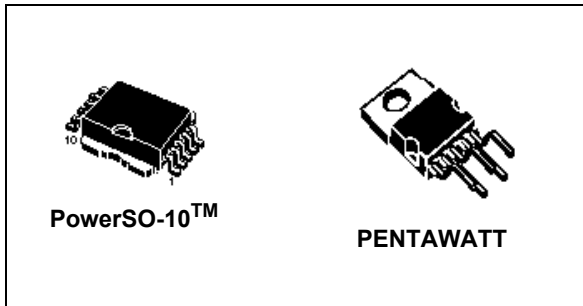


## Single high-side smart power solid state relay

Datasheet - production data



- Protection against:
  - Loss of ground
  - Shorted load and overtemperature
- Built-in current limiter
- Undervoltage shutdown
- Open drain diagnostic output
- Fast demagnetization of inductive loads

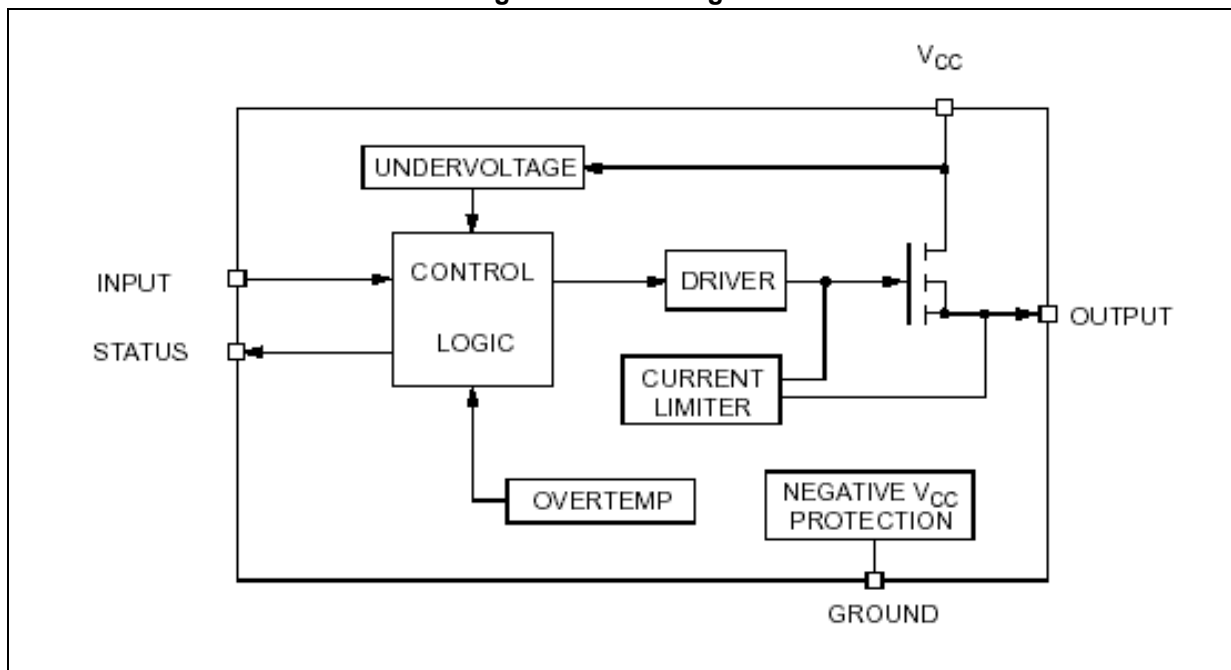
### Features

- 10 V to 36 V supply voltage range
- Up to  $I_{OUT} = 2.8$  A operating current
- $R_{DS(on)}$ : 50 m $\Omega$
- $V_{demag} = V_{CC} - 55$  V
- Digital input clamped at 32 V

### Description

The VN540-E and VN540SP-E are monolithic devices designed in STMicroelectronics VIPower technology, intended for driving resistive or inductive loads with one side connected to ground. Active current limitation avoids the system power supply dropping in case of shorted load. Built-in thermal shutdown protects the chip from overtemperature. The open drain diagnostic output indicates overtemperature conditions.

Figure 1. Block diagram



# Contents

<b>1</b>	<b>Absolute maximum rating</b> .....	<b>3</b>
<b>2</b>	<b>Pin connections</b> .....	<b>4</b>
<b>3</b>	<b>Thermal data</b> .....	<b>5</b>
<b>4</b>	<b>Electrical characteristics</b> .....	<b>6</b>
<b>5</b>	<b>Switching characteristics</b> .....	<b>8</b>
<b>6</b>	<b>Truth table</b> .....	<b>8</b>
<b>7</b>	<b>Test circuits and waveforms</b> .....	<b>9</b>
<b>8</b>	<b>Package information</b> .....	<b>12</b>
	8.1 PowerSO-10 package information .....	12
	8.2 PENTAWATT vertical package information .....	14
<b>9</b>	<b>Ordering information</b> .....	<b>17</b>
<b>10</b>	<b>Revision history</b> .....	<b>17</b>

# 1 Absolute maximum rating

Table 1. Absolute maximum rating

Symbol	Parameter	Value	Unit
$V_{CC}$	Power supply voltage	45	V
$-V_{CC}$	Reverse supply voltage	-4.0	V
$I_{OUT}$	Maximum DC load current	Internally limited	A
$I_R$	Reverse output current	-10	A
$I_{IN}$	Input current	$\pm 10$	mA
$I_{STAT}$	Status pin current	$\pm 10$	mA
$V_{ESD}$	Electrostatic discharge (R = 1.5 KW; C = 100 pF)	2000	V
$P_{TOT}$	Power dissipation (see thermal thresholds in <a href="#">Table 6 on page 7</a> )	Internally limited	W
$T_J$	Junction operating temperature	Internally limited	°C
$T_{STG}$	Storage temperature	-55 to 150	°C
$E_{AS}$	Single pulse avalanche energy ( $T_{amb} = 125\text{ °C}$ , $V_{CC} = 24\text{ V}$ , $I_{load} = 2.0\text{ A}$ )	12	J

## 2 Pin connections

Figure 2. Connection diagram (top view)

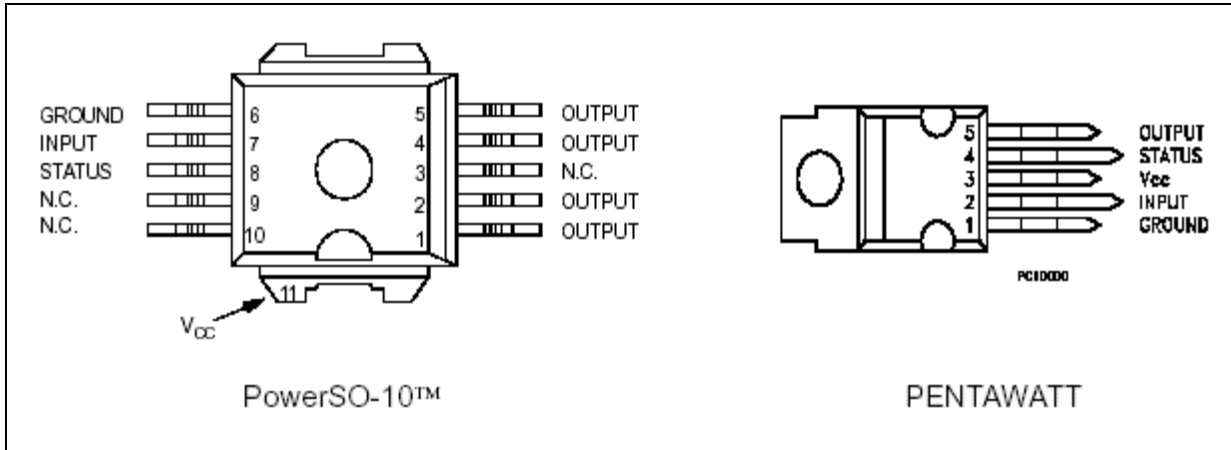
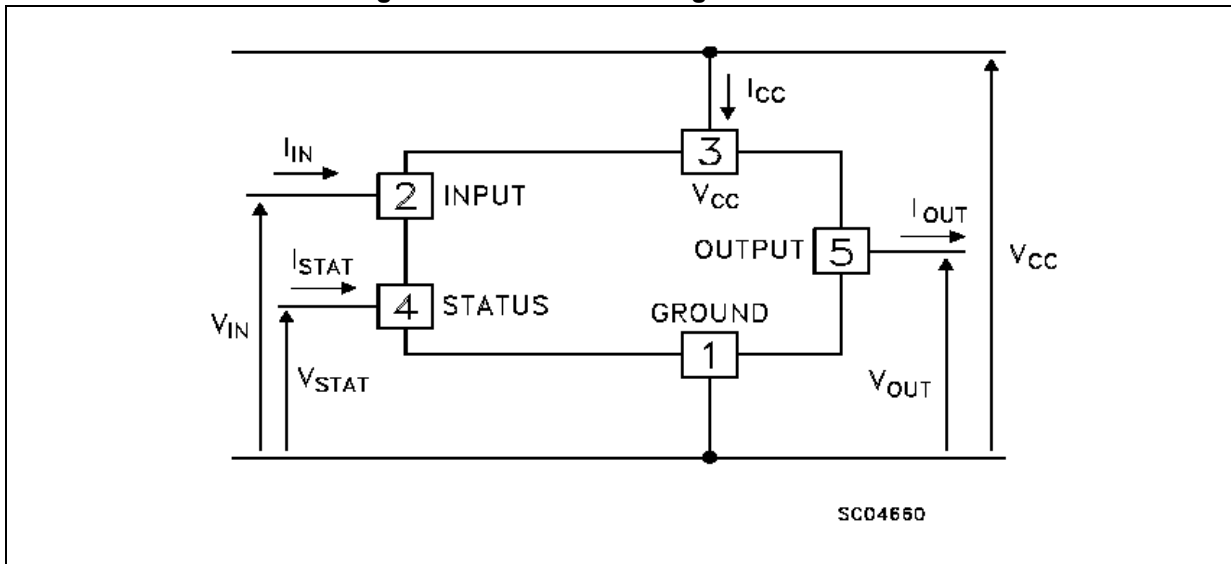


Figure 3. Current and voltage conventions



### 3 Thermal data

Table 2. Thermal data

Symbol	Parameter		Value		Unit
			PowerSO-10	PENTAWATT	
$R_{thJC}$	Thermal resistance junction-case	Max.	1.5	2.0	$^{\circ}C/W$
$R_{thJA}$	Thermal resistance junction-ambient	Max.	50	60	$^{\circ}C/W$

## 4 Electrical characteristics

Electrical characteristics (10 V < V<sub>CC</sub> < 36 V; -25 °C < T<sub>J</sub> < 85 °C; unless otherwise specified).

**Table 3. Power section**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V <sub>CC</sub>	Supply voltage		10	-	36	V
R <sub>ON</sub>	On state resistance	I <sub>OUT</sub> = 2.8 A; T <sub>J</sub> = 25 °C I <sub>OUT</sub> = 2.8 A	-	-	50 90	mΩ mΩ
I <sub>S</sub>	Supply current	OFF state ON state; T <sub>J</sub> = 125 °C I <sub>OUT</sub> = 0 A	-	-	1 3	mA mA
I <sub>LS</sub>	Output leakage current	Channel OFF V <sub>CC</sub> = 45 V	-	-	100	μA
I <sub>LGND</sub>	Output current at turn-off	V <sub>CC</sub> = V <sub>IN</sub> = V <sub>GND</sub> = V <sub>STAT</sub> = 24 V T <sub>J</sub> = -25 °C < T <sub>J</sub> < 100 °C	-	-	2	mA
V <sub>OL</sub>	Low state output voltage	V <sub>IN</sub> = V <sub>IL</sub> ; R <sub>LOAD</sub> ≥ 10 MΩ	-	-	1.5	V
V <sub>demag</sub>	Output voltage at turn-off	I <sub>OUT</sub> = 2.8 A; L <sub>LOAD</sub> ≥ 1 mH	V <sub>CC</sub> - 65	V <sub>CC</sub> - 55	V <sub>CC</sub> - 45	V

**Table 4. Switching**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
t <sub>d(ON)</sub>	Turn-on delay on output current	I <sub>OUT</sub> = 2.8 A, resistive load input rise time < 0.1 s, V <sub>CC</sub> = 24 V; T <sub>J</sub> = 25 °C	-	40	-	μs
t <sub>r</sub>	Rise time of output current	I <sub>OUT</sub> = 2.8 A, resistive load input rise time < 0.1 s, V <sub>CC</sub> = 24 V; T <sub>J</sub> = 25 °C	-	60	-	μs
t <sub>d(OFF)</sub>	Turn-off delay time of output current	I <sub>OUT</sub> = 2.8 A, resistive load input rise time < 0.1 s, V <sub>CC</sub> = 24 V; T <sub>J</sub> = 25 °C	-	60	-	μs
t <sub>f</sub>	Fall time of output current	I <sub>OUT</sub> = 2.8 A, resistive load input rise time < 0.1 s, V <sub>CC</sub> = 24 V; T <sub>J</sub> = 25 °C	-	25	-	μs
dI/dt <sub>(on)</sub>	Turn-on current average slope	I <sub>OUT</sub> = 2.8 A, I <sub>OUT</sub> = I <sub>LIM</sub> ; 25 °C < T <sub>J</sub> < 140 °C	-	-	0.5 2	A/μs
dI/dt <sub>(off)</sub>	Turn-off current average slope	I <sub>OUT</sub> = 2.8 A, I <sub>OUT</sub> = I <sub>LIM</sub> ; 25 °C < T <sub>J</sub> < 140 °C	-	-	2 4	A/μs

Table 5. Logical input

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{IL}$	Input low level voltage	-	-	-	2.0	V
$V_{IH}$	Input high level voltage	-	3.5	-	-	V
$V_{I(HYST)}$	Input hysteresis voltage	-	-	0.5	-	V
$I_{IN}$	Input current	$V_{IN} = 30\text{ V}$ $V_{IN} = 2.0\text{ V}$	- 25	- -	300 -	$\mu\text{A}$ $\mu\text{A}$
$V_{ICL}$	I/O input clamp voltage <sup>(1)</sup>	$I_{IN} = 1\text{ mA}$ $I_{IN} = -1\text{ mA}$	32 -	36 -0.7	- -	V V

1. The input voltage is internally clamped at 32 V minimum, it is possible to connect the input pins to a higher voltage via an external resistor calculate to not exceed 10 mA.

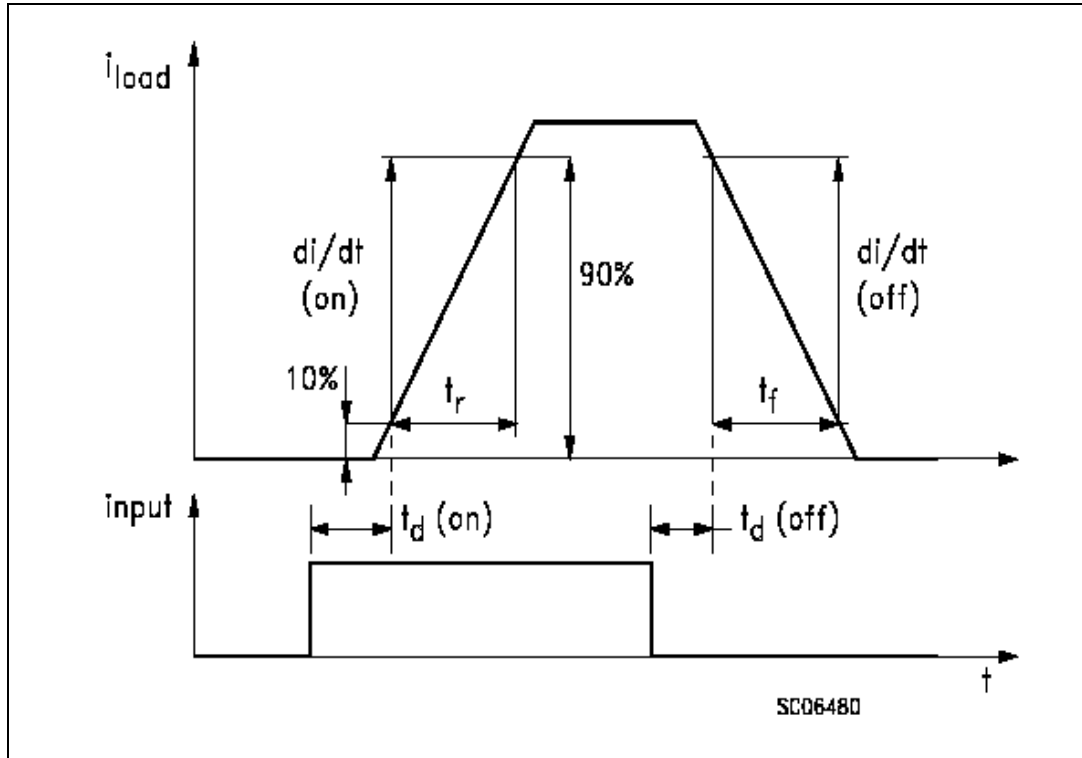
Table 6. Protection and diagnostic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{STAT}$	Status output voltage	$I_{STAT} = 5\text{ mA}$ (fault condition)	-	-	1	V
$V_{SCL}^{(1)}$	Status clamp voltage	$I_{STAT} = 1\text{ mA}$ $I_{STAT} = -1\text{ mA}$	32	36 -0.7	- -	V V
$I_{STAT}$	Leakage on diagnostic pin in high state	$V_{STAT} = 5\text{ V}$	-	-	-	$\mu\text{A}$
$V_{USD}$	Undervoltage shutdown	-	5.0	-	8.0	V
$I_{LIM}$	DC short-circuit current	$V_{CC} = 24\text{ V}$ ; $R_{LOAD} < 10\text{ m}\Omega$	2.8	5.0	8.0	A
$I_{OVPK}$	Peak short-circuit current	$V_{CC} = 24\text{ V}$ ; $V_{IN} = 30$ ; $R_{LOAD} < 10\text{ m}\Omega$	-	-	4	A
$t_{SC}$	Delay time of current limiter	-	-	-	100	$\mu\text{s}$
$T_{TSD}$	Thermal shutdown temperature	-	150	170	-	$^{\circ}\text{C}$
$T_R$	Thermal reset temperature	-	135	155	-	$^{\circ}\text{C}$

1. Status determination > 100 ms after the switching edge.

## 5 Switching characteristics

Figure 4. Switching characteristics



## 6 Truth table

Table 7. Truth table

Conditions	INPUT	OUTPUT	STATUS
Normal operation	L	L	H
	H	H	H
Overtemperature	L	L	H
	H	L	L
Undervoltage	L	L	H
	H	L	H
Shorted load (current limitation)	L	L	H
	H	H	H



## 7 Test circuits and waveforms

Figure 5. Peak short test circuit

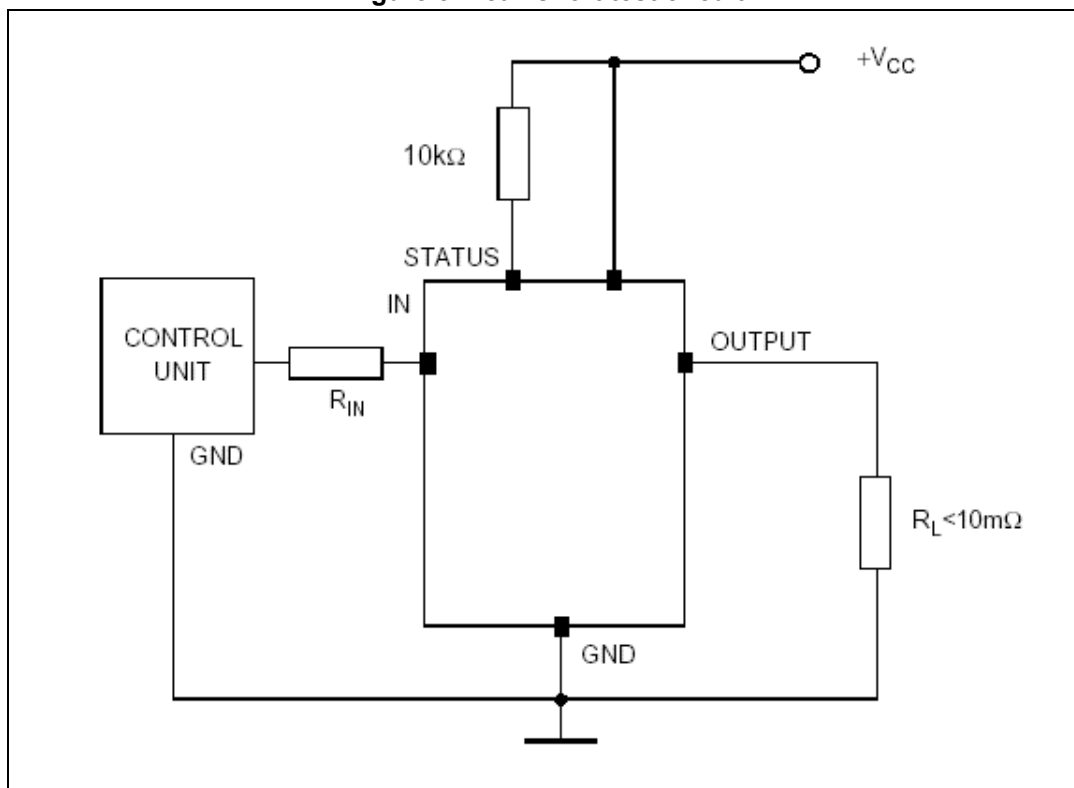


Figure 6. Switching waveforms

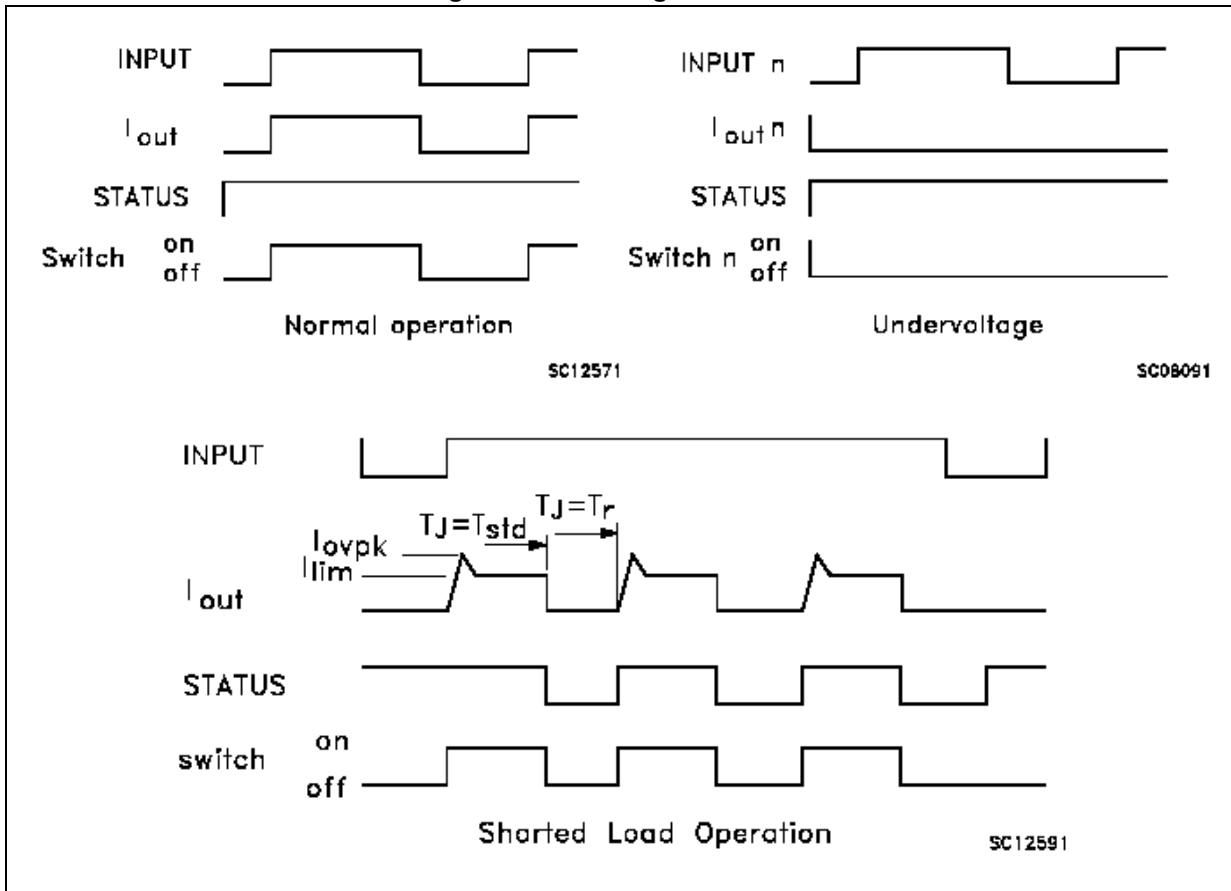


Figure 7. I<sub>LGND</sub> test configuration

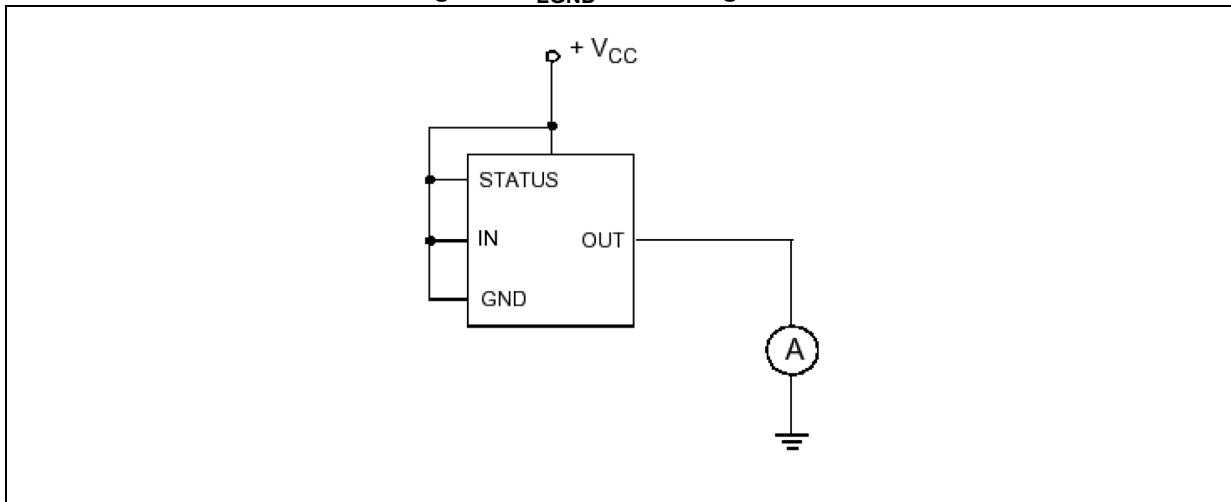
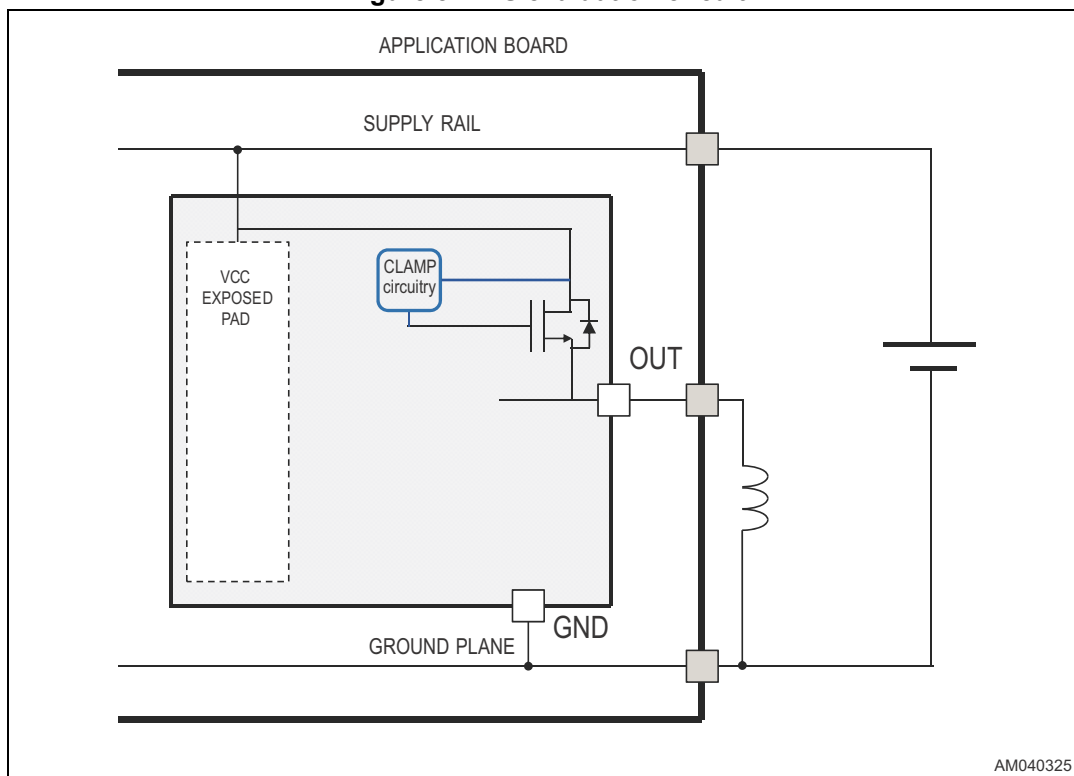


Figure 8. EAS evaluation circuit



## 8 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. These packages have a Lead-free second level interconnect. The category of second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK® is an ST trademark.

### 8.1 PowerSO-10 package information

Figure 9. PowerSO-10 package outline

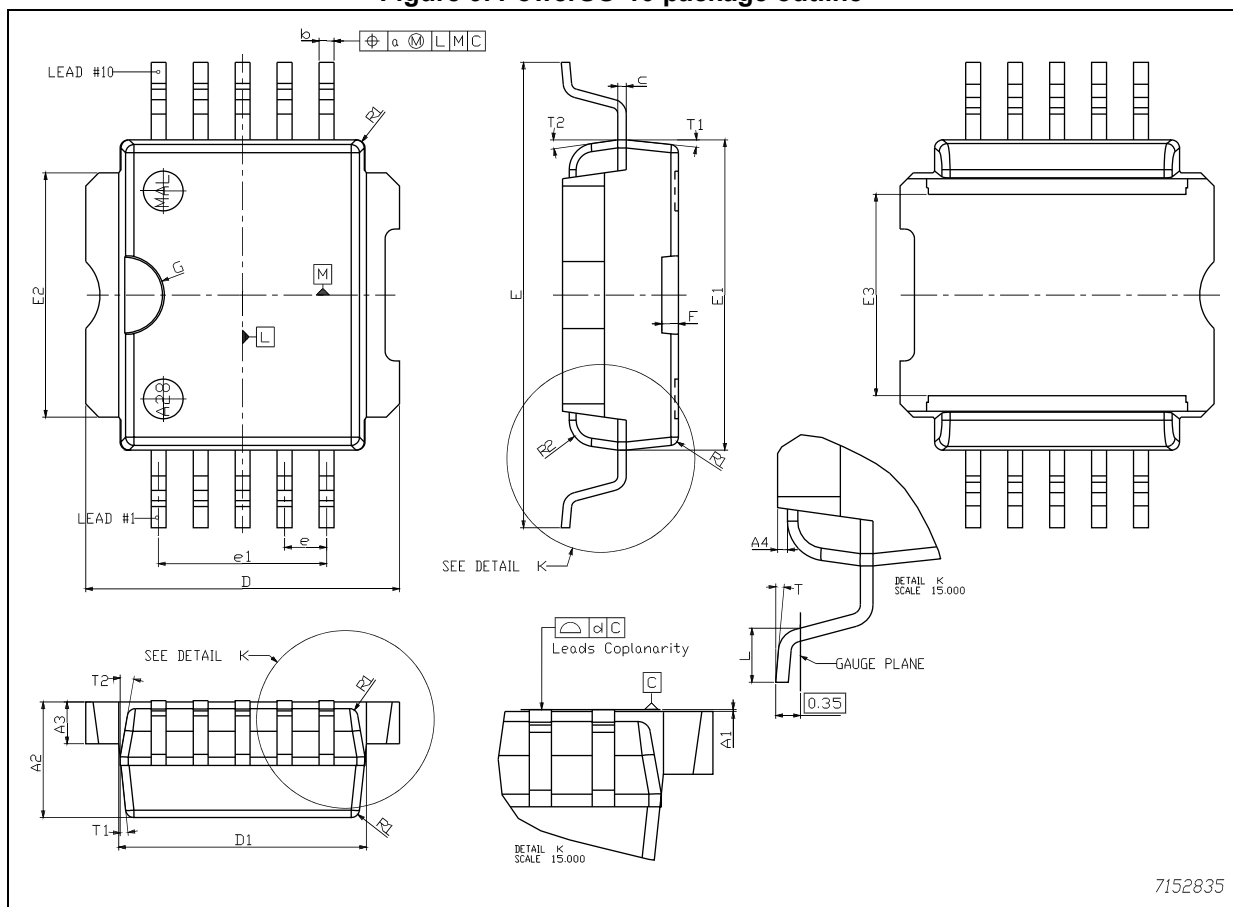


Table 8. PowerSO-10 package mechanical data

Symbol	Dimensions (mm )			Dimensions (inch )			Note
	Typ.	Min.	Max.	Typ.	Min.	Max.	
A1	0.05	0	0.1	0.0019	0.0004	0.003	-
A2	3.5	3.4	3.6	0.137	0.135	0.139	-
A3	1.3	1.2	1.4	0.05	0.048	0.052	-
A4	0.2	0.15	0.25	0.007	0.006	0.01	-
a	0.2	-	-	0.007	-	-	-
b	0.45	0.37	0.53	0.017	0.015	0.019	-
c	0.27	0.23	0.32	0.01	0.009	0.011	-
D	9.5	9.4	9.6	0.374	0.372	0.377	-
D1	7.5	7.4	7.6	0.295	0.292	0.298	-
d	0.05	0	0.1	0.0015	0	0.0035	-
E	14.1	13.85	14.35	0.555	0.547	0.562	-
E1	9.4	9.3	9.5	0.37	0.367	0.372	(1)
E2	7.4	7.3	7.5	0.292	0.291	0.295	-
E3	6.1	5.9	6.3	0.24	0.234	0.246	-
e	1.27	-	-	0.05	0.048	0.051	-
e1	5.08	-	-	0.2	-	-	-
F	0.5	-	-	0.019	-	-	-
G	1.2	-	-	0.047	-	-	-
L	1	0.8	1.1	0.039	0.033	0.043	-
R1	-	-	0.25	-	-	0.01	-
R2	0.8	-	-	0.031	-	-	-
T	5 deg.	2 deg.	8 deg.	5 deg.	3 deg.	7 deg.	-
T1	6 deg.	-	-	6 deg.	-	-	-
T2	10 deg.	-	-	10 deg.	-	-	-

1. Resin protrusions not included (max. value: 0.15 mm per side).

### 8.2 PENTAWATT vertical package information

Figure 10. PENTAWATT vertical package outline

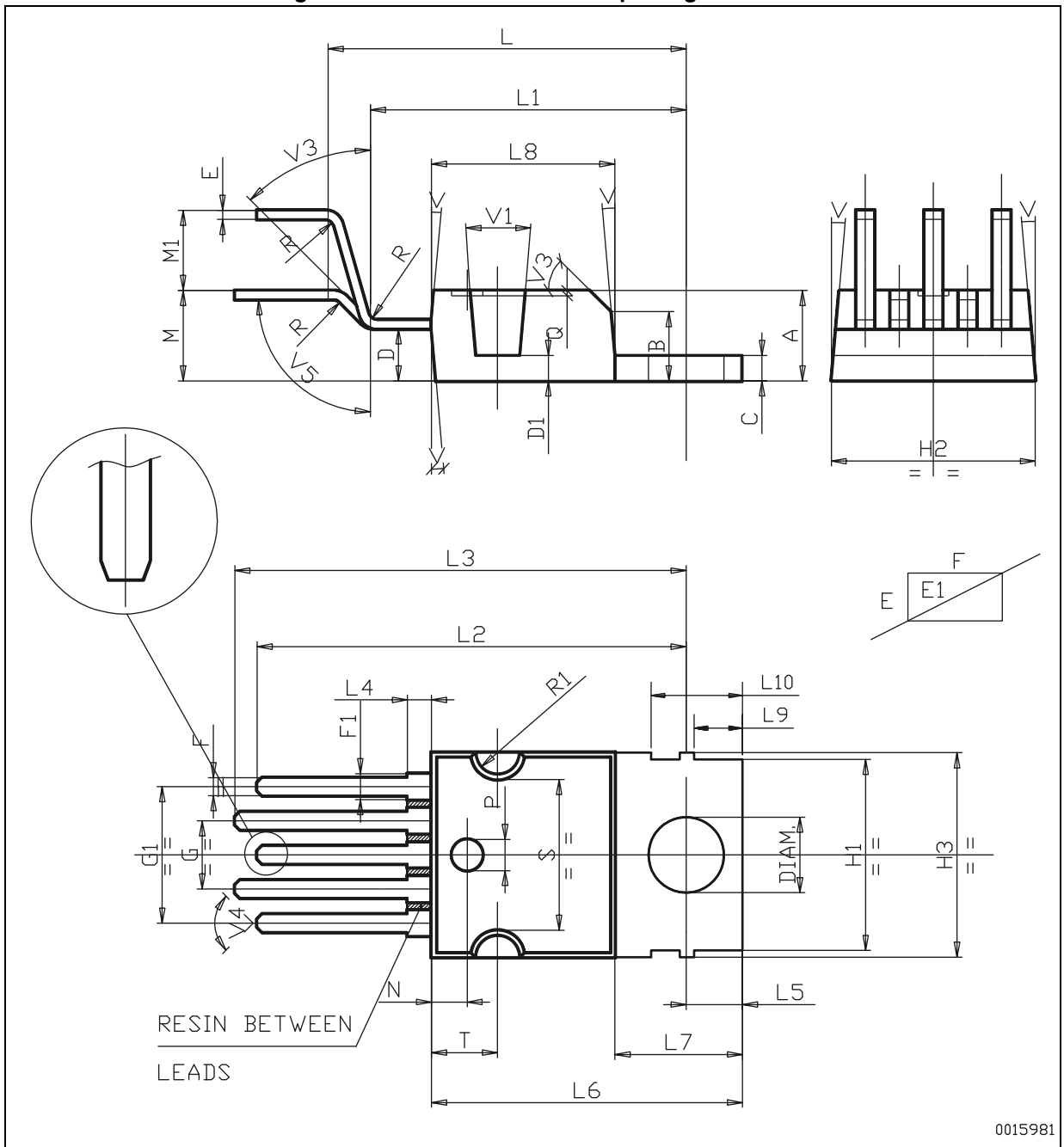


Table 9. PENTAWATT vertical package mechanical data

Symbol	Dimensions (mm )			Dimensions (inch )		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	-	-	4.80	0.178	0.174	0.182
B	-	-	-	0.136	0.132	0.140
C	-	-	1.37	0.050	0.047	0.053
D	-	2.40	2.80	0.102	0.098	0.106
D1	-	1.20	1.35	0.050	0.049	0.051
E	-	0.35	0.55	0.016	0.014	0.018
E1	-	0.76	1.19	-	0.029	0.044
F	-	0.80	1.05	0.036	0.033	0.039
F1	-	1.00	1.40	-	0.043	0.053
G	3.40	3.20	3.60	0.134	0.130	0.138
G1	6.80	6.60	7.00	0.268	0.264	0.272
H1	-	-	-	0.375	0.367	0.382
H2	-	-	10.4	-	-	0.400
H3	-	-	10.40	0.401	0.399	0.405
L	17.85	17.55	18.15	0.703	0.693	0.713
L1	15.75	15.55	15.95	0.620	0.614	0.626
L2	21.40	21.20	21.60	0.842	0.836	0.848
L3	22.50	22.30	22.70	0.886	0.881	0.889
L4	-	-	1.29	-	-	0.051
L5	-	2.60	3.00	0.110	0.106	0.114
L6	-	15.10	15.80	0.610	0.604	0.615
L7	-	6.00	6.60	0.250	0.246	0.254
L8	-	-	-	0.361	0.358	0.364
L9	-	2.10	2.70	0.094	0.090	0.098
L10	-	4.30	4.80	0.183	0.180	0.187
M	4.50	4.23	4.75	0.178	0.171	0.183
M1	4.00	3.75	4.25	0.157	0.151	0.163
N	-	-	-	0.070	-	-
P	-	-	-	-	0.059	0.063
Q	-	-	-	-	0.002	0.004
R	-	-	-	-	0.023	0.039
R1	-	-	-	0.043	-	-
S	-	-	-	0.315	0.313	0.317

Table 9. PENTAWATT vertical package mechanical data (continued)

Symbol	Dimensions (mm )			Dimensions (inch )		
	Min.	Typ.	Max.	Min.	Typ.	Max.
T	-	-	-	0.130	0.128	0.132
V	-	-	-	5d	-	-
V1	-	-	-	10d	-	-
V3	-	-	-	45d	-	-
V4	40d	-	-	40d	-	-
V5	90d	-	-	90d	-	-
Diam.	-	3.65	3.85	0.148	0.146	0.150



## 9 Ordering information

Table 10. Order codes

Package	Tube	Tape and reel
PowerSO-10	VN540SP-E	VN540SPTR-E
PENTAWATT vertical	VN540-E	-

## 10 Revision history

Table 11. Document revision history

Date	Revision	Changes
2-Nov-2005	1	Initial release.
09-May-2018	2	Removed VN540-12-E and PENTAWATT(012Y) from the whole document. Updated $P_{TOT}$ and $E_{AS}$ in <a href="#">Table 1 on page 3</a> . Added <a href="#">Figure 8 on page 11</a> . Updated <a href="#">Section 8 on page 12</a> . Minor modifications throughout document.

**IMPORTANT NOTICE – PLEASE READ CAREFULLY**

STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST's terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers' products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2018 STMicroelectronics – All rights reserved



Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



#### Как с нами связаться

**Телефон:** 8 (812) 309 58 32 (многоканальный)

**Факс:** 8 (812) 320-02-42

**Электронная почта:** [org@eplast1.ru](mailto:org@eplast1.ru)

**Адрес:** 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.