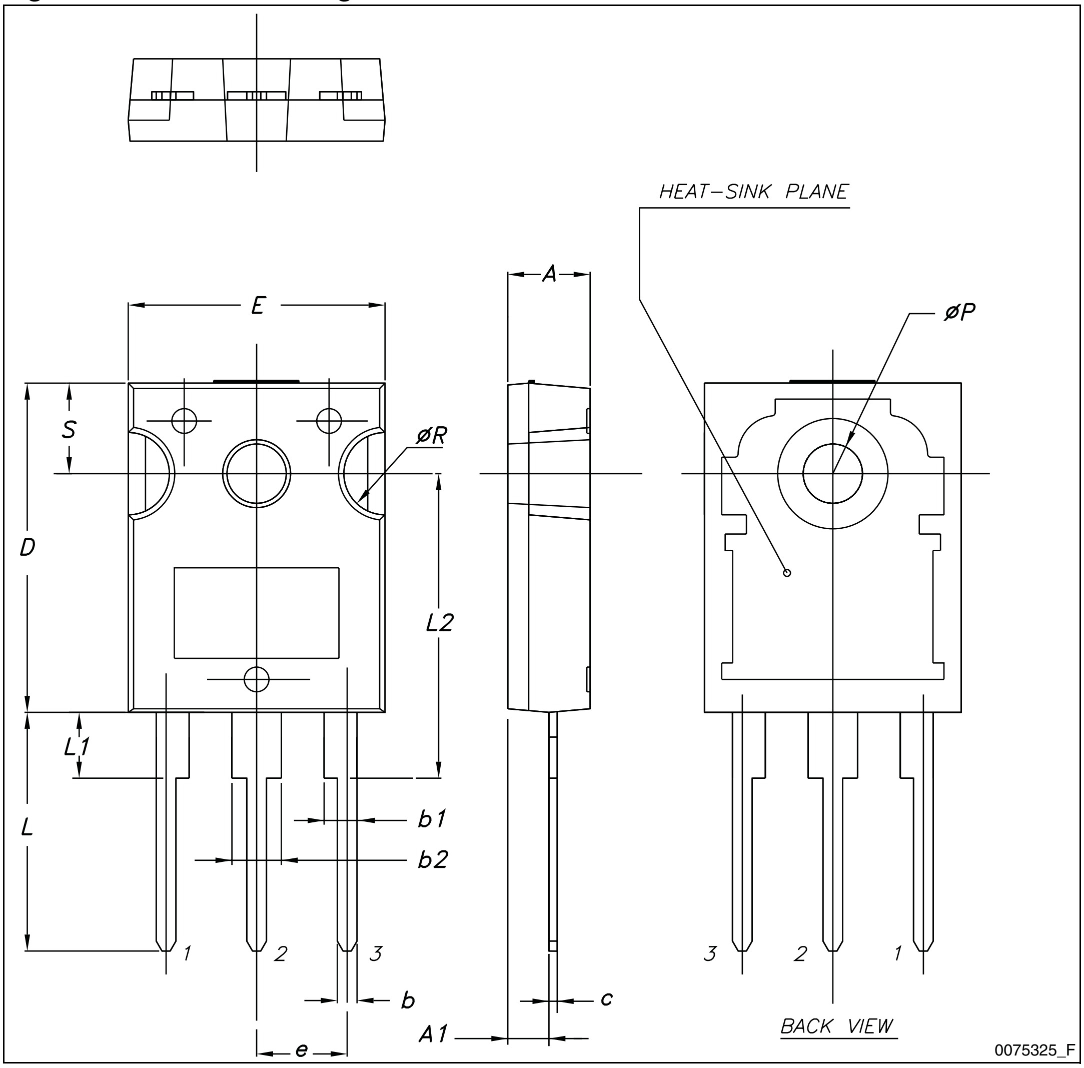
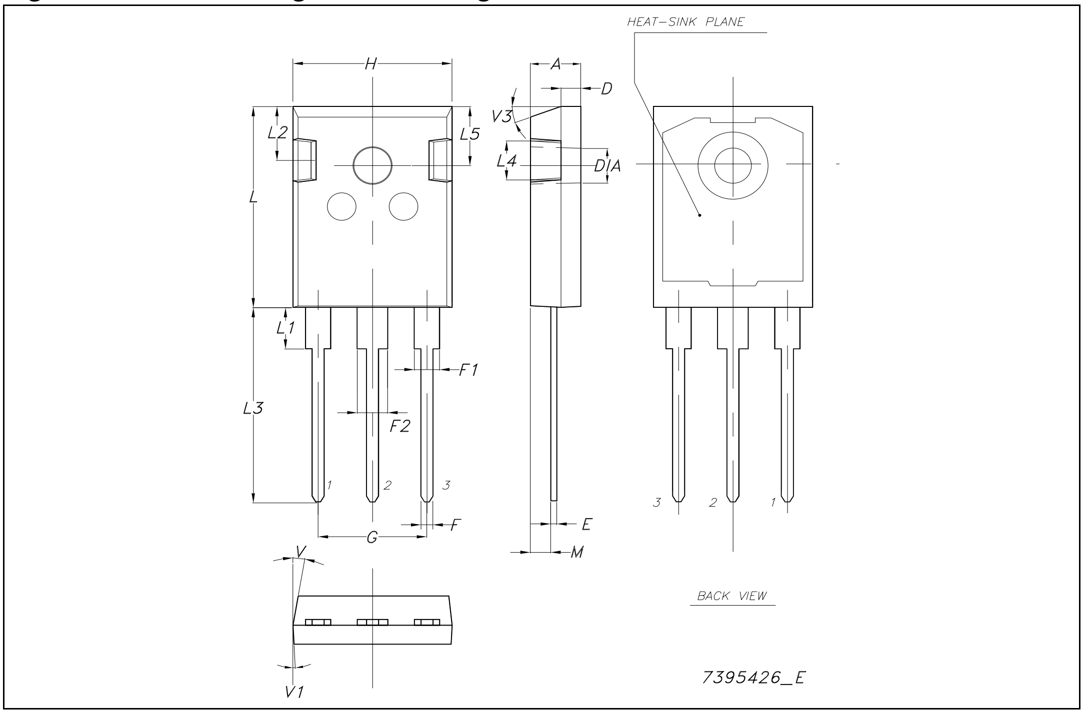


Table 10. TO-247 long leads mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.90		5.15
D	1.85		2.10
E	0.55		0.67
F	1.07		1.32
F1	1.90		2.38
F2	2.87		3.38
G	10.90 BSC		
H	15.77		16.02
L	20.82		21.07
L1	4.16		4.47
L2	5.49		5.74
L3	20.05		20.30
L4	3.68		3.93
L5	6.04		6.29
M	2.27		2.52
V		10°	
V1		3°	
V3		20°	
Dia.	3.55		3.66

Figure 22. TO-247 long leads drawing



5 Revision history

Table 11. Document revision history

Date	Revision	Changes
04-Aug-2009	1	Initial release.
21-Dec-2010	2	Document status promoted from preliminary data to datasheet. Inserted dynamic parameters on *Table 5*, *Table 6*, *Table 7* and *Table 8*. Inserted *Section 2.1: Electrical characteristics (curves)*. Updated TO-247 long leads package mechanical data.