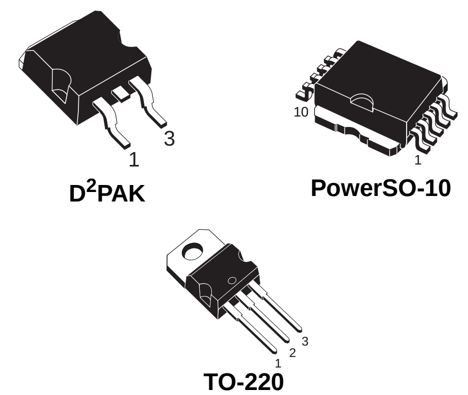
VNB35NV04-E
VNP35NV04-E, VNV35NV04-E

OMNIFET II
fully autoprotected Power MOSFET

Datasheet - production data



Features

Type	$R_{DS(on)}$	I_{lim}	V_{clamp}
VNB35NV04-E VNP35NV04-E VNV35NV04-E	10 mΩ(1)	30 A	40 V

1. For PowerSO-10 only

- Linear current limitation
- Thermal shutdown
- Short circuit protection
- Integrated clamp
- Low current drawn from input pin
- Diagnostic feedback through input pin
- ESD protection
- Direct access to the gate of the Power MOSFET (analog driving)
- Compatible with standard Power MOSFET

Description

The VNB35NV04-E, VNP35NV04-E and VNV35NV04-E are monolithic devices designed in STMicroelectronics® VIPower® M0-3 Technology, intended for replacement of standard Power MOSFETs from DC up to 25 kHz applications.

Built in thermal shutdown, linear current limitation and overvoltage clamp protect the chip in harsh environments. Fault feedback can be detected by monitoring the voltage at the input pin.

Table 1. Device summary

Package	Order codes	
	Tube	Tape and reel
D^2PAK	VNB35NV04-E	VNB35NV04TR-E
TO-220	VNP35NV04-E	—
PowerSO-10	VNV35NV04-E	VNV35NV04TR-E

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1 Block diagram and pin connection

Figure 1. Block diagram

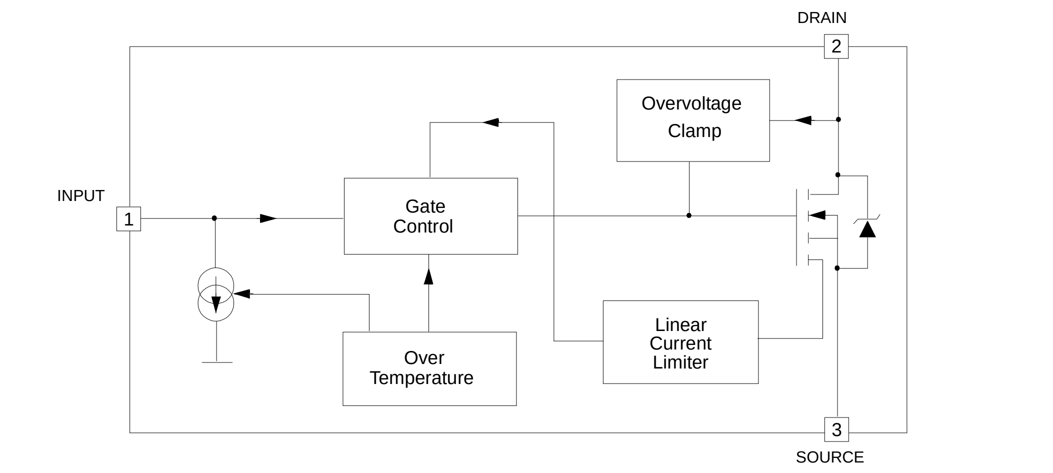
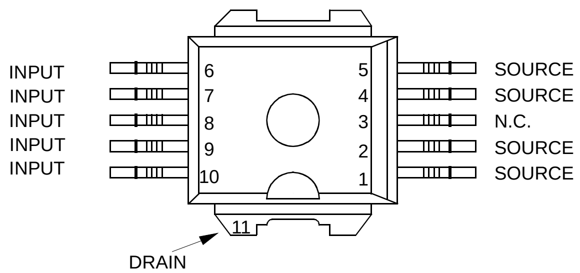


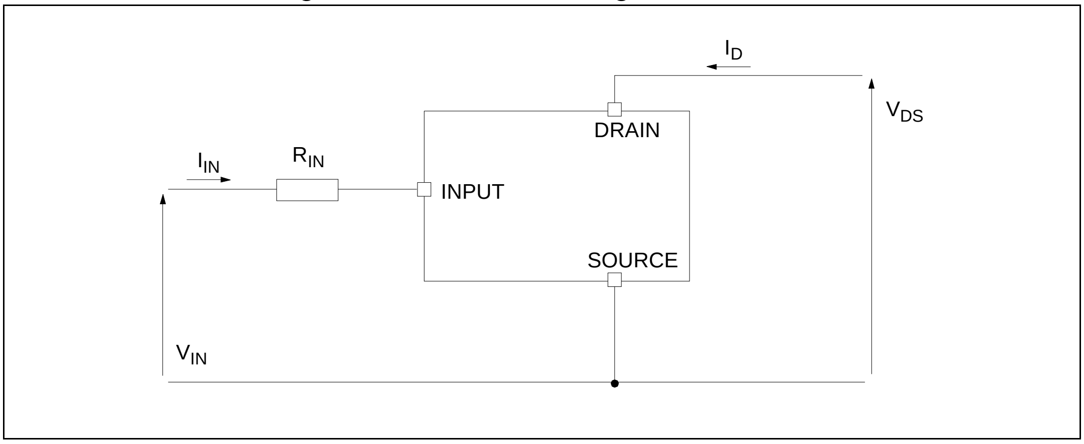
Figure 2. Pin connection



1. For the pins configuration related to TO-220, D^{2}PAK, see *Figure 1*.

2 Electrical specification

Figure 3. Current and voltage conventions



2.1 Absolute maximum ratings

Stressing the device above the rating listed in *Table 2* may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the operating sections of this specification is not implied. Exposure to the conditions in table below for extended periods may affect device reliability

Table 2. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		PowerSO-10	D^2PAK	TO-220	
V_{DS}	Drain-source voltage (V_{IN} = 0 V)	Internally clamped			V
V_{IN}	Input voltage	Internally clamped			V
I_{IN}	Input current	+/-20			mA
$R_{IN\ MIN}$	Minimum input series impedance	4.7			Ω
I_D	Drain current	Internally limited			A
I_R	Reverse DC output current	-30			A
V_{ESD1}	Electrostatic discharge (R = 1.5 KΩ, C = 100 pF)	4000			V
V_{ESD2}	Electrostatic discharge on output pin only (R = 330 Ω, C = 150 pF)	16500			V
P_{tot}	Total dissipation at T_c = 25°C	125	125	125	W
T_j	Operating junction temperature	Internally limited			°C
T_c	Case operating temperature	Internally limited			°C
T_{stg}	Storage temperature	-55 to 150			°C

2.2 Thermal data

Table 3. Thermal data

Symbol	Parameter	Value			Unit
		PowerSO-10	D^2PAK	TO-220	
$R_{thj-case}$	Thermal resistance junction-case (max)	1	1	1	°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient (max)	50(1)	50(1)	50	°C/W

1. When mounted on a standard single-sided FR4 board with $50mm^2$ of Cu (at least 35 mm thick) connected to all DRAIN pins.

2.3 Electrical characteristics

-40°C < T_j < 150°C, unless otherwise specified.

Table 4. Off

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
V_{CLAMP}	Drain-source clamp voltage	V_{IN} = 0 V; I_D = 15 A	40	45	55	V
V_{CLTH}	Drain-source clamp threshold voltage	V_{IN} = 0 V; I_D = 2 mA	36			V
V_{INTH}	Input threshold voltage	V_{DS} = V_{IN}; I_D = 1 mA	0.5		2.5	V
I_{ISS}	Supply current from input pin	V_{DS} = 0 V; V_{IN} = 5 V		100	150	µA
V_{INCL}	Input-source clamp voltage	I_{IN} = 1 mA	6	6.8	8	V
		I_{IN} = -1 mA	-1.0		-0.3	V
I_{DSS}	Zero input voltage drain current (V_{IN} = 0 V)	V_{DS} = 13 V; V_{IN} = 0 V; T_j = 25 °C			30	µA
		V_{DS} = 25 V; V_{IN} = 0 V			75	µA

Table 5. On

Symbol	Parameter	Test conditions	Max		Unit
			PowerSO-10	D^2PAK TO-220	
$R_{DS(on)}$	Static drain-source on resistance	V_{IN} = 5 V; I_D = 15 A; T_j = 25 °C	10	13	mΩ
		V_{IN} = 5 V; I_D = 15 A; T_j = 150 °C	20	24	mΩ

T_j = 25°C, unless otherwise specified.

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
g_{fs}(1)	Forward transconductance	V_{DD} = 13 V; I_D = 15 A	—	35	—	S
C_{OSS}	Output capacitance	V_{DS} = 13 V; f = 1 MHz; V_{IN} = 0 V	—	1300	—	pF

1. Pulsed: Pulse duration = 300 ms, duty cycle 1.5%

Table 7. Switching

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
$t_{d(on)}$	Turn-on delay time	V_{DD} = 15 V; I_D = 15 A; V_{gen} = 5 V; R_{gen} = $R_{IN\ MIN}$ = 4.7 Ω (see *Figure 3*)	—	150	500	ns
t_r	Rise time		—	840	2500	ns
$t_{d(off)}$	Turn-off delay time		—	980	3000	ns
t_f	Fall time		—	600	1500	ns
$t_{d(on)}$	Turn-on delay time	V_{DD} = 15 V; I_D = 15 A; V_{gen} = 5 V; R_{gen} = 2.2 KΩ (see *Figure 3*)	—	4	12	µs
t_r	Rise time		—	27	100	µs
$t_{d(off)}$	Turn-off delay time		—	34	120	µs
t_f	Fall time		—	31	110	µs
$(di/dt)_{on}$	Turn-on current slope	V_{DD} = 15 V; I_D = 15 A;V_{gen} = 5 V; R_{gen} = $R_{IN\ MIN}$ = 4.7 Ω	—	18		A/µs
Q_i	Total input charge	V_{DD} = 12 V; I_D = 15 A; V_{IN} = 5 V; I_{gen} = 2.13 mA (see *Figure 8*)	—	118		nC

Table 8. Source drain diode

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{SD}(1)	Forward on voltage	I_{SD} = 15 A; V_{IN} = 0 V	—	0.8	—	V
t_{rr}	Reverse recovery time	I_{SD} = 15 A; dI/dt = 100 A/µs; V_{DD} = 30 V; L = 200 µH (see *Figure 4*)	—	400	—	ns
Q_{rr}	Reverse recovery charge		—	1.4	—	µC
I_{RRM}	Reverse recovery current		—	7	—	A

1. Pulsed: Pulse duration = 300 ms, duty cycle 1.5%

Table 9. Protections (-40°C < T_j < 150°C, unless otherwise specified)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
I_{lim}	Drain current limit	V_{IN} = 6 V; V_{DS} = 13 V	30	45	60	A
t_{dlim}	Step response current limit	V_{IN} = 6 V; V_{DS} = 13 V		50		µs

Table 9. Protections (-40°C < T_j < 150°C, unless otherwise specified) (continued)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
T_{jsh}	Overtemperature shutdown		150	175	200	°C
T_{jrs}	Overtemperature reset		135			°C
I_{gf}	Fault Sink Current	V_{IN} = 5 V; V_{DS} = 13 V; T_j = T_{jsh}	10	15	20	mA
E_{as}	Single pulse avalanche energy	Starting T_j = 25°C; V_{DD} = 24 V; V_{IN} = 5 V; R_{gen} = $R_{IN\ MIN}$ = 4.7 Ω; L = 24 mH (see *Figure 6* and *Figure 7*)	1.7			J

2.4 Protection features

During normal operation, the INPUT pin is electrically connected to the gate of the internal power MOSFET through a low impedance path.

The device then behaves like a standard power MOSFET and can be used as a switch from DC up to 25 KHz. The only difference from the user’s standpoint is that a small DC current I_{SS} (typ. 100 µA) flows into the INPUT pin in order to supply the internal circuitry.

The device integrates:

- Overvoltage clamp protection:

  internally set at 45 V, along with the rugged avalanche characteristics of the Power MOSFET stage give this device unrivalled ruggedness and energy handling capability. This feature is mainly important when driving inductive loads.
- Linear current limiter circuit:

  limits the drain current I_D to I_{lim} whatever the INPUT pin voltages is. When the current limiter is active, the device operates in the linear region, so power dissipation may exceed the capability of the heatsink. Both case and junction temperatures increase, and if this phase lasts long enough, junction temperature may reach the overtemperature threshold T_{jsh}.
- Overtemperature and short circuit protection:

  these are based on sensing the chip temperature and are not dependent on the input voltage. The location of the sensing element on the chip in the power stage area ensures fast, accurate detection of the junction temperature. Overtemperature cutout occurs in the range 150°C to 190°C, a typical value being 170°C. The device is automatically restarted when the chip temperature falls of about 15°C below shutdown temperature.
- Status feedback:

  in the case of an overtemperature fault condition (T_j > T_{jsh}), the device tries to sink a diagnostic current I_{gf} through the INPUT pin in order to indicate fault condition. If driven from a low impedance source, this current may be used in order to warn the control circuit of a device shutdown. If the drive impedance is high enough so that the INPUT pin driver is not able to supply the current I_{gf}, the INPUT pin falls to 0 V. This does not however affect the device operation: no requirement is put on the current capability of the INPUT pin driver except to be able to supply the normal operation drive current I_{SS}.

Additional features of this device are ESD protection according to the Human Body model and the ability to be driven from a TTL Logic circuit.

Figure 4. Switching time test circuit for resistive load

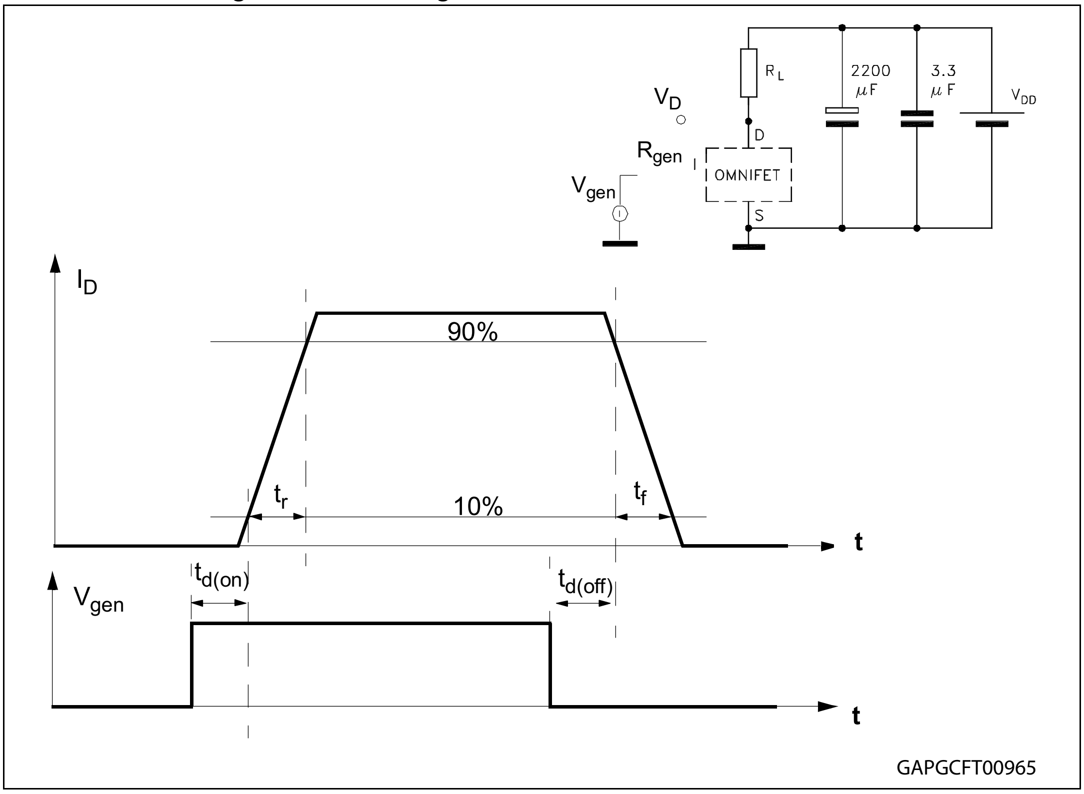


Figure 5. Test circuit for diode recovery times

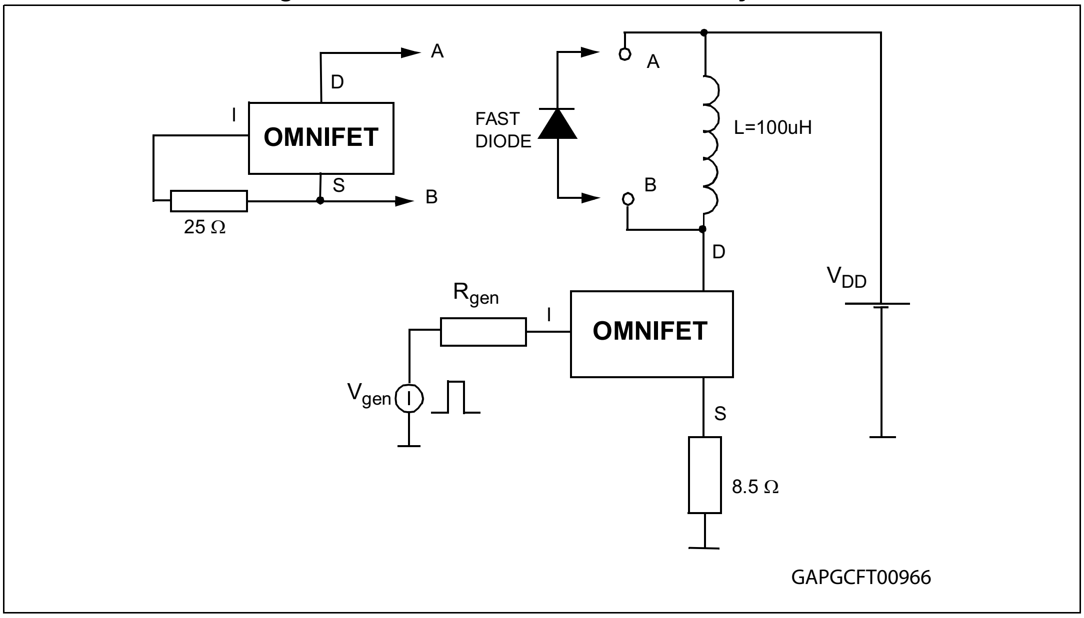


Figure 6. Unclamped inductive load test circuits

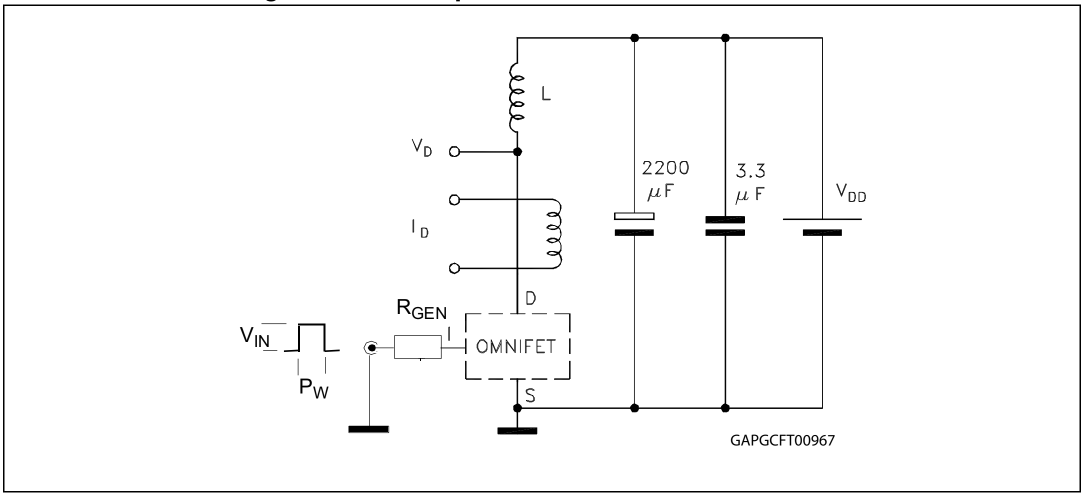


Figure 7. Unclamped inductive waveforms

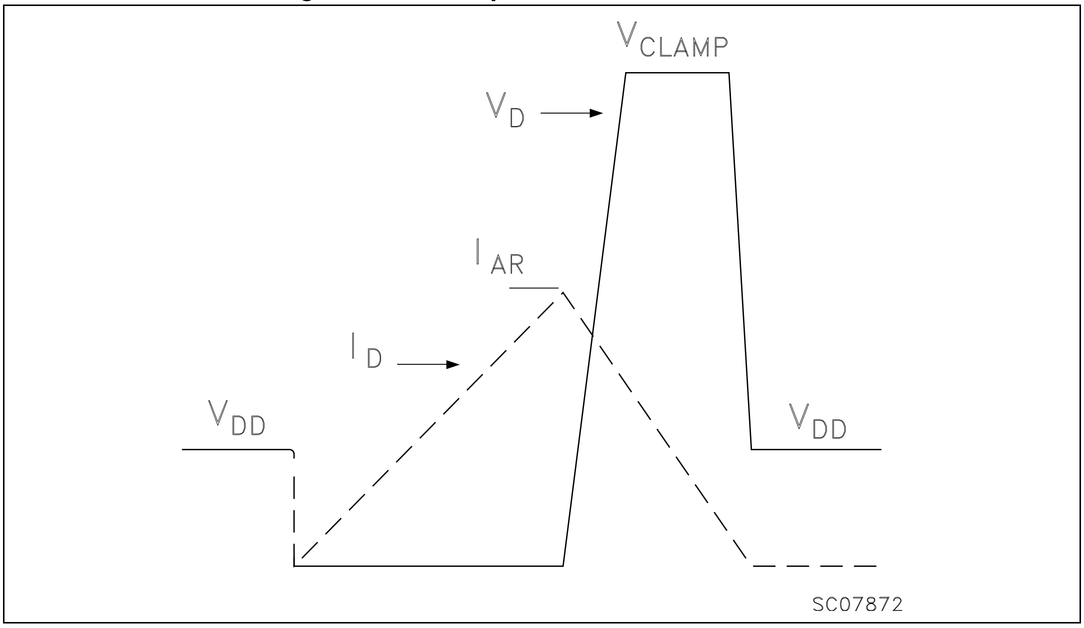


Figure 8. Input charge test circuit

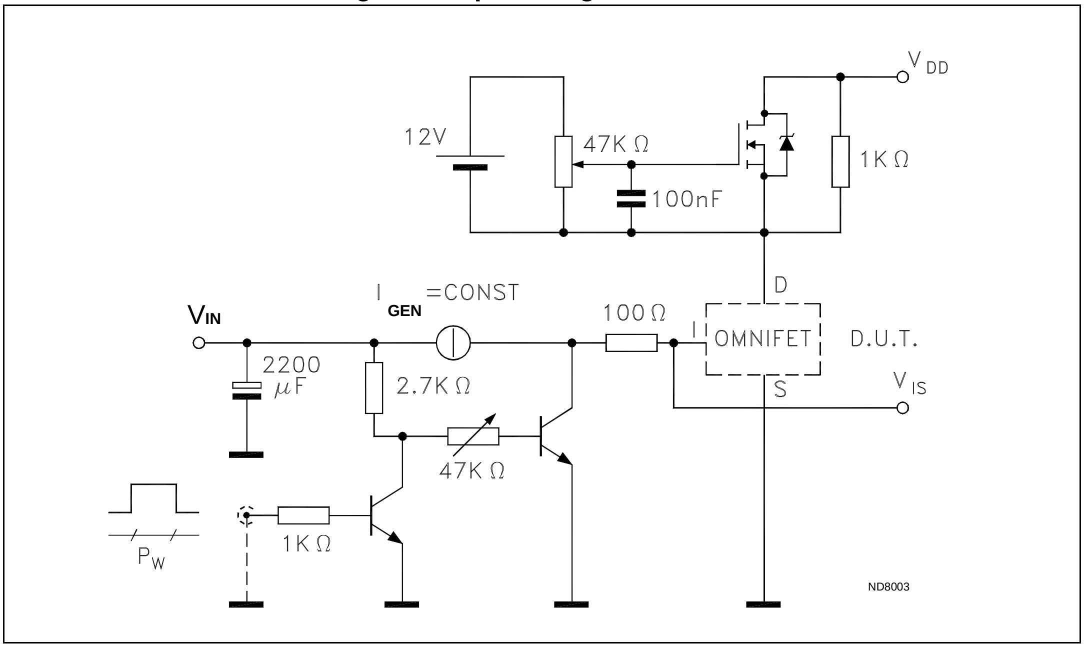
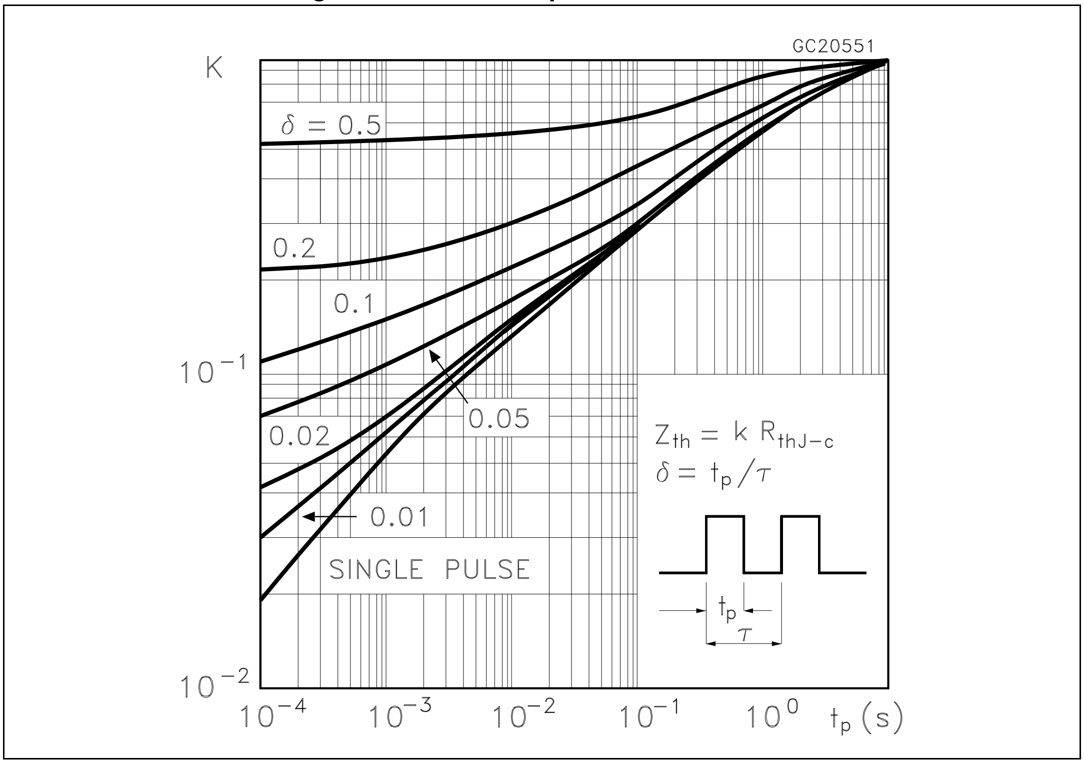


Figure 9. Thermal impedance for TO-220



2.5 Electrical characteristics curves

Figure 10. Source-drain diode forward characteristics

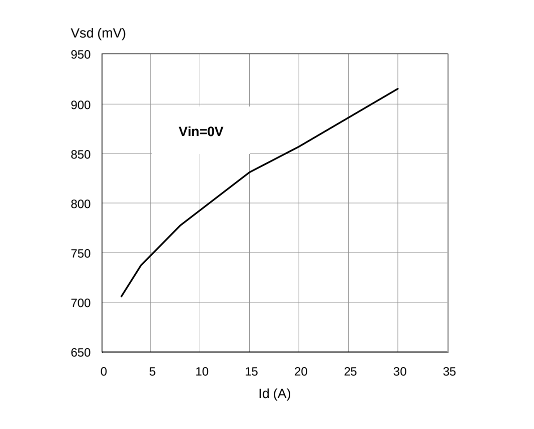


Figure 11. Static drain source on resistance

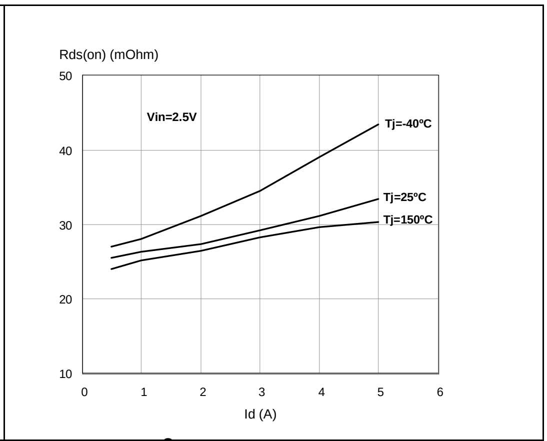


Figure 12. PowerSO-10 static drain-source on resistance vs. input voltage

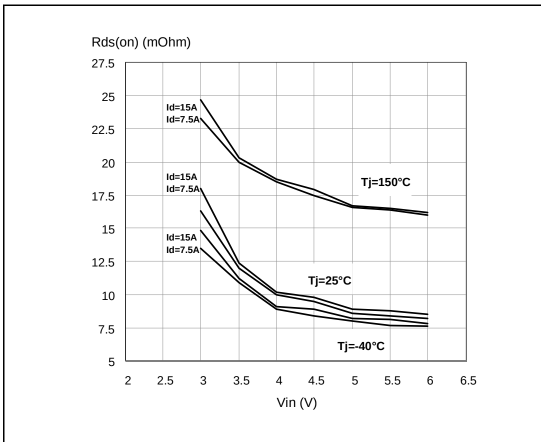


Figure 13. D²PAK and TO-220 static drain-source on resistance vs. input voltage

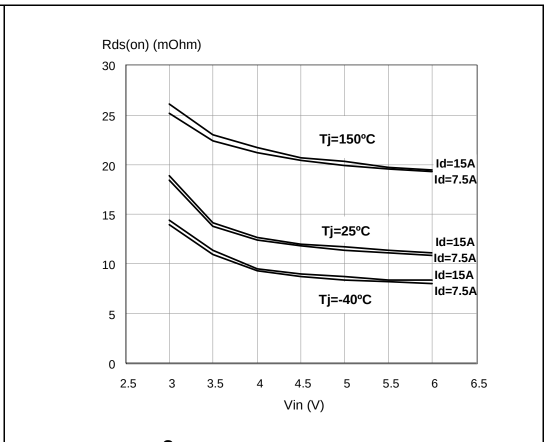


Figure 14. PowerSO-10 static drain-source on resistance vs. id

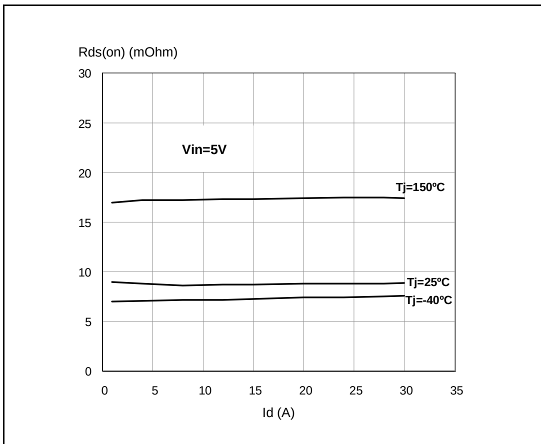


Figure 15. D²PAK and TO-220 static drain-source on resistance vs. id

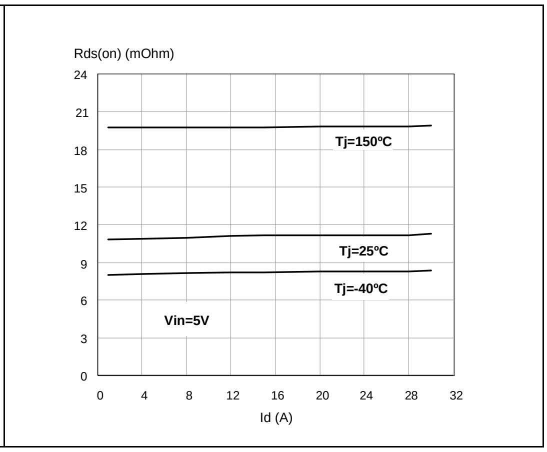


Figure 16. Transconductance

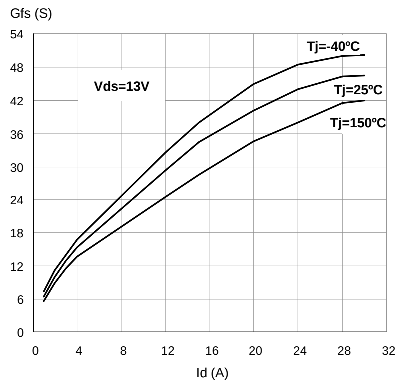


Figure 17. Transfer characteristics

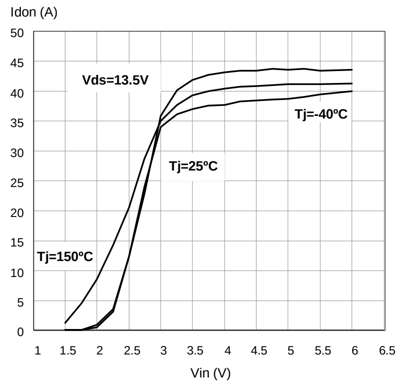


Figure 18. Output characteristics

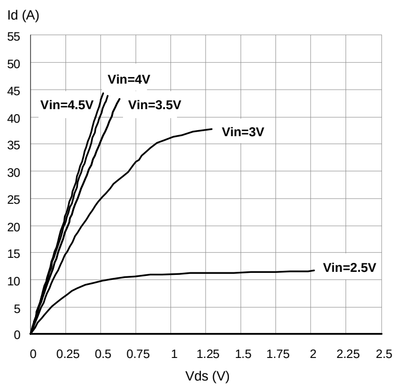


Figure 19. Normalized on resistance vs. temperature

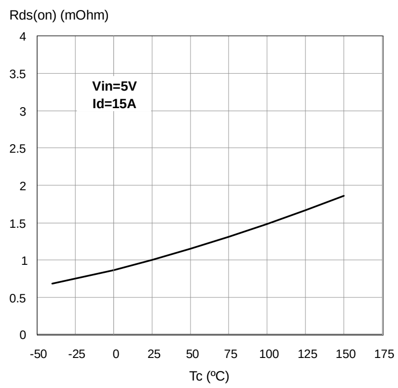


Figure 20. Turn-on current slope, V_{IN} = 5 V

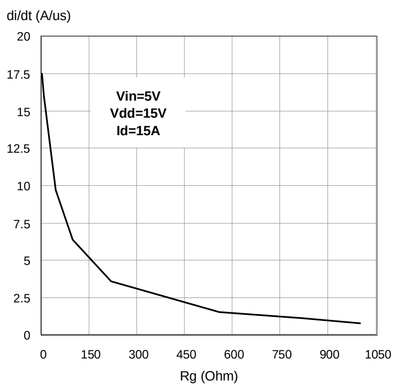


Figure 21. Turn-on current slope, V_{IN} = 3.5 V

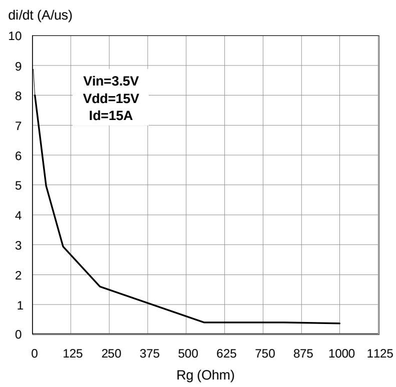


Figure 22. Input voltage vs. input charge

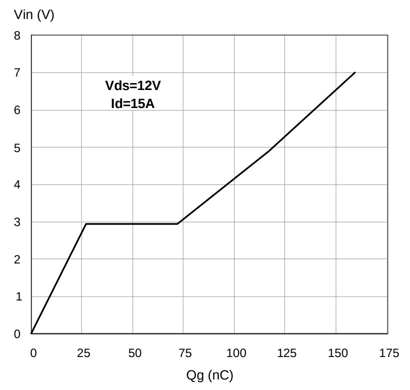


Figure 23. Turn off drain source voltage slope, V_{IN} = 5 V

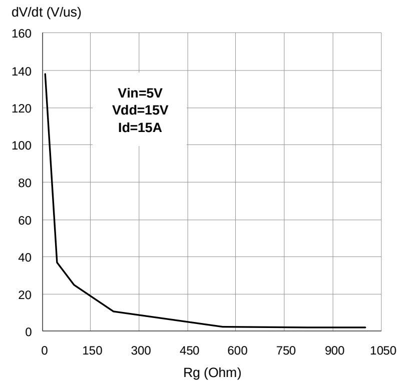


Figure 24. Turn off drain-source voltage slope, V_{IN} = 3.5 V

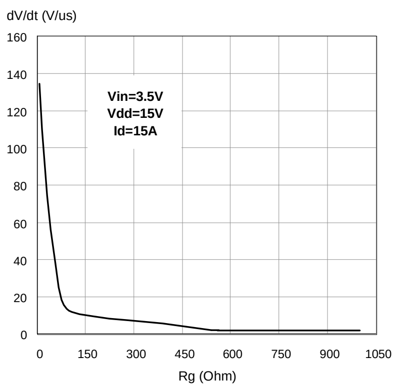


Figure 25. Switching time resistive load (part 1)

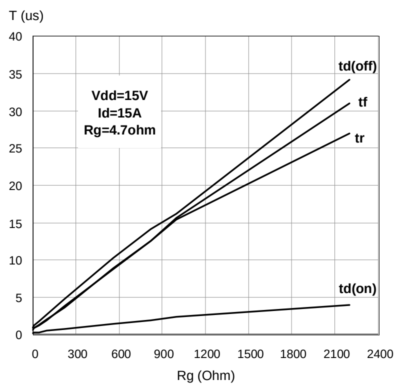


Figure 26. Switching time resistive load (part 2)

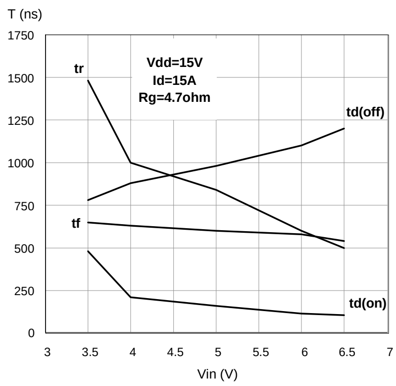


Figure 27. Normalized input threshold voltage vs. temperature

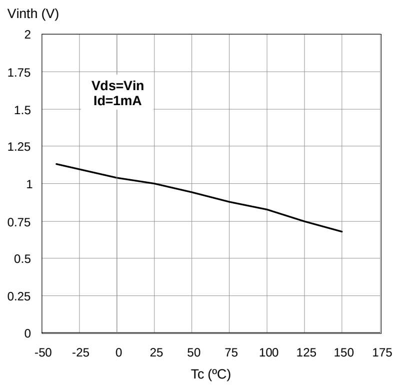


Figure 28. Current limit vs. junction temperature

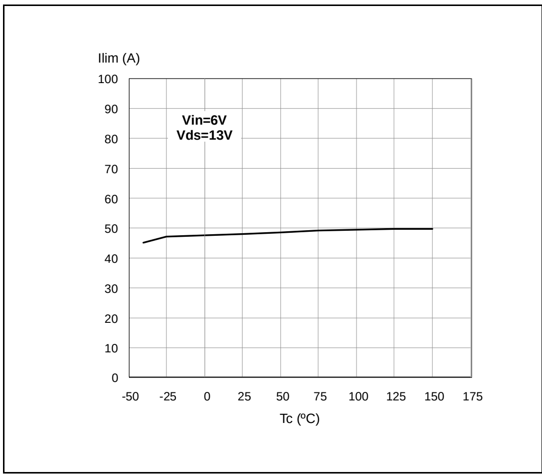


Figure 29. Step response current limit

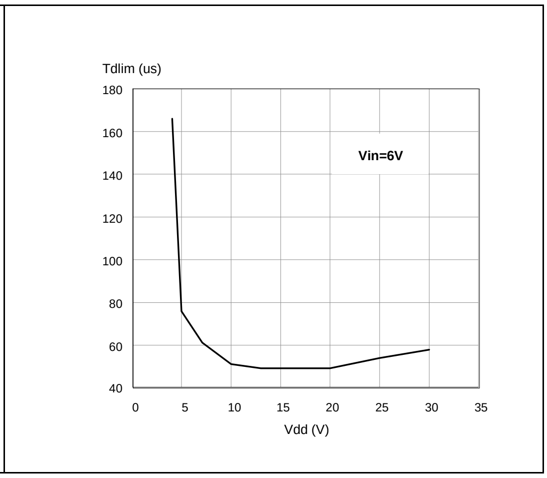
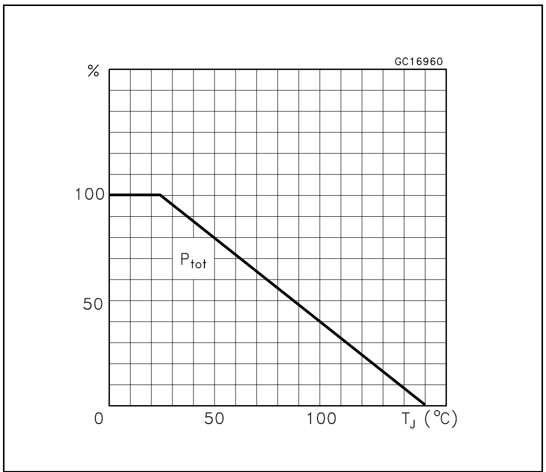


Figure 30. Derating curve



3 Package informantion

3.1 ECOPACK®

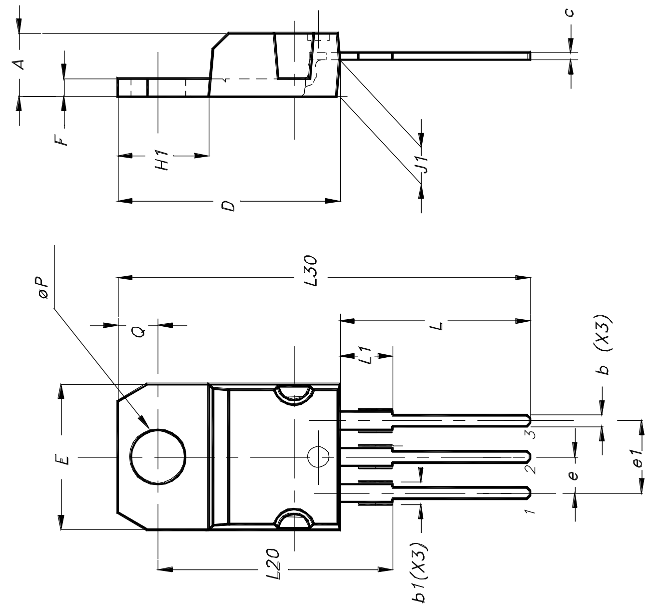
In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: *www.st.com*. ECOPACK® is an ST trademark.

3.2 TO-220 mechanical data

Table 10. TO-220 mechanical data

Dim.	mm.		
	Min.	Typ	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.15		1.70
c	0.49		0.70
D	15.25		15.75
E	10		10.40
e	2.40		2.70
e1	4.95		5.15
F	1.23		1.32
H1	6.20		6.60
J1	2.40		2.72
L	13		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
∅P	3.75		3.85
Q	2.65		2.95
Package weight	1.9Gr. (Typ.)		

Figure 31. TO-220 package dimensions



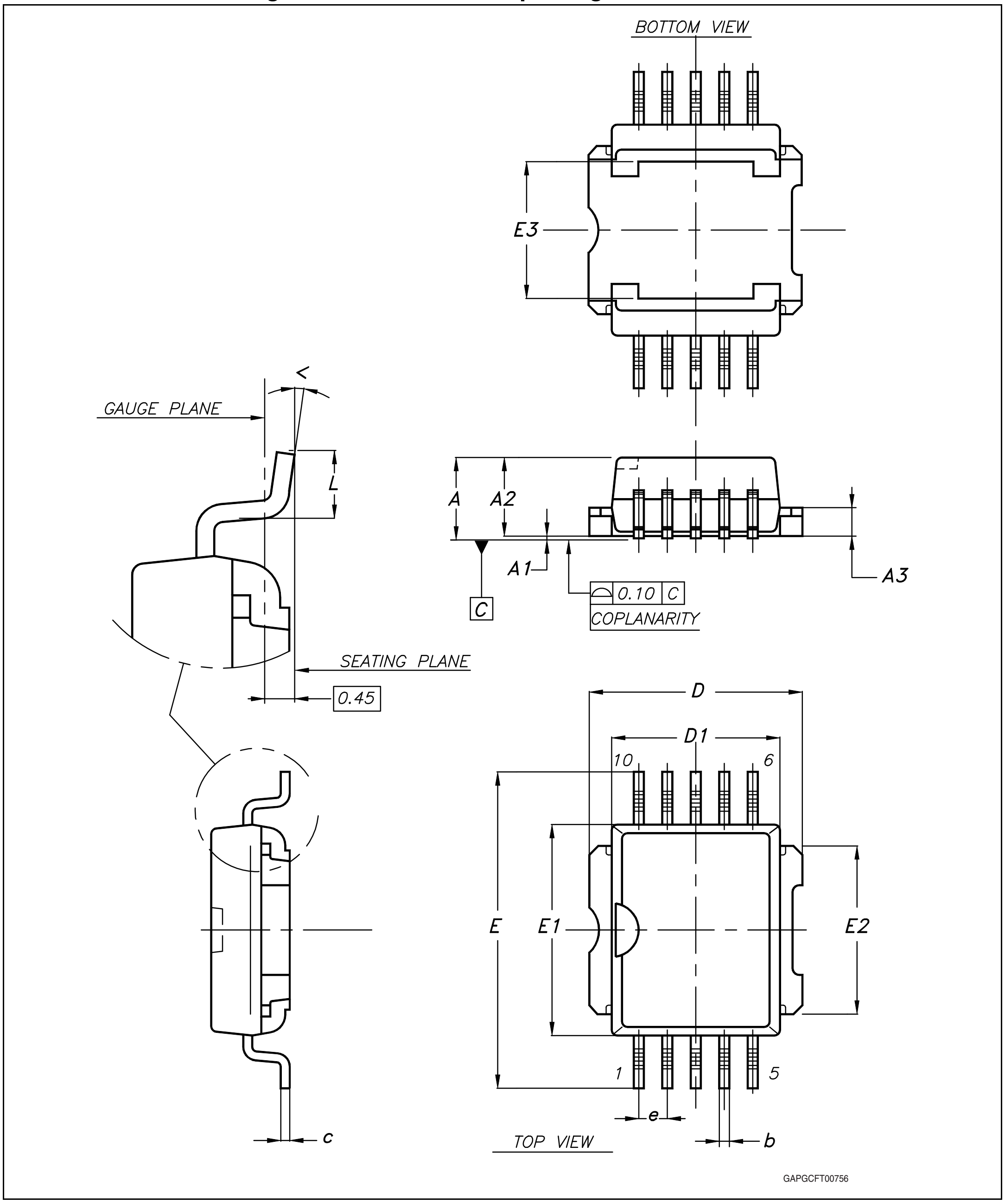
3.3 PowerSO-10 mechanical data

Table 11. PowerSO-10 mechanical data

Dim.	mm.		
	Min.	Typ.	Max.
A			3.70
A1	0.00		0.10
A2	3.40		3.60
A3	1.25		1.35
b	0.40		0.53
c	0.35		0.55
D	9.40		9.60
D1(1)	7.40		7.60
E	13.80		14.40
E1(1)	9.30		9.50
E2	7.20		7.60
E3	5.90		6.10
e		1.27	
L	0.95		1.65
<	0°		8°

1. Resin protrusion not included (max value: 0.20 mm per side)

Figure 32. PowerSO-10 package dimensions

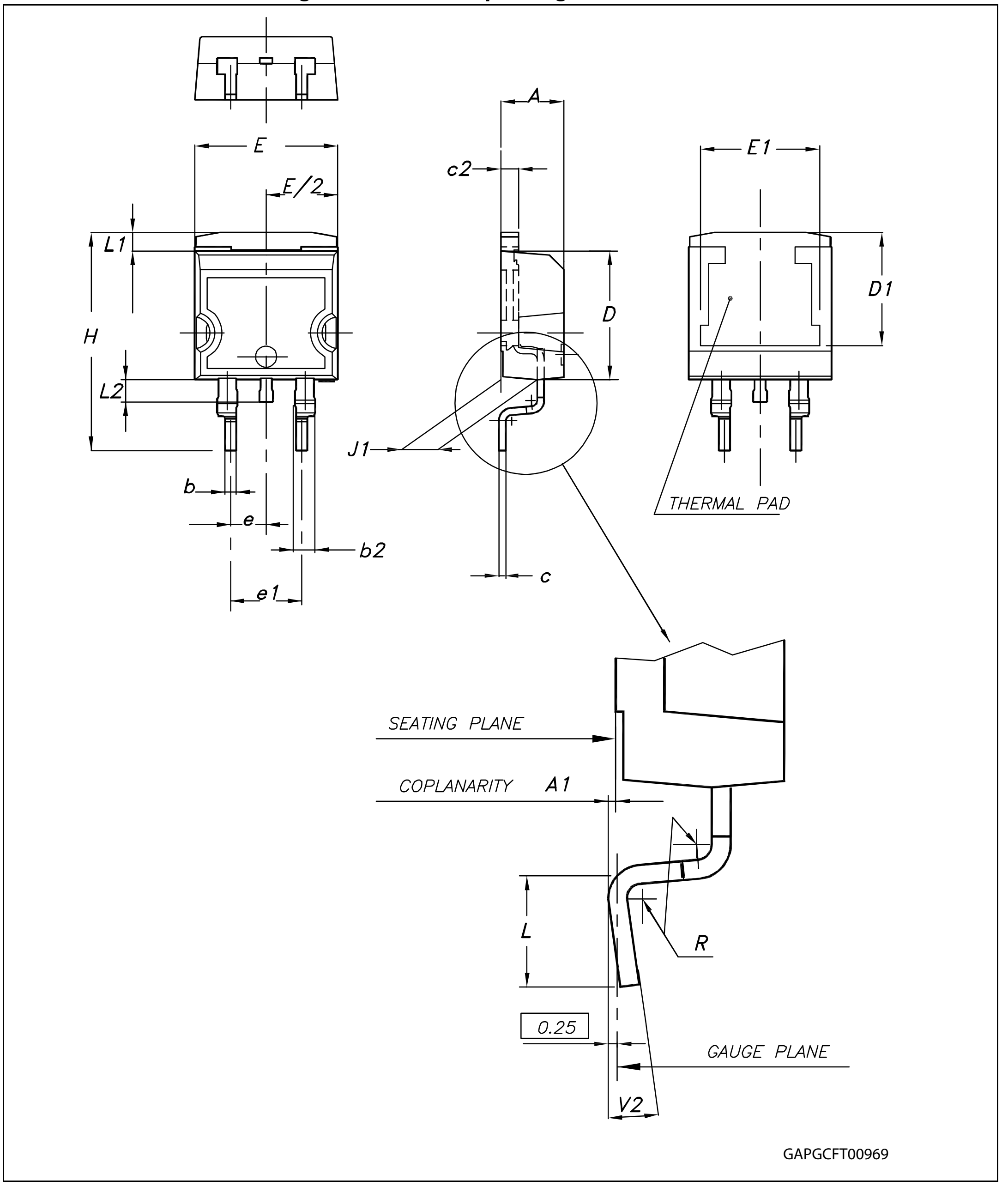


3.4 D^{2}PAK mechanical data

Table 12. D^{2}PAK mechanical data

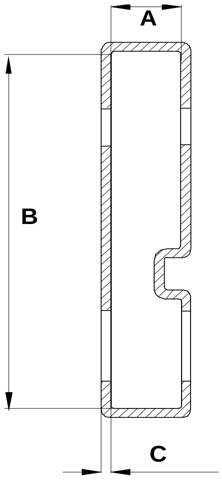
Dim.	mm.		
	Min.	Typ	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50		
E	10		10.40
E1	8.50		
e		2.54	
e1	4.88		5.28
H	15		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.4	
V2	0°		8°

Figure 33. D²PAK package dimensions



3.5 TO-220 packing information

Figure 34. TO-220 tube shipment (no suffix)

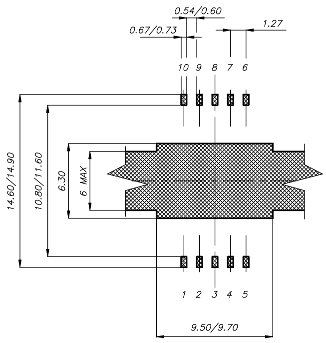


Base Q.ty	50
Bulk Q.ty	1000
Tube length (± 0.5)	532
A	5.5
B	31.4
C (± 0.1)	0.75

All dimensions are in mm.

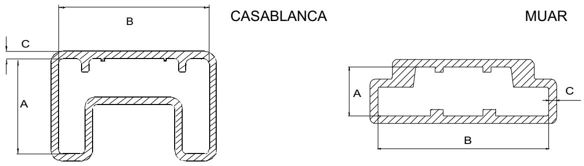
3.6 PowerSO-10 packing information

Figure 35. PowerSO-10 suggested pad layout



GAPGCFT00178

Figure 36. Tube shipment (no suffix)



All dimensions are in mm.

	Base Q.ty	Bulk Q.ty	Tube length (± 0.5)	A	B	C (± 0.1)
Casablanca	50	1000	532	10.4	16.4	0.8
Muar	50	1000	532	4.9	17.2	0.8

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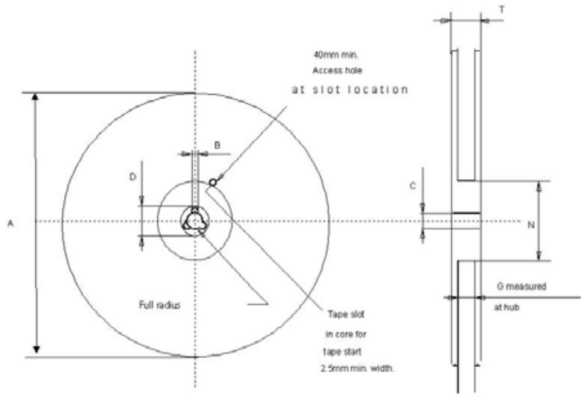
Figure 37. Tape and reel shipment (suffix “13TR”)



REEL DIMENSIONS

Base Q.ty	600
Bulk Q.ty	600
A (max)	330
B (min)	1.5
C (± 0.2)	13
F	20.2
G (+ 2 / -0)	24.4
N (min)	60
T (max)	30.4

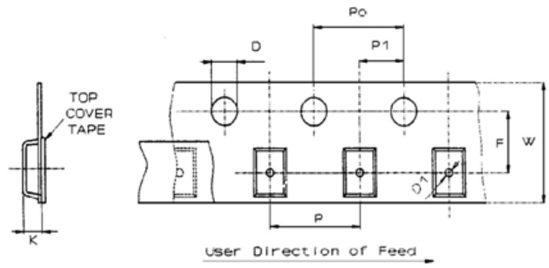
All dimensions are in mm.

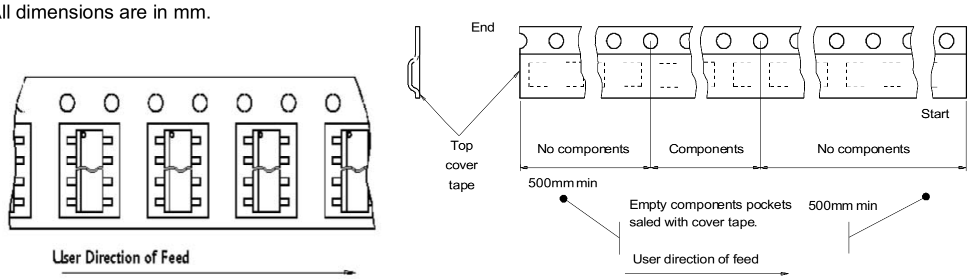
TAPE DIMENSIONS

According to Electronic Industries Association (EIA) Standard 481 rev. A, Feb 1986

Tape width	**W**	24
Tape Hole Spacing	**P0 (± 0.1)**	4
Component Spacing	**P**	24
Hole Diameter	**D (± 0.1/-0)**	1.5
Hole Diameter	**D1 (min)**	1.5
Hole Position	**F (± 0.05)**	11.5
Compartment Depth	**K (max)**	6.5
Hole Spacing	**P1 (± 0.1)**	2

All dimensions are in mm.





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3.7 D²PAK packing information

Figure 38. D²PAK footprint

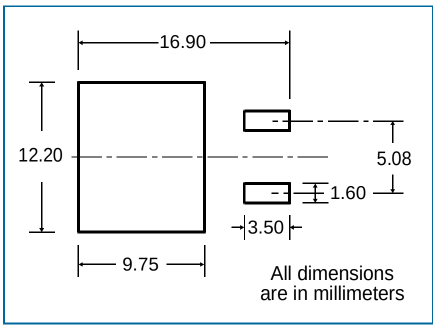
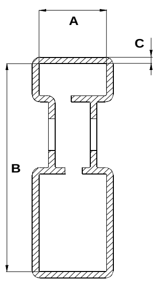


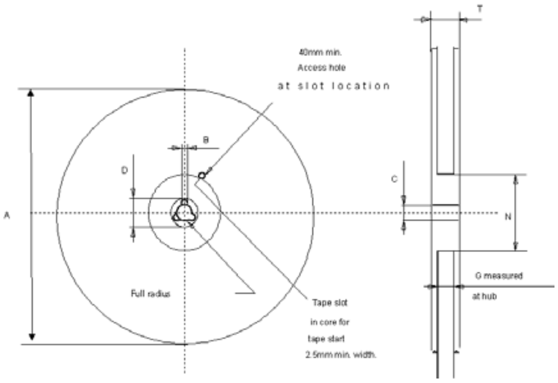
Figure 39. Tube shipment (no suffix)



Base Q.ty	50
Bulk Q.ty	500
Tube length (± 0.5)	532
A	6
B	21.3
C (± 0.1)	0.6

All dimensions are in

Figure 40. Tape and reel shipment (suffix "13TR")



REEL DIMENSIONS

Base Q.ty	1000
Bulk Q.ty	1000
A (max)	330
B (min)	1.5
C (± 0.2)	13
F	20.2
G (+ 2 / -0)	24.4
N (min)	60
T (max)	30.4

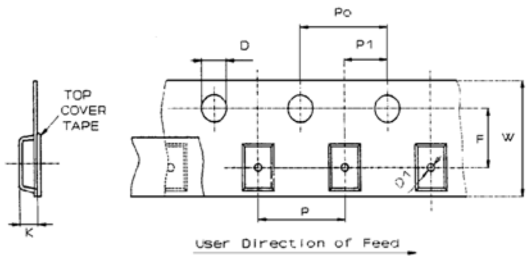
All dimensions are in mm.

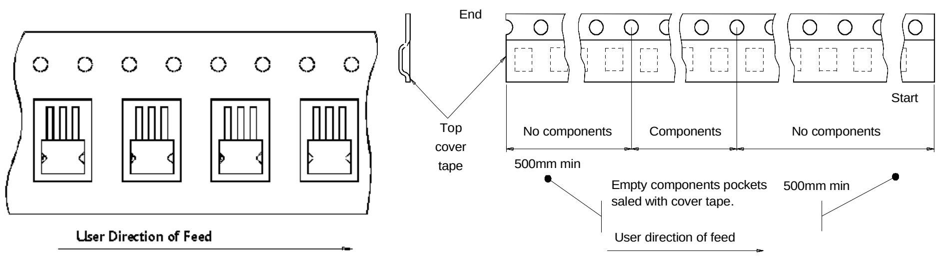
TAPE DIMENSIONS

According to Electronic Industries Association (EIA) Standard 481 rev. A, Feb 1986

Tape width	**W**	24
Tape Hole Spacing	**P0 (± 0.1)**	4
Component Spacing	**P**	16
Hole Diameter	**D (± 0.1/-0)**	1.5
Hole Diameter	**D1 (min)**	1.5
Hole Position	**F (± 0.05)**	11.5
Compartment Depth	**K (max)**	6.5
Hole Spacing	**P1 (± 0.1)**	2

All dimensions are in mm.





4 Revision history

Table 13. Document revision history

Date	Revision	Changes
19-Sep-2012	1	Initial release.
25-Sep-2013	2	Updated disclaimer.
30-Sep-2013	3	Added *Table 5: On*
09-Oct-2013	4	Corrections of typos

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