

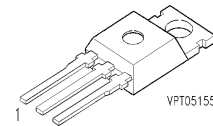
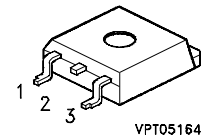
### Smart Lowside Power Switch

#### Features

- Logic Level Input
- Input Protection (ESD)
- Thermal Shutdown
- Overload protection
- Short circuit protection
- Overvoltage protection
- Current limitation
- Status feedback with external input resistor
- Analog driving possible

#### Product Summary

Drain source voltage	$V_{DS}$	60	V
On-state resistance	$R_{DS(on)}$	28	mΩ
Current limit	$I_{D(lim)}$	25	A
Nominal load current	$I_{D(ISO)}$	12	A
Clamping energy	$E_{AS}$	4000	mJ

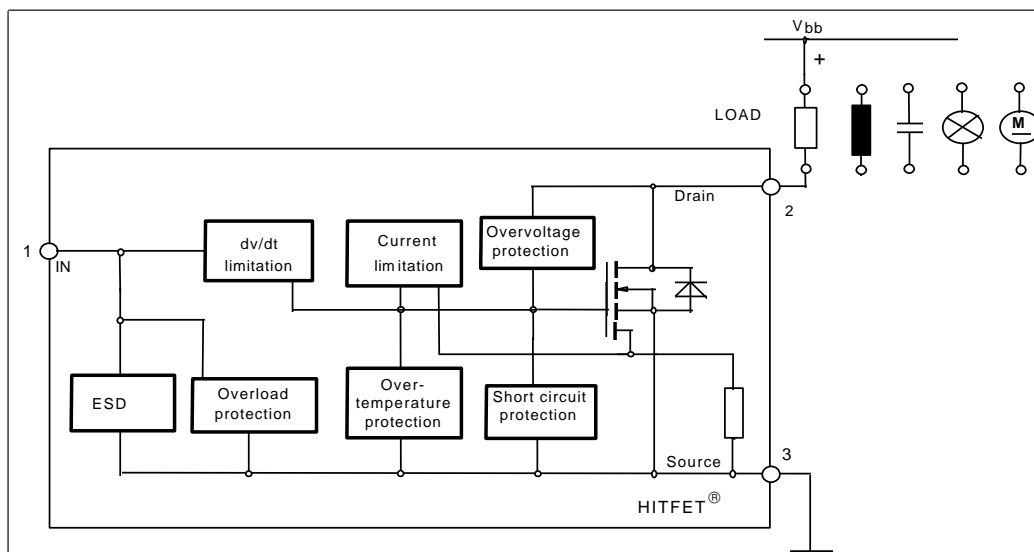


#### Application

- All kinds of resistive, inductive and capacitive loads in switching or linear applications
- μC compatible power switch for 12 V and 24 V DC applications
- Replaces electromechanical relays and discrete circuits

#### General Description

N channel vertical power FET in Smart SIPMOS® chip on chip technology. Fully protected by embedded protected functions.



### Maximum Ratings at $T_j = 25\text{ °C}$ unless otherwise specified

Parameter	Symbol	Value	Unit
Drain source voltage	$V_{DS}$	60	V
Drain source voltage for short circuit protection	$V_{DS(SC)}$	32	
Continuous input current <sup>1)</sup> -0.2V $\leq V_{IN} \leq 10V$ $V_{IN} < -0.2V$ or $V_{IN} > 10V$	$I_{IN}$	no limit $ I_{IN}  \leq 2$	mA
Operating temperature	$T_j$	- 40 ... +150	°C
Storage temperature	$T_{stg}$	- 55 ... +150	
Power dissipation $T_C = 25\text{ °C}$	$P_{tot}$	149	W
Unclamped single pulse inductive energy $I_{D(ISO)} = 12\text{ A}$	$E_{AS}$	4000	mJ
<b>Electrostatic discharge voltage</b> (Human Body Model) according to MIL STD 883D, method 3015.7 and EOS/ESD assn. standard S5.1 - 1993	$V_{ESD}$	3000	V
Load dump protection $V_{LoadDump}^{2)} = V_A + V_S$ $V_{IN} = \text{low or high}; V_A = 13.5\text{ V}$ $t_d = 400\text{ ms}, R_l = 2\ \Omega, I_D = 0,5 \cdot 12A$ $t_d = 400\text{ ms}, R_l = 2\ \Omega, I_D = 12A$	$V_{LD}$	100 84	V
DIN humidity category, DIN 40 040		E	
IEC climatic category; DIN IEC 68-1		40/150/56	

### Thermal resistance

junction - case:	$R_{thJC}$	0.84	K/W
junction - ambient:	$R_{thJA}$	75	
SMD version, device on PCB: <sup>3)</sup>	$R_{thJA}$	45	

<sup>1)</sup> A sensor holding current of 500  $\mu A$  has to be guaranteed in the case of thermal shutdown (see also page 3)

<sup>2)</sup>  $V_{LoadDump}$  is setup without the DUT connected to the generator per ISO 7637-1 and DIN 40839

<sup>3)</sup> Device on 50mm\*50mm\*1.5mm epoxy PCB FR4 with 6cm<sup>2</sup> (one layer, 70  $\mu m$  thick) copper area for Drain connection. PCB is vertical without blown air.

### Electrical Characteristics

Parameter at $T_j=25^\circ\text{C}$ , unless otherwise specified	Symbol	Values			Unit
		min.	typ.	max.	
<b>Characteristics</b>					
Drain source clamp voltage $T_j = -40 \dots +150^\circ\text{C}$ , $I_D = 10 \text{ mA}$	$V_{DS(AZ)}$	60	-	73	V
Off state drain current $V_{DS} = 32 \text{ V}$ , $T_j = -40\dots+150^\circ\text{C}$ , $V_{IN} = 0 \text{ V}$	$I_{DSS}$	-	-	20	$\mu\text{A}$
Input threshold voltage $I_D = 2,7 \text{ mA}$	$V_{IN(th)}$	1.3	1.7	2.2	V
Input current - normal operation, $I_D < I_{D(lim)}$ : $V_{IN} = 10 \text{ V}$	$I_{IN(1)}$	-	35	100	$\mu\text{A}$
Input current - current limitation mode, $I_D = I_{D(lim)}$ : $V_{IN} = 10 \text{ V}$	$I_{IN(2)}$	-	270	500	
Input current - after thermal shutdown, $I_D = 0 \text{ A}$ : $V_{IN} = 10 \text{ V}$	$I_{IN(3)}$	1000	2500	4000	
Input holding current after thermal shutdown $T_j = 25^\circ\text{C}$ $T_j = 150^\circ\text{C}$	$I_{IN(H)}$	500 300	- -	- -	
On-state resistance $I_D = 12 \text{ A}$ , $V_{IN} = 5 \text{ V}$ , $T_j = 25^\circ\text{C}$ $I_D = 12 \text{ A}$ , $V_{IN} = 5 \text{ V}$ , $T_j = 150^\circ\text{C}$	$R_{DS(on)}$	- -	31 52	34 68	$\text{m}\Omega$
On-state resistance $I_D = 12 \text{ A}$ , $V_{IN} = 10 \text{ V}$ , $T_j = 25^\circ\text{C}$ $I_D = 12 \text{ A}$ , $V_{IN} = 10 \text{ V}$ , $T_j = 150^\circ\text{C}$	$R_{DS(on)}$	- -	25 45	28 56	
Nominal load current (ISO 10483) $V_{IN} = 10 \text{ V}$ , $V_{DS} = 0.5 \text{ V}$ , $T_C = 85^\circ\text{C}$	$I_{D(ISO)}$	12	-	-	A

### Electrical Characteristics

Parameter at $T_j=25^\circ\text{C}$ , unless otherwise specified	Symbol	Values			Unit
		min.	typ.	max.	

### Characteristics

Initial peak short circuit current limit $V_{IN} = 10\text{ V}$ , $V_{DS} = 12\text{ V}$	$I_{D(SCP)}$	-	100	-	A
Current limit <sup>1)</sup> $V_{IN} = 10\text{ V}$ , $V_{DS} = 12\text{ V}$ , $t_m = 350\text{ }\mu\text{s}$ , $T_j = -40\dots+150\text{ }^\circ\text{C}$	$I_{D(lim)}$	25	35	50	

### Dynamic Characteristics

Turn-on time $V_{IN}$ to 90% $I_D$ : $R_L = 2,2\text{ }\Omega$ , $V_{IN} = 0$ to $10\text{ V}$ , $V_{bb} = 12\text{ V}$	$t_{on}$	-	40	100	$\mu\text{s}$
Turn-off time $V_{IN}$ to 10% $I_D$ : $R_L = 2,2\text{ }\Omega$ , $V_{IN} = 10$ to $0\text{ V}$ , $V_{bb} = 12\text{ V}$	$t_{off}$	-	70	170	
Slew rate on 70 to 50% $V_{bb}$ : $R_L = 2,2\text{ }\Omega$ , $V_{IN} = 0$ to $10\text{ V}$ , $V_{bb} = 12\text{ V}$	$-dV_{DS}/dt_{on}$	-	1	3	$\text{V}/\mu\text{s}$
Slew rate off 50 to 70% $V_{bb}$ : $R_L = 2,2\text{ }\Omega$ , $V_{IN} = 10$ to $0\text{ V}$ , $V_{bb} = 12\text{ V}$	$dV_{DS}/dt_{off}$	-	1	3	

### Protection Functions

Thermal overload trip temperature	$T_{jt}$	150	165	-	$^\circ\text{C}$
Unclamped single pulse inductive energy $I_D = 12\text{ A}$ , $T_j = 25\text{ }^\circ\text{C}$ , $V_{bb} = 32\text{ V}$ $I_D = 12\text{ A}$ , $T_j = 150\text{ }^\circ\text{C}$ , $V_{bb} = 32\text{ V}$	$E_{AS}$	4000 900	- -	- -	mJ

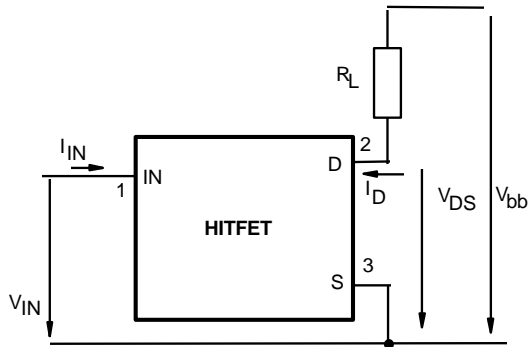
### Inverse Diode

Inverse diode forward voltage $I_F = 5*12\text{ A}$ , $t_m = 300\text{ }\mu\text{s}$ , $V_{IN} = 0\text{ V}$	$V_{SD}$	-	1.13	-	V
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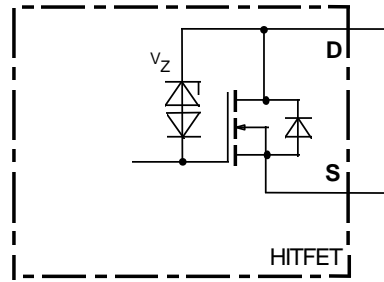
<sup>1)</sup> Device switched on into existing short circuit (see diagram Determination of  $I_{D(lim)}$ ). Dependant on the application, these values might be exceeded for max. 50  $\mu\text{s}$  in case of short circuit occurs while the device is on condition

## Block Diagramm

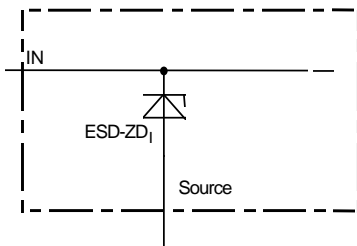
### Terms



### Inductive and overvoltage output clamp

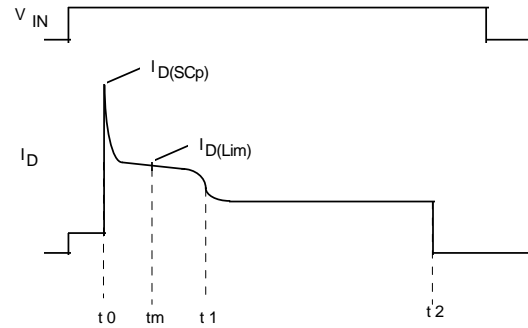


### Input circuit (ESD protection)



ESD zener diodes are not designed for DC current > 2 mA @  $V_{IN} > 10V$ .

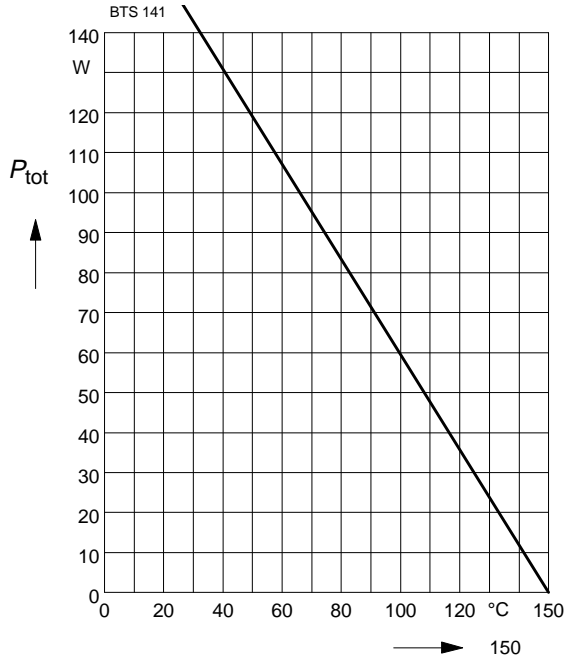
### Short circuit behaviour



- $t_0$ : Turn on into a short circuit
- $t_m$ : Measurementpoint for  $I_{D(lim)}$
- $t_1$ : Activation of the fast temperature sensor and regulation of the drain current to a level wher the junction temperature remains constant.
- $t_2$ : Thermal shutdown caused by the second temperature sensor, achieved by an integrating measurement.

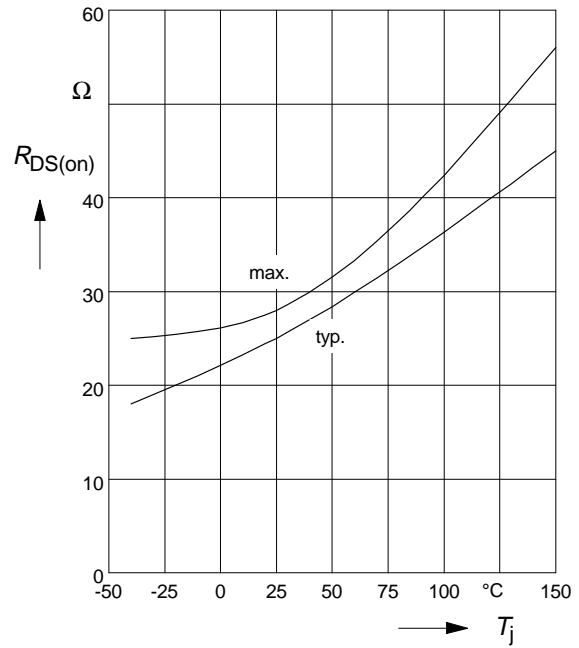
### Maximum allowable power dissipation

$$P_{\text{tot}} = f(T_c)$$



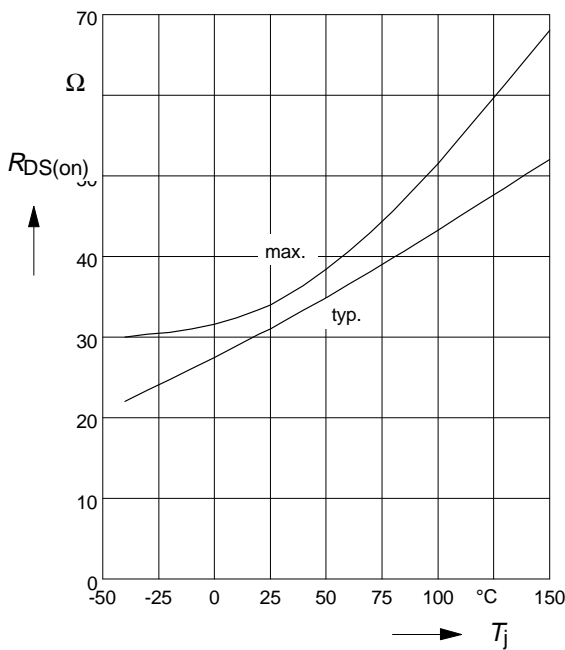
### On-state resistance

$$R_{\text{ON}} = f(T_j); I_D=12\text{A}; V_{\text{IN}}=10\text{V}$$



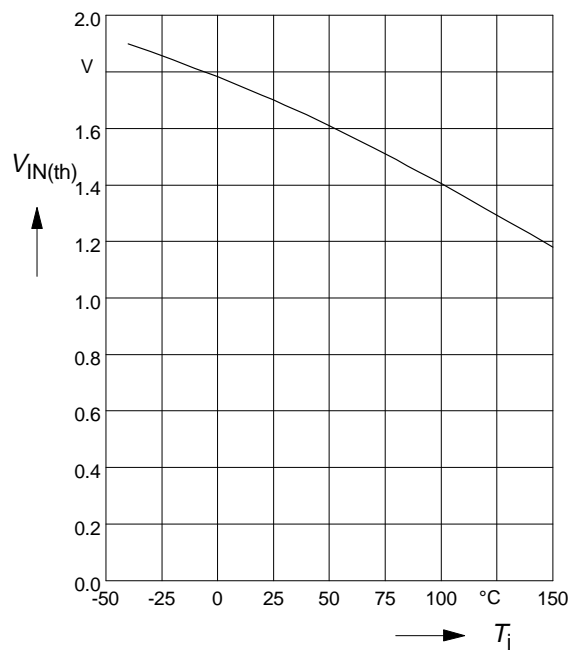
### On-state resistance

$$R_{\text{ON}} = f(T_j); I_D=12\text{A}; V_{\text{IN}}=5\text{V}$$



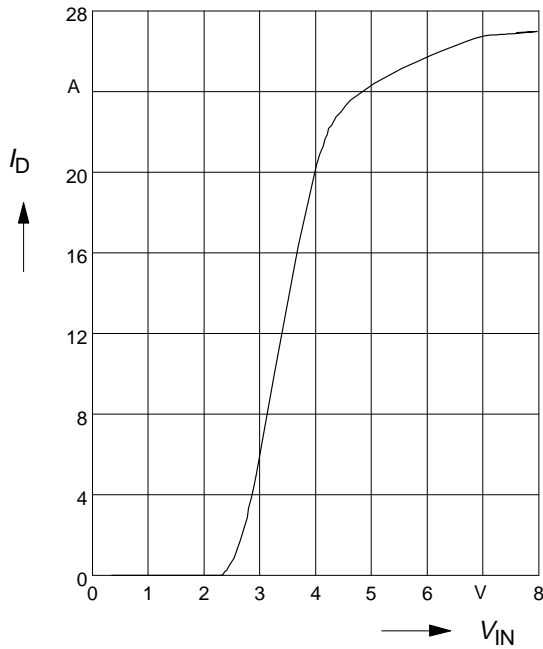
### Typ. input threshold voltage

$$V_{\text{IN(th)}} = f(T_j); I_D=2,7\text{A}; V_{\text{DS}}=12\text{V}$$



**Typ. transfer characteristics**

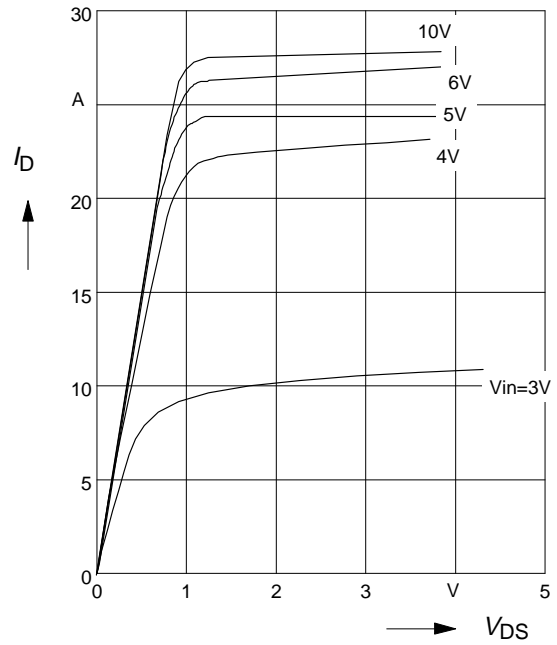
$I_D = f(V_{IN}); V_{DS}=12V; T_j=25^\circ C$



**Typ. output characteristic**

$I_D = f(V_{DS}); T_j=25^\circ C$

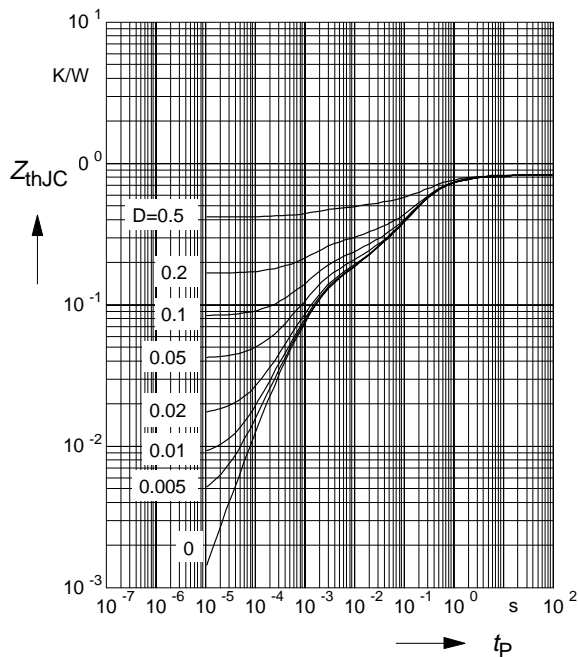
Parameter:  $V_{IN}$



**Transient thermal impedance**

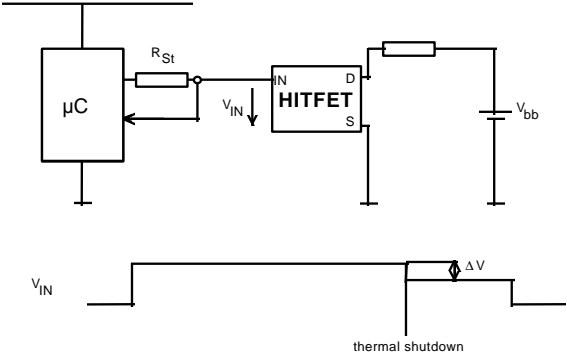
$Z_{thJC} = f(t_p)$

Parameter:  $D=t_p/T$



Application examples:

**Status signal of thermal shutdown by monitoring input current**

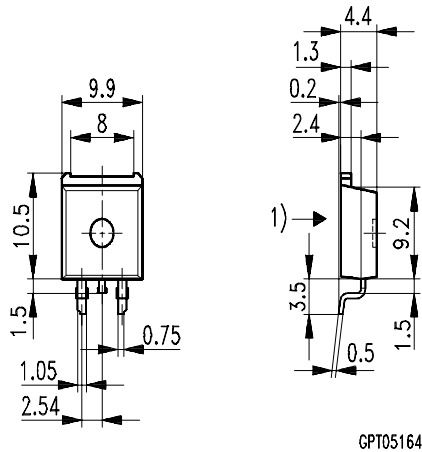


$$\Delta V = R_{ST} * I_{IN(3)}$$



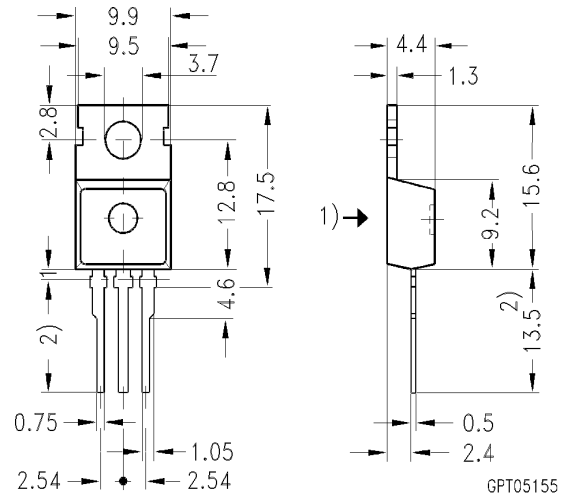
**Package and ordering code**  
all dimensions in mm

Ordering code: Q67060-S6502-A3



1) shear and punch direction no burrs this surface

Ordering Code: Q67060-S6502-A2



- 1) punch direction, burr max. 0.04
- 2) dip tinning
- 3) max. 14.5 by dip tinning press burr max. 0.05

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