LED Drivers for High Power LEDs

ILD2035

350 mA Step Down LED Driver

Data Sheet

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Revision History	
Page or Item	**Subjects (major changes since previous revision)**
Revision 1.0, 2011-08-17	
All	Initial release of data sheet

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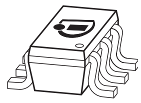
350 mA Step Down LED Driver with Internal Switch
ILD2035

1 Features

- Input voltage range 8 V to 22 V
- Internal switch for up to 400 mA average LED current
- Up to 92 % efficiency
- Over current protection
- Temperature protection mechanism
- Inherent open-circuit LED protection
- Soft-start capability
- Low shut down current
- Typical 3 % output current accuracy
- Minimum external components required
- Small package: SC74



SC74-3D

RoHS

Applications

- LED replacement lamps, e.g. MR16 halogen replacement
- Downlights
- Architectural lighting

Product Name	Package	Pin Configuration						Marking
ILD2035	SC74-6-4	1 = V_S	2 = GND	3 = EN	4 = V_{switch}	5 = GND	6 = V_{sense}	25

2 Product Brief

The ILD2035 is a hysteretic step down LED driver IC for general lighting applications, which is capable to drive high power LEDs with average currents up to 400 mA.

The IC incorporates an input voltage range from 8 to 22 V and an internal power switch. The output current level can be adjusted with an external sense resistor.

Depending on the value of the switching inductor the switching frequency and the voltage ripple can be set.

The precise internal bandgap stabilizes the circuit and provides stable current conditions over temperature range.

To ensure a long lifetime of the LED system, the ILD2035 incorporates an overcurrent protection.

In addition, the integrated thermal protection will actively control the output current to protect the LEDs and the IC against thermal stress and hence ensure longer LED lifetimes.

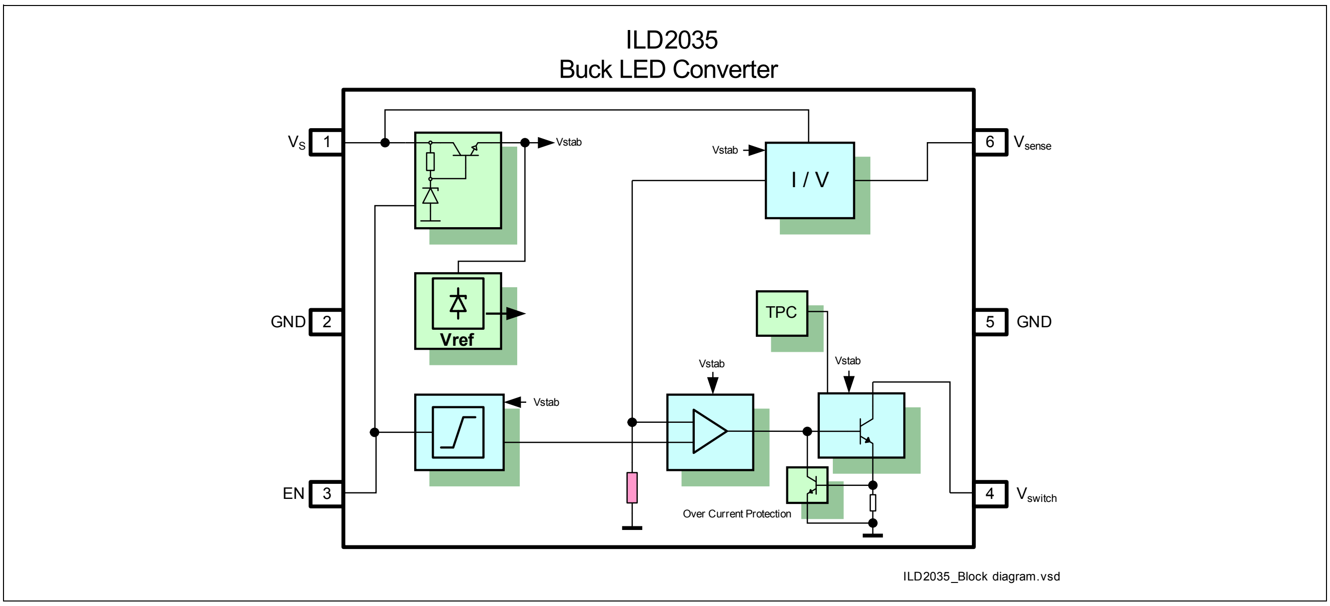


Figure 1 Block Diagram

Pin Definition

Table 1 Pin Definition and Function

Pin No.	Name	Pin Type	Buffer Type	Function
1	V_s	Input	–	Supply voltage
2	GND	GND	–	IC ground
3	EN	Input	–	Chip enable signal
4	V_{switch}	Output	–	Power switch output
5	GND	GND	–	IC ground
6	V_{sense}	Input	–	LED current sense input

3 Maximum Ratings

Table 2 Maximum Ratings

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Supply voltage	V_S	–	–	24	V	–
Peak output current	I_{Switch}	–	–	550	mA	Hysteretic peak current
Total power dissipation, $T_s \leq 85°C$	P_{tot}	–	–	1000	mW	–
Junction temperature	T_J	–	–	150	°C	–
Solder temperature of GND pins	T_{SGND}	–	–	125	°C	–
Storage temperature range	T_{STG}	-65	–	150	°C	–
ESD capability at all pins	$V_{ESD\ HBM}$	–	–	4	kV	HBM acc. to JESD22-A114

***Attention:** Stresses above the max. values listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit.*

4 Thermal Characteristics

Table 3 Maximum Thermal Resistance

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Junction - soldering point[1)]	R_{thJS}	–	–	65	K/W	–

1) For calculation of R_{thJA} please refer to application note AN077 (Thermal Resistance Calculation)

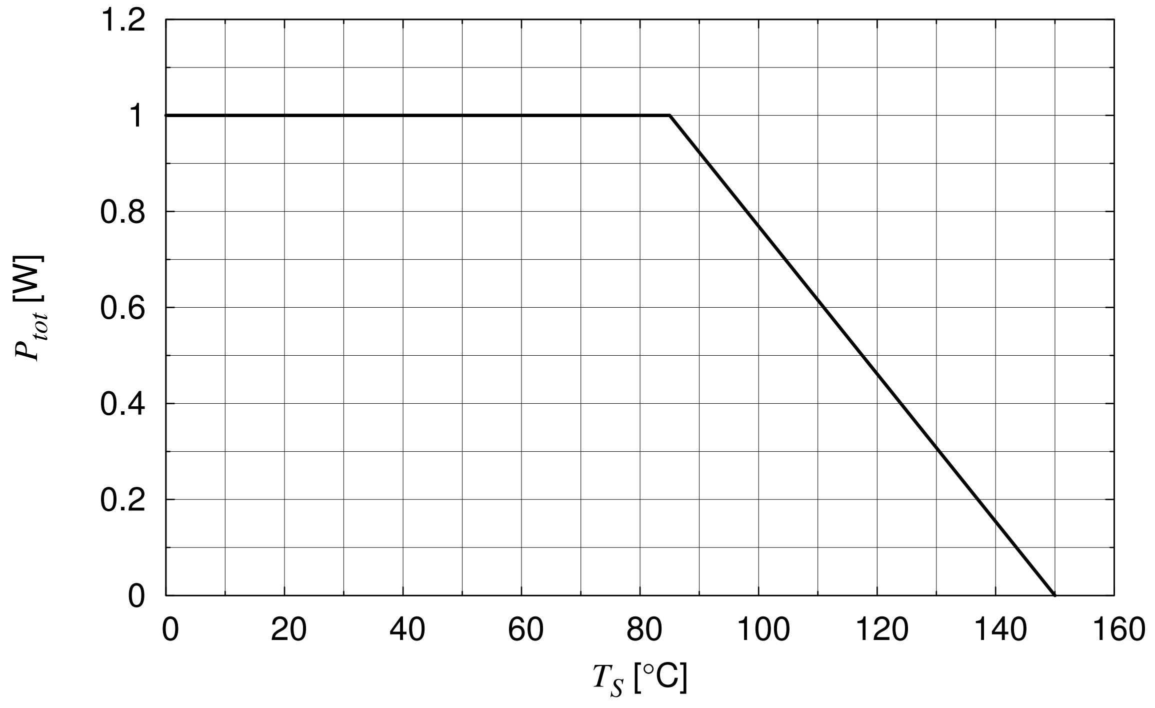


Figure 2 Total Power Dissipation

Equation (1) is gives an estimation for the power dissipation of ILD2035.

$$P_{tot} = 1.1V \cdot I_{LED} \cdot duty\ cycle + f_{Switch} \cdot 1\mu W \cdot {I_{LED}}/{350\ mA} \quad (1)$$

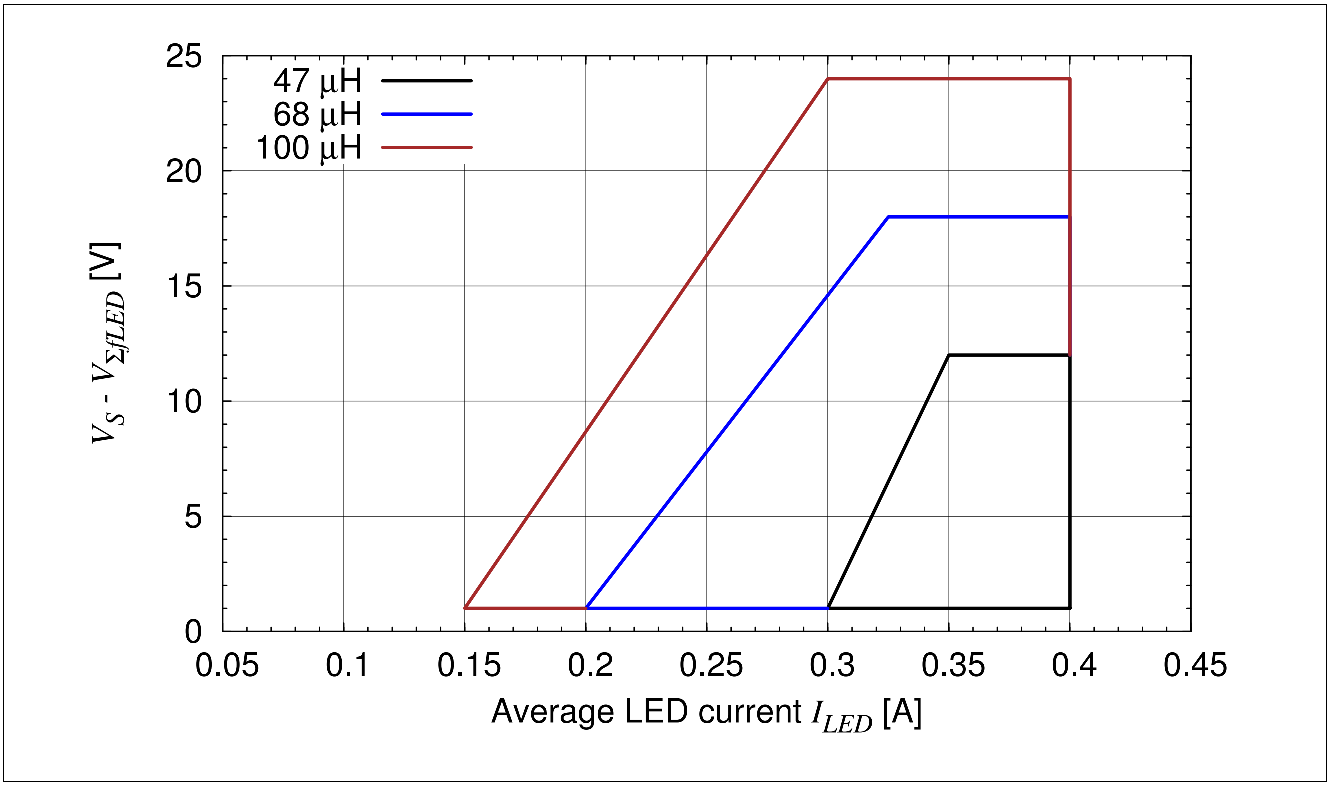


Figure 3 Safe Operating Area

Figure 2 shows the safe operating area for the respective inductance values. The safe operating area consists of the minimum and maximum allowed average LED current and the resulting voltage overhead. The voltage overhead $V_{overhead}$ is the difference between the supply voltage V_S and the sum of the LED forward voltages $V_{\Sigma fLED}$.

Example calculation

3 LEDs in series, V_{fLED}= 3V, I_{LED} = 350 mA, V_S = 12 V

$V_{overhead}$ = V_S - $V_{\Sigma fLED}$ = 12 V - 9 V = 3 V

→ any of the above coil values can be used

Outside the safe operating area the switching frequency, hysteretic peak current and associated power dissipation P_{tot} of ILD2035 will increase beyond the maximum ratings.

5 Electrical Characteristics

5.1 DC Characteristics

All parameters at T_A = 25 °C, unless otherwise specified.
V_S = 12 V, 3 LEDs, R_{sense} = 303 mΩ (I_{LED} = 375 mA), L = 100 µH, V_{EN} = 12 V, V_{fLED} = 3 V

Table 4 DC Characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Supply voltage	V_S	8	–	22	V	
Overall current consumption open load	$I_{S\ open\ load}$	–	2.4	–	mA	V_S = 12 V I_{LED} = 0 mA
Overall standby current consumption	$I_{S\ standby}$	–	–	1	µA	V_{EN} = 0 V; V_S= 12 V
Current of Sense input	I_{sense}	–	20	–	µA	at any LED current
Enable voltage for standby mode	$V_{EN,Off}$	-0.3	–	0.4	V	
Enable voltage for power on	$V_{EN,On}$	2.5	3	22	V	full LED current
Min. power on puls duration	$t_{EN,On}$	10	–	–	µs	
Input current of enable pin	I_{EN}	–	310	–	µA	V_{EN} =12 V
Over temperature protection	$T_{S,\ TSD}$	–	113	–	°C	T_S for 10 % I_{LED} reduction, defined by T_J

5.2 Switching Characteristics

All parameters at T_A = 25 °C, unless otherwise specified.

V_S = 12 V, 3 LEDs, R_{sense} = 303 mΩ (I_{LED} = 375 mA), L = 100 µH, V_{EN} = 12 V, V_{fLED} = 3 V

Table 5 Switching Characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Switching frequency	f_{Switch}	–	120	–	kHz	
Maximum switching frequency	$f_{Switch\ max}$	–	–	500	kHz	for any coil value
Mean current sense threshold voltage	V_{sense}	–	114	–	mV	
Sense threshold hysteresis	$V_{sensehys}$	–	±7.5	–	%	
Residual voltage at collector of power transistor	$V_{switch\ on}$	–	1.1	–	V	output switch turned on
Output current accuracy	I_{outacc}	–	±3	–	%	

5.3 Digital Signals

All parameters at T_A = 25 °C, unless otherwise specified.

Table 6 Digital Control Parameter at Pin EN

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input voltage for power on	V_{On}	2.5	3	22	V	full LED current
Input voltage for power off	V_{Off}	-0.3	–	0.4	V	
Min. power on puls duration	t_{On}	10	–		µs	

6 Basic Application Information

This section covers the basic information required for calculating the parameters for a certain LED application. For detailed application information please visit our web site **http://www.infineon.com/led.appnotes**

6.1 Setting the average LED current

The average output current for the LEDs is set by the external sense resistor R_{sense}. To calculate the value of this resistor a first approximation can be calculated using **Equation (2)**.

V_{sense} is dependent on the supply voltage V_S and the number of LEDs in series.

$$R_{sense} = \frac{V_{sense}}{I_{LED}} \tag{2}$$

Example calculation

V_S = 12 V, 100 µH, V_{fLED} = 3 V, 3 LEDs in series

→ V_{sense} = 114 mV

I_{LED} = 375 mA

→ R_{sense} = 303 mΩ

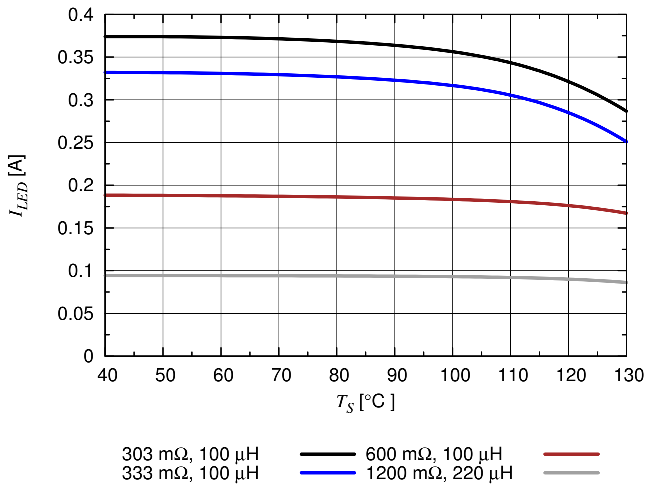
An easy way to achieve these resistor values is to connect standard resistors in parallel.

6.1.1 Temperature Protection Circuit

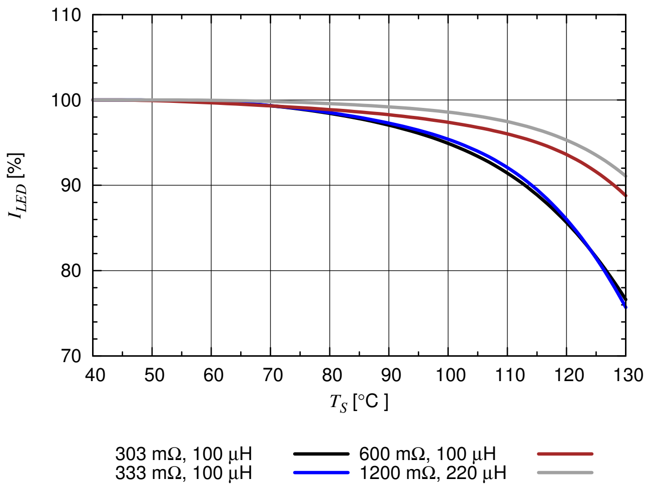
ILD2035 incorporates a temperature protection circuit referring to the junction temperature of the IC. The higher the junction temperature the lower the current of the LEDs. This feature helps to reduce the power dissipation of ILD2035 and the LEDs. Yet still the product specific maximum ratings for the junction temperature need to be observed to avoid a permanent damage of the devices.

ILD2035 has been characterized on ILD4035/4001 application board heated from the backside without additional air flow on the circuit board surface besides natural convection. The size and layout of the circuit board as well as the air flow around it influence the thermal resistance junction to ambient R_{thJA} of ILD2035 and thus its junction temperature. Below figures show the LED current versus soldering point temperature T_S.

LED current versus T_S, V_S = 12 V



LED current (relative) versus T_S, V_S = 12 V

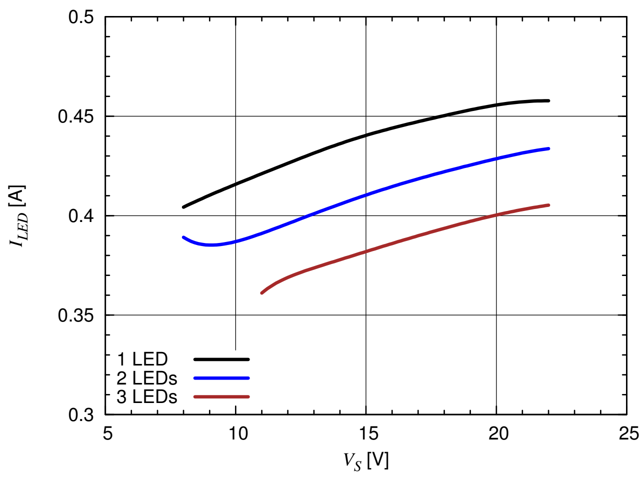


6.2 Switching Parameters

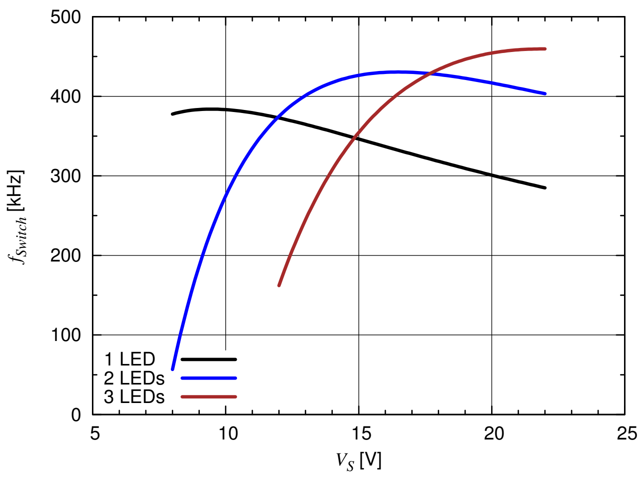
For all shown parameters ILD2035 has been measured at T_A = 25 °C. Used LEDs have a typical V_{fLED} of 3 V.

R_{sense} = 303 mΩ, L= 47 µH

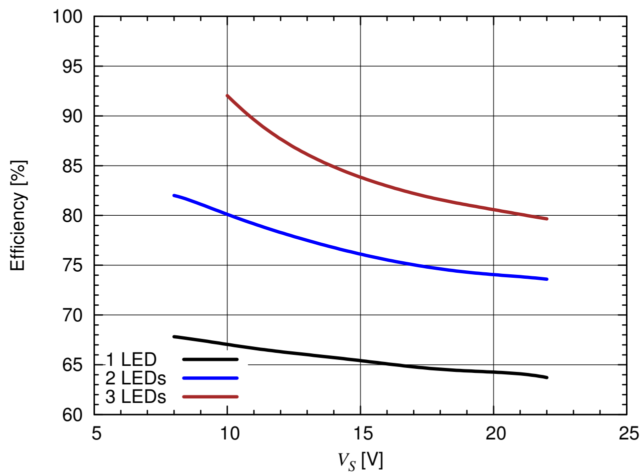
I_{LED} versus V_S and Number of LEDs



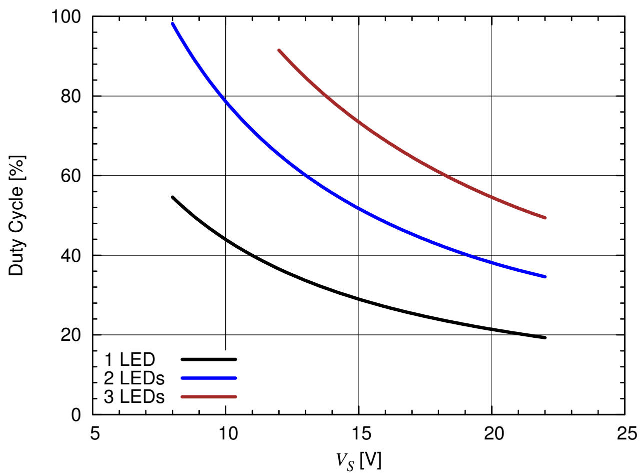
f_{Switch} versus V_S and Number of LEDs



Efficiency versus V_S and Number of LEDs

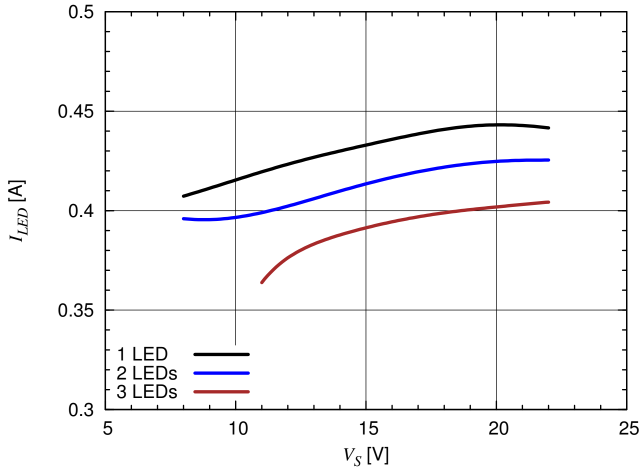


Duty Cycle versus V_S and Number of LEDs

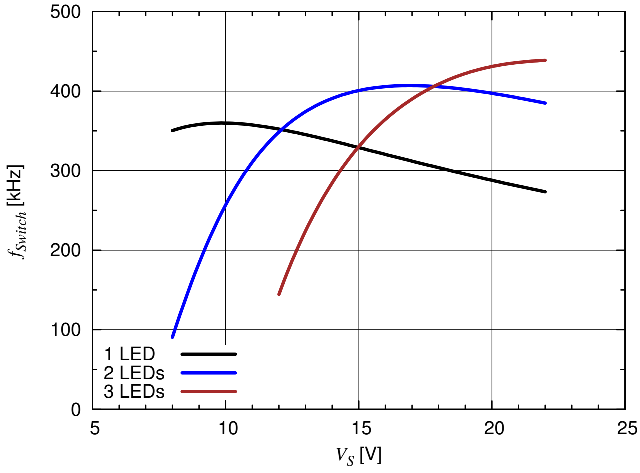


R_{sense} = 303 mΩ, L= 68 µH

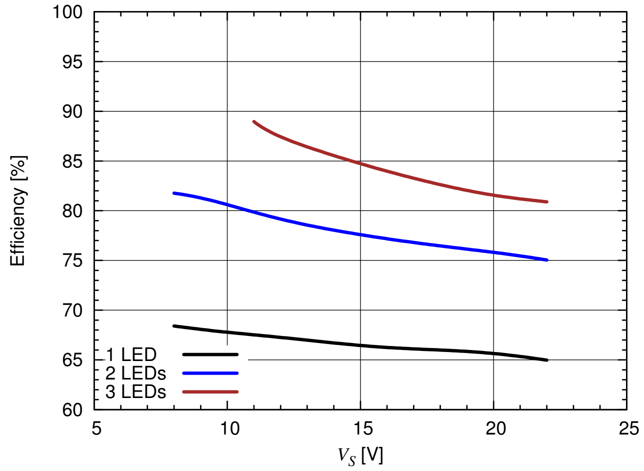
I_{LED} versus V_S and Number of LEDs



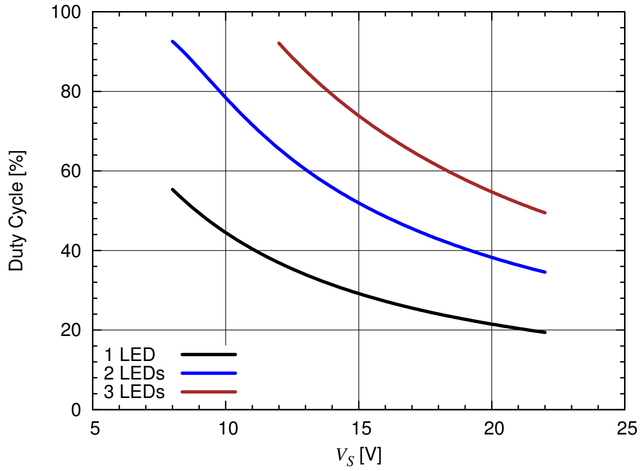
f_{Switch} versus V_S and Number of LEDs



Efficiency versus V_S and Number of LEDs

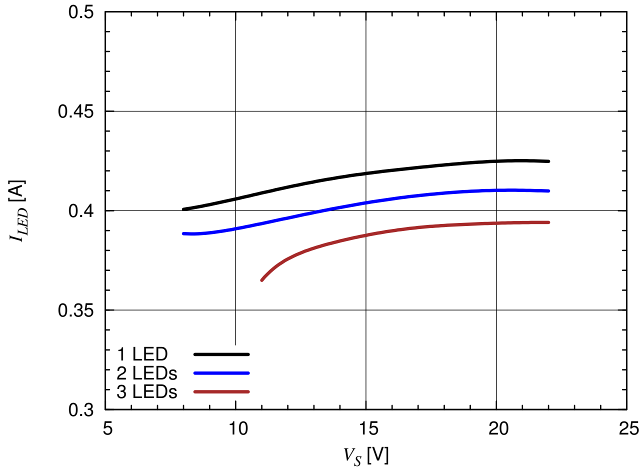


Duty Cycle versus V_S and Number of LEDs

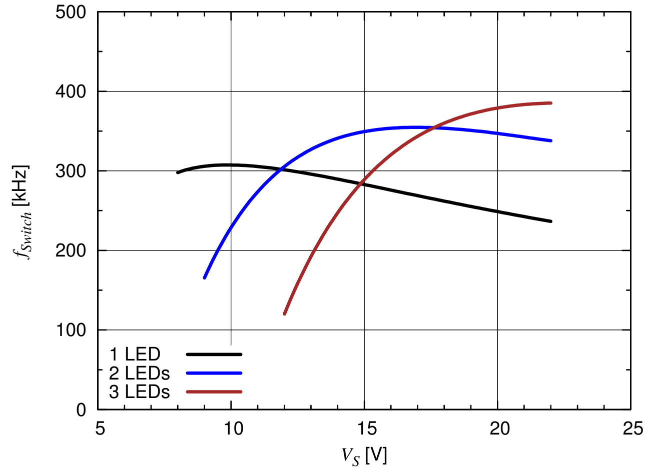


R_{sense} = 303 mΩ, L= 100 µH

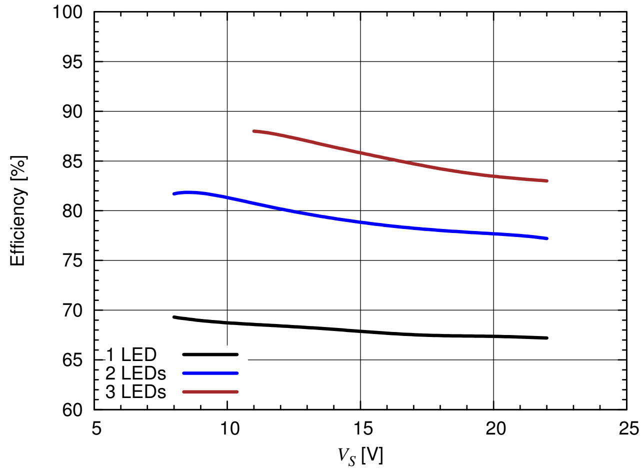
I_{LED} versus V_S and Number of LEDs



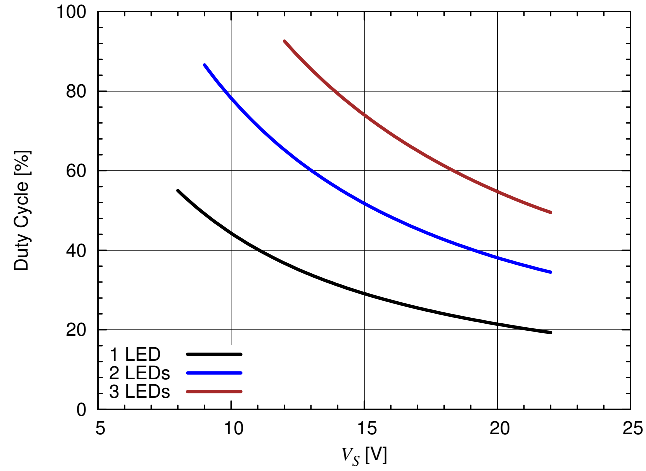
f_{Switch} versus V_S and Number of LEDs



Efficiency versus V_S and Number of LEDs

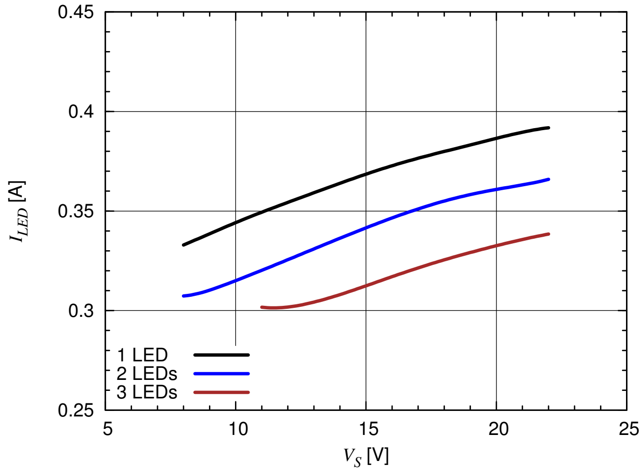


Duty Cycle versus V_S and Number of LEDs

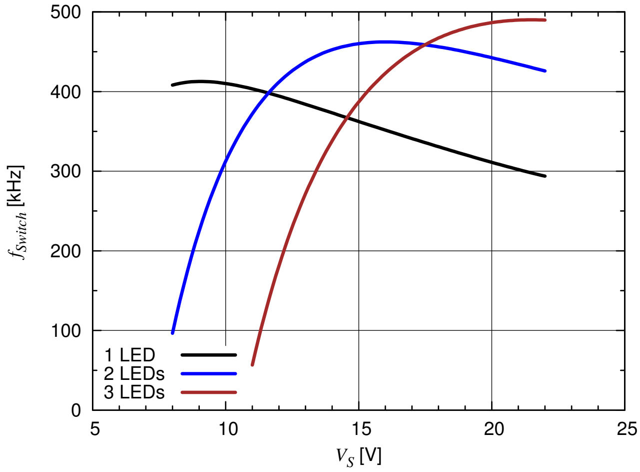


R_{sense} = 367 mΩ, L= 47 µH

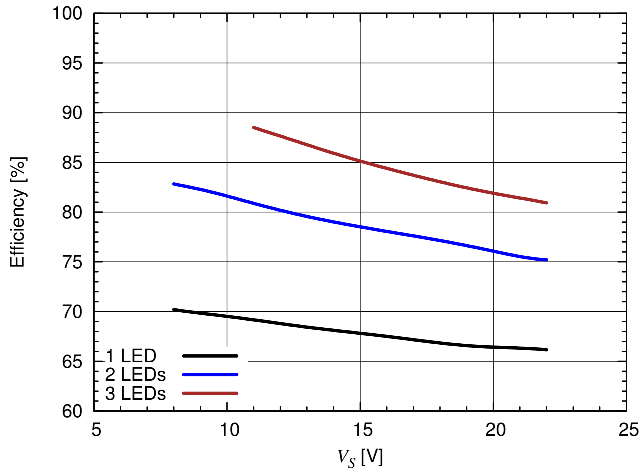
I_{LED} versus V_S and Number of LEDs



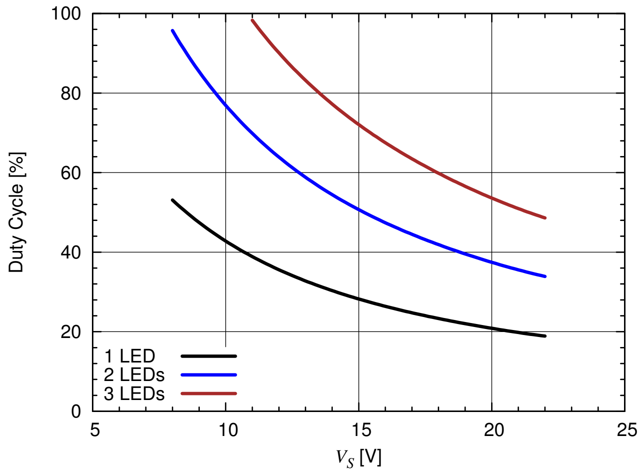
f_{Switch} versus V_S and Number of LEDs



Efficiency versus V_S and Number of LEDs

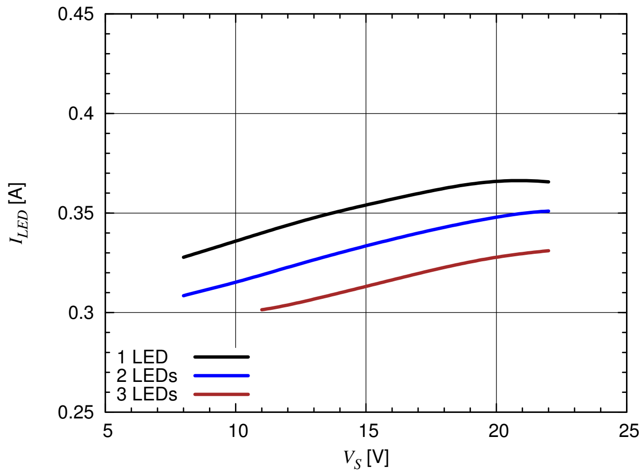


Duty Cycle versus V_S and Number of LEDs

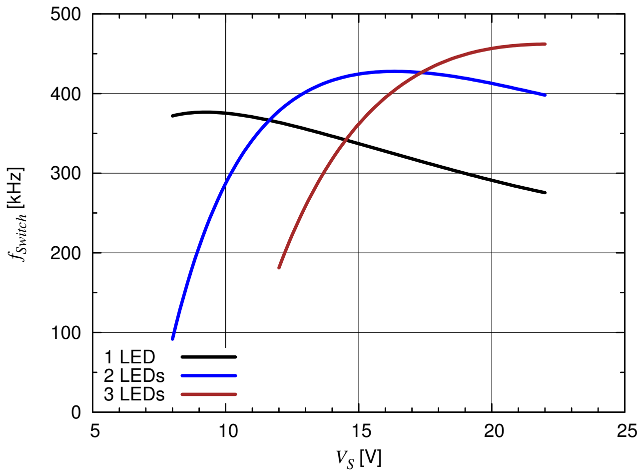


R_{sense} = 367 mΩ, L= 68 µH

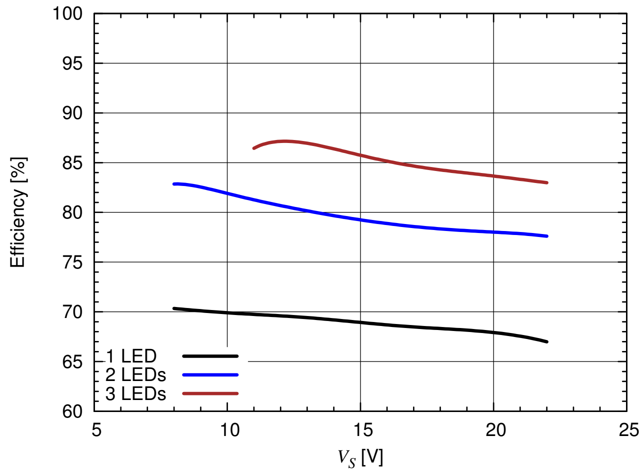
I_{LED} versus V_S and Number of LEDs



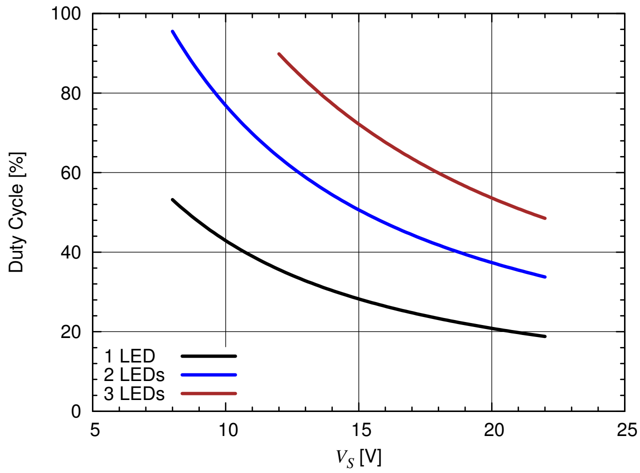
f_{Switch} versus V_S and Number of LEDs



Efficiency versus V_S and Number of LEDs

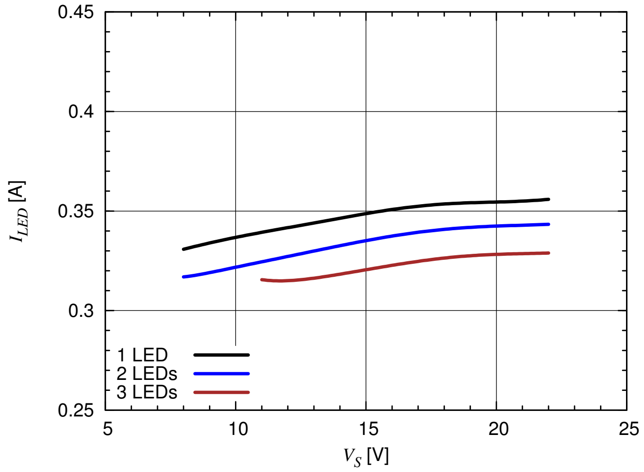


Duty Cycle versus V_S and Number of LEDs

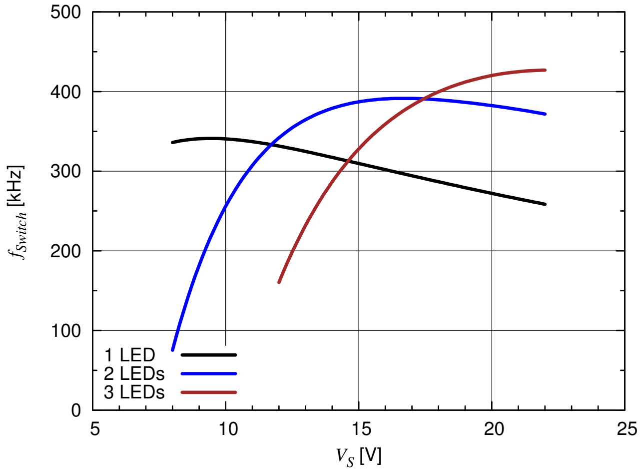


R_{sense} = 367 mΩ, L= 100 µH

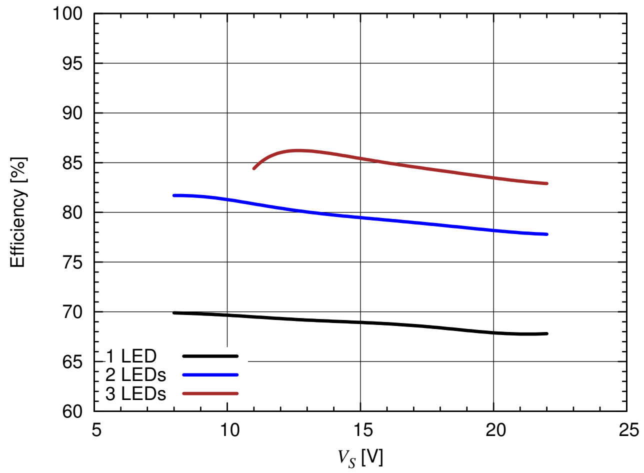
I_{LED} versus V_S and Number of LEDs



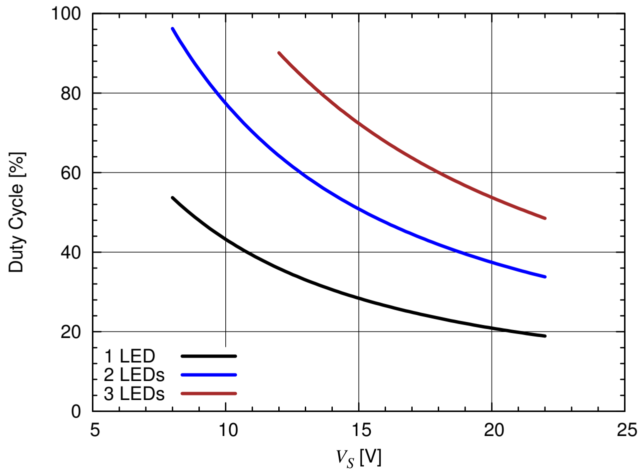
f_{Switch} versus V_S and Number of LEDs



Efficiency versus V_S and Number of LEDs



Duty Cycle versus V_S and Number of LEDs



7 Application Circuit

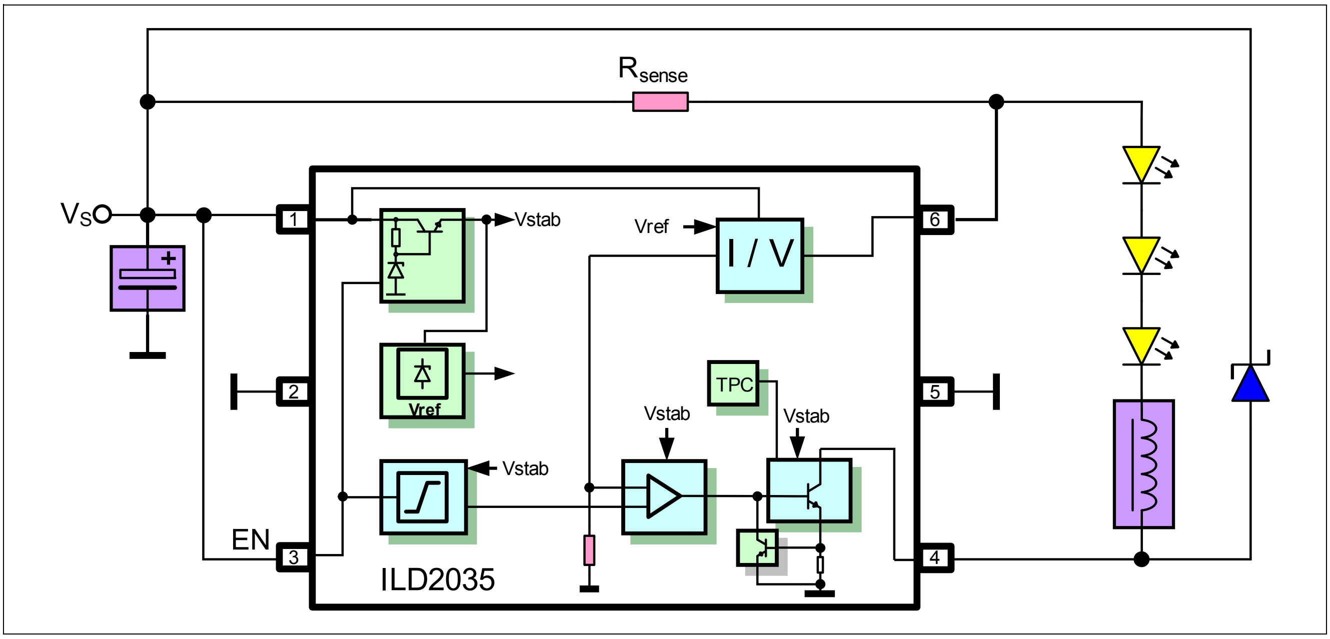


Figure 4 Application Circuit

7.1 Evaluation Board

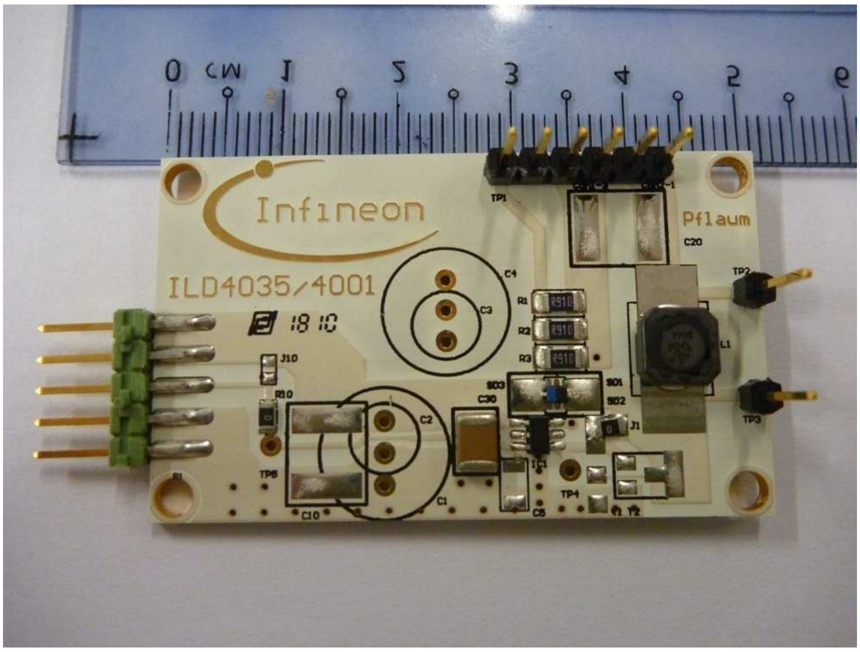


Figure 5 ILD2035 on Evaluation Board

8 Package Information

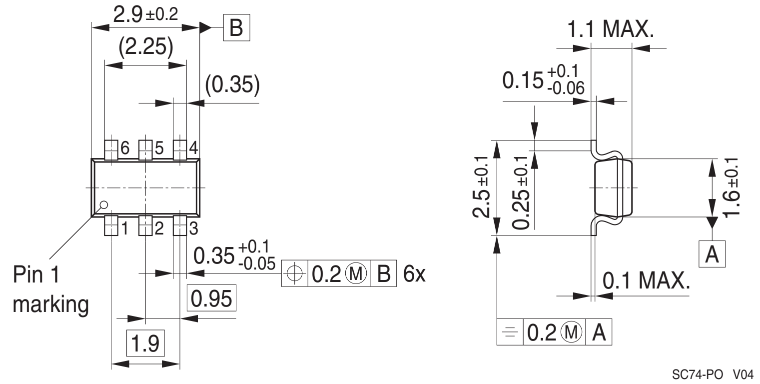


Figure 6 Package Outline SC74

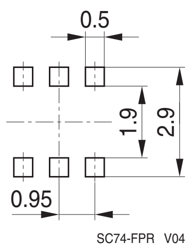


Figure 7 Recommended PCB Footprint for Reflow Soldering

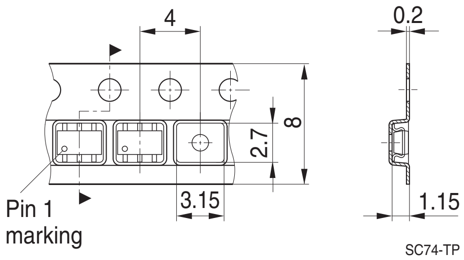


Figure 8 Tape Loading

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