

## 1. General description

Planar passivated high commutation three quadrant triac in a ITO220 internally insulated plastic package. This "series ET" triac balances the requirements of commutation performance and gate sensitivity and is intended for interfacing with low power drivers including microcontrollers. It is used in applications where "high junction operating temperature" capability is required.

## 2. Features and benefits

- 3Q technology for improved noise immunity
- High commutation capability with sensitive gate
- High blocking voltage capability
- Direct interfacing with low power drives and microcontrollers
- High junction operating temperature ( $T_{j(max)} = 150\text{ °C}$ )
- Isolated mounting base with 2500 V (RMS) isolation
- Internally insulated package
- Planar passivated for voltage ruggedness and reliability
- Good immunity to false turn-on by  $dV/dt$
- Triggering in three quadrants only

## 3. Applications

- Electronic thermostats (heating and cooling)
- Motor controls (large and small home appliances, light industrial)
- Refrigeration and air-conditioner compressor controls
- Lamp dimmers (LED and incandescent)
- AC power tools

## 4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DRM}$	repetitive peak off-state voltage		-	-	800	V
$I_{T(RMS)}$	RMS on-state current	full sine wave; $T_{mb} \leq 118\text{ °C}$ ; <a href="#">Fig.1</a> ; <a href="#">Fig.2</a> ; <a href="#">Fig.3</a>	-	-	12	A
$I_{TSM}$	non-repetitive peak on-state current	full sine wave; $T_{j(init)} = 25\text{ °C}$ ; $t_p = 20\text{ ms}$ ; <a href="#">Fig.4</a> ; <a href="#">Fig.5</a>	-	-	140	A
		full sine wave; $T_{j(init)} = 25\text{ °C}$ ; $t_p = 16.7\text{ ms}$	-	-	150	A
$T_j$	junction temperature		-	-	150	°C
<b>Static characteristics</b>						
$I_{GT}$	gate trigger current	$V_D = 12\text{ V}$ ; $I_T = 0.1\text{ A}$ ; T2+ G+; $T_j = 25\text{ °C}$ ; <a href="#">Fig.7</a>	0.5	-	10	mA
		$V_D = 12\text{ V}$ ; $I_T = 0.1\text{ A}$ ; T2+ G-; $T_j = 25\text{ °C}$ ; <a href="#">Fig.7</a>	0.5	-	10	mA
		$V_D = 12\text{ V}$ ; $I_T = 0.1\text{ A}$ ; T2- G-; $T_j = 25\text{ °C}$ ; <a href="#">Fig.7</a>	0.5	-	10	mA

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$I_H$	holding current	$V_D = 12\text{ V}$ ; $T_j = 25\text{ °C}$ ; <a href="#">Fig. 9</a>	-	-	10	mA
$V_T$	on-state voltage	$I_T = 17\text{ A}$ ; $T_j = 25\text{ °C}$ ; <a href="#">Fig. 10</a>	-	1.3	1.6	V
<b>Dynamic characteristics</b>						
$dV_D/dt$	rate of rise of off-state voltage	$V_{DM} = 536\text{ V}$ ; $T_j = 125\text{ °C}$ ; ( $V_{DM} = 67\%$ of $V_{DRM}$ ); exponential waveform; gate open circuit	300	-	-	V/ $\mu$ s
		$V_{DM} = 536\text{ V}$ ; $T_j = 150\text{ °C}$ ; ( $V_{DM} = 67\%$ of $V_{DRM}$ ); exponential waveform; gate open circuit	150	-	-	V/ $\mu$ s
$dI_{com}/dt$	rate of change of commutating current	$V_{DM} = 400\text{ V}$ ; $T_j = 150\text{ °C}$ ; $I_{T(RMS)} = 12\text{ A}$ ; $dV_{com}/dt = 20\text{ V}/\mu\text{s}$ ; (snubberless condition); gate open circuit; <a href="#">Fig. 12</a>	3	-	-	A/ms
		$V_{DM} = 400\text{ V}$ ; $T_j = 150\text{ °C}$ ; $I_{T(RMS)} = 12\text{ A}$ ; $dV_{com}/dt = 10\text{ V}/\mu\text{s}$ ; gate open circuit	4	-	-	A/ms
		$V_{DM} = 400\text{ V}$ ; $T_j = 150\text{ °C}$ ; $I_{T(RMS)} = 12\text{ A}$ ; $dV_{com}/dt = 1\text{ V}/\mu\text{s}$ ; gate open circuit	6	-	-	A/ms

## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	T1	main terminal 1		
2	T2	main terminal 2		
3	G	gate		
mb	n.c.	mounting base; isolated		

## 6. Ordering information

Table 3. Ordering information

Type number	Package Name	Orderable part number	Packing method	Small packing quantity	Package version	Package issue date
BTA412Y-800ET	IITO220	BTA412Y-800ETQ	Tube	50	IITO220E (E)	15-Dec-2017
					IITO220P (P)	31-Mar-2023

## 7. Marking

Table 4. Marking codes

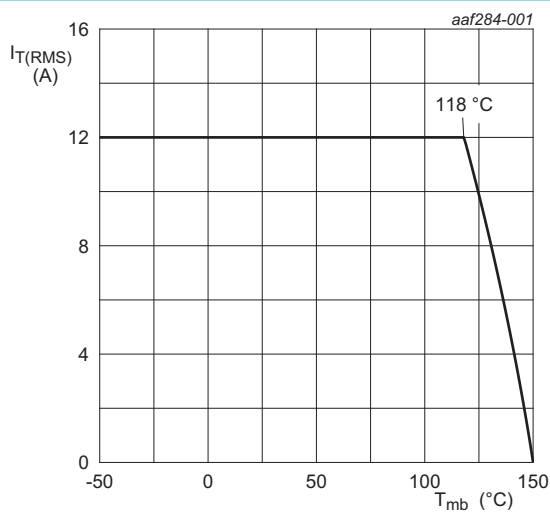
Type number	Marking codes	
	Assembly factory: E	Assembly factory: P
BTA412Y-800ET	BTA412Y 800ET PJExxxx xx	BTA412Y 800ET PJPxxxx xx

## 8. Limiting values

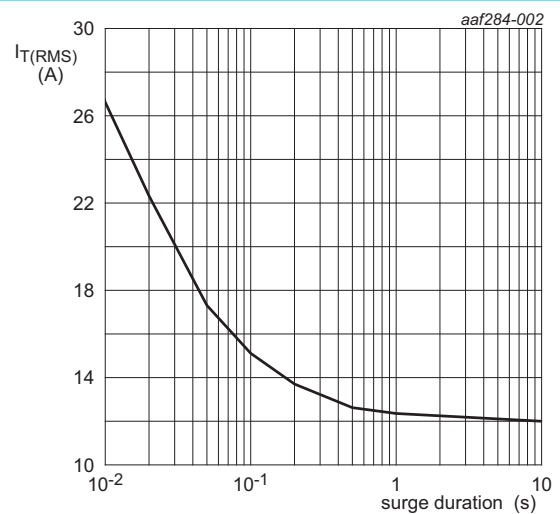
**Table 5. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{DRM}$	repetitive peak off-state voltage		-	800	V
$I_{T(RMS)}$	RMS on-state current	full sine wave; $T_{mb} \leq 118\text{ °C}$ ; <a href="#">Fig.1</a> ; <a href="#">Fig. 2</a> ; <a href="#">Fig. 3</a>	-	12	A
$I_{TSM}$	non-repetitive peak on-state current	full sine wave; $T_{j(init)} = 25\text{ °C}$ ; $t_p = 20\text{ ms}$ ; <a href="#">Fig. 4</a> ; <a href="#">Fig. 5</a>	-	140	A
		full sine wave; $T_{j(init)} = 25\text{ °C}$ ; $t_p = 16.7\text{ ms}$	-	150	A
$I^2t$	$I^2t$ for fusing	$t_p = 10\text{ ms}$ ; sine wave pulse	-	98	$A^2s$
$di_T/dt$	rate of rise of on-state current	$I_G = 0.2\text{ A}$	-	100	$A/\mu s$
$I_{GM}$	peak gate current		-	2	A
$P_{GM}$	peak gate power		-	5	W
$P_{G(AV)}$	average gate power	over any 20 ms period	-	0.5	W
$T_{stg}$	storage temperature		-40	150	$^{\circ}C$
$T_j$	junction temperature		-	150	$^{\circ}C$

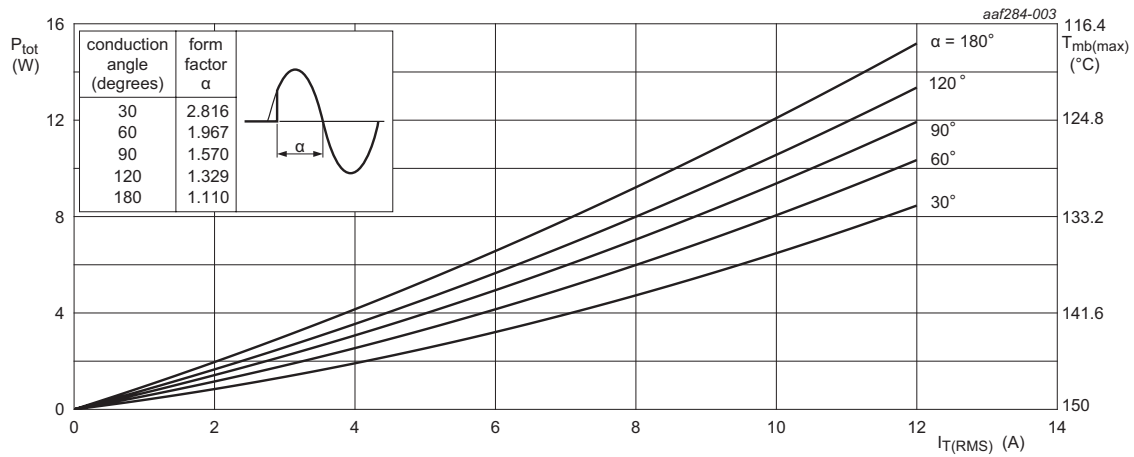


**Fig. 1. RMS on-state current as a function of mounting base temperature; maximum values**



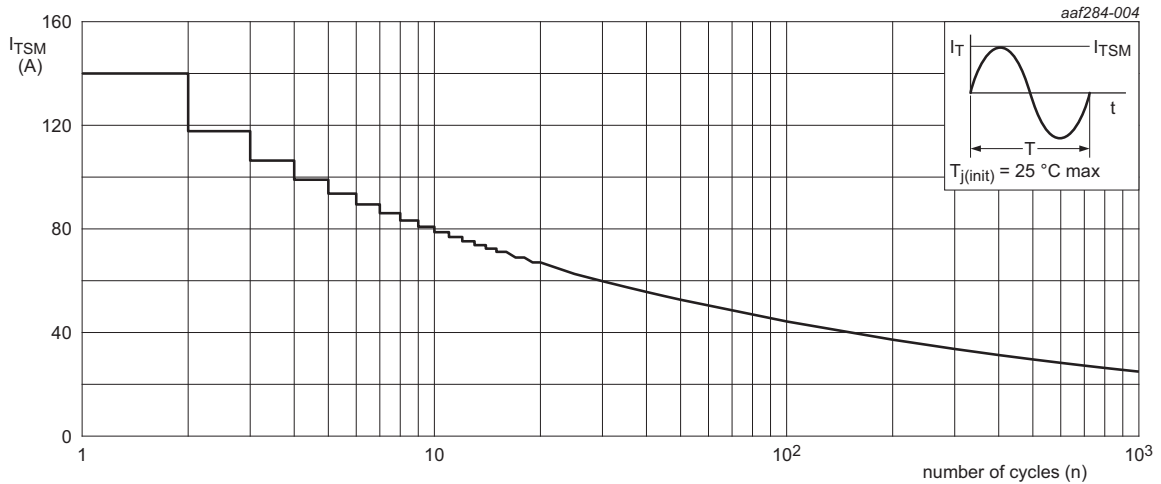
$f = 50\text{ Hz}$ ;  $T_{mb} = 118\text{ °C}$

**Fig. 2. RMS on-state current as a function of surge duration; maximum values**



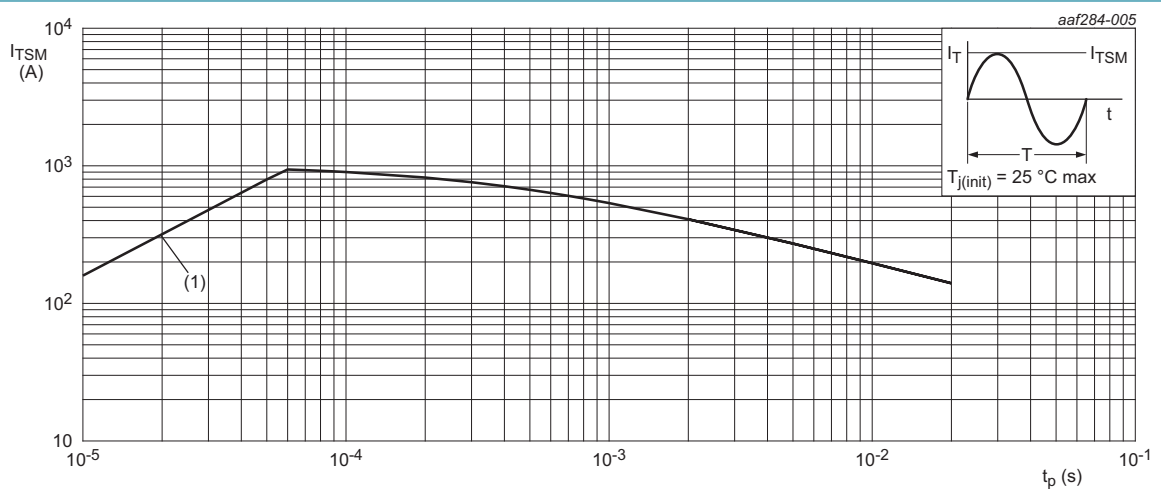
$a = \text{form factor} = I_{T(RMS)} / I_{T(AV)}$   
 $\alpha = \text{conduction angle}$

Fig. 3. Total power dissipation as a function of RMS on-state current; maximum values



f = 50 Hz

Fig. 4. Non-repetitive peak on-state current as a function of the number of sinusoidal current cycles; maximum values



$t_p \leq 20 \text{ ms}$   
 (1)  $dI_T/dt$  limit

Fig. 5. Non-repetitive peak on-state current as a function of pulse duration; maximum values

## 9. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{th(j-mb)}$	thermal resistance from junction to mounting base	full cycle; <a href="#">Fig. 6</a>	-	-	2.1	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	-	60	-	K/W

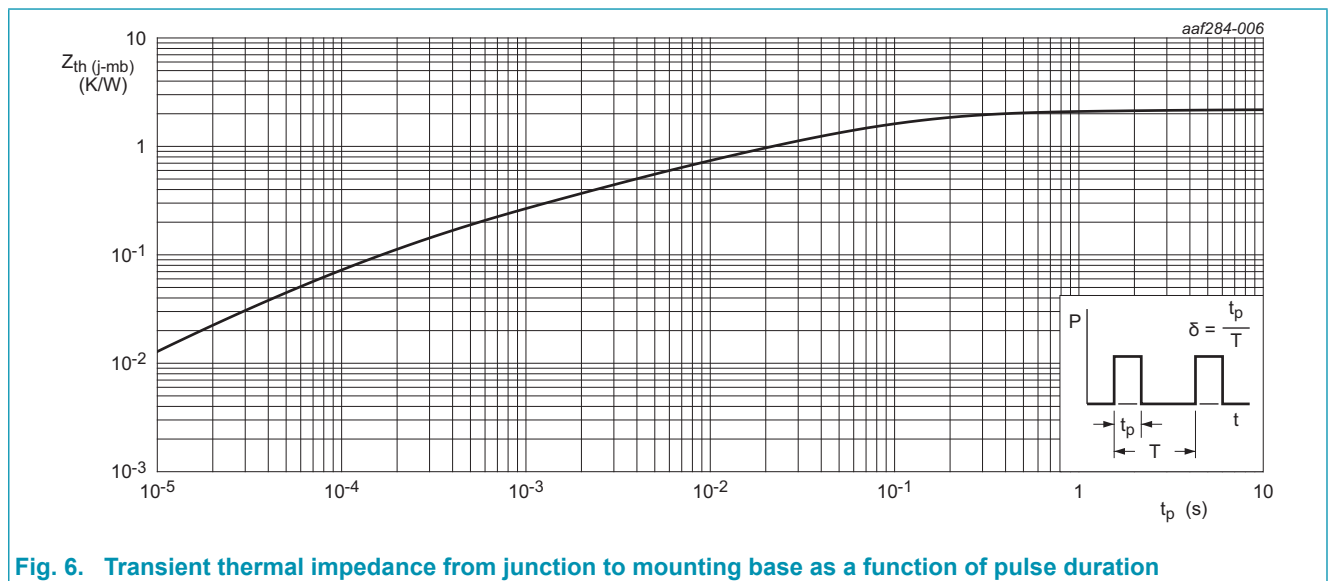


Fig. 6. Transient thermal impedance from junction to mounting base as a function of pulse duration

## 10. Isolation characteristics

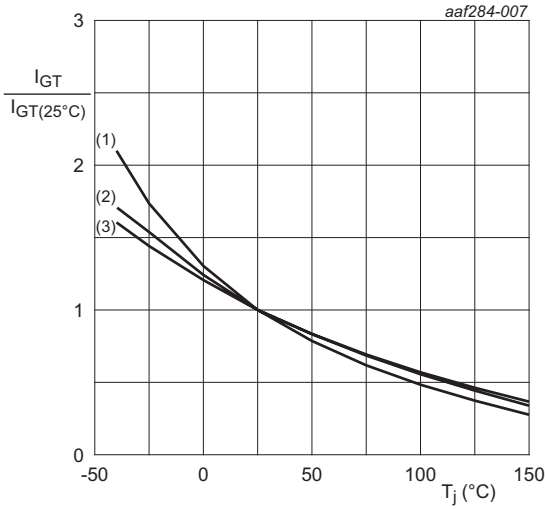
Table 7. Isolation Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{isol(RMS)}$	RMS isolation voltage	from all terminals to external heatsink; sinusoidal waveform; clean and dust free; $50 \text{ Hz} \leq f \leq 60 \text{ Hz}$ ; $RH \leq 65 \%$ ; $T_{mb} = 25 \text{ }^\circ\text{C}$	-	-	2500	V
$C_{isol}$	isolation capacitance	from main terminal 2 to external heatsink; $f = 1 \text{ MHz}$ ; $T_{mb} = 25 \text{ }^\circ\text{C}$	-	10	-	pF

## 11. Characteristics

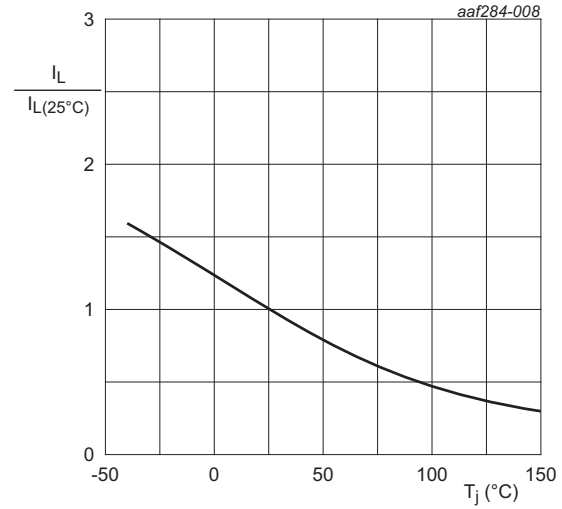
Table 8. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
$I_{GT}$	gate trigger current	$V_D = 12\text{ V}; I_T = 0.1\text{ A}; T_2+ G+;$ $T_j = 25\text{ °C};$ <a href="#">Fig. 7</a>	0.5	-	10	mA
		$V_D = 12\text{ V}; I_T = 0.1\text{ A}; T_2+ G-;$ $T_j = 25\text{ °C};$ <a href="#">Fig. 7</a>	0.5	-	10	mA
		$V_D = 12\text{ V}; I_T = 0.1\text{ A}; T_2- G-;$ $T_j = 25\text{ °C};$ <a href="#">Fig. 7</a>	0.5	-	10	mA
$I_L$	latching current	$V_D = 12\text{ V}; I_G = 0.1\text{ A}; T_2+ G+;$ $T_j = 25\text{ °C};$ <a href="#">Fig. 8</a>	-	-	25	mA
		$V_D = 12\text{ V}; I_G = 0.1\text{ A}; T_2+ G-;$ $T_j = 25\text{ °C};$ <a href="#">Fig. 8</a>	-	-	35	mA
		$V_D = 12\text{ V}; I_G = 0.1\text{ A}; T_2- G-;$ $T_j = 25\text{ °C};$ <a href="#">Fig. 8</a>	-	-	25	mA
$I_H$	holding current	$V_D = 12\text{ V}; T_j = 25\text{ °C};$ <a href="#">Fig. 9</a>	-	-	10	mA
$V_T$	on-state voltage	$I_T = 17\text{ A}; T_j = 25\text{ °C};$ <a href="#">Fig. 10</a>	-	1.3	1.6	V
$V_{GT}$	gate trigger voltage	$V_D = 12\text{ V}; I_T = 0.1\text{ A}; T_j = 25\text{ °C}$ <a href="#">Fig. 11</a>	-	0.8	1	V
		$V_D = 400\text{ V}; I_T = 0.1\text{ A}; T_j = 150\text{ °C}$	0.2	0.5	-	V
$I_D$	off-state current	$V_D = 800\text{ V}; T_j = 25\text{ °C}$	-	-	10	mA
		$V_D = 800\text{ V}; T_j = 150\text{ °C}$	-	0.4	2	mA
<b>Dynamic characteristics</b>						
$dV_D/dt$	rate of rise of off-state voltage	$V_{DM} = 536\text{ V}; T_j = 125\text{ °C}; (V_{DM} = 67\%$ of $V_{DRM});$ exponential waveform; gate open circuit	300	-	-	V/μs
		$V_{DM} = 536\text{ V}; T_j = 150\text{ °C}; (V_{DM} = 67\%$ of $V_{DRM});$ exponential waveform; gate open circuit	150	-	-	V/μs
$dI_{com}/dt$	rate of change of commutating current	$V_{DM} = 400\text{ V}; T_j = 150\text{ °C}; I_{T(RMS)} = 12\text{ A};$ $dV_{com}/dt = 20\text{ V}/\mu\text{s};$ (snubberless condition); gate open circuit; <a href="#">Fig. 12</a>	3	-	-	A/ms
		$V_{DM} = 400\text{ V}; T_j = 150\text{ °C}; I_{T(RMS)} = 12\text{ A};$ $dV_{com}/dt = 10\text{ V}/\mu\text{s};$ gate open circuit	4	-	-	A/ms
		$V_{DM} = 400\text{ V}; T_j = 150\text{ °C}; I_{T(RMS)} = 12\text{ A};$ $dV_{com}/dt = 1\text{ V}/\mu\text{s};$ gate open circuit	6	-	-	A/ms

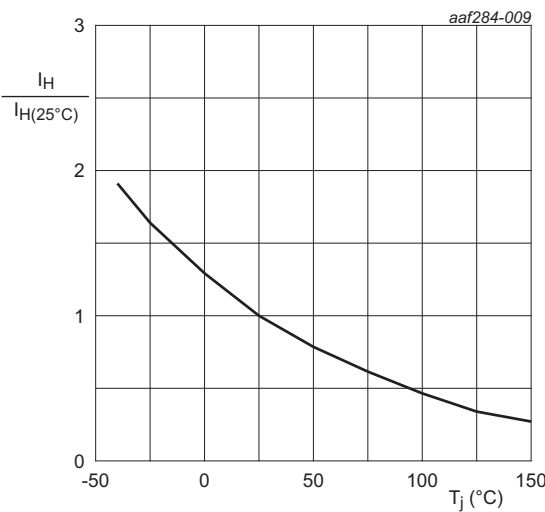


- (1) T2- G-
- (2) T2+ G-
- (3) T2+ G+

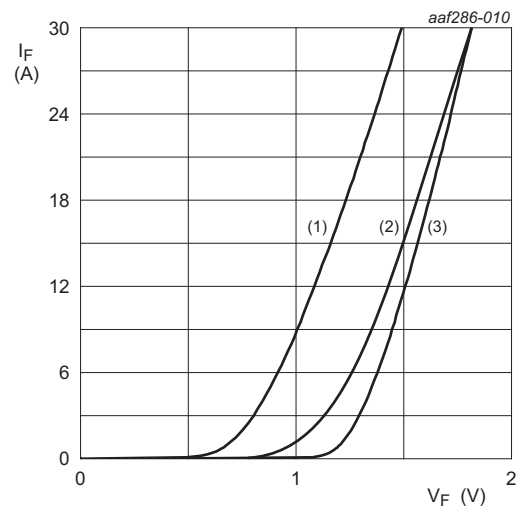
**Fig. 7. Normalized gate trigger current as a function of junction temperature**



**Fig. 8. Normalized latching current as a function of junction temperature**



**Fig. 9. Normalized holding current as a function of junction temperature**



- $V_o = 1.027\text{ V}; R_s = 0.0283\ \Omega$   
 (1)  $T_j = 150^\circ\text{C}$ ; typical values  
 (2)  $T_j = 150^\circ\text{C}$ ; maximum values  
 (3)  $T_j = 25^\circ\text{C}$ ; maximum values

**Fig. 10. On-state current as a function of on-state voltage**

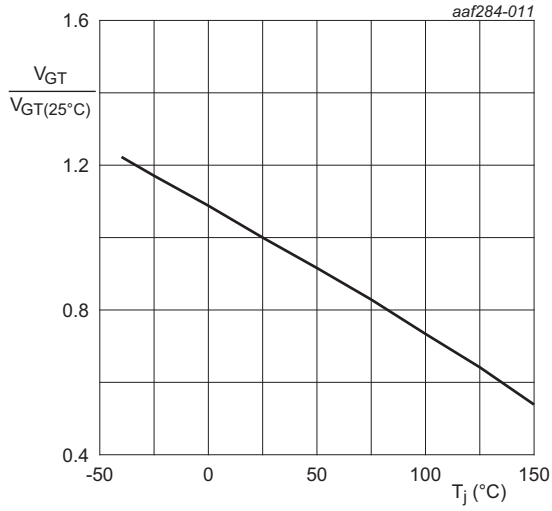


Fig. 11. Normalized gate trigger voltage as a function of junction temperature

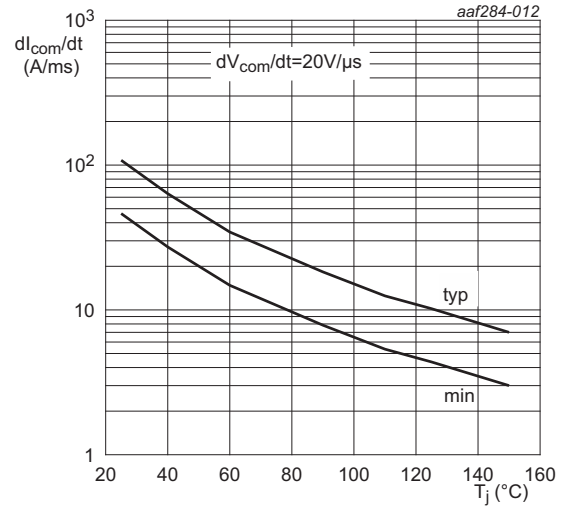


Fig. 12. Rate of change of commutating current as a function of junction temperature; typical and minimum values

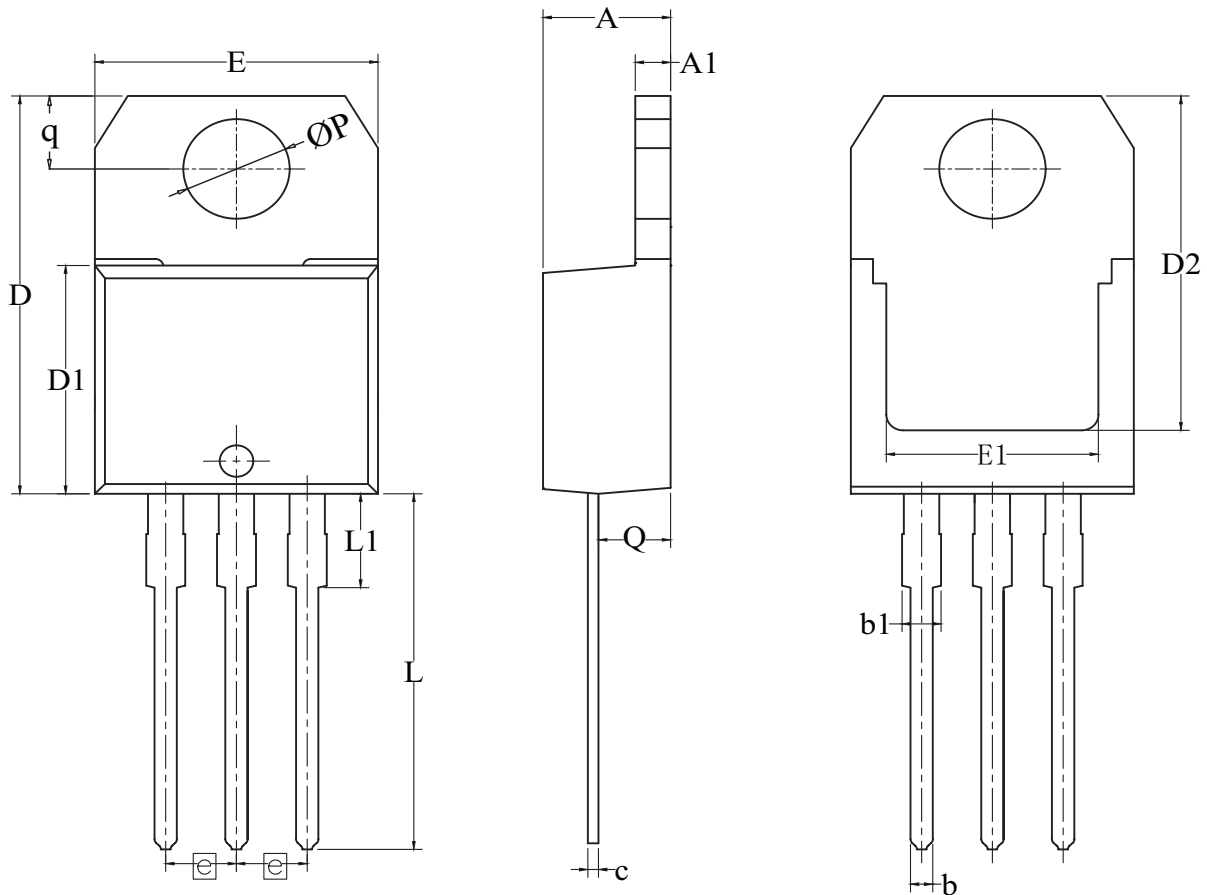


## 12. Package outline

Assembly factory: E

Plastic single-ended package; isolated heatsink mounted; 1 mounting hole; 3 leads TO-220

IITO220

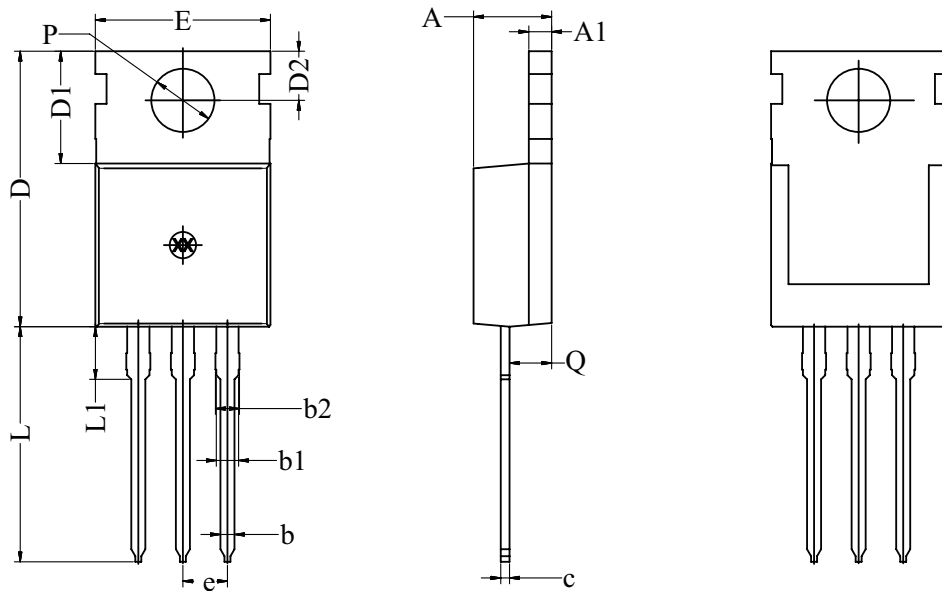


Unit	A	A1	b	b1	c	D	D1	D2	E	E1	e	L	L1	P	Q	q
MM	min	4.30	1.25	0.69	1.20	0.40	15.20	8.50	12.20	10.00	6.86	12.80	2.70	3.70	2.40	2.70
	max	4.70	1.40	0.90	1.72	0.60	16.00	9.02	12.88	10.40	8.89	2.54 (BSC)	14.00	3.30	3.95	2.80

Assembly factory: P

Plastic single-ended package; isolated heatsink mounted; 1 mounting hole; 3 leads TO-220

IITO220



Dim	All Dimensions in Millimeters		
	Min	Typ	Max
A	4.30	4.45	4.70
A1	1.25	1.30	1.40
b	0.60	0.80	0.90
b1	1.10	1.27	1.40
b2	1.32	1.37	1.72
c	0.40	0.50	0.60
D	15.20	15.70	16.00
D1	6.20	6.40	6.60
D2	2.70	2.80	3.00
E	9.70	10.00	10.30
e	2.54 BSC		
L	12.80	13.40	14.00
L1	2.80	3.00	3.20
P	3.50	3.60	3.70
Q	2.20	2.40	2.60

## 13. Legal information

### Data sheet status

Document status [1][2]	Product status [3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

- [1] Please consult the most recently issued document before initiating or completing a design.
- [2] The term 'short data sheet' is explained in section "Definitions".
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Date of release: 02 June 2023

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