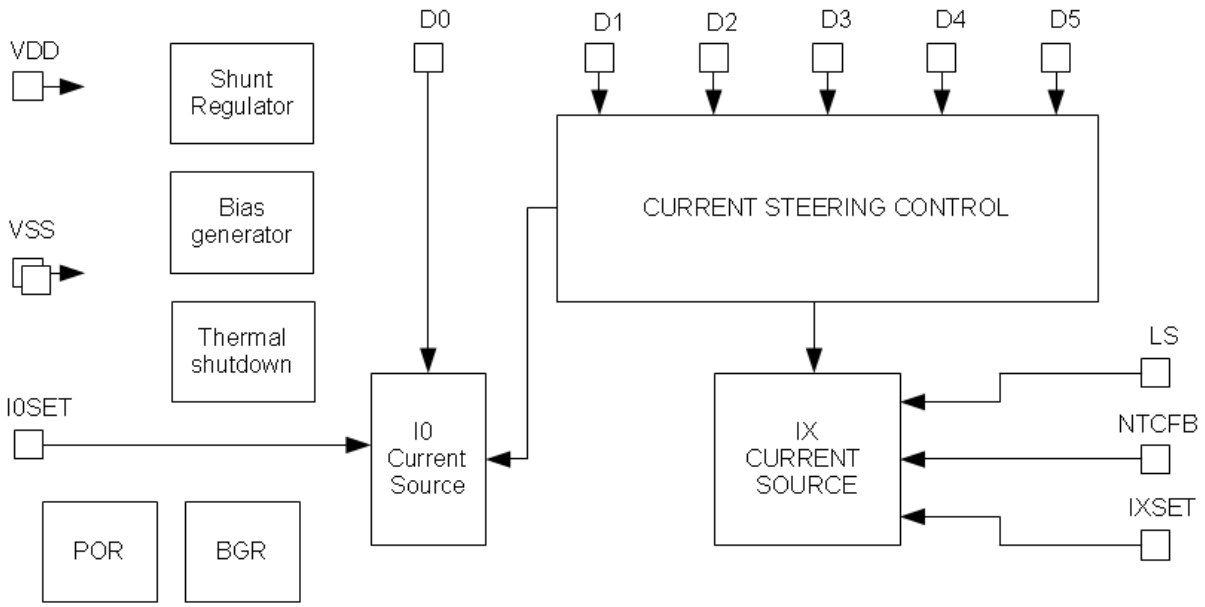
S006B Dimmable LED Lamp Controller IC Datasheet

Features

- High efficiency dimmable LED controller IC
- Dimmable to <1%
- Dims with standard TRIAC or IGBT dimmers or voltage control
- High power factor, > 95%
- No electrolytic capacitors used: delivers a greatly improved lamp life
- Small 13 pin DFN package
- No line filter required
- Thermal regulation of light output based on LED thermal sensor

Description

The S006B provides high-performance LED lamp control and driver. High power factor, dimmablility, and safety features are included.



S006B Block Diagram

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1. Overview:

The S006B was designed for a minimum sized ballast for low to medium power LED lighting. Wattages up to 20W are contemplated for single IC designs. Multiple S006B ICs may be used in parallel for higher wattages. Dim profile modifications and thermal controls are available.

1.1 Pin Description

Number	Name	Type	Description
1	I0SET	input	holding current reference
2	NTCFB	input	thermal compensation feedback voltage
3	IXSET	input	LED current reference
4	VSS	power	ground
5	VSS	power	ground
6	VDD	power	power
7	LS	input	LED current adjustment voltage
8	D5	output	LED drain 5
9	D4	output	LED drain 4
10	D3	output	LED drain 3
11	D2	output	LED drain 2
12	D1	output	LED drain 1
13	D0	output	Holding current drain
back plate	VSS	power	ground / heat sink

1.2 Absolute Maximum Ratings

Parameter	Pins	Value	Units
Supply Voltage	VDD to VSS	-0.3 to 7.0	V
Input Voltage	NTCFB, LS, IXSET, I0SET, to VSS	-0.3 to (VDD +0.3)	V
Output Voltage	D0-D5	-0.3 to 650	V
Maximum power dissipation at Tcase < 85°C		3	W
Operating Ambient Temperature (T_a)		-40 to 110	°C
Storage Temperature		-65 to 150	°C
Junction Temperature (T_j)		125	°C
Lead Temperature (soldering, 10s)		300	°C

Note: Stresses beyond those listed above may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified under “Electrical Characteristics” is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

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Electrical Characteristics

T_j = 0 to 125°C, VDD = 5V-6V, VSS = 0V (unless otherwise noted)

Parameter	Description	Conditions	Value			Units
			Min	Typ	Max	
Supply						
VDD-VSS	Analog supply voltage	5mA applied to VDD	5.0	5.3	5.6	V
I_{VDD}	Supply current	5.0V applied to VDD		0.5	1	mA
I_{VDDmax}	Maximum voltage regulator shunt current				20	mA
Inputs/Outputs						
IXSET	LED current reference		5		70	uA
I0SET	holding current reference		5		100	uA
IX_{ripple}	Current ripple during DX transitions	Fac=60Hz		3		%
V_{LSoff}	LS control shutoff voltage	~ +/-10mV hysteresis		70		mV
V_{LSfull}	LS control full current			4.5		V
$V_{NTCFBoff}$	NTCFB control shutoff voltage	~ +/-10mV hysteresis		0.7		V

Bulb Characteristics

T_j = 0 to 125°C, VDD 5.3v, VSS= 0V, with typical application circuit

Parameter	Description	Conditions	Value			Units
			Min	Typ	Max	
Eff	Electrical conversion efficiency	Line power to lamp power		85		%
dim%	Dimming range	Percentage of luminance	1		100	%
PF	Power factor	LS shape matches line		0.96		
T_{LIFE}	Rated lamp life	dimmed or un-dimmed, 180min on/20min off per cycle, 25°C, 50% survival, V_{AC}=120V	50,000			hours
T_{START}	Initial lamp ignition time	Time from applied line power to lamp current		20		ms
F_{AC}	AC line frequency		DC		800	Hz

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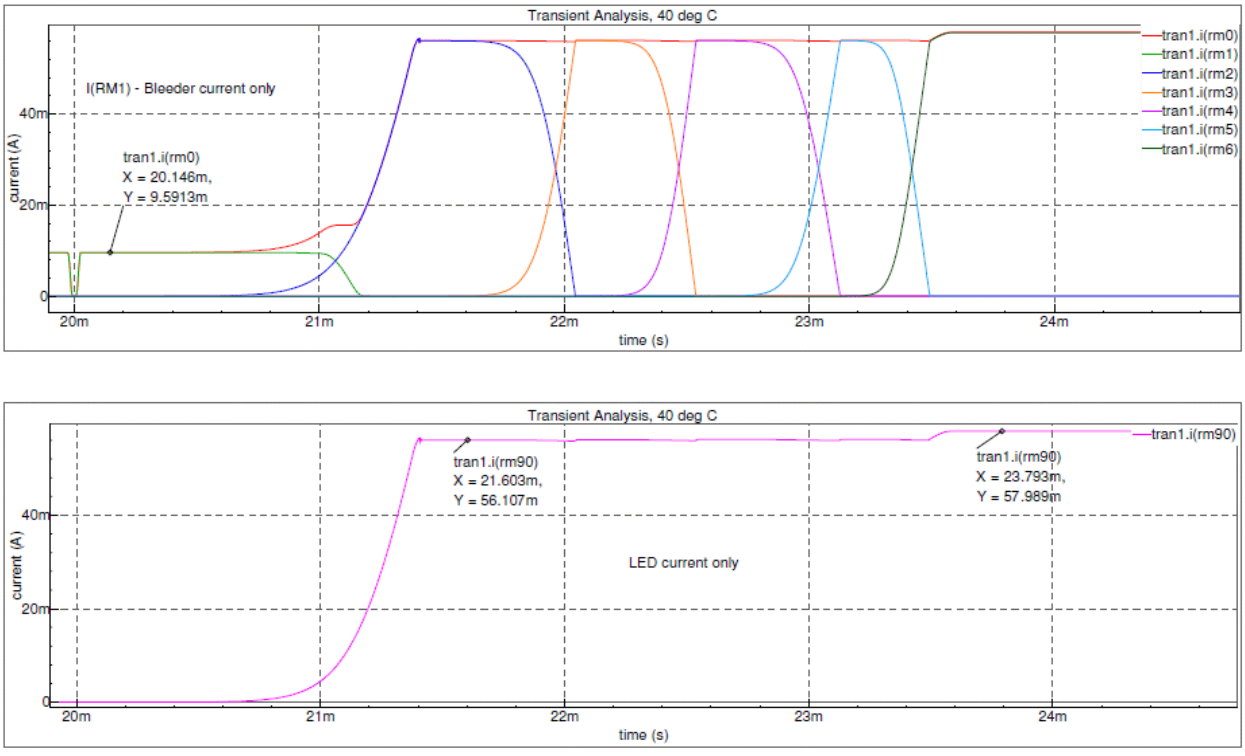
2. Circuit Operation:

A global LED current, ICOM, is set by an external resistor using an internal voltage reference. There are an array of current delivery stages, I1-I5 which selectively switch the ICOM current source to their respective pins. Additionally there is an I0 current source which is enabled when none of the LED current sources are active.

Each Dx pin is connected to a point along a continuous string of LEDs. D5 connects to the cathode of the last LED. D0 connects to the annode of the first LED, which is also connected to the output of the bridge rectifier, V_RECT. D1 to D4 are connected at points along the LED string.

When no voltage is applied to the line, all of the stages are active. As the line voltage increases, but is less than the voltage needed to turn on the first string of LEDs, D0 will source a holding current from V_RECT. As the voltage exceeds the voltage of the first string of LEDs, D1 begins to deliver some of the ICOM current (all Dx are still enabled at this point). As voltage further increases, D1 will supply the full ICOM current, which disables the D0 holding current source. As voltage further increases the second string of LEDs begins to conduct through D2. The ICOM current with then be supplied partially by both D1 and D2; once D2 can support all of ICOM, D1 is disabled. As the voltage further increases, each stage in sequence turns on and disables the stage before it.

After the RECT voltage peaks D5 will be the only stage enabled. As voltage decreases near the voltage of the sum of the entire LED string, D5 will have difficulty maintaining ICOM. A flag will occur indicating that the ICOM current source cannot maintain the constant current (current source is nearly out of saturation). This flag will cause the next lower stage, D4, to be enabled. This continues down the line until only D0 remains on.



Holding current and LED current switching waveforms

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2.1 Minimum external requirements:

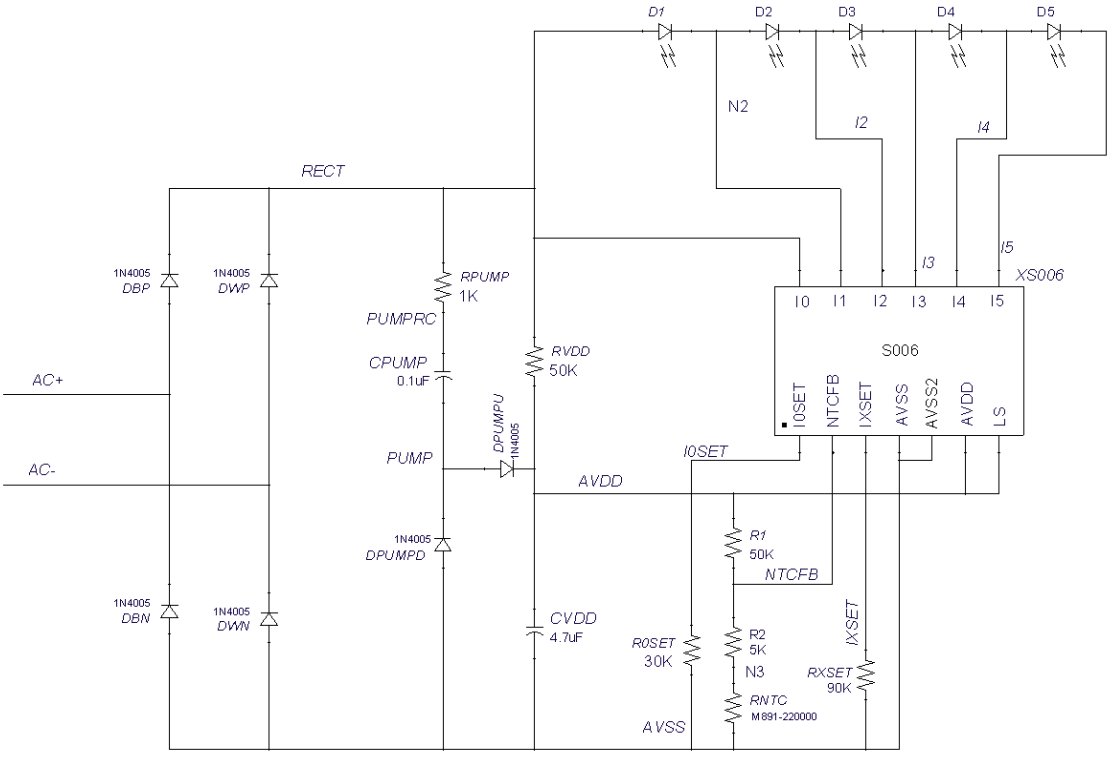
2.1.1) A series of LEDs which in total is just less than line voltage peak in 3 to 5 groups. For example, a 12W 220Vac lamp can be implemented with 15 LEDs each with Vf=20v in 5 groups, 5+4+3+2+1.

2.1.2) VDD power source. For traic dimmable applications, this consists of the following: 500ohm resistor, 80Kohm resistor, 2 diodes, a 0.1uF capacitor, and a 4.7uF capacitor. For non-dimmable or voltage controlled dimming, only a 100K resistor and 4.7uF capacitor are needed.

2.1.3) a bridge rectifier.

2.1.4) Current setting resistors for the triac hold current (optional) and one for the main LED current.

2.1.5) thermal and/or dim profile circuitry (optional)



Application circuit example

3. Functional Description

3.1 Reference current adjustment

The LED current sources are set by a resistor connected to IXSET pin in conjunction with voltages at LS and NTCFB.

Current delivered to the LED current sources is nominally determined as follows:

I_LED = 1460 X VIXSET/RIXSET ; 0 if V_LS<60mV or V_NTCFB<0.7V

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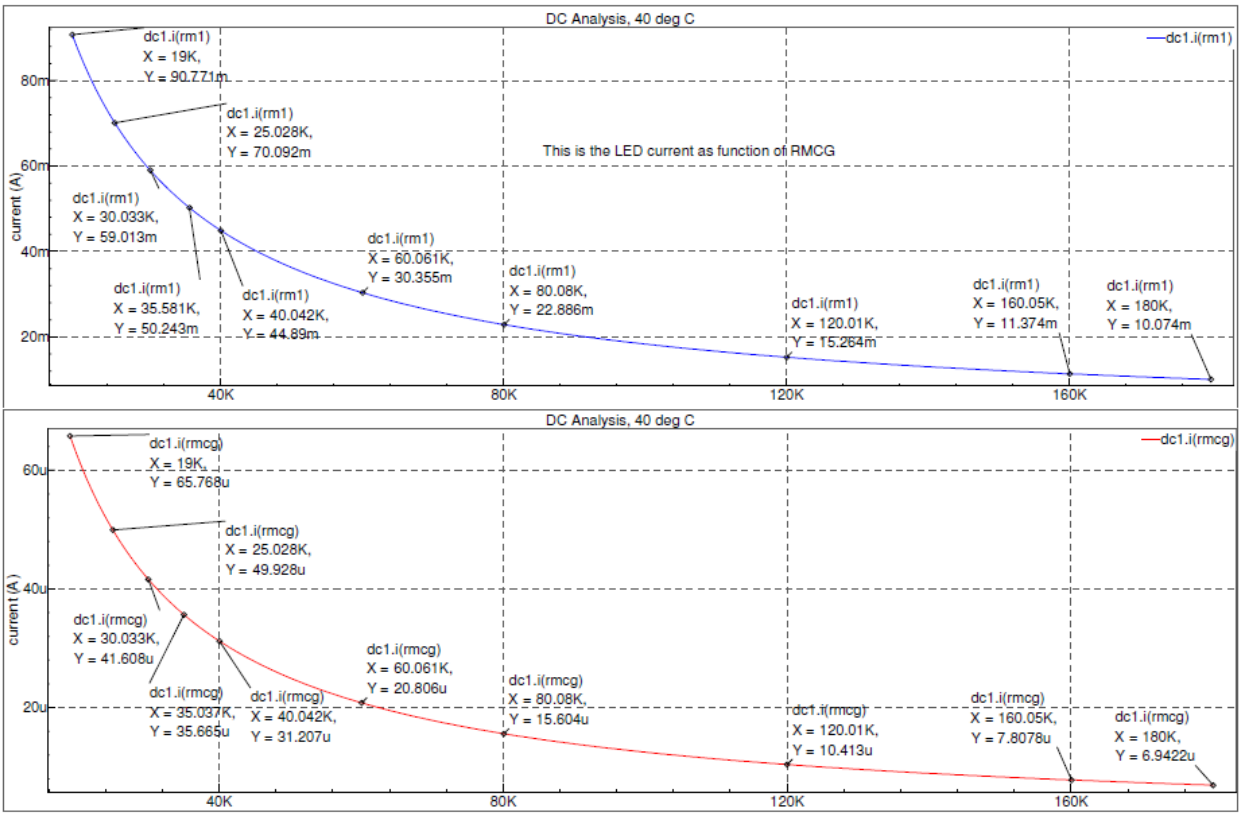
VIXSET = minimum of [1.25 , VLS*0.29, 1.41*VNTCFB-0.63]



LED current and IXSET current vs RXSET

3.2 Dimming Control and Shutdown (LS pin)

Output current is reduced proportionally to the LS input voltage. At 4.4v (nominal) or higher the current is at 100%. For voltages lower than 4.4v output current is scaled proportionally. For voltages less than 65mV LED current is shut down. This controls I1-I5 directly. I0 current will not exceed this current (internally limited).

3.3 Holding Current setting (I0SET pin)

A holding circuit is designed to stabilize a triac dimmer by applying a current source when no LEDs are active. The holding current is set by a resistor connected from the I0SET pin to ground.

Holding current is calculated approximately as follows (nominal current is more accurately shown in Figure 5):

I0 = 585 X 1.25/RI0SET ; can not exceed IX current

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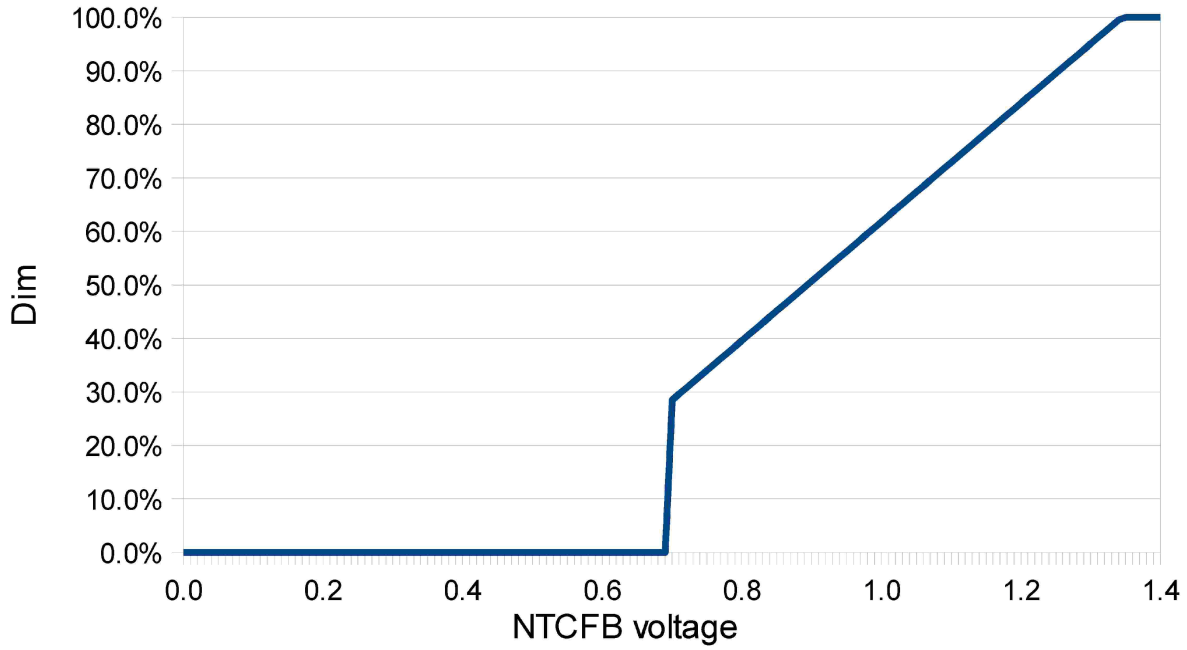
3.4 Thermal compensation (NTCFB pin)

An external NTC/resistor divider is connected to the NTCFB pin to sense the LED temperature. If the NTC temperature rises to a pre-determined value, say 95 degrees C, the LED current is reduced. Typically, the current will be 100% up to 95 degrees C and reduce to 50% at 120 degrees C with the example circuit. These values are determined by the voltage at NTCFB. Current is linearly proportional to the voltage at NTCFB with the 100% current reached at 1.35v (nom).



5 Over Temperature Shutdown

When the IC junction is operating above 140 degrees C, the thermal shut down circuit will disable all current sources. The system will operate again when the IC's junction temperature drops below 100 degrees C.

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4. Package information

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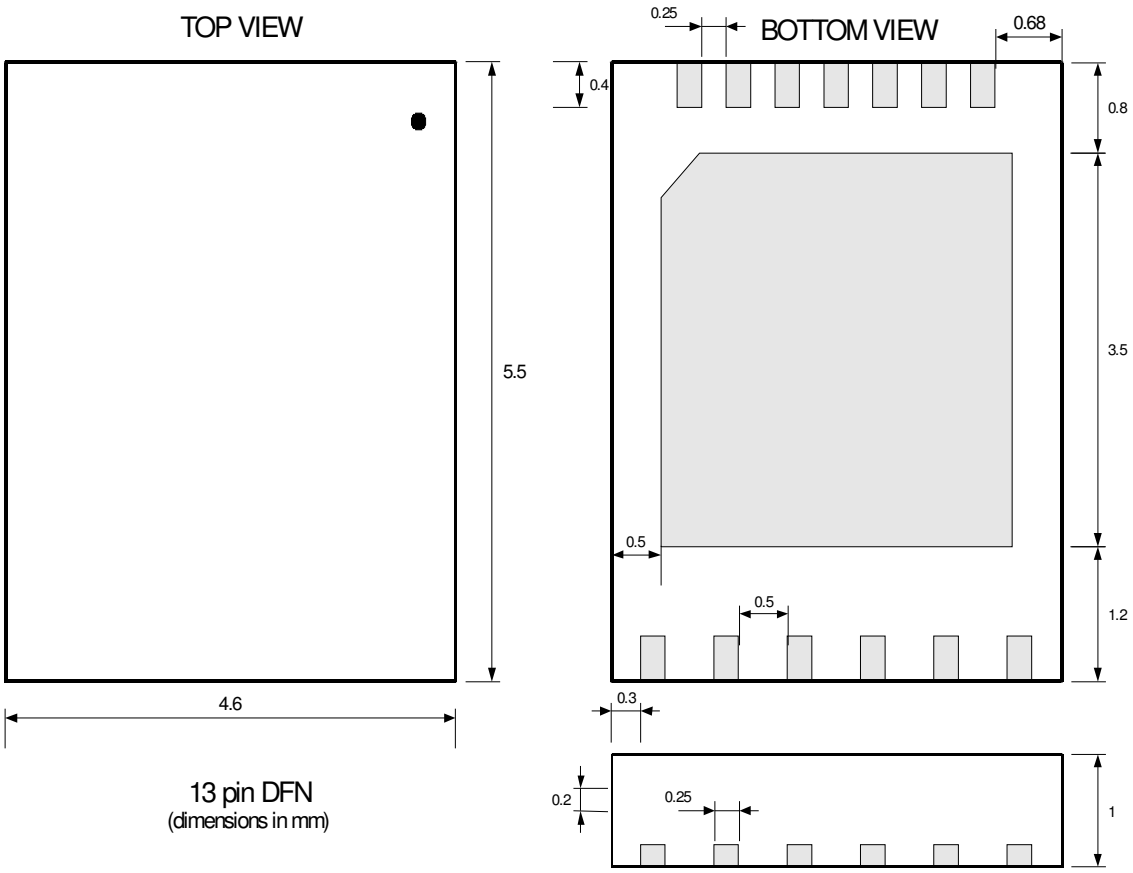

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