

## DESCRIPTION

The PT5634A is a Power Factor Correction control IC for electronic ballast and switching mode power supply application. With a wide bandwidth error amplifier and a wide linear operating range multiplier, the PT5634A is available to operate in Critical Conduction Mode and implement a high PF and excellent THD in wide input voltage application. Furthermore, PT5634A provides a low start-up current and operating current, a precise over-voltage protection and the disable function.

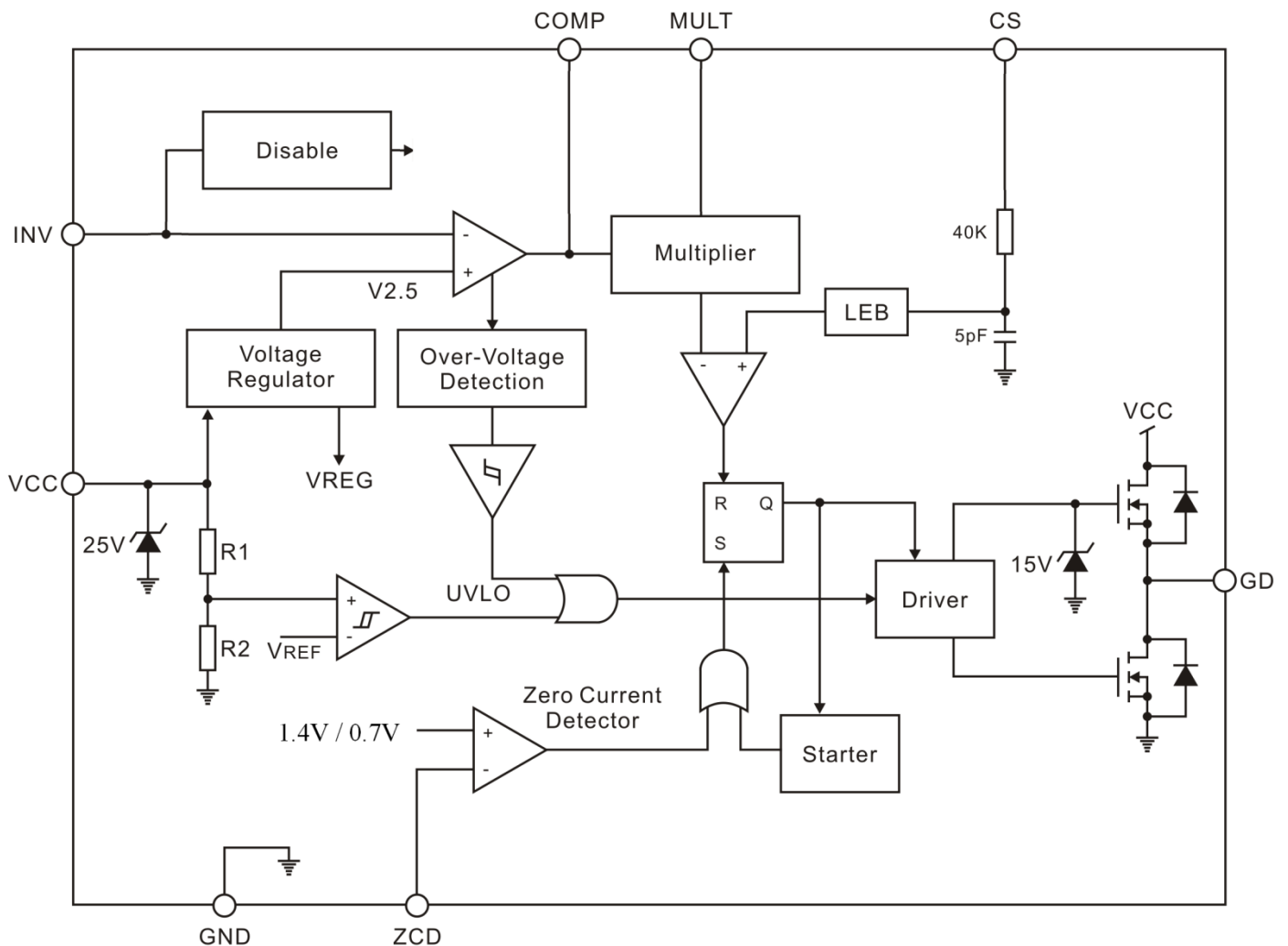
## FEATURES

- Critical Conduction Mode (CRM) control
- Very low start-up current (30 $\mu$ A)
- Precise reference voltage ( $\pm 1\%$ )
- Precise adjustable output over-voltage protection
- Restart timer
- Leading edge blocking time
- Disable function

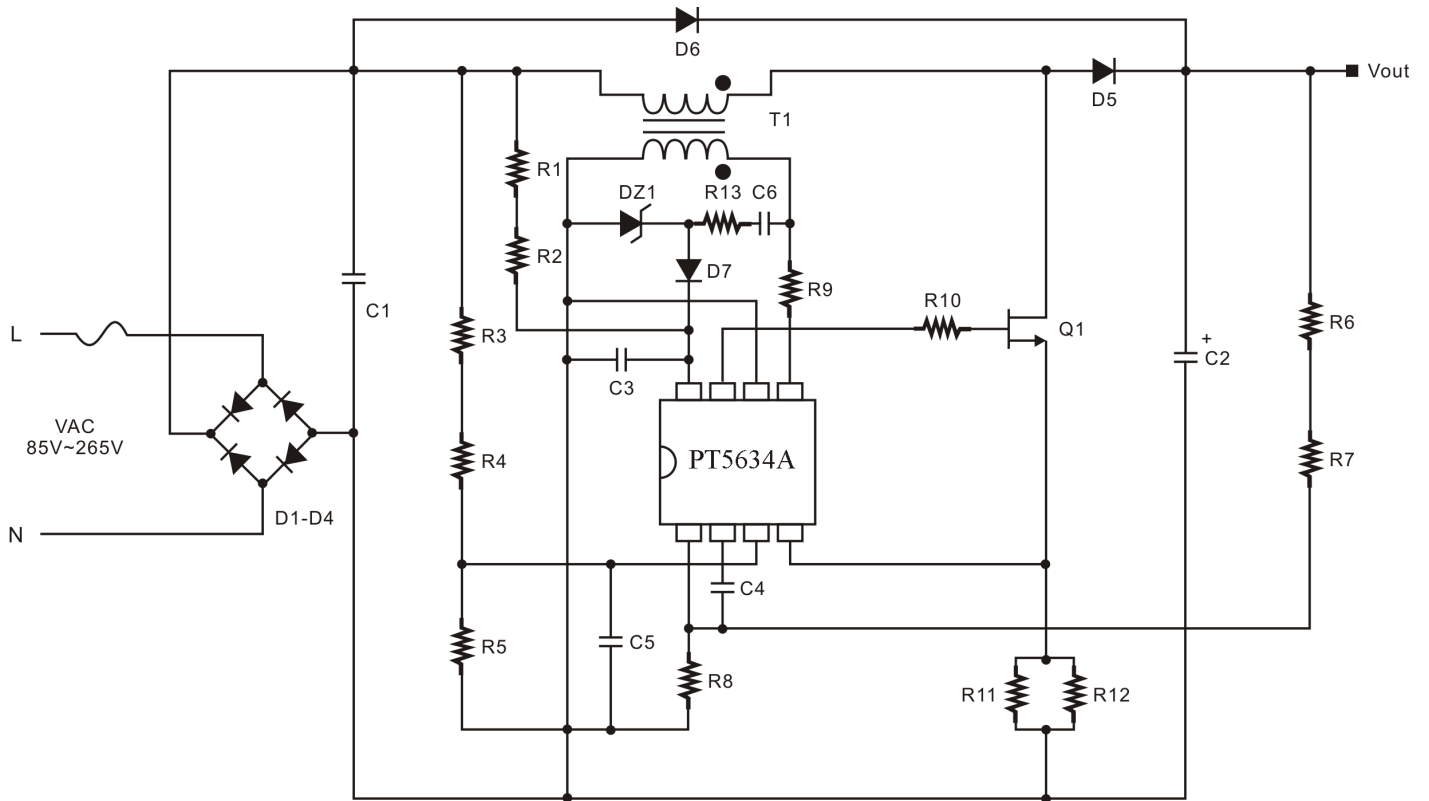
## APPLICATIONS

- Electronic ballast
- AC-DC adaptor and switching mode power supply

## BLOCK DIAGRAM



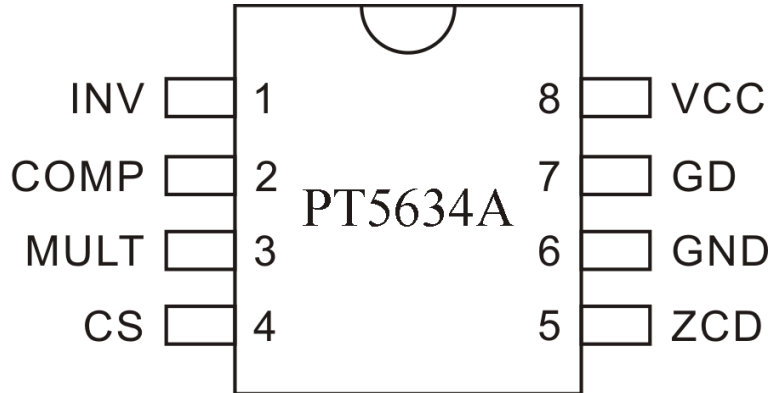
# TYPICAL APPLICATION



## ORDER INFORMATION

Valid Part Number	Package Type	Top Code
PT5634A-S	8 Pins, SOP, 150mil	PT5634A-S

## PIN CONFIGURATION



## PIN DESCRIPTION

Pin Name	Description	Pin No.
INV	Error amplifier inverting input	1
COMP	Error amplifier compensation	2
MULT	Multiplier input	3
CS	Current sense	4
ZCD	Zero current detection	5
GND	System ground	6
GD	Gate driver output	7
VCC	IC power supply	8

## **FUNCTION DESCRIPTION**

### ***UNDER VOLTAGE LOCK OUT AND VOLTAGE CLAMP***

The turn-on threshold of Under-Voltage Lock-Out (UVLO) circuit is 12.5V, and the turn-off threshold is 10V. In UVLO mode, PT5634A is locked and the start-up current is very low (30 $\mu$ A, typ.).

A VCC voltage clamp is added to prevent the device from destroy by over-voltage. When the voltage of VCC reaches the clamp threshold, there is an internal additional current to clamp the VCC voltage.

### ***ERROR AMPLIFIER***

The non-inverting input of error amplifier (EA) is connected to the internal reference 2.5V, and the inverting input INV is connected to the external resistor divider. In typical application, with an external capacitor between INV pin and COMP pin (the output of EA), the EA acts an integrator which detects the PFC output and provides a negative feedback. Generally, the bandwidth of the integrator is designed below 20Hz in order to suppress the 100Hz rippers of PFC output.

Additionally, the disable function is built in. When the INV voltage is pulled down below 0.2V, PT5634A will enter disable mode and shut down the driver output GD.

### ***OVER-VOLTAGE REGULATOR AND OVER-VOLTAGE PROTECTION***

The response speed of the low bandwidth integrator is slow and the PFC output could not be stabilized in the conditions of the input line voltage increasing or the load decreasing abruptly. PT5634A provides an over-voltage regulator and an over-voltage protection to limit the PFC output.

The over-voltage regulator and the over-voltage protection are implemented by detecting the sink current of COMP. During stable operation, there is not current flowing in the external capacitor (C4) between INV and COMP. However, When the PFC output increases abruptly, the current in R6 and R7 increases, but the INV voltage is stuck in 2.5V and the current in R8 does not change. The increment current in R6 and R7 flows through the capacitor C4 and flows into COMP. When the current flowing into COMP reaches to 24 $\mu$ A, the over-voltage regulator is triggered and decreases the multiplier output rapidly, and then the turn-on time of Power MOSFET decreases and the energy from input line to PFC output decreases. When the current flowing into COMP reaches to 27 $\mu$ A, the over-voltage protection is triggered and shut down the driver output GD. The over-voltage protection has a 20 $\mu$ A hysteresis. In application, the over-voltage increment of PFC output is set by adjusting the value of R6 and R7.

There is a static OVP in COMP which threshold is 2.2V. If the over-voltage protection is triggered, PT5634A will be un-locked in the conditions that the COMP sinking current is below 7 $\mu$ A and the COMP voltage is higher than 2.2V.

### ***MULTIPLIER***

The multiplier has two inputs: COMP pin and MULT pin. The MULT pin detects the rectifier line voltage through an external resistor divider. In stable operation, because the COMP voltage is a constant in an AC cycle, the multiplier output is proportional to the MULT voltage, as well as the rectifier line voltage. The multiplier, with a wide linear operating range, has a good linearity in 85V~265V AC input voltage range.

The multiplier output is internally clamped to 1.08V in order to limit the PFC current and protect the Power MOSFET.

### ***CURRENT SENSE***

PT5634A connects CS pin to a sense resistor which is connected between the source of Power MOSFET and ground. An internal comparator, connecting to the multiplier output as a reference, detects the CS voltage which is proportional to PFC current. Via detecting the PFC current cycle by cycle, the PFC current is proportional to the multiplier output, as well as the rectifier line voltage. The PFC current is proportional to the input line current too. So, the input line current follows the input line voltage and the PF is nearly 1.

There is a turn-on spike in CS pin when the Power MOSFET is switched on, which will disturb the PFC current detection. PT5634A inserts a Leading Edge Blank time at the rise edge of GD. The LEB circuit, instead of the conventional RC filter, can minimize the propagation delay.

## ***ZERO CURRENT DETECTION***

In CRM control, it needs to sense the PFC inductor current. When the PFC current decreases to zero, the zero current detection circuit outputs the set signal to the driver output GD and starts a switch cycle. In application circuit, if the energy stored in the inductor releases fully, the drain voltage of the power MOSFET and the ZCD voltage begin to decrease. As soon as the ZCD voltage decreases below the threshold 0.7V, the GD is set to “high” and starts a new cycle. The zero current switch of the MOSFET reduces the power dissipation and the switching noise.

## ABSOLUTE MAXIMUM RATINGS

Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. All voltage parameters are absolute voltages referenced to GND.

Parameter	Symbol	Min.	Max.	Unit
Power supply <sup>(see Note)</sup>	VCC	-	25	V
INV input voltage	V <sub>INV</sub>	-0.3	7.0	V
COMP input voltage	V <sub>COMP</sub>	-0.3	7.0	V
MULT input voltage	V <sub>MULT</sub>	-0.3	7.0	V
CS input voltage	V <sub>CS</sub>	-0.3	7.0	V
ZCD input voltage	V <sub>ZCD</sub>	-0.3	7.5	V
ZCD output current	I <sub>ZCD</sub>	-3	3	mA
GD maximum output voltage	V <sub>GD</sub>	-0.3	VCC+0.3	V
GD maximum output current	I <sub>OMAX</sub>	-400	400	mA
Operating temperature	T <sub>opr</sub>	-40	+125	°C
Junction temperature operating range	T <sub>j</sub>	-	+125	
Storage temperature	T <sub>stg</sub>	-40	+150	°C

Note: A clamp circuit is integrated. When the VCC voltage exceeds 25V, the clamp circuit pulls down a large current; if the current stands a long time, the device may damage.

## RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min.	Typ.	Max.	Unit
IC power supply	VCC	V <sub>CCUV+</sub>	14	22	V
MULT input voltage	V <sub>MULT</sub>	0	-	3.5	V
ZCD current	I <sub>ZCD</sub>	-2	-	2	mA

# ELECTRICAL CHARACTERISTICS

VCC=14V, TA=25°C.

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
<b>Supply Characteristics</b>						
VCC supply under voltage positive voltage threshold	V <sub>CCUV+</sub>		11.5	12.5	13.5	V
VCC supply under voltage negative voltage threshold	V <sub>CCUV-</sub>		9	10	11	
VCC supply under voltage lockout hysteresis	V <sub>UVHYS</sub>		-	2.5	-	
VCC UVLO mode quiescent current	I <sub>QCCUV</sub>	VCC=V <sub>CCUV+</sub> -0.2V	-	30	70	μA
In OVP VCC quiescent current	I <sub>QCCOVP</sub>	OVP	-	0.9	1.2	mA
In disable mode VCC quiescent current	I <sub>QCCSD</sub>	V <sub>ZCD</sub> <0.2V	-	0.9	1.2	
VCC operation current (fPFC=50K)	I <sub>CCOP</sub>	GD: 1nF+10R	-	-	6	
VCC clamp voltage	V <sub>CCCLAMP</sub>	I <sub>CC</sub> =10mA	22	25	28	V
<b>Error Amplifier Characteristics</b>						
Reference voltage in pin INV	V <sub>INV</sub>		2.475	2.5	2.525	V
Voltage gain	G <sub>V</sub>		-	80	-	dB
Bandwidth	G <sub>B</sub>		-	1	-	MHz
COMP maximum output voltage	V <sub>COMP_HIGH</sub>	V <sub>INV</sub> =2.4V	5	5.5	6	V
COMP minimum output voltage	V <sub>COMP_LOW</sub>	V <sub>INV</sub> =2.6V	2.1	2.25	2.4	
COMP maximum sink current	I <sub>COMP_SINK</sub>	V <sub>INV</sub> =2.6V, V <sub>COMP</sub> =4V	2.0	3.5	-	mA
COMP maximum source current	I <sub>COMP_SOURCE</sub>	V <sub>INV</sub> =2.4V, V <sub>COMP</sub> =4V	-2.0	-3.0	-	
INV Disable threshold	V <sub>INV_DIS</sub>		0.1	0.2	0.3	
INV Restart threshold	V <sub>INV_EN</sub>		0.3	0.45	0.55	
<b>Multiplier Characteristics</b>						
MULT input voltage range	V <sub>MULT</sub>		0~2.5	-	-	V
Factor of multiplier	K	V <sub>MULT</sub> =1V, V <sub>COMP</sub> =4V	0.32	0.38	0.44	1/V
<b>OVP Characteristics</b>						
OVP threshold	I <sub>OVP</sub>		23.5	27	30.5	μA
OVP current hysteresis	I <sub>HYS</sub>		-	20	-	
Static OVP voltage threshold in COMP	V <sub>S_OVP</sub>		2.1	2.25	2.4	V
<b>Zero Current Detection Characteristics</b>						
ZCD positive voltage threshold	V <sub>ZCD</sub>		-	1.4	-	V
ZCD voltage threshold hysteresis	V <sub>ZCD_HYS</sub>		-	0.7	-	
ZCD upper clamp voltage	V <sub>ZCD_HIGH</sub>	I <sub>ZCD</sub> =2.5mA	-	6.5	7.0	
ZCD lower clamp voltage	V <sub>ZCD_LOW</sub>	I <sub>ZCD</sub> =-0.5mA	-0.3	0	0.3	mA
ZCD sink current	I <sub>ZCD_SINK</sub>		2.5	-	-	
ZCD source current	I <sub>ZCD_SOURCE</sub>		-1.5	-	-	
Maximum delay from ZCD to GD	T <sub>DEAD</sub>		100	-	400	ns
Restart timer	T <sub>RESTART</sub>		75	190	300	μs
<b>Current Sense Characteristics</b>						
threshold voltage for current sense	V <sub>CS</sub>		0.98	1.08	1.18	V
Propagation delay	T <sub>PKD</sub>		-	100	200	ns
Leading-edge blanking time	T <sub>LEB</sub>		-	200	400	
<b>Driver (GD) Characteristics</b>						
Turn-on rise time	t <sub>r</sub>	GD: 1nF+10R	-	50	100	ns
Turn-off fall time	t <sub>f</sub>	GD: 1nF+10R	-	30	70	
GD clamp voltage	V <sub>gd_clamp</sub>	VCC=20V	11	13.5	16	V
GD voltage in UVLO mode	V <sub>gd_s</sub>	I <sub>gd</sub> =10mA	-	-	1.1	

## PT5634A VS PT5634

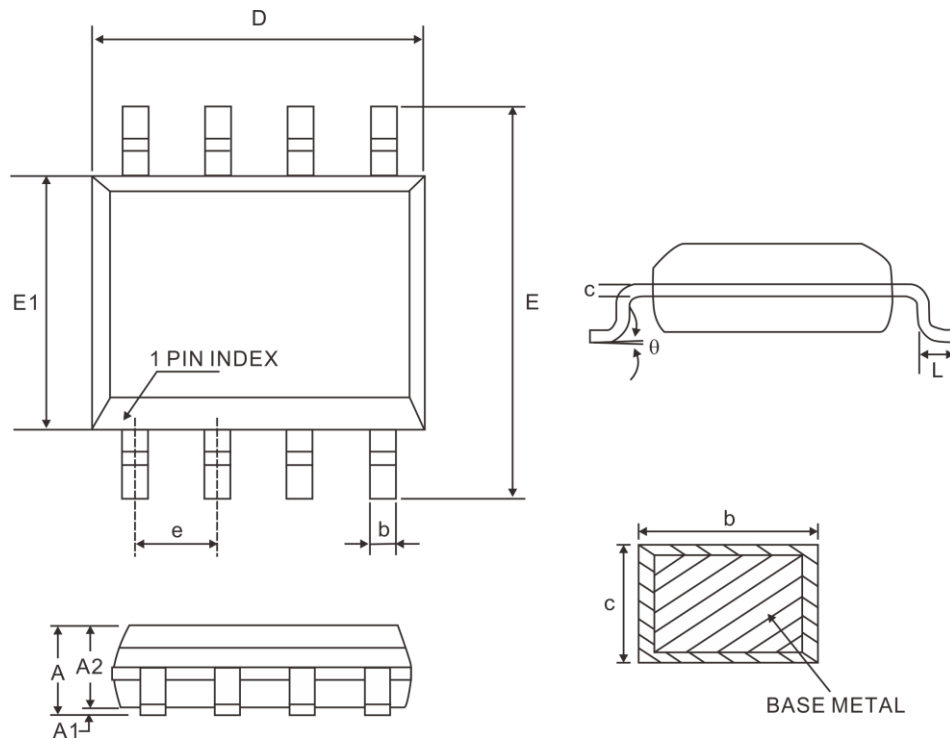
There are some differences between PT5634A and PT5634, even if they have the same pin-out. The Disable function has been relocated, and some parameters have been modified.

Parameter	PT5634	PT5634A
VCC supply under voltage positive/negative voltage threshold	12/9.3V	12.5/10V
Factor of multiplier	0.5	0.38
Threshold voltage for current sense	1.7V	1.08V
OVP threshold	40uA	27uA
ZCD positive/negative/ lower clamp voltage threshold	2.1/1.6/0.5V	1.4/0.7/0V
Enable threshold	0.3V (1)	0.45V (2)

- (1) Function located on pin 5 (ZCD)  
 (2) Function located on pin 1 (INV)

# PACKAGE INFORMATION

8 PINS, SOP, 150MIL



Symbol	Millimeter		
	Min.	Nom.	Max.
A	1.35	1.60	1.77
A1	0.08	0.15	0.28
A2	1.20	1.40	1.65
b	0.33	-	0.51
c	0.17	-	0.26
D	4.70	4.90	5.10
E	5.80	6.00	6.20
E1	3.70	3.90	4.10
e	1.27 BSC.		
L	0.38	0.60	1.27
θ	0°	-	8°

Note: All dimensions meet JEDEC Standard MS-012 AA do not include mold flash or protrusions.

## **IMPORTANT NOTICE**

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