Technical Explanation Sheet SKYPER® Prime O

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Keyword: IGBT Driver

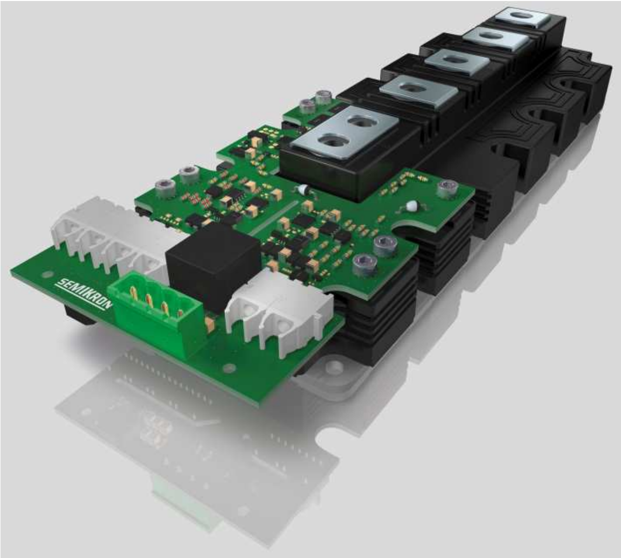
1. Introduction

The SKYPER Prime O constitutes an interface between Semitrans 10 or Primepack modules and the controller. SKYPER Prime can drive IGBTs up to 1400 A and 1700V.

Benefits

- Optical interface for EMC robust connection
- Cost saving with integrated & optical insulated temp + DC link signal
- Qualified module driver bundle: Simple plug & play, no redesign loops on customer side
- For SEMITRANS 10 and Primepack modules
- Long service life with ASIC integration (MTBF>3 Mio h)
- Safe gate control with SoftOff, UVP, Vce, regulated gate voltages

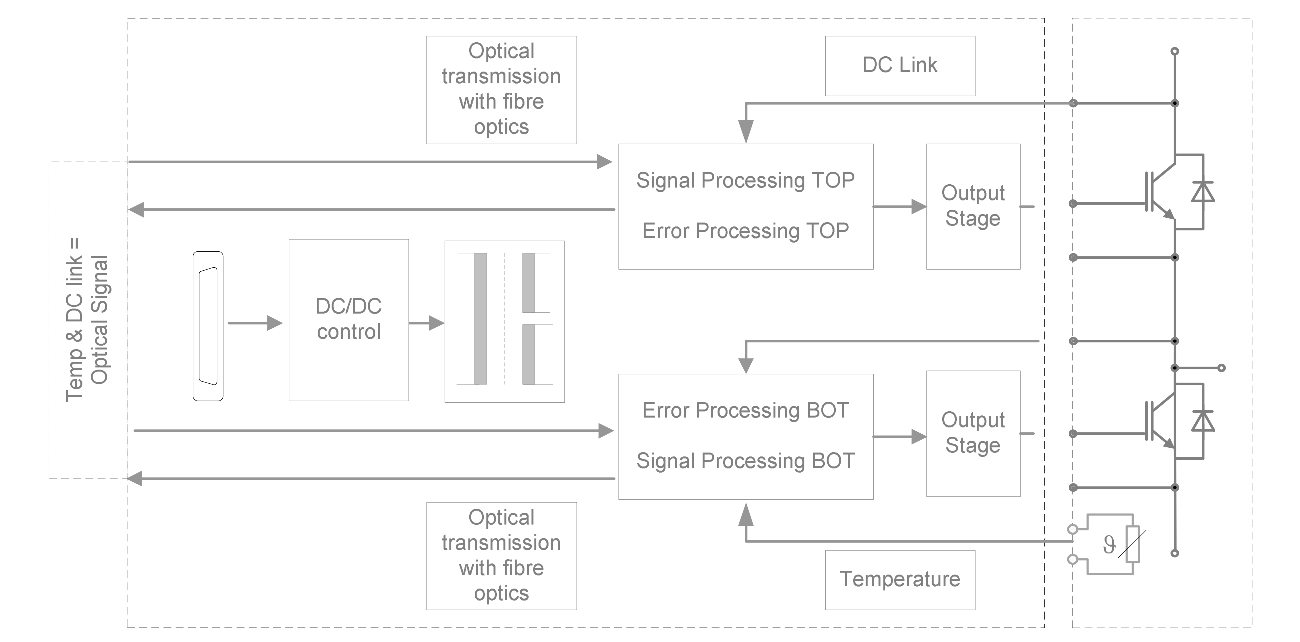
Figure 1: SKYPER® Prime O



Features

- Two output channels
- Optical signal transmission directly on high side potential
- Highest noise immunity with optical interface
- Insulated temp and DC link signal
- Under voltage protection
- Dynamic Short Circuit Protection (DSCP) by VCE monitoring and direct SoftOff
- Integrated isolated power supply for the secondary side
- Up to 15 µC gate charge
- **MTBF rate > 3 Million hours**

Figure 2: Block diagram of SKYPER® Prime

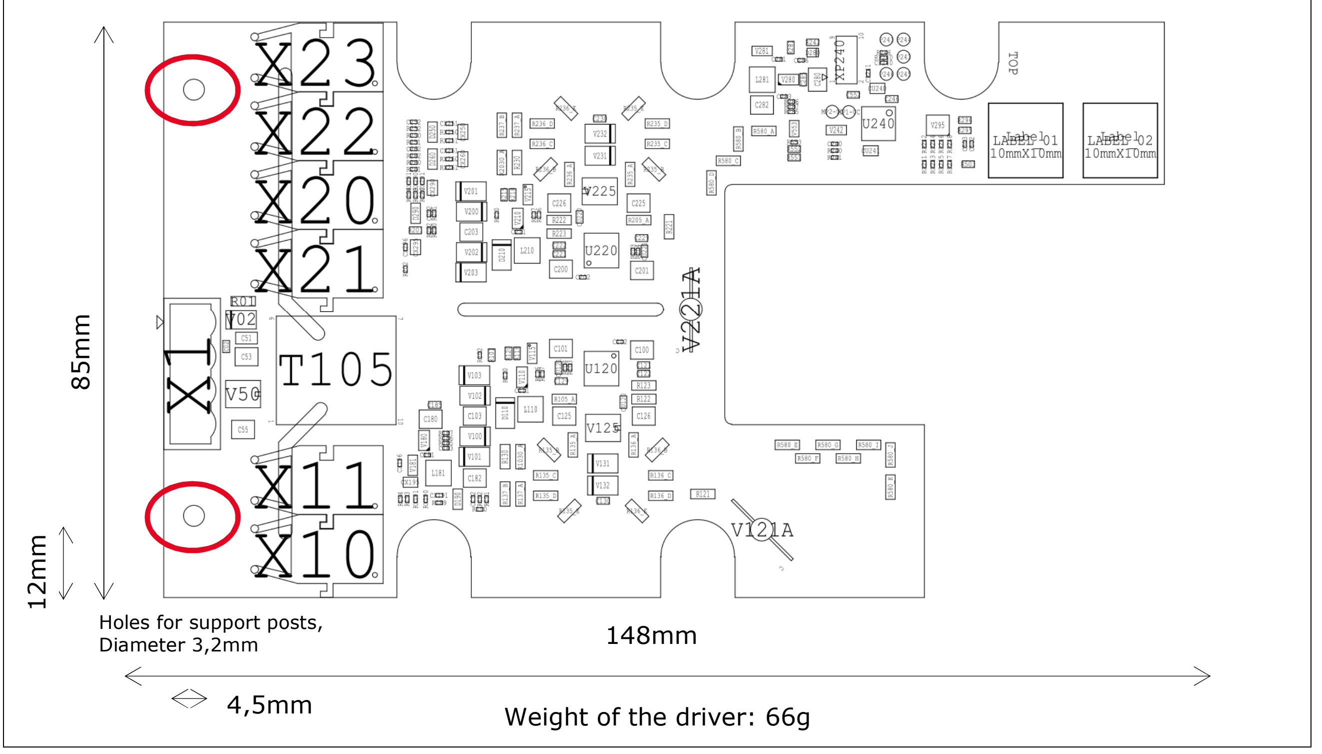


2. Portfolio

Optical Interface	Description
L5068111 ≥01	1700V / 1000A for Primepack
L5068112 ≥01	1700V / 1400A for Semitrans 10 - 22290412 (Renesas)
L5068113 ≥01	1700V / 1400A for Primepack
L5068114 ≥01	1200V / 1400A for Primepack
L5068115 ≥01	1200V / 1400A for Semitrans 10 - 22290312 (IFX)
L5068117 ≥01	1700V / 1000A for Semitrans 10 - 22290422 (Renesas)

3. Mechanical information

Figure 3: Mechanical Dimensions and Pinning



Details for assembly: Please refer to each IGBT module mounting instruction like "Mounting Instruction SEMITRANS® 10".

Make sure that the mechanical support posts are dimensioned with the right distance between heatsink and driver PCB. The maximum bending of the PCB according IPC 610 A must not be exceeded. The maximum head diameter of the support post must not exceed 7mm.

The maximum height of the screw head for the support post must be below 2mm to avoid collision with the fibre optic connectors.

4. Driver interface

4.1 Controller interface – primary side pinning (see fig. 3)

Please consider that as soon as the driver is supplied with power, an external light emission on open fibre optic connectors can produce switching signals on the driver. The safe plug in process has to be ensured.

IMPORTANT: Please make sure that the optical cables are mechanically stabilized and are installed according specification of the optical cable. The maximum cable length is limited to 5m.

Table 1: Power Supply - Connector X1 male (Phoenix Contact MSTBVA 2,5/4-G-5,08)			
PIN	**Signal**	**Function**	**Specification**
X1:01	IF_PWR_24P	Drive power supply	Stabilized+24V ±3%
X1:02	IF_GND	GND	To be connected to ground
X1:03	IF_PWR_24P	Drive power supply – can be used for parallel power supply connection with other drivers. Max 2A.	Stabilized +24V ±3%
X1:04	IF_GND	GND	To be connected to ground

Table 2: Controller Interface – Fibre connector X1x (Avago AFBR-15x9Z)			
PIN	**Signal**	**Function**	**Specification**
X10	IF_ERROR_TOP	ERROR output TOP	LightOff = ERROR
X11	IF_HB_TOP	Switching signal input (TOP switch)	LightOff = TOP switch off LightOn = TOP switch on
X20	IF_ERROR_BOT	ERROR output BOT	LightOff = ERROR
X21	IF_HB_BOT	Switching signal input (BOTTOM switch)	LightOff = BOT switch off LightOn = BOT switch on
X23	IF_DC_LINK	Digitized DC Link signal	PWM output
X22	IF_TEMP	Digitized NTC signal	PWM output

Protection features

4.2 Failure management

The SKYPER PRIME detects certain errors on the driver. Any error detected will force the output IF_ERROR_OUT into low state (LightOff). The IGBTs will be switched off (IGBT driving signals set to LOW).

The controller must react within 30µs after the error indication with switching off the PWM and must react on the error signal for further processing.

Following failures are indicated by the failure output
- Over DC link voltage
- Under voltage supply on primary and secondary side
- Short circuit with SoftOff

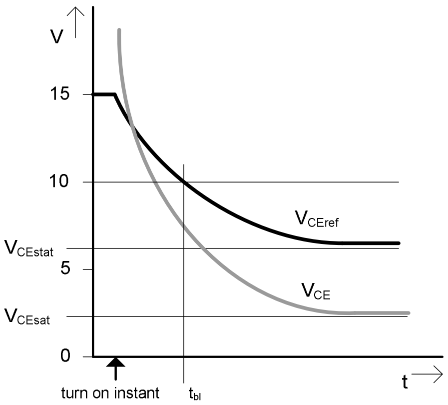
4.3 Dead time

The dead time/ interlock **must be realized by the customer controller**. The driver works with both inputs independently and there is **no dead time by the driver** provided.

4.4 Dynamic short circuit protection by V_{CEsat} monitoring (DSCP)

The DSCP monitors the collector-emitter voltage V_{CE} of the IGBT during its on-state. Immediately after turn-on of the IGBT, a higher value is effective than in steady state.

Figure 4: Reference Voltage ((VCEref) Characteristic



After t_{bl} has passed, the V_{CE} monitoring will be triggered as soon as $V_{CE} > V_{CEref}$ and will turn off the IGBT. The Vce monitoring settings is optimized to each module type and must not be adjusted by the user. The short circuit monitoring is set according to each module type separately. No further modification is necessary. Blanking time and threshold voltage is written in the datasheet.

4.5 Soft Off

In the event of short circuit, the driver switches off with a separate output stage which slows down the turn-off speed of the IGBT. The over voltage will be reduced significantly and the IGBTs will be switched off safely. The softoff setup is done according to each module and must not be changed.

4.6 Under voltage protection primary and secondary

The driver monitors the supply voltages on primary and secondary side. Threshold voltages are indicated in the data sheet.

	Specification
Threshold level primary side	< 17,0 V
Reset threshold level primary side	> 23,0V
Threshold level secondary side	< 9,4 V

5. Sense signals

The driver offers optically insulated temperature and DC link signals to the interface connector saving external power supplies and insulation boards.

5.1 Temperature signal

The temperature signal of the module integrated NTC KG3B-35-5-S6Z sensor is insulated and available as digital PWM signal to the customer's controller. The NTC signal is converted in the form of a pulse pattern (PWM information) corresponding to the analogue value. That information can be directly read out by the customer's controller – capture-compare unit.

Table 3: Temperature signal

Parameters	**Min**	**Typ**	**Max**	**Unit**
ADC		12		bit
Bandwidth		1		kHz
Accuracy at 85°C		5		%
Measurement range	25		135	°C
PWM output		10		kHz
Duty cycle ratio: $Duty\ cycle = \frac{98\% * (T - 25°C)}{110°C} + 1\%$	1% =25°C		99% =135°C	

Temperatures below 25°C will be indicated with 1%. Please consider that there is a deviation between the chip temperature and the NTC value.

5.2 DC Link signal

The DC link signal is galvanically insulated and available as PWM signal to the customer.

Table 4: DC Llink signal

Parameters	Min	Typ	Max	Unit
ADC		12		bit
Bandwidth		1		kHz
Accuracy at 1300V, -40°C to 85°C		1,7		%
Trip level		1250		V
Measurement range	0		1300	V
PWM output		10		kHz
Duty cycle ratio: $Duty\ cycle = \frac{98\% * UDC}{1300V} + 1\%$	1% =0V		99% =1300V	
Reaction time with switch off		75		µs
Response time (90% U_{in})	100		175	µs

Figure 5: DC Link PWM read out

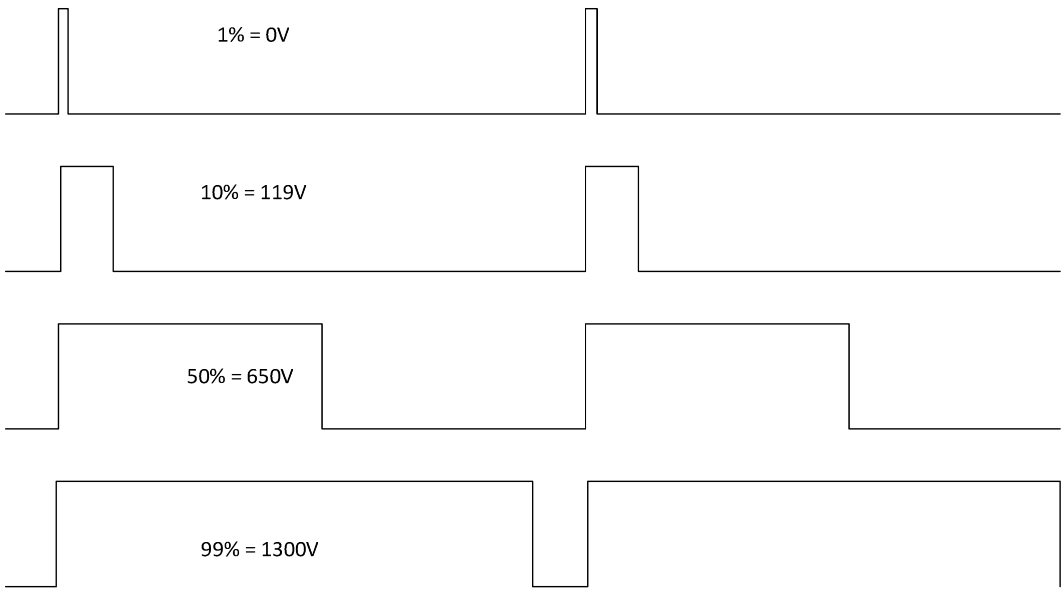
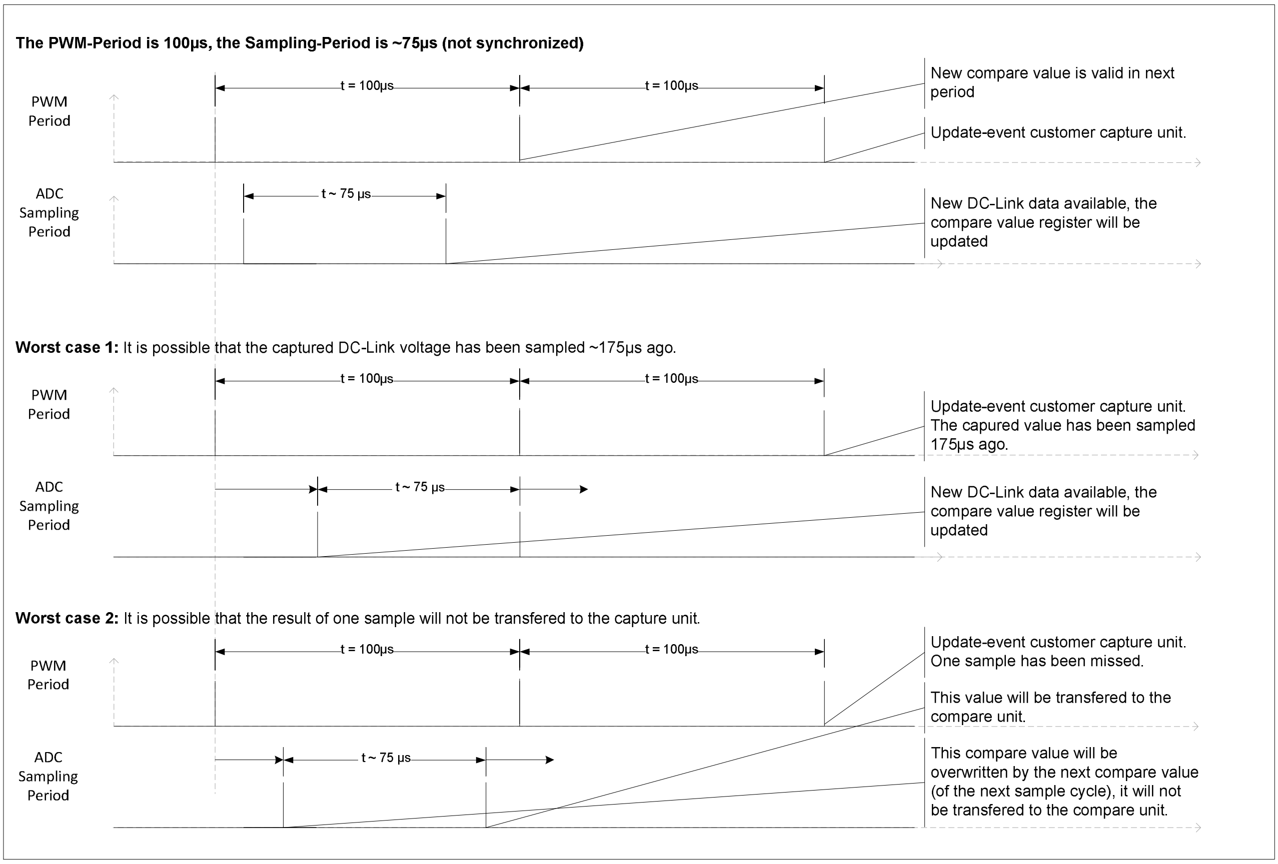


Figure 6: Signal characteristic samples

Example for capture of DC-Link voltage (unsynchronized output)



6. Electrical characteristic

Figure 7: Maximum switching frequency @ different gate charges @ Tamb=25°C

$$f_{\max} = \frac{Iout_{AV\max}}{Q_{GE}}$$

f_{max}: Maximum switching frequency
$Iout_{AVmax}$: Maximum output average current
Q_{GE}: Gate charge of the driven IGBT

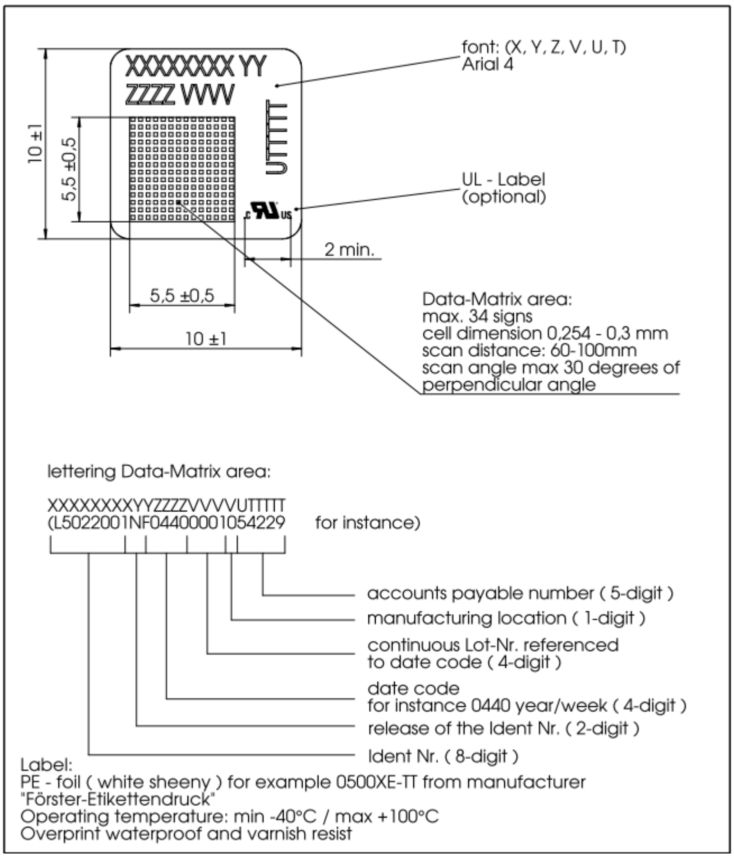
The maximum switching frequency is related to each module type and is indicated in the data sheet.

7. Environmental conditions

Table 5: Conditions		
Insulation parameters		**Rating**
Grid voltage (grounded star)		690V
Climatic Classification Pollution Degree (PD)		PD2
Climate class		3K3 – IEC 60068-2-67
Maximum altitude (above sea level)		2000 meter above sea
Overvoltage category (according to EN50178)		OVC 3
Isolation resistance test, Prim-Sec, not performed as series test. Insulation test must be performed in the system.		5000 V_{AC}, rms,2s
Rated insulation voltage (EN60664-1)		8 kV Cat. III
Environmental Condition	**Norm / Standard**	
Operating/storage temperature		-40.. +85 °C
High humidity		85 °C, 85%
Flammability	UL94 V0	Heavy flammable materials only
	RoHS / WEEE / China RoHS	
EMC Condition	**Norm / Standard**	**Parameter**
ESD	IEC 61000-4-2 IEC 61800-3 EN 50121-3-2	6 kV contact discharge / 8 kV air discharge
Burst	IEC 61000-4-4 IEC 61800-3 EN 50121-3-2	≥ 2kV on adaptor board for signal lines ≥ 4kV for AC lines
Immunity against radiated interference	IEC 61000-4-3 IEC 61800-3 EN 50121-3-2	≥ 20V/m 80MHz – 1000MHz
Immunity against conducted interference	IEC 61000-4-6 IEC 61800-3 EN 50121-3-2	≥ 20V 150kHz – 80MHz
Shock Vibration		
Vibration	Sinusoidal 20Hz … 500Hz, 5g, 2h per axis (x, y, z), 26 sweeps Random 10Hz … 2000Hz, 3g, 2 h per axis (x, y, z)	
Shock	180 Shocks (6 axis; +-x, +-y, +-z, 30 shocks per axis), 30g, 11ms Connection between driver and PCB has to be reinforced by support post	

8. Marking

Figure 8: Label



Every driver core is marked with a data matrix label. The marking contains the following items.

References

[1] www.SEMIKRON.com
[2] A. Wintrich, U. Nicolai, W. Tursky, T. Reimann, "Application Manual Power Semiconductors", ISLE Verlag 2011, ISBN 978-3-938843-666

HISTORY

SEMIKRON reserves the right to make changes without further notice herein

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