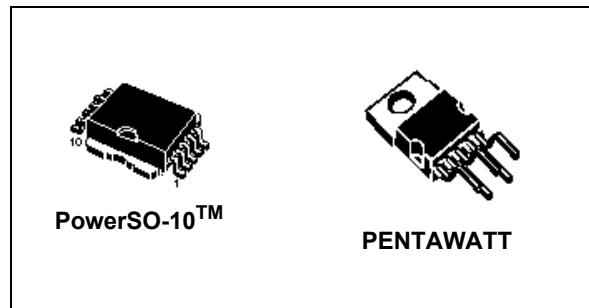


## Single high-side smart power solid state relay

Datasheet - production data



### Features

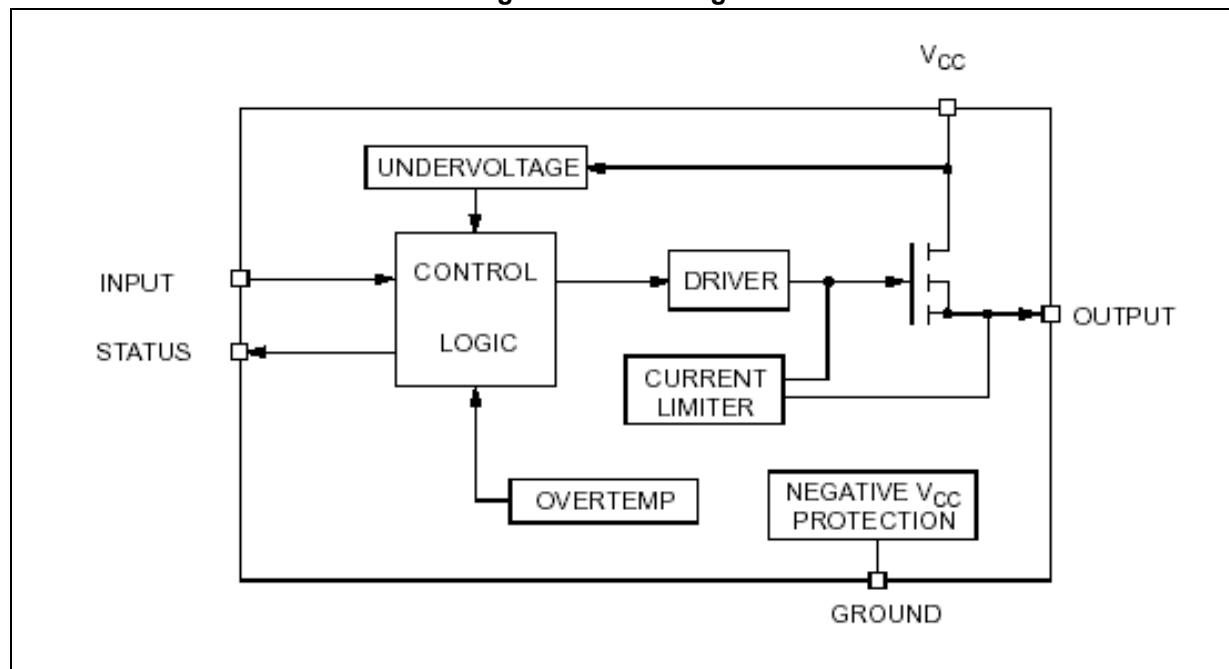
- 10 V to 36 V supply voltage range
- Up to  $I_{OUT} = 2.8$  A operating current
- $R_{DS(on)}: 50\text{ m}\Omega$
- $V_{demag} = V_{CC} - 55$  V
- Digital input clamped at 32 V

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

### 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 ( $R = 1.5 \text{ KW}$ ; $C = 100 \text{ pF}$ )	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	$^{\circ}\text{C}$
$T_{STG}$	Storage temperature	-55 to 150	$^{\circ}\text{C}$
$E_{AS}$	Single pulse avalanche energy ( $T_{amb} = 125 \text{ }^{\circ}\text{C}$ , $V_{CC} = 24 \text{ V}$ , $I_{load} = 2.0 \text{ A}$ )	12	J

## 2 Pin connections

Figure 2. Connection diagram (top view)

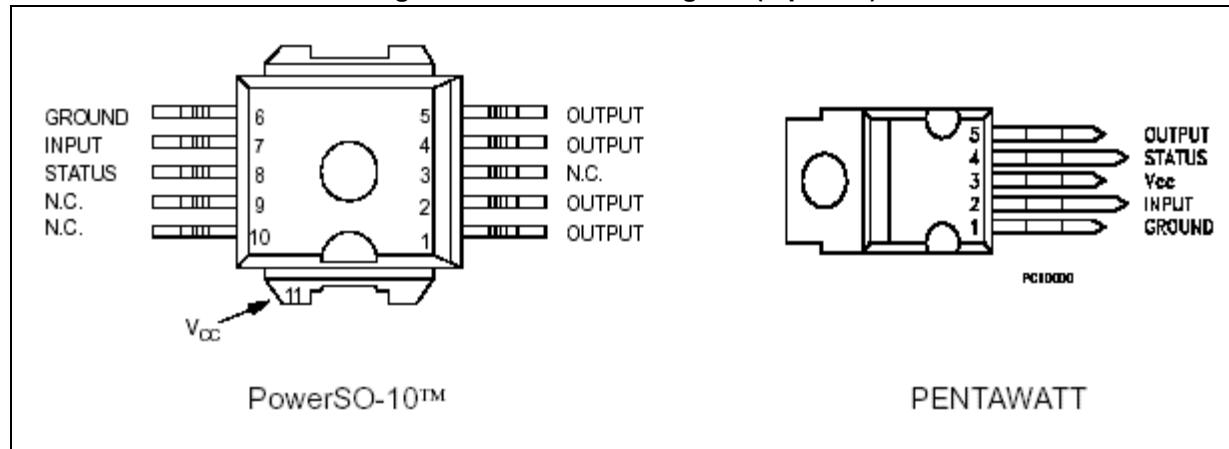
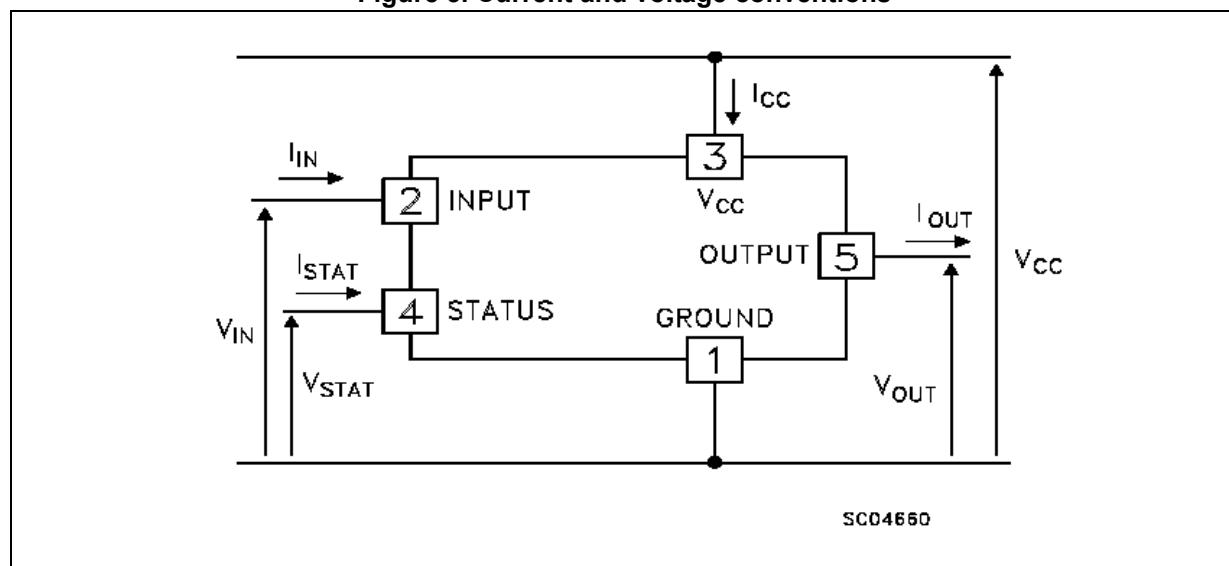


Figure 3. Current and voltage conventions



### 3 Thermal data

Table 2. Thermal data

Symbol	Parameter	Value		Unit
		PowerSO-10	PENTAWATT	
R <sub>thJC</sub>	Thermal resistance junction-case	Max.	1.5	°C/W
R <sub>thJA</sub>	Thermal resistance junction-ambient	Max.	50	60 °C/W

## 4 Electrical characteristics

Electrical characteristics ( $10 \text{ V} < V_{CC} < 36 \text{ V}$ ;  $-25^\circ\text{C} < T_J < 85^\circ\text{C}$ ; unless otherwise specified).

**Table 3. Power section**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{CC}$	Supply voltage		10	-	36	V
$R_{ON}$	On state resistance	$I_{OUT} = 2.8 \text{ A}; T_J = 25^\circ\text{C}$ $I_{OUT} = 2.8 \text{ A}$	-	-	50	$\text{m}\Omega$
$I_S$	Supply current	OFF state ON state; $T_J = 125^\circ\text{C}$ $I_{OUT} = 0 \text{ A}$	-	-	1	$\text{mA}$
$I_{LS}$	Output leakage current	Channel OFF $V_{CC} = 45 \text{ V}$	-	-	100	$\mu\text{A}$
$I_{LGND}$	Output current at turn-off	$V_{CC} = V_{IN} = V_{GND} = V_{STAT} = 24 \text{ V}$ $T_J = -25^\circ\text{C} < T_J < 100^\circ\text{C}$	-	-	2	$\text{mA}$
$V_{OL}$	Low state output voltage	$V_{IN} = V_{IL}; R_{LOAD} \geq 10 \text{ M}\Omega$	-	-	1.5	V
$V_{demag}$	Output voltage at turn-off	$I_{OUT} = 2.8 \text{ A}; L_{LOAD} \geq 1 \text{ mH}$	$V_{CC} - 65$	$V_{CC} - 55$	$V_{CC} - 45$	V

**Table 4. Switching**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(ON)}$	Turn-on delay on output current	$I_{OUT} = 2.8 \text{ A}$ , resistive load input rise time $< 0.1 \text{ s}$ , $V_{CC} = 24 \text{ V}$ ; $T_J = 25^\circ\text{C}$	-	40	-	$\mu\text{s}$
$t_r$	Rise time of output current	$I_{OUT} = 2.8 \text{ A}$ , resistive load input rise time $< 0.1 \text{ s}$ , $V_{CC} = 24 \text{ V}$ ; $T_J = 25^\circ\text{C}$	-	60	-	$\mu\text{s}$
$t_{d(OFF)}$	Turn-off delay time of output current	$I_{OUT} = 2.8 \text{ A}$ , resistive load input rise time $< 0.1 \text{ s}$ , $V_{CC} = 24 \text{ V}$ ; $T_J = 25^\circ\text{C}$	-	60	-	$\mu\text{s}$
$t_f$	Fall time of output current	$I_{OUT} = 2.8 \text{ A}$ , resistive load input rise time $< 0.1 \text{ s}$ , $V_{CC} = 24 \text{ V}$ ; $T_J = 25^\circ\text{C}$	-	25	-	$\mu\text{s}$
$dI/dt_{(on)}$	Turn-on current average slope	$I_{OUT} = 2.8 \text{ A}$ , $I_{OUT} = I_{LIM}$ ; $25^\circ\text{C} < T_J < 140^\circ\text{C}$	-	-	0.5 2	$\text{A}/\mu\text{s}$
$dI/dt_{(off)}$	Turn-off current average slope	$I_{OUT} = 2.8 \text{ A}$ , $I_{OUT} = I_{LIM}$ ; $25^\circ\text{C} < T_J < 140^\circ\text{C}$	-	-	2 4	$\text{A}/\mu\text{s}$

**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.

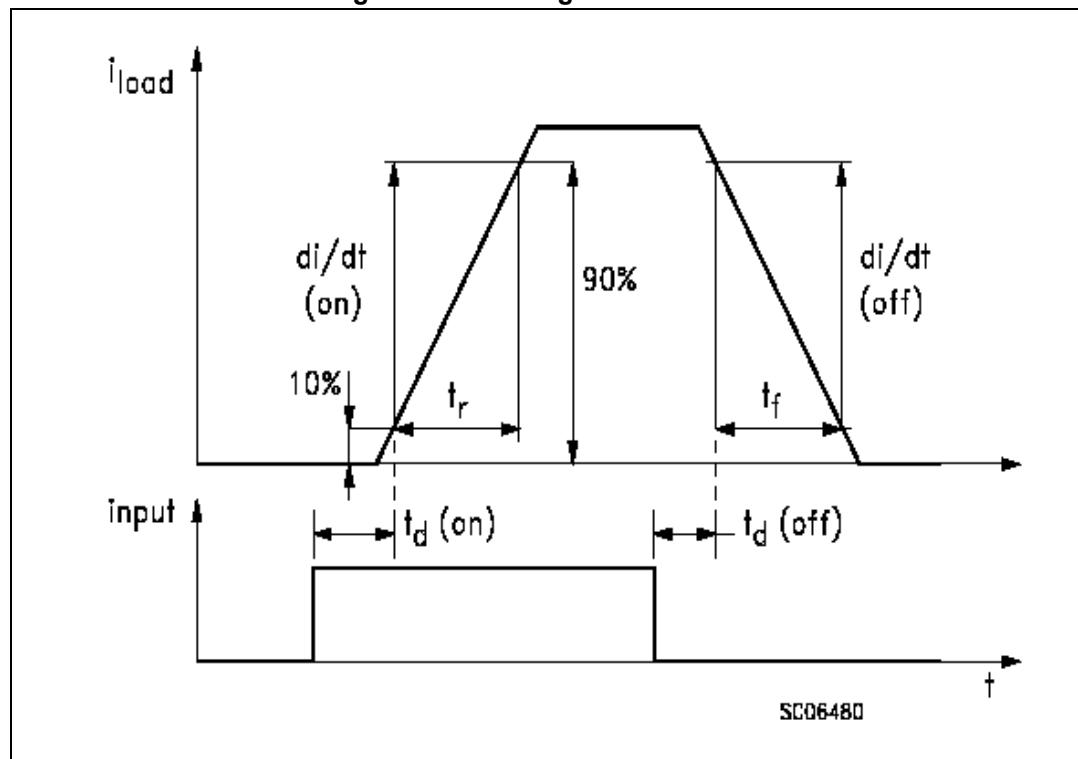
**Table 6. Protection and diagnostic**

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 -0.7	36 -	-	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	-	°C
$T_R$	Thermal reset temperature	-	135	155	-	°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

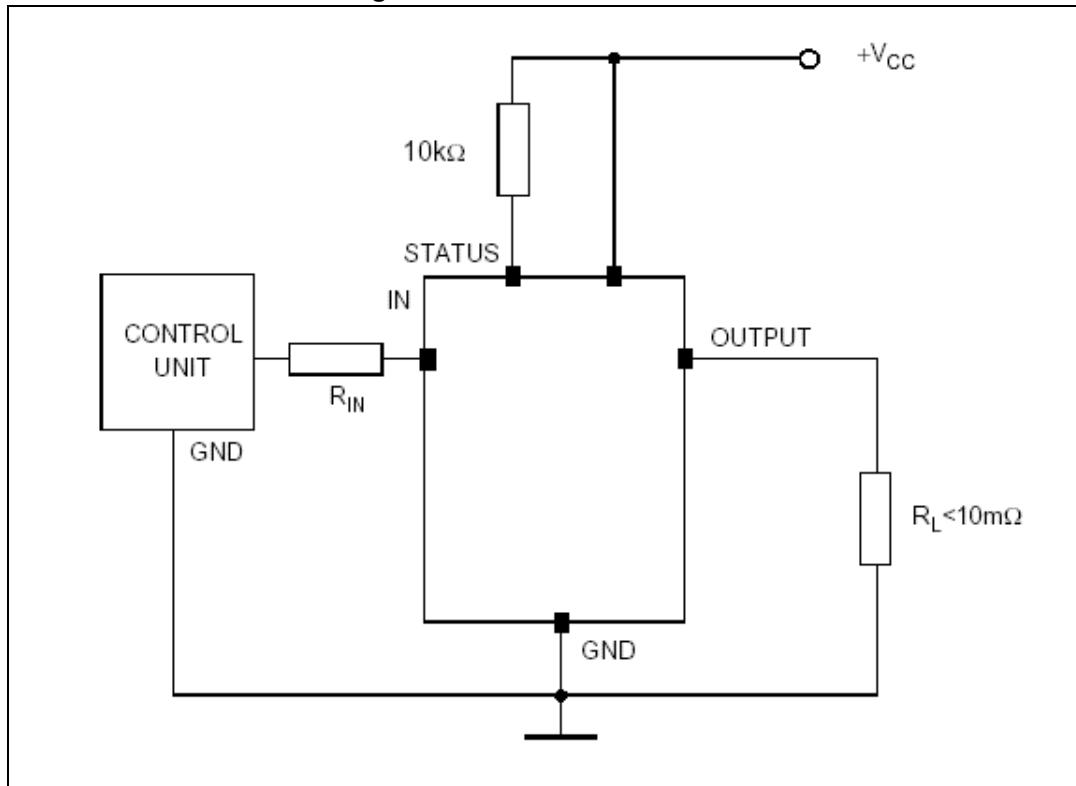
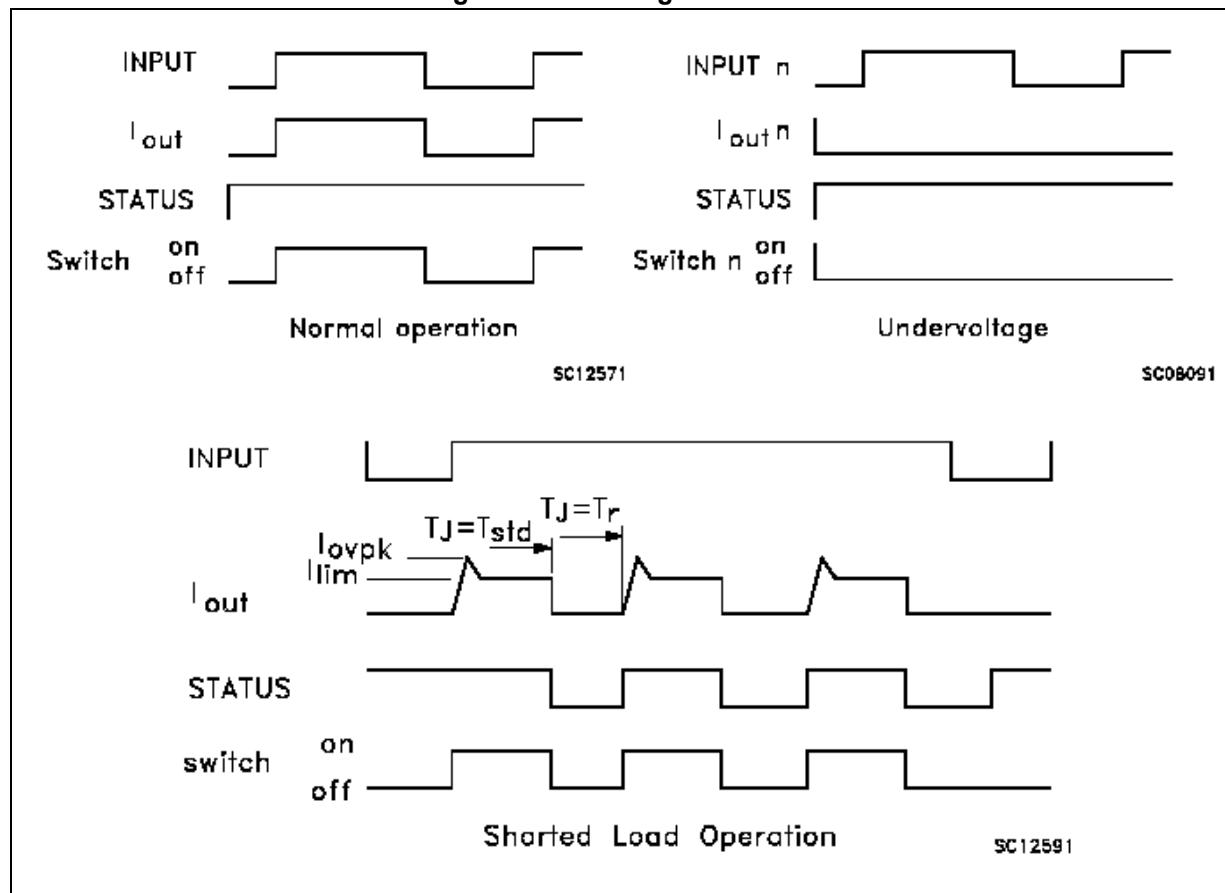
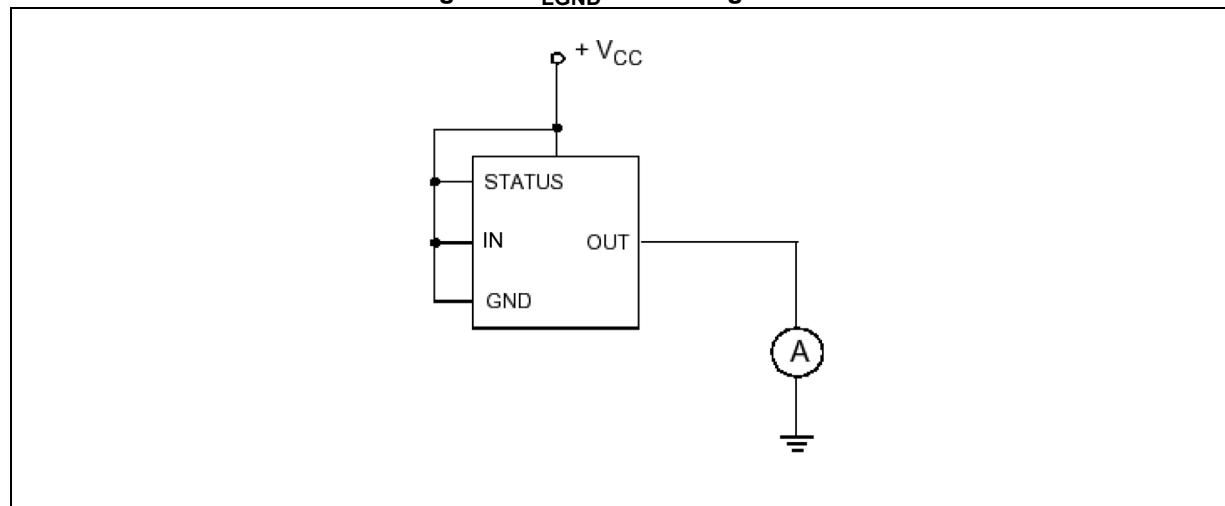
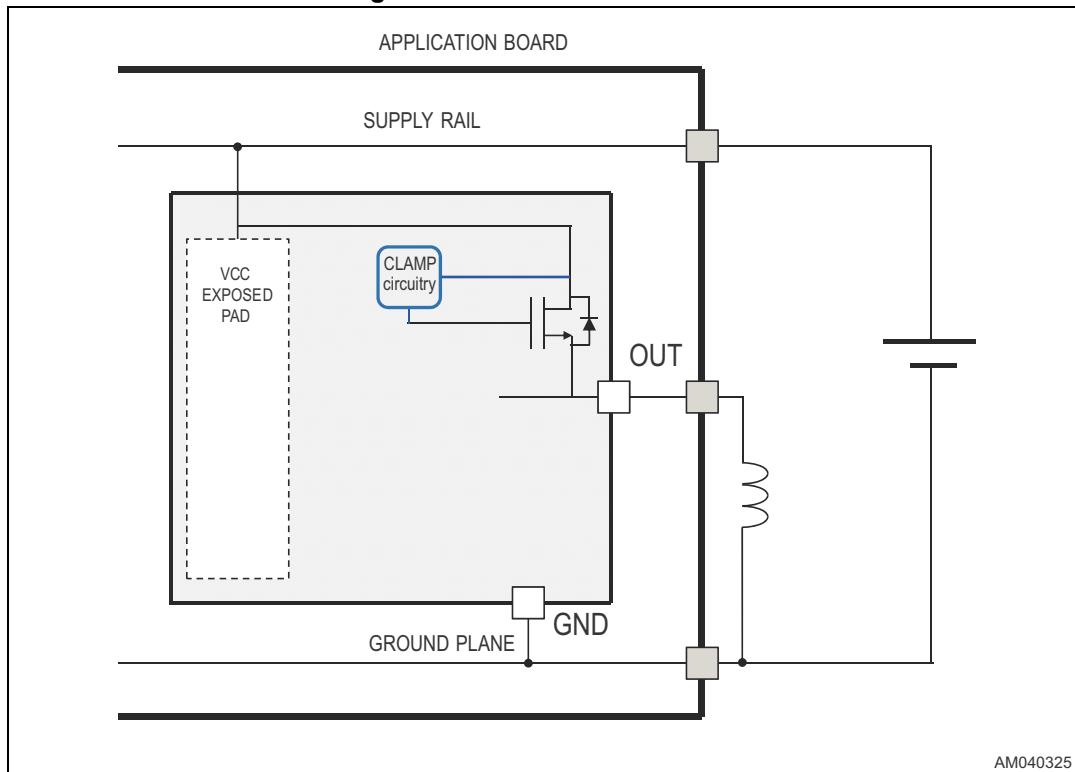


Figure 6. Switching waveforms

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

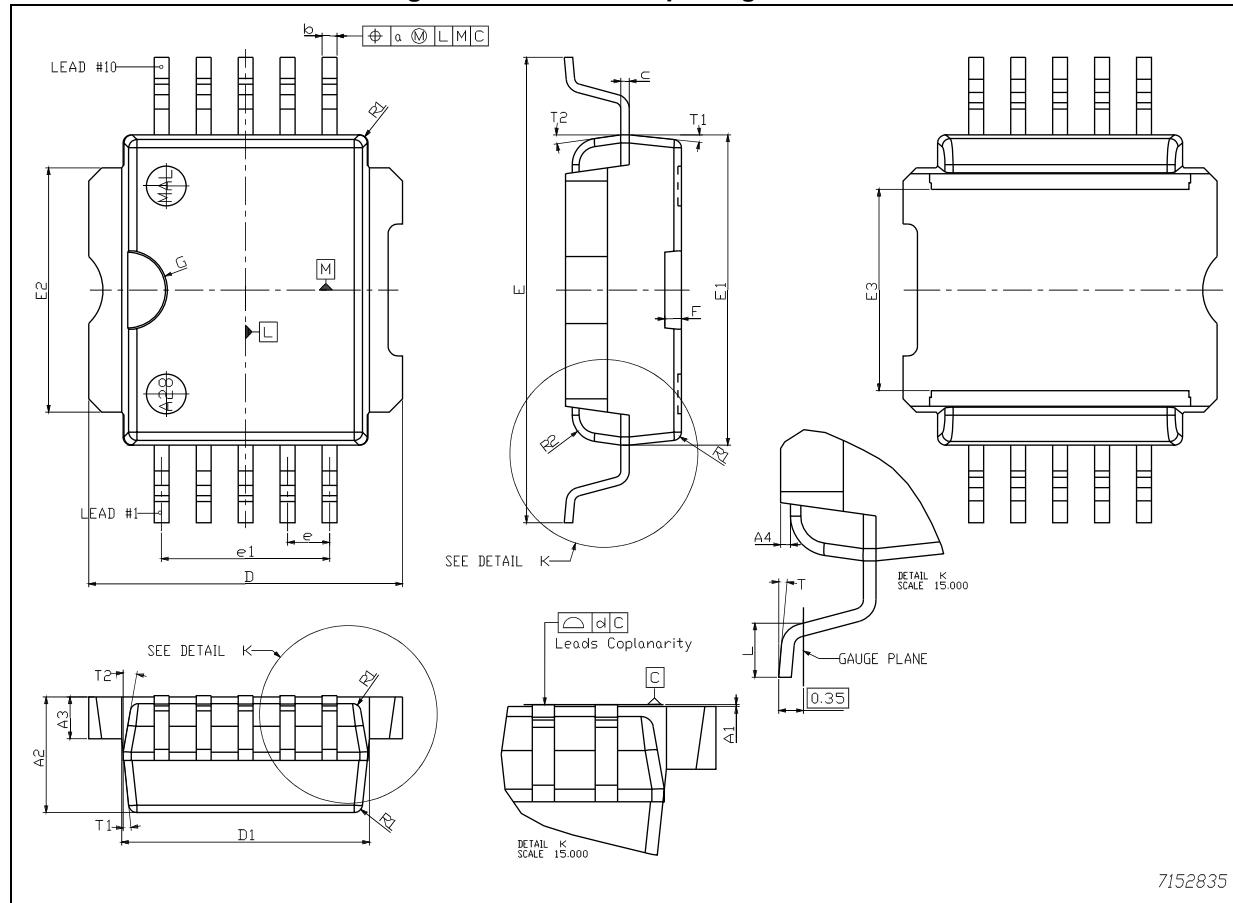
**Figure 8. EAS evaluation circuit**

## 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



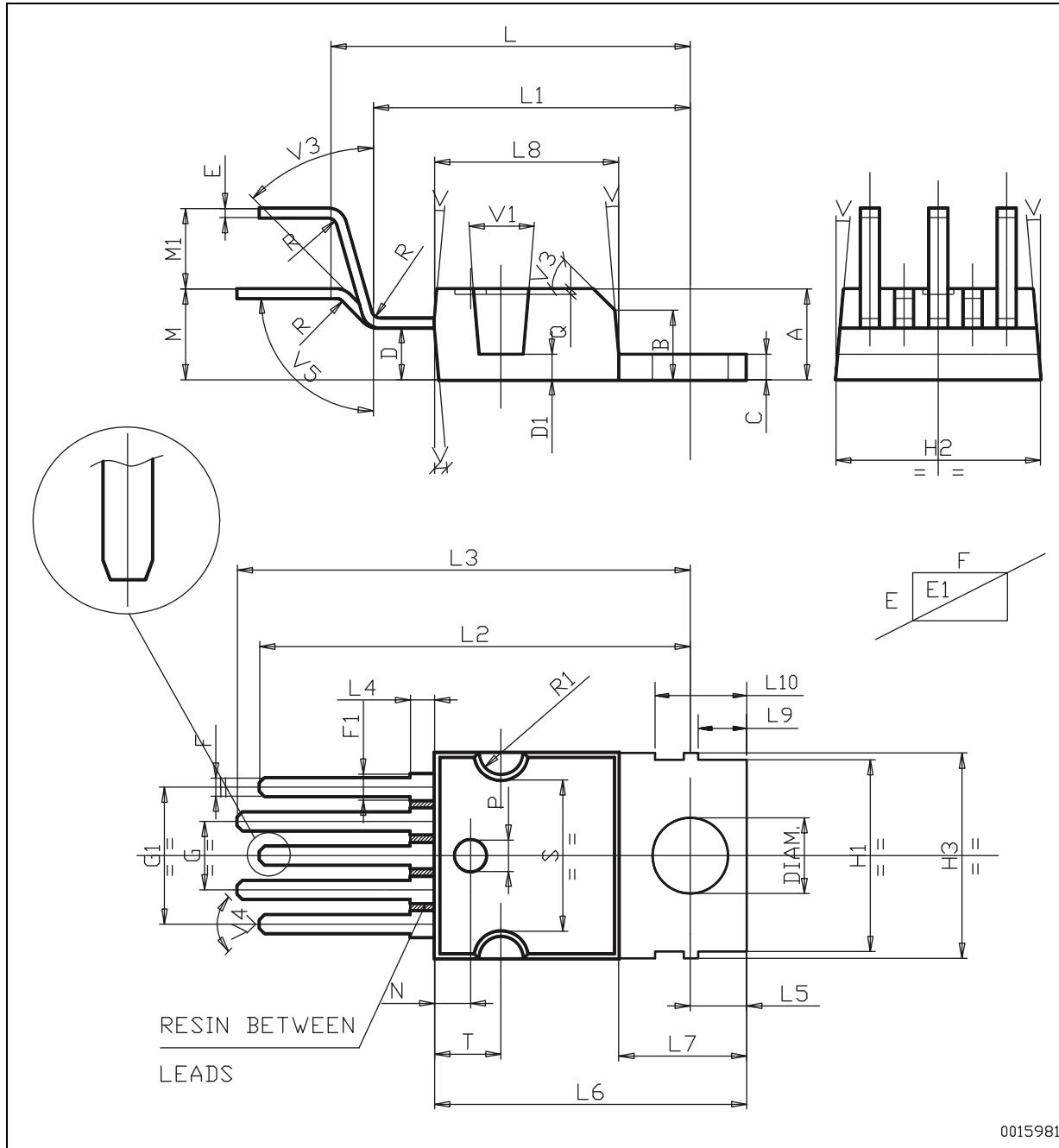
**Table 8. PowerSO-10 package mechanical data**

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



**Стандарт  
Электрон  
Связь**

Мы молодая и активно развивающаяся компания в области поставок электронных компонентов. Мы поставляем электронные компоненты отечественного и импортного производства напрямую от производителей и с крупнейших складов мира.

Благодаря сотрудничеству с мировыми поставщиками мы осуществляем комплексные и плановые поставки широчайшего спектра электронных компонентов.

Собственная эффективная логистика и склад в обеспечивает надежную поставку продукции в точно указанные сроки по всей России.

Мы осуществляем техническую поддержку нашим клиентам и предпродажную проверку качества продукции. На все поставляемые продукты мы предоставляем гарантию .

Осуществляем поставки продукции под контролем ВП МО РФ на предприятия военно-промышленного комплекса России , а также работаем в рамках 275 ФЗ с открытием отдельных счетов в уполномоченном банке. Система менеджмента качества компании соответствует требованиям ГОСТ ISO 9001.

Минимальные сроки поставки, гибкие цены, неограниченный ассортимент и индивидуальный подход к клиентам являются основой для выстраивания долгосрочного и эффективного сотрудничества с предприятиями радиоэлектронной промышленности, предприятиями ВПК и научно-исследовательскими институтами России.

С нами вы становитесь еще успешнее!

**Наши контакты:**

**Телефон:** +7 812 627 14 35

**Электронная почта:** [sales@st-electron.ru](mailto:sales@st-electron.ru)

**Адрес:** 198099, Санкт-Петербург,  
Промышленная ул, дом № 19, литер Н,  
помещение 100-Н Офис 331