IN-PLUG® series: IPS15H
Enhanced Off-line Switcher With Hiccup,
Low Cost, High Efficiency, Low Stand-By Power.
Fail-Safe Protection from Optocoupler Failure
When Combined with Low Power Zener.

– REVISION 10 -

INTRODUCTION

DESCRIPTION

The IN-PLUG® IPS15H is an enhanced off-line switcher version of the IPS15 that includes the same basic features plus offers a special overload protection mode called "hiccup" to control the maximum output power from the line side and eliminate the current sensing circuitry on the load side.

The original functions of the IPS15 have been retained. They include soft start, line over-voltage protection, shunt-regulator, precision oscillator, PWM with its associated comparator and loop compensation components as well as all the necessary biasing and protection circuitry (thermal shutdown, under-voltage, over-voltage and over-current).

The IPS15H "hiccup" circuitry involves a counter and some other digital blocks. This feature has been added to avoid delivering a high current to the load in an overload condition, which may result in damages to the SMPS, the load or both.

The overload condition is sensed from the line-side by monitoring the MOSFET current. The MOSFET must be allowed to operate at maximum current for the SMPS to properly start and respond to transient conditions. If the operation at maximum current is too long, then it is in an overload condition and the circuit enters "Hiccup Mode". The peak current in the load is still high in order to be able to return to normal mode, but the duty cycle is so low that the average current drops below 100mA therefore allowing the SMPS to remain overloaded indefinitely without any reliability or safety concerns.

The IPS15H not only protects against overload conditions but also avoid the losses involved in the sensing circuitry which increases the overall SMPS efficiency by up to 10%. This is significant!

FEATURES

- "Hiccup" version of the IPS15 with overload protection.
- Max output power controlled from line-side to avoid load-side current sensing circuitry and associated 10% losses.
- Fail-safe protection from optocoupler failure when combined with low-cost low-power zener.
- Lower quiescent current (max. 50% of the IPS15)
- Can drive a large variety of power MOSFETs
- Simple, less critical, lower cost transformer.
- Wide range PWM for stable operation at any load and line voltage.
- Operates with optocoupler or bias winding for constant voltage applications: zeners, adjustable shunt regulator like TL431.
- EMI reduction in critical applications thanks to:
  - Adjustable operating frequency.
  - Separate MOSFET N & P drives
- Power shut-down for stand-by modes.
- Cycle to cycle over-current protection
- Under-voltage lock-out
- Line over-voltage protection.
- External component savings: MOV, X-cap, Y-cap (Application permitting)

APPLICATIONS

- Standby power supplies for TV, VCR and IR remotely-controlled appliances.
- Cordless and feature phones.
- Cellular phone chargers.
- Power tools fast chargers with trickle and on/off.
- Laptops and personal digital assistants.
- Utility meters.
- Replacements for bulky plug-in transformers.
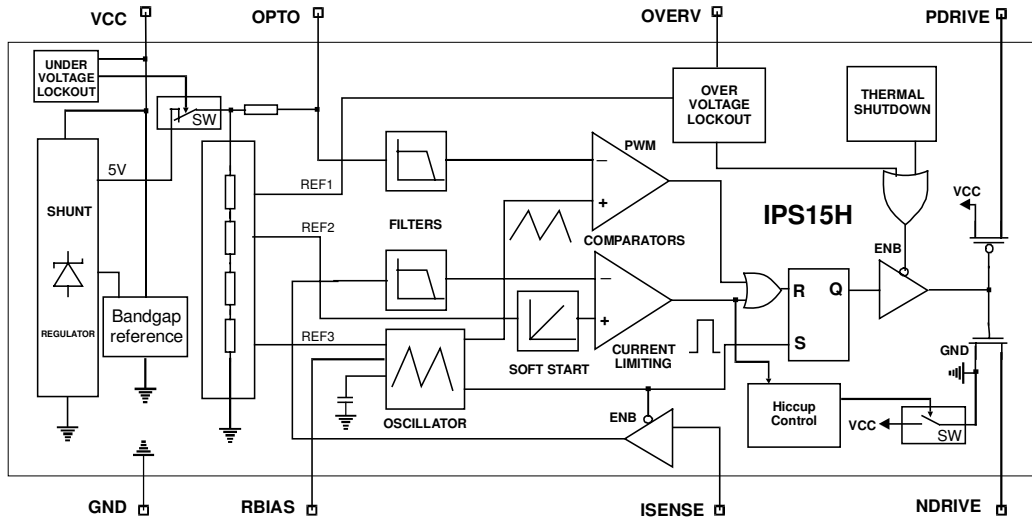
PIN CONFIGURATION: DIP-8 / SOIC-8   **ORDERING INFORMATION**
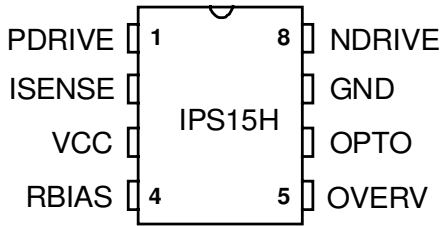
Part No.	ROHS / Pb-Free	Package	Temperature Range	
IPS15HC-D	-G-LF	8-Pin PDIP	0°C to +70°C	Commercial
IPS15HI-D	-G-LF	8-Pin PDIP	-40°C to +85°C	Industrial
IPS15HC-SO	-G-LF	8-Pin SOIC	0°C to +70°C	Commercial
IPS15HI-SO	-G-LF	8-Pin SOIC	-40°C to +85°C	Industrial

For detailed ordering information, see page 15

FUNCTIONAL BLOCK DIAGRAM

TYPICAL APPLICATION SCHEMATIC: AC in 90-265V, DC out 5V, Imax 600mA

R11 and R12 to be adjusted for max line overvoltage protection

R4 controls max pick current
when the ISENSE pin voltage exceeds ~700 mv

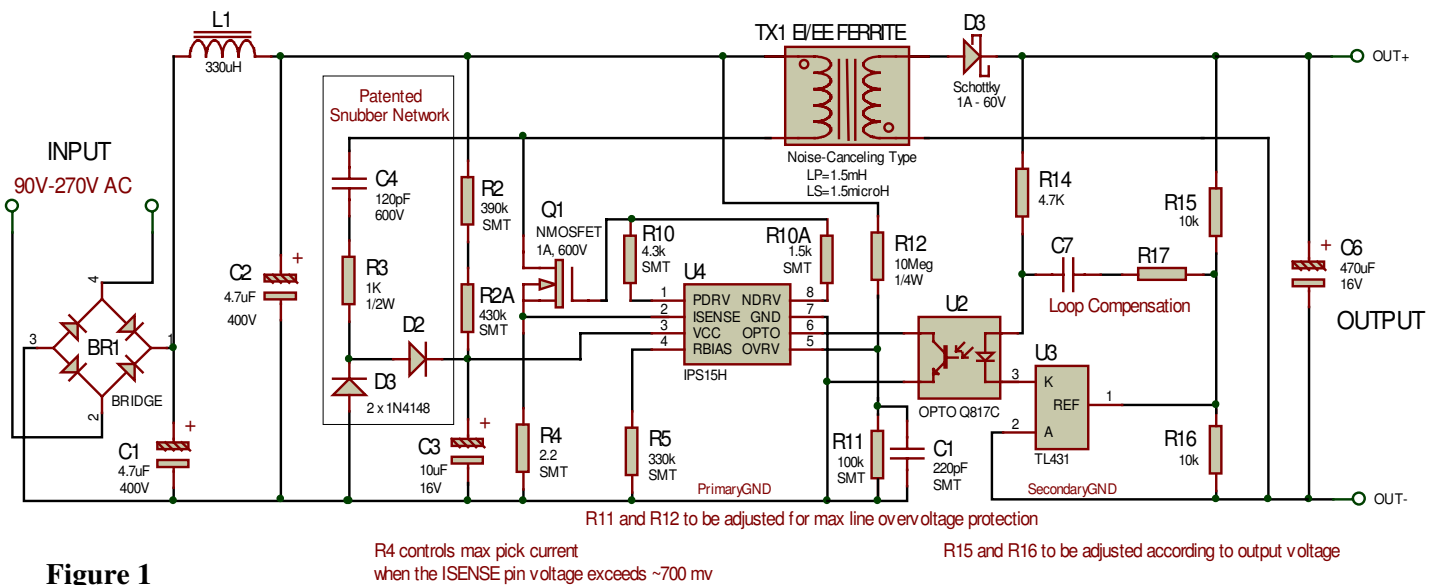R15 and R16 to be adjusted according to output voltage

Figure 1

Note: Original R2 has been split into R2 and R2A to double the voltage rating.

Hiccup mode:

The output power that triggers the hiccup mode is monitored from the line-side by sensing the MOSFET current through the ISENSE resistor (R4 in the example of Fig.1). The hiccup mode doesn't require any specific component on the load-side. This mode called "hiccup" is a special "overload protection" mode where the IPS15H resets itself when an overload condition is detected and which duration exceeds the maximum authorized time T_{Hdtc} as described below:

Approximatly **T_{Hoff}** after power-up and when the IPS15H is fully operational, the output power is sensed to check an overload condition present or not ("true" or "false"). If it is "true" and remains "true" all over **T_{Hdtc}** then the IPS15H resets. Power supply re-establishes and after **T_{Hoff}** time, the chip restarts monotoring the output power through RSENSE and the "hiccup" mode could repeat itself as described.

If the overload condition is "false" or when it is true for less than **T_{Hdtc}**, the IPS15H simply operates like the original IPS10 / IPS15 flyback controllers.

Overload Condition:

An overload condition is defined by

$P_{Sout} > P_{Smax}$ → "true";

$P_{Sout} < P_{Smax}$ → "false";

P_{Sout} = SMPS output power (secondary);

P_{Smax} = maximum authorized output power delivered by the SMPS secondary.

Hiccup detect time T_{Hdtc} and off time T_{Hoff}:

T_{Hoff} = time from start-up to P_{SOUT} sensing;

T_{Hdtc} = maximum detect time of overload condition to trigger chip reset;

$(T_{Hoff} + T_{Hdtc})/ T_{Hoff.}$ = hiccup duty cycle.

Note: Conditions of figure 2 were altered to better show the "hiccup" operation mode. Actual duty cycle will be much less as indicated in formula below.
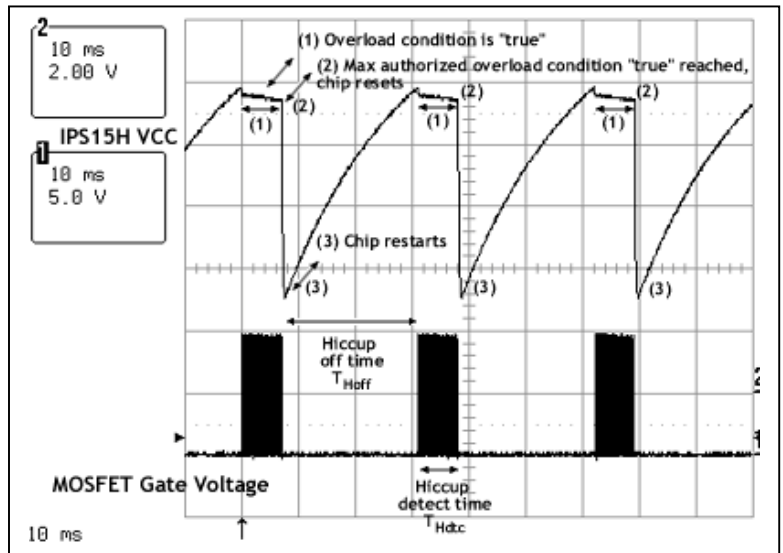

Figure 2: "Hiccup" mode in constant overload

Calculation of the output power "P_{Smax}" that triggers the hiccup mode:

As explained above, when $P_{Sout} > P_{Smax}$ for more than T_{Hdtc} time, hiccup mode starts. The previous formula could also be seen from the primary as $P_{Sout} = (P_{Pout} - losses) > P_{Smax}$ where losses correspond to the overall losses (schottky, transformer, MOSFET, snubber etc..). As a first approximation the losses could be estimated to 25% and consequently 75% of primary power P_{Pmax} could be used.

$P_{Pout} > (P_{Smax} + losses) = ½ L_p Ipeak^2 F$ → Ipeak = 0.7V/RSENSE (0.7V = max ISENSE pin voltage, Ipeak = peak MOSFET current).

$P_{Smax} /0.75 = ½ L_p Ipeak^2 F = ½ L_p (0.7V/RSENSE)^2 F$

This relation will help the SMPS designer to determine the 3 suitable parameters for their application: Lp = primary inductance of TX transformer, RSENSE = ISENSE resistor, F = frequency of operation.

As in our example of Fig.1 with R4 = 2.2Ohm, L_p=1.5mH and F= 70KHz → Pout = 4W – losses ~ 3W. At 5V, the overload condition is set "true" when Ipeak reaches approximately 600mA.

Calculation of hiccup detect time (T_{Hdtc}) and off time (T_{Hoff})

T_{Hdtc} is proportional to 1/F and typically is 7ms for F_{nom}=70KHz. To calculate **T_{Hdtc}** at any other frequency, apply 7ms x F_{nom}/F1. Example: F1= 50KHz, **T_{dtc}** = 7ms x 70KHz/50KHz ~ 10ms

T_{Hoff} ~ $\underline{6 \times (R2 + R2A) \times C3}$. In the example of figure 1, with Vin =90V, **T_{Hoff}** ~ $\underline{6 \times 1.5MΩ \times 10μF}$ ~ 1s
$\qquad\qquad$ Vin RMS $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ 90V

Calculation of the max value of the output capacitor C6 (see Fig.1):

During the power-up phase, the output capacitor C6 needs to be fully charged within the hiccup detect time T_{Hdtc} otherwise the IPS15H would detect an overload condition which doesn't exist and will enter hiccup mode. Please calculate the maximum capacitor value suitable for your application by applying:

$$C6\ max\ \leq\ \frac{Lp \times 385 \times (Ipeak)^2}{Vout^2}$$

Where Lp = primary inductance of TX transformer
Ipeak = maximum peak current in the MOSFET
Vout = output DC voltage of the SMPs

In the schematic page 2, the calculation of C6 max shows an absolute max value of ~ 2300µF.

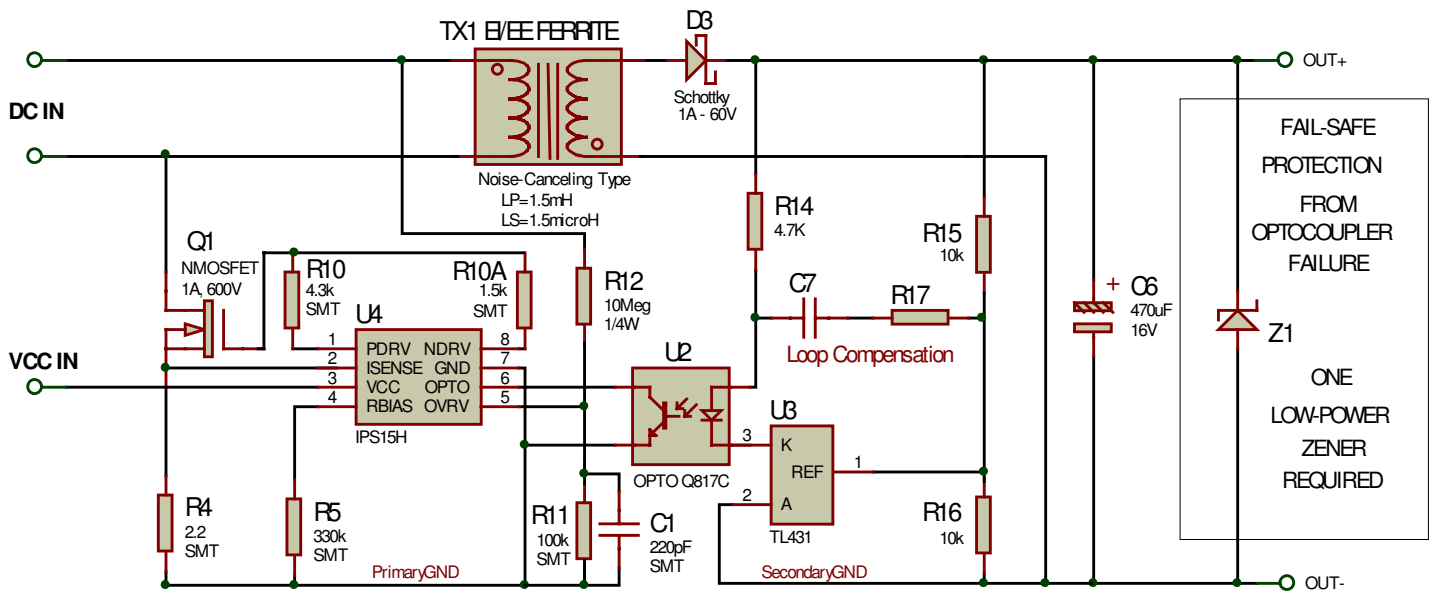**PROTECTION AGAINST OPTOCOUPLER FAILURE USING A SIMPLE LOW-COST, LOW-POWER ZENER**

Figure 3

When adding a zener diode with a voltage slightly above the maximum output DC operating voltage, the SMPS will automatically enter hiccup mode if the optocoupler fails open.

Thanks to entering hiccup mode, the average power dissipation in the diode will be limited to a small fraction of what the SMPS could deliver when the feedback loop is opened. This is why a low-power zener is sufficient for full protection.

Therefore the combination of the IPS15H hiccup capability with a simple low-power low-cost ouput diode brings a very affordable protection against optocoupler failure, avoiding destruction of the load and the SMPS itself. A simple replacement of the optocoupler then will bring the SMPS back to normal operation.

As already described in the front page, in hiccup mode the average current drops well below 100mA. A very low-power rated zener can be therefore selected according to the intrinsic voltage required by the application. This will allow the SMPS to remain overloaded indefinitely without any reliability or safety concerns.

PIN DESCRIPTION

Number	Name	Description
1	PDRIVE	Internal P drive terminal to be connected to the gate of the outside power MOSFET. (The rising edge can be adjusted with an external resistor)
2	I_{SENSE}	MOSFET current sensing. Any voltage over 700 mv @ 25°C on this pin for an internally defined number of clock cycles, will trigger "hiccup" mode.
3	V_{CC}	IC positive supply. The chip behaves like a 9.7 volts zener diode.
4	R_{BIAS}	External R_{BIAS} connection to set the operating frequency.
5	OVERV	Line over-voltage lock-out pin. @ 25°C a voltage over 4V on this pin will pull the MOSFET gate to GND.
6	OPTO	Feedback input
7	GND	Ground
8	NDRIVE	Internal N drive terminal to be connected to the gate of the outside power MOSFET. (The falling edge can be adjusted with an external resistor)

IN-PLUG® IPS15H FUNCTIONAL DESCRIPTION

As the IPS15, the IN-PLUG® **IPS15H** is a PWM controller for flyback switching power supply applications. This version has been designed to protect SMPSs from overload conditions with a minimum circuitry and minimum load side losses. The principal features are:
- Low quiescent Current (half of IPS15);
- Max output power (overload) controlled from line-side;
- Shunt regulator to allow the maximum flexibility to power the chip;
- Protections against overheating, and line over-voltage;
- Under-voltage lockout;
- Precise oscillator with externally adjustable frequency;
- On-chip filters for the loop compensation and the over-current sensing;
- Soft start and over-voltage shut-down to protect the MOSFET;
- Separate MOSFET P and N drivers to adjust rising and falling edge independently.

The shunt regulator operates like a zener diode, keeping the chip supply voltage around 9.7 volts. At start-up the chip stays in stand-by mode until the voltage of VCC reaches about 9.7 volts. During this phase, the consumption is of the order of 60 µA and the IC being partially disabled can only handle a maximum of 1mA of supply current. When the 9.7 volts are reached, the driver starts providing gate pulses. The chip will go back to the stand-by mode if the supply voltage decreases down to ~8 volts. The overall chip consumption in normal operation is about 350 µA, not counting the current required to drive the MOSFET gate.

For domestic application, the chip can be supplied from the rectified line voltage through a resistor. In such case, the resistor has to be sized to drive enough current to the chip.

For international applications, the IC gets the start current from a resistor connected to the rectified line voltage (~70 µA) then, after the first gate pulse, the patented modified snubber network (*) provides the additional current to keep the chip running.

The opto pin is pulled to internal 5V through an on-chip resistor which value is 60KΩ nominal, allowing a maximal duty cycle of 66 %. During start-up, the duty cycle is controlled by the internal soft start unit which smoothly increases the MOSFET current up to its maximum, corresponding to 700mV developed across the sense resistor.

When the expected output voltage is reached, the optocoupler's led is driven, and the opto pin voltage decreases, reducing the duty cycle to a controlled value. The initial current limiting protection of the original IPS15 that was simply turning-off the MOSFET when the ISENSE pin voltage exceeds ~700 mv, is now used to trigger the "hiccup mode" when the condition is present for a maximum time defined by an internal IPS15H digital counter.

This overload condition is sensed from the line-side by monitoring the MOSFET current. The MOSFET must be allowed to operate at maximum current for the SMPS to properly start and respond to transient conditions. When the "time of operation at maximum current" counter overflows, it is in an overload condition and the circuit enters "Hiccup Mode". The peak current in the load is still high in order to be able to return to normal mode, but the duty cycle is so low that the average current drops below 100mA therefore allowing the SMPS to remain overloaded indefinitely without any reliability or safety concerns.
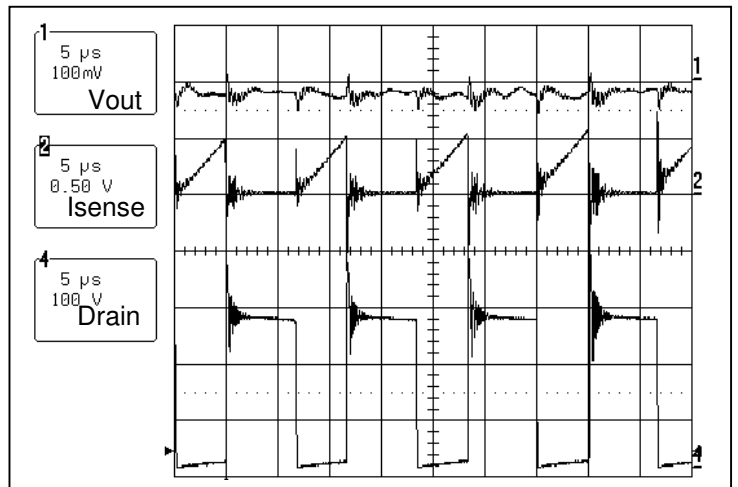
The line-side voltage limiting protection operates by turning-off the MOSFET when the OVERV pin voltage exceeds ~4V.

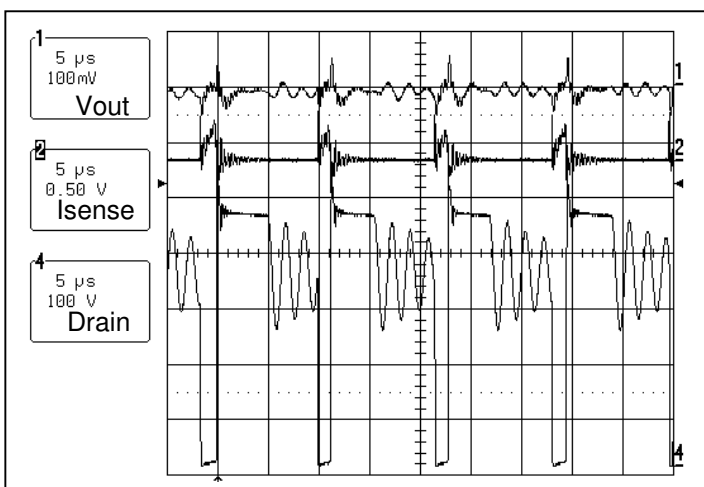(*) *US Patent # 6,233,165 - **Royalty free licence for IN-PLUG® Customers.***

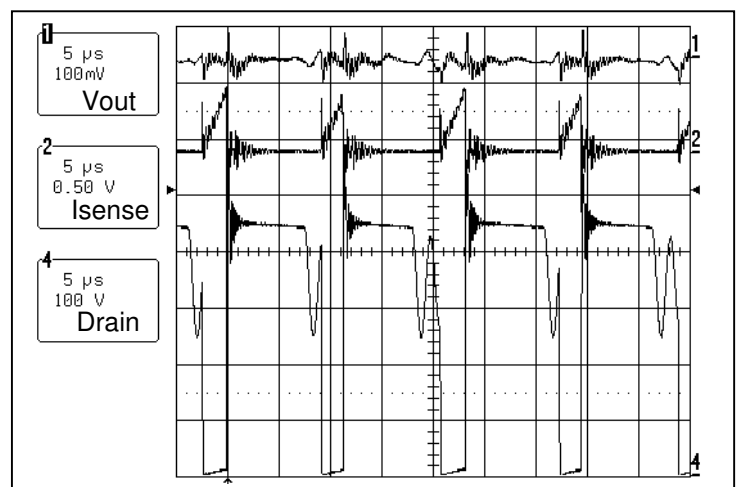**AC 110V - IPS15H normal operation at 5W***
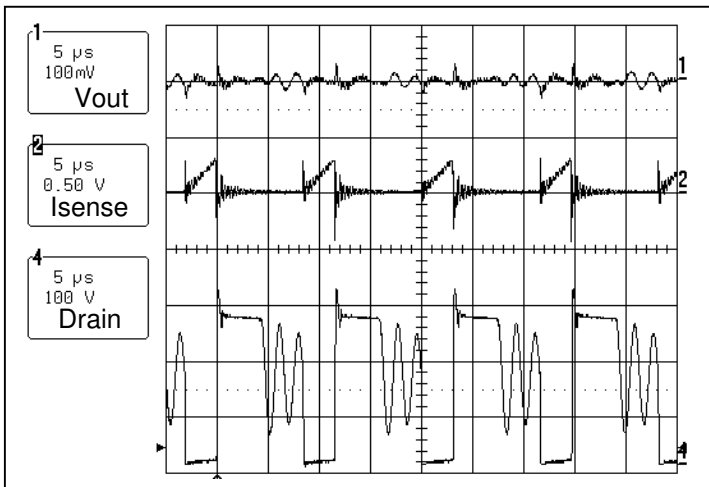
IPS15H normal operation at 15W*

AC 250V - IPS15H normal operation at 5W*

IPS15H normal operation at 15W*

* Together with a 1A, 600V MOSFET.

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OUTPUT POWER CAPABILITY

Part Number	Package	230V AC or 115V AC w/ Doubler	85 – 285V AC
IPS15H	DIP-8 / SOIC-8	Up to 70W (1)	Up to 30W (1)

Note (1): Governed by size and package of external MOSFET

ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATING

Characteristics	Value	UNITS
Shunt regulator max I_{CC} in normal operation (pin 3) - see fig 6-	50	mA
Shunt regulator max I_{CC} at start-up	1	mA
All analog inputs (pin 2, 4, 5, 6)	Min= -0.3, Max= +6.3V	V
Peak drive output current (pin1)	Source=100, Sink=170	mA
Junction to case thermal resistance $R_{\theta J-C}$	PDIL = 42, SOIC = 45	°C / W
Junction to PCB thermal resistance $R_{\theta J-A}$	PDIL = 125, SOIC =155	
Power dissipation for T_A <= 70°C	PDIL = 640, SOIC = 500	mW
Operating junction temperature	- 40 to 150	°C
Storage temperature range	- 55 to 150	
Lead temperature (3 mm from case for 5 sec.)	260	

PARAMETER	TEST CONDITIONS	PARAMETERS			UNITS
	@ 25°C unless specified	MIN.	TYP.	MAX.	
Supply, bias & circuit protection					
Shunt regulator voltage	ICC = 1 to 30 mA	9.2	9.7	10.5	V
Shunt regulator dynamic resistance	1 to 30 mA	2	3	5	Ω
Shunt regulator max peak repetitive current		-	35	-	mA
Min I_{CC} to start oscillator		-	-	80	μA
Under voltage lock-out		V_{CC} – 2.2	V_{CC} - 1.5	V_{CC} - 1.4	V
Min I_{CC} to ensure continuous operation	1A, 600V, 5 nC MOSFET	1.1 @ 20KHz	3.2 @ 80KHz	4.9 @ 150KHz	mA
Current limiting sensing voltage		655	700	745	mV
Temperature coefficient of current limiting		-	30	-	μV/°C
Overvoltage sensing voltage		3.85	4	4.15	V
Soft/start duration	0 to 700mV	-	30	-	clock cycles
Leading edge blanking		-	900	-	ns
Thermal shutdown trip temperature		-	140	-	°C

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ELECTRICAL CHARACTERISTICS (cont'd)

PARAMETER	PARAMETER	PARAMETERS			UNITS
	@ 25°C unless specified	MIN.	TYP.	MAX.	
Oscillator & PWM					
Range of operating frequencies		30	80	150	KHz
RBIAS values for above frequencies (see figure 4)		550	170	80	KΩ
Oscillator stability with supply & temperature (see figure 5 for average)	I_{CC} = 5 mA Temp = 0 to 70°C	-1.5	-	1.5	%
Maximum duty cycle		-	66	-	%
Minimum duty cycle		-	0	-	%
Hiccup run time T_{Hdtc}	F = 70 KHz* - see Note2	-	7	-	ms
Hiccup off time T_{Hroff}	Proportional to R2 x C3 See explanation page 3				
Error amplifier					
Sensitivity in mV / % of PWM		-	54	95	mV
Voltage for max duty cycle	(On OPTO pin)	-	4	-	V
Voltage for min duty cycle	(On OPTO pin)	-	0.6	-	V
Input impedance	OPTO pin	40	60	80	KΩ
P & N Outputs to MOSFET gate					
P gate driver saturation	10 mA (source)	-	-	1	V
N gate driver saturation	10 mA (sink)	-	-	0.6	V
Gate pull-down resistor	(internal)	280	400	520	KΩ
PDRIVE Rise time (10% to 90%)	240 pF load	-	150	-	ns
NDRIVE Fall time (10% to 90%)	240 pF load	-	75	-	ns
Max recommended total external MOSFET charge	@ 20 KHz	-	-	100	nC
"	@ 80 KHz	-	-	50	nC
"	@ 150 KHz	-	-	15	nC

Note1: Electrical parameters, although guaranteed, are not all 100% tested in production.

* Note2: Detect time T_{Hdtc} is proportional to 1/F. For example at 50KHz, detect time T_{Hdtc} = 7ms x 70KHz / 50KHz = 10ms (full explanation page 3)
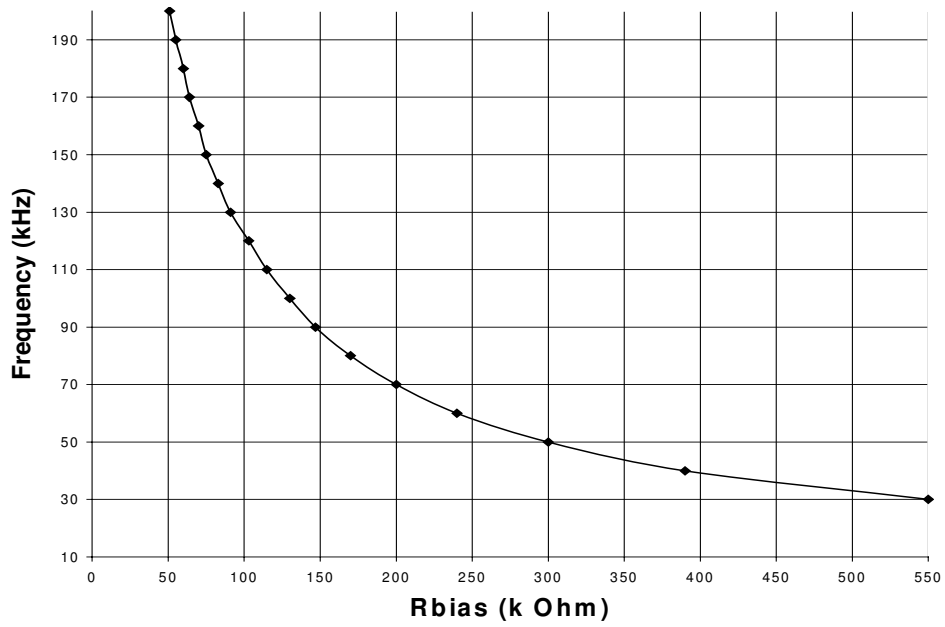
Figure 4: Frequency vs Rbias
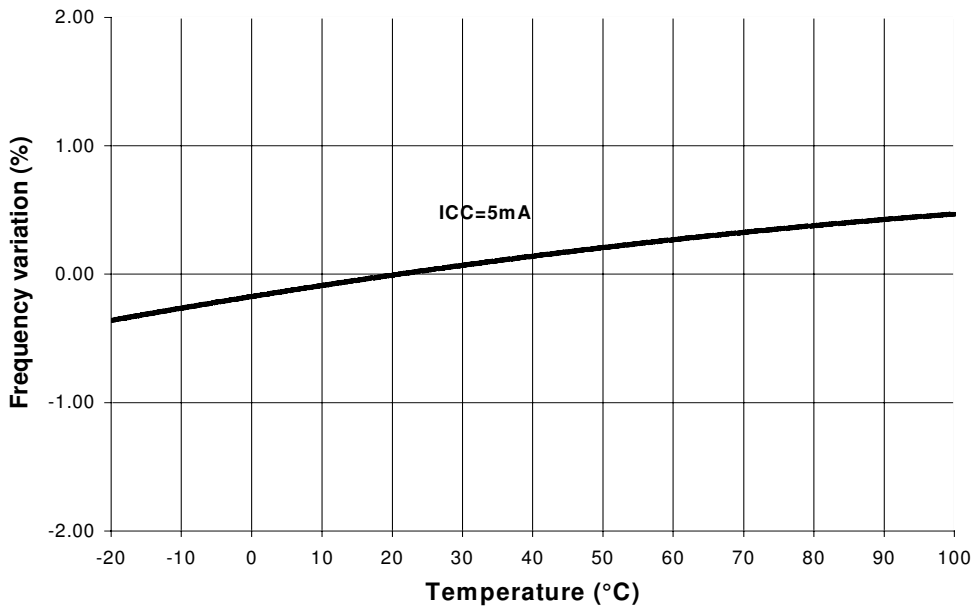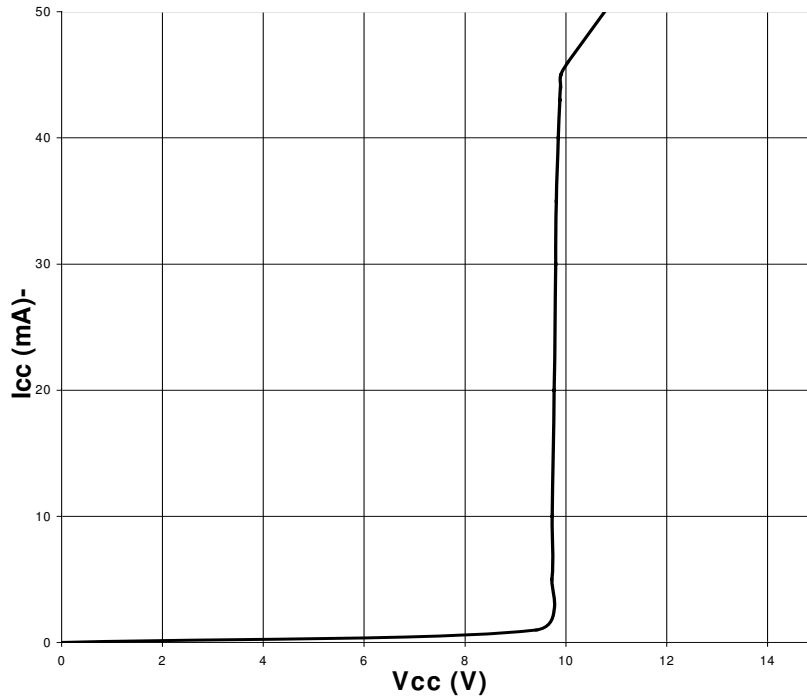

Figure 5 Frequency drift vs temperature

Figure 6: Shunt regulator V/I characteristics*

* Note: Do not attempt to force more than 1mA into Vcc pin during start-up.

GOOD DESIGN PRACTICES

IPS15H and loop stability:

The IPS15H is intrinsically very fast and doesn't participate to the loop stability. It only involves a comparator that doesn't bring any gain and exhibits a negligible phase shift.

It has been designed on purpose to allow its utilization in a large range of applications:

(a) Operating at frequencies up to 200 kHz and even above,

(b) Involving very different types of loop stability from "cycle skipping" where the loop is not compensated at all, to good stability achieved through the utilization of a TL431 and finally superior transient response when using half of the IPS25 feedback controller.

The loop compensation is entirely achieved on the load side and the feedback is performed by an optocoupler which gain and dynamic response play an important role in the loop stability.

Precaution in selecting the optocoupler:

The optocoupler must be **using a Phototransistor** and **NOT** a Photodarlington. Most optocouplers of this type are offered in a wide range of coupling efficiency, also called transfer ratio. Even the cheapest ones have a guaranteed transfer ratio of the order of 100% meaning that 1mA of current in the IR LED creates approximately 1mA of current in the receiving phototransistor. The user should be able to design the loop to be stable even though the actual transfer ratio differs by more than a factor of 3 (example from 100% to 300% or 50% to 150%).

Unfortunately optocouplers were not designed for low-current applications and this results in very bad speed and saturation characteristics for the phototransistor which could become incredibly slow and create severe loop stability problems should it be allowed to saturate hard in the application (the optocoupler could cause the IPS15H to skip cycles due to the long time required by the opto transistor to go out of saturation).

In the example of figure 1, the output voltage is 10 volts as defined by R15 and R16 and 2.5V at the Pin #1 of the TL431. The cathode of the TL431 can go to a voltage as low as 2 Volts. The IR LED requires approximately 1 Volt which means that the voltage drop across R14 could be up to 6 volts resulting in a maximum current of 700uA. This value is plentiful for the utilization of a broad range of optocouplers and yet small enough to avoid hard saturation.

Loop stability with the TL431:

The TL431 has an enormous DC gain and will not ensure stability unless specific loop-compensation components such as a RC network are added as indicated below.

The RC network should have a cut-off frequency at 100Hz to roll-off the gain at low frequencies but **reach a plateau around 100Hz** and have enough AC gain at twice the line frequency and achieve a good line ripple rejection.

This is achieved by the loop compensation network **C7, R17** of figure1. The gain rolls off until the impedance of C7 reaches the value of R7. At much higher frequencies, the gain continue to roll-off due to the natural frequency response of the TL431.

The goal is to reach a very low gain at the switching frequency.

If the addition of C7 & R17 with values as shown results in gain is too low, the values of R15 & R16 should be reduced in proportion to lower the impedance at Pin #1 of TL 431. Alternately, if the gain is too high the values of R17 should be reduced and C7 re-adjusted accordingly to maintain the required cut-off frequency.

Criteria to calculate the network :

1) R17 must be much higher than the input resistance of TL431 constituted by R16//R15=5K → 68Kohm OK.

2) F=100Hz=1/(2 x 3.14 x R17 x C7) gives approximately 22,000 pF for C7.

Discontinuous operation:

Check discontinuous mode of operation of the transformer (see application note AN-IPS02 page 2 for details) to ensure that the Flyback SMPS is indeed operating in discontinuous mode in the entire range of Input Voltages and Output Current. The response of the SMPS drastically changes in continuous mode, it gets considerably slower which requires a totally different loop compensation technique. Remember that it is very difficult to ensure loop stability with a simple schematic when the SMPS is allowed to transition between Discontinuous and Continuous modes.

MOSFET driver protection:

The MOSFET driver has been sized to be capable of driving power MOSFETs featuring a total gate charge up to 100nC.

The MOSFET should be turned-on relatively slowly and turned-off much faster. These 2 parameters can be independently adjusted through the external resistors R10 (pin1) and R10A (pin8).

The minimum value of these resistors should be 50Ω in order to reduce EMI and minimize the noise injection which could result from Miller-capacitance kick-back during transient conditions.

See application note AN-IPS-02 for EMI reduction techniques.

ADDITIONAL RECOMMENDATIONS:

For best results in low power off-line SMPSs with the **IPS15H**, the following MOSFET features are recommended:
- Low gate charge (max 50 nC).
- 400 V breakdown voltage for domestic use (USA / Japan).
- 600V breakdown voltage for European use (800V when transformer leakage inductance is very small).
- 1, 2 or 3A depending on the maximum output power.

Examples of suitable MOSFETS:
- **IXYS PolarHT™ and Polar HV™** MOSFET series: IXTY1R4N60P, IXTY2N60P, IXTY3N60P
- **Fairchild** MOSFET series: FQPF1N60, FQPF 2N60, FQPF 3N60.
- **Infineon COOLMOS^{TM}** series: SPD01N60S5, SPD02N60S5, SPD03N60S5.
- **Motorola** MOSFET series: MTP1N60, MTP2N60, MTP3N60.
- **SGS-Thomson** MOSFET series: STD1NB60, STD2NB60, STD3NB60.
- **Etc…**

Notes:
- Due to the rapid evolution of MOSFET technologies, please check for current models when designing a new SMPS.
- **PolarHT™ and Polar HV™** are trademarks of IXYS corporation
- **COOLMOS^{TM}** is a trademark of Infineon.
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TRANSFORMER CHARACTERISTICS:

(a) Transformer design:
E-core with suitable gap to prevent saturation or distributed-gap toroid. Primary inductance of 1.5 mH is very typical in 5 -10W applications with 5V output DC:
Turn ratio = 9 for 220V input or universal 85V – 265V.
Turn ratio = 7 for 100-120V AC input (Japan and USA)

(b) Transformer phasing:
Check the phase indicated in figure 1. Also refer to applications notes AN-IPS-01 and AN-IPS-02.

SNUBBER NETWORK:

With reference to figure 1, R2 + R2A provide the start-up current for the chip. C3 is being charged through R2+R2A. Once the chip supply voltage is high enough, the gate drive starts and the chip is then powered by the modified snubber network presently being patented by our company.
The snubber values may have to be optimized for different specific operating conditions:
- R3 could be reduced to 100 ohms and sometimes eliminated.
- C4 could be increased to 200pF and sometimes more.
Depending on the characteristics of the transformer, essentially leakage inductance and distributed capacitance, the snubber network shown in figure 1, may not be efficient enough to reduce the voltage spikes when operating at 20W or above. Please refer to applications notes AN-IPS-01 and AN-IPS-02 design tips or EMI reduction techniques, or feel free to contact our technical support for assistance.

POWER SHUT-DOWN SOLUTIONS for STAND-BY REQUIREMENTS:

For low-power stand-by requirements, the primary circuitry can be shut-down by pulling the IPS15H VCC pin "LOW" through a 100Ω resistor.

This can be easily done using a:

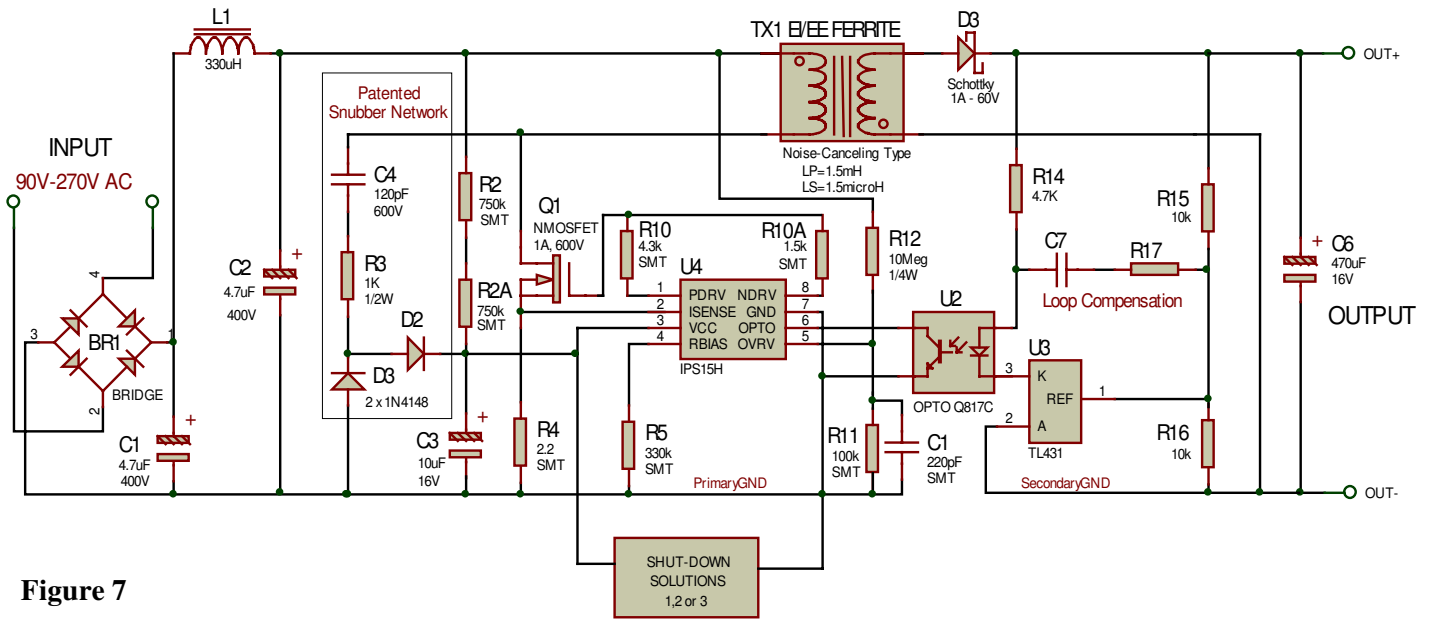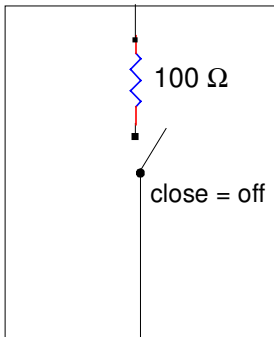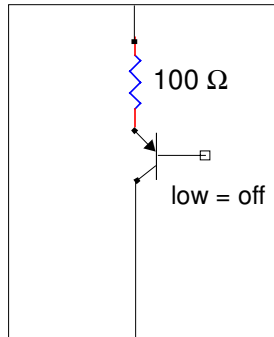• Simple switch
• PNP transistor
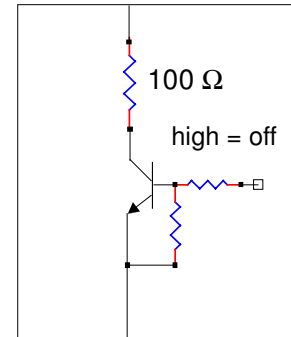• NPN transistor

Figure 7

Solution 1:
simple switch, close = off
100Ω resistor
mandatory

Solution 2:
PNP transistor, low = off
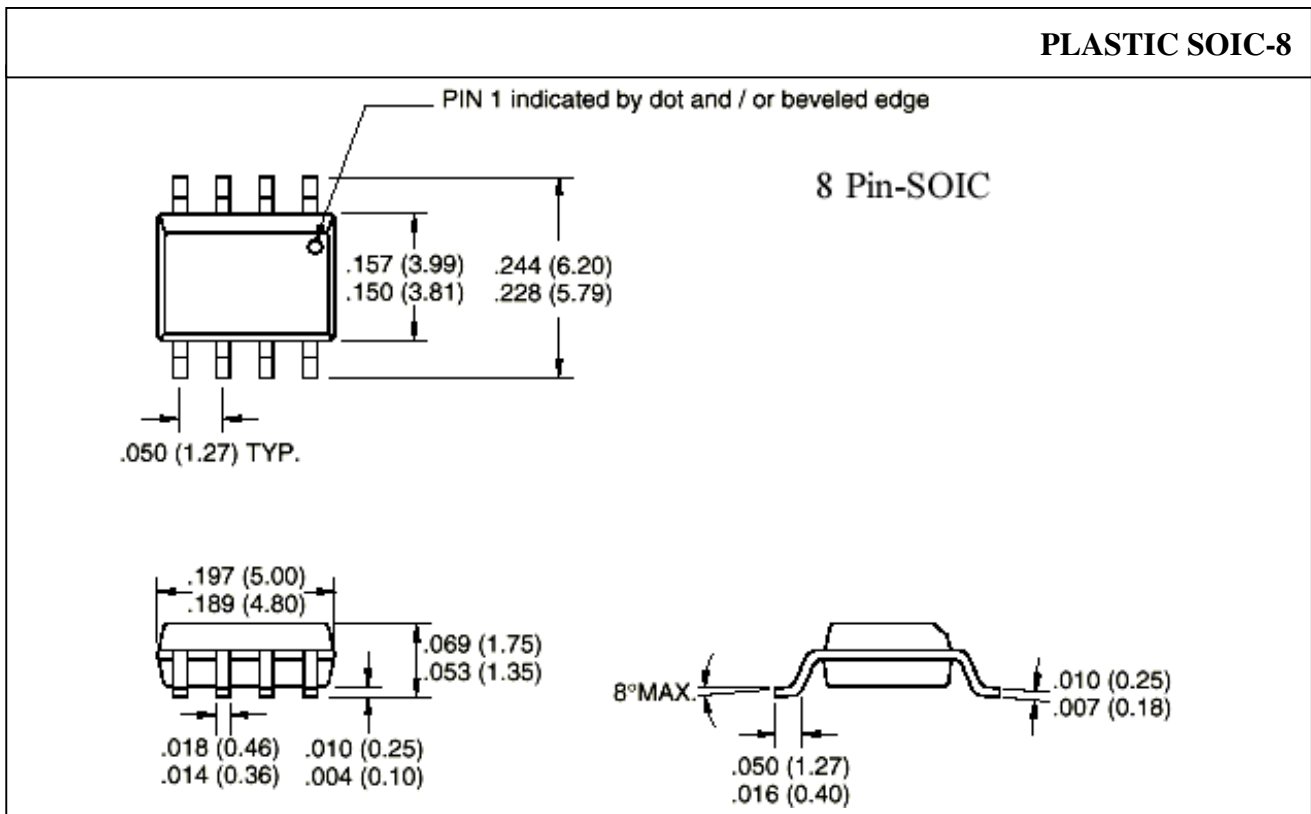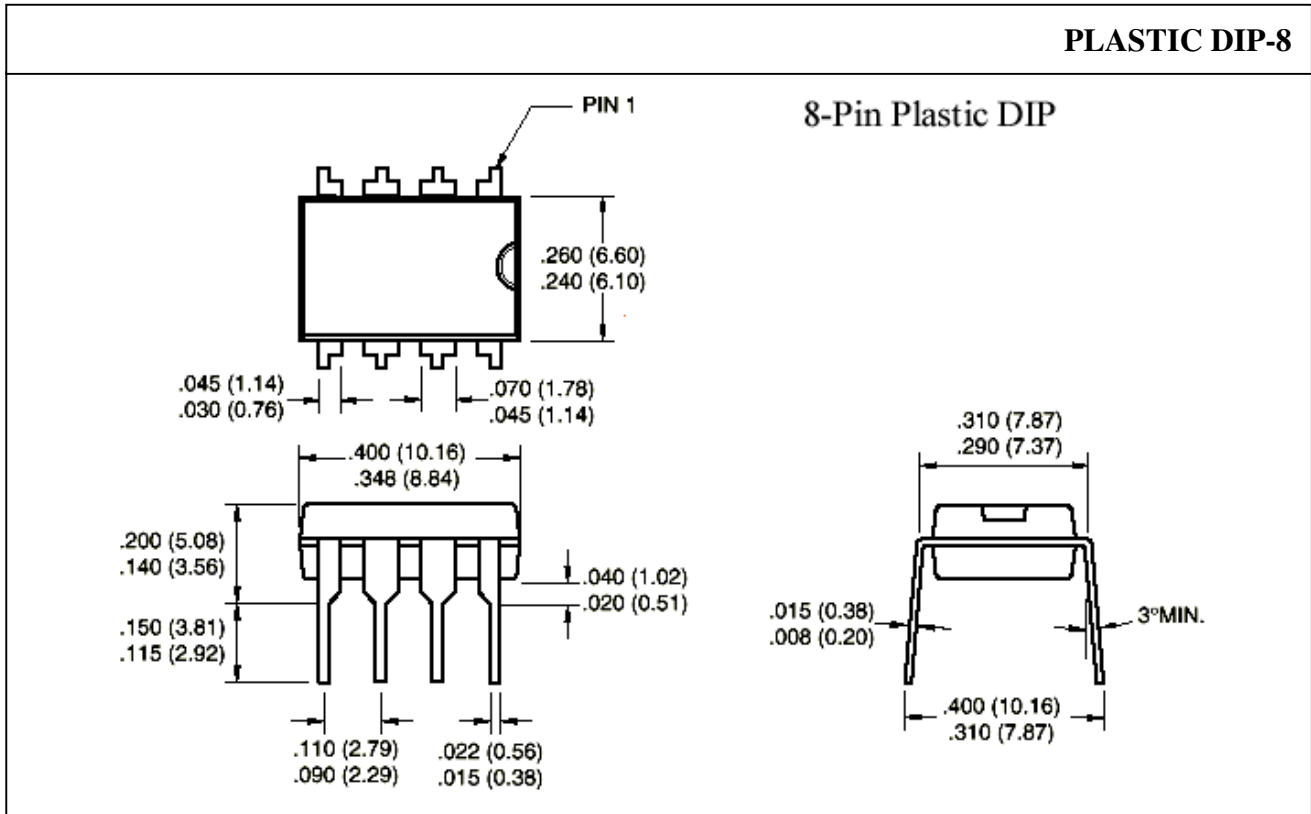(low = less than 4V)
100Ω resistor
optional

Solution 3:
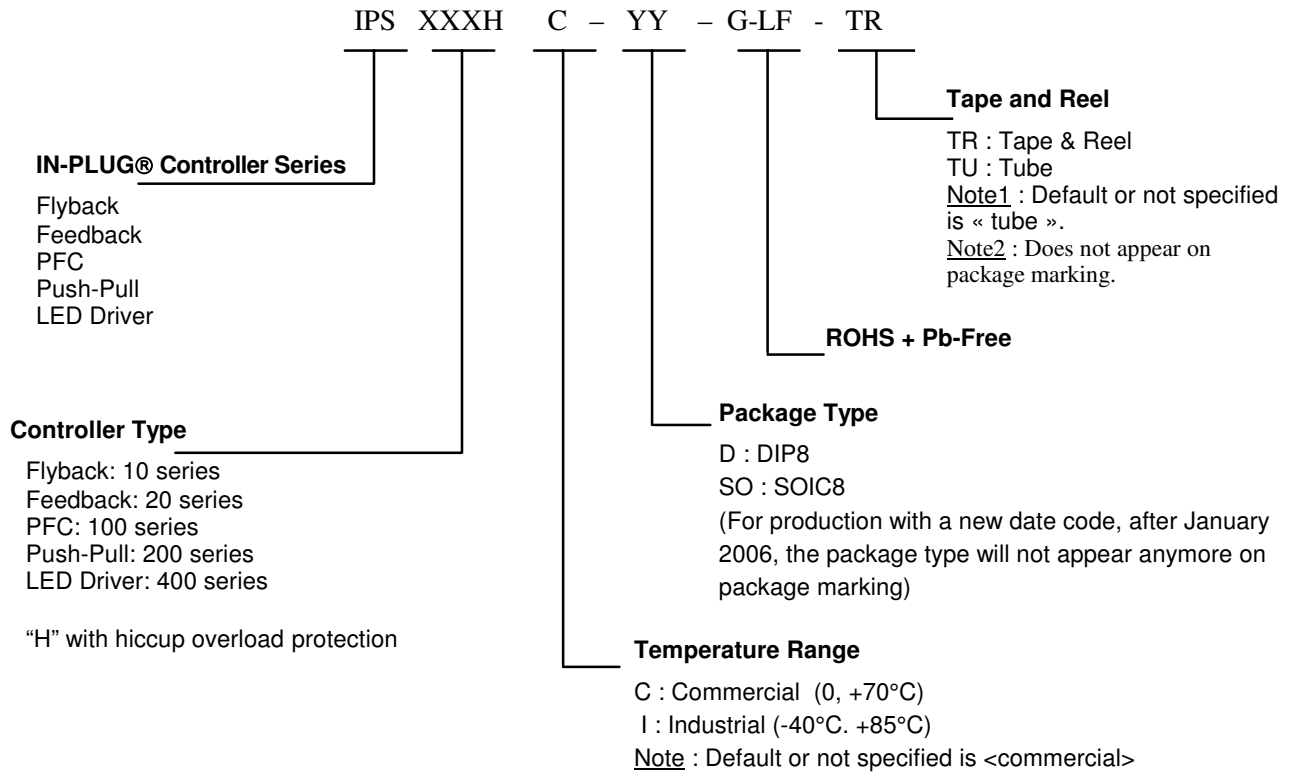NPN transistor, high = off
100Ω resistor
optional

When the "LOW" state is released, the VCC is naturally re-established, re-activating the IPS15H.
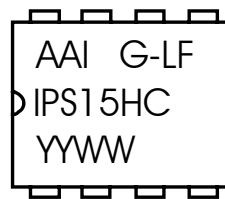
PACKAGE DIMENSIONS

PLASTIC DIP-8

8-Pin Plastic DIP

PLASTIC SOIC-8

8 Pin-SOIC

ORDERING INFORMATION

Part-Number

IPS XXXH   C – YY – G-LF - TR

Tape and Reel

TR : Tape & Reel
TU : Tube
Note1 : Default or not specified is « tube ».
Note2 : Does not appear on package marking.

ROHS + Pb-Free

IN-PLUG® Controller Series

Flyback
Feedback
PFC
Push-Pull
LED Driver

Package Type

D : DIP8
SO : SOIC8
(For production with a new date code, after January 2006, the package type will not appear anymore on package marking)

Controller Type

Flyback: 10 series
Feedback: 20 series
PFC: 100 series
Push-Pull: 200 series
LED Driver: 400 series

"H" with hiccup overload protection

Temperature Range

C : Commercial (0, +70°C)
 I : Industrial (-40°C. +85°C)
Note : Default or not specified is <commercial>

Example of Marking

```
AAI
⊃IPS15HC
YYWW
```

Non-Green Package

```
AAI  G-LF
⊃IPS15HC
YYWW
```

Green ROHS + Pb-Free Package

(Note : For production with a new date code, since January 2006, the package type does not appear anymore on package marking)

This ordering information is for commercial and industrial standard IN-PLUG® controllers ONLY. For custom controllers or for automotive and military temperature ranges, call AAI's sales representative.

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