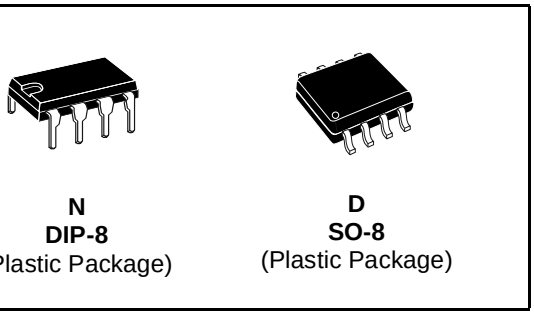
TSM007

Primary PWM Controller

- **Current-mode PWM Controller**
- **Internal Under Voltage Protection**
- **Programmable Under Voltage**
- **High-current Output Drive Suitable for Power Mosfet**
- **Programmable Soft Start**
- **2kV ESD Protection**



N
DIP-8
(Plastic Package)

D
SO-8
(Plastic Package)

DESCRIPTION

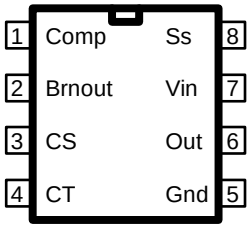
The TSM007 integrated circuit incorporates all circuitry to implement off line or DC-DC power supply applications using a fixed frequency current mode control.

Based on a standard current mode PWM controller, this device includes additional features for higher integration.

APPLICATION

- **PC SMPS**

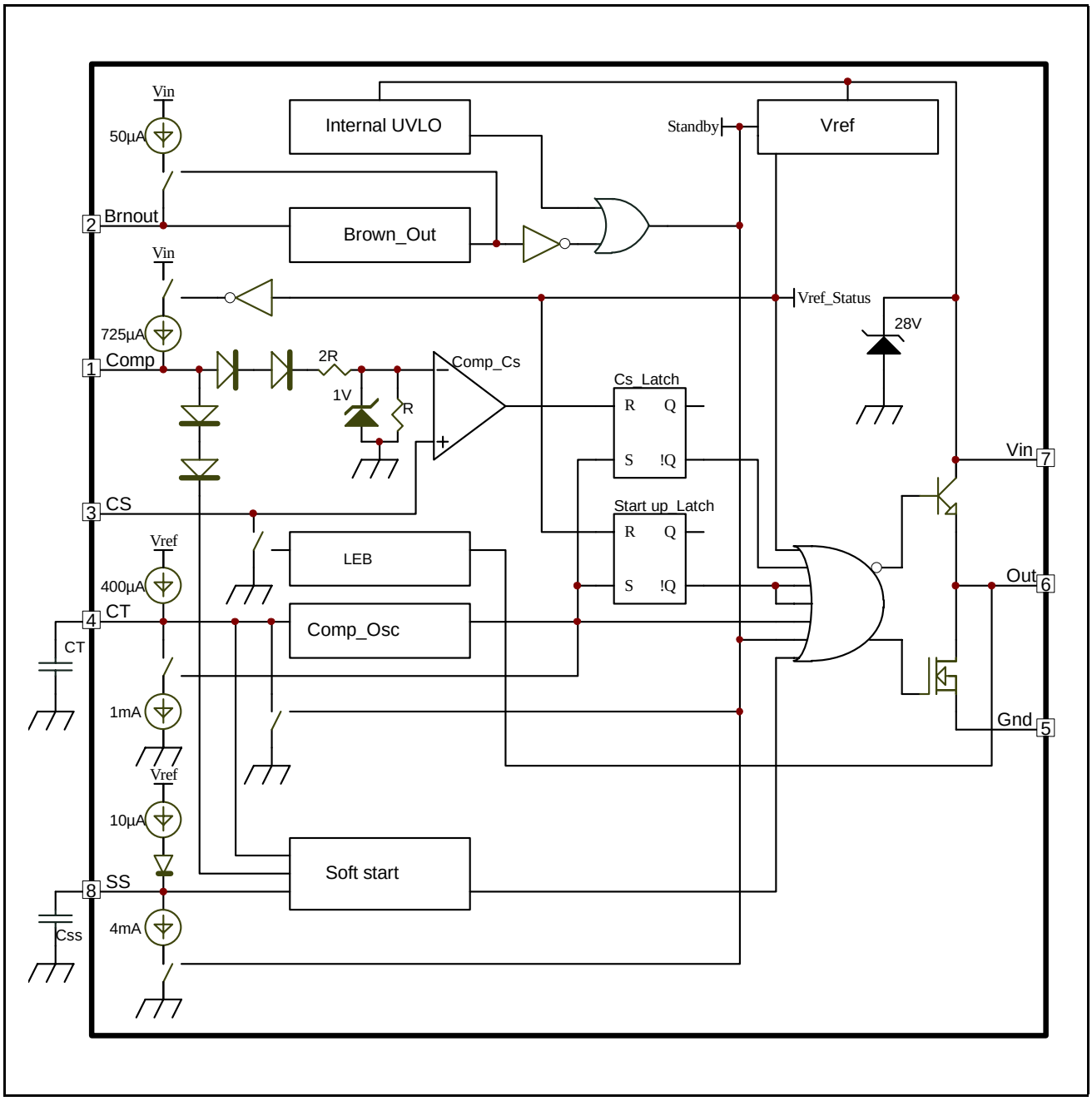
PIN CONNECTIONS (top view)



ORDER CODE

Part Number	Temperature Range	Package	Packaging
TSM007IN	0, +95°C	DIP	Tube
TSM007ID		SO	Tube
TSM007IDT		SO	Tape & Reel

1 Block Diagram



PIN DESCRIPTION

Name	Pin	Type	Function
COMP	1	Analog input	Current comparator for current mode control.
BRNOUT	2	Analog input	Undervoltage.
CS	3	Analog input	Current sense.
CT	4	Timing capacitor	Sets the oscillator frequency.
GND	5	Power supply	Signal ground.
OUT	6	Analog output	Totem pole output to direct drive a power MOSFET.
VIN	7	Power supply	Supply input voltage.
SS	8	Timing capacitor	Soft start.

2 Absolute Maximum Ratings

Symbol	DC Supply Voltage	Value	Unit
Vin	DC Supply Voltage [1]	-0.3 to 25	V
Io	DC output current	0.1	A
Iopeak	Peak output current	1	A
Vcomp	COMP terminal voltage	-0.3 to 5.5	V
Isinkcomp	COMP terminal sink current	6	mA
VBrnout	Brown out terminal voltage	-0.3 to Vin	V
Vcs	CS terminal voltage	-0.3 to 6.3	V
Vct	CT terminal voltage	-0.3 to 5.0	V
Vout	OUT terminal voltage	-0.3 to Vin	V
Vss	SS terminal voltage	-0.3 to 6.4	V
Pt	Power dissipation at 25°C	500	mW
Tstg	Storage temperature	-40 to 150	°C
Tj	Junction temperature	150	°C
ESD	Electrostatic Discharge	2	kV

1) All voltage values, except differential voltage are with respect to network ground terminal (GND).

OPERATING CONDITIONS

Symbol	Parameter	Value	Unit
Vcc	DC Supply Conditions	12 to 25	V
Toper	Operating Free Air Temperature Range	0 to 95	°C

3 Electrical Characteristics

Tamb = 25°C, Vin=12V, Ct=1.5nF unless otherwise specified

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
Oscillator						
Fosc	Oscillating frequency		84	100	116	kHz
Foscmax	Maximum oscillating frequency		500			kHz
Δfosc1	Typical oscillating voltage stability	12V ≤ Vin ≤ 25V		±0.5	±2.0	%
Δfosc2	Typical oscillating temperature stability	0°C ≤ Ta ≤ 70°C		±10		%
Ici	Charge current	Vct=2V	336	400	464	µA
Icd	Discharge current	Vct=2V	504	600	696	µA
Vthct	Upper trip point			3.0		V
Vtlct	Lower trip point			1.4		V
ΔVct	Amplitude			1.6		V
Brown out						
Vbr	Threshold voltage		2.42	2.50	2.58	V
Ibr-on	Brown out terminal source current	Vbr=3V, 0°C≤T≤ 70°C	42	50	58	µA
Vbrin	Input voltage		-0.3		Vin	V
Comp						
Icomp	Source surrent	Vcomp=5V	0.5	0.725	0.950	µA
Current sense						
Avcs	Gain	0V ≤ Vcs ≤ 0.8V	2.85	3.00	3.15	
Vthcs	Maximum sensing voltage	Vcomp=5V	0.9	1.0	1.1	V
PSRR	Power supply voltage rejection ratio	12V ≤ Vin ≤ 25V		70		dB
Ibcs	Input bias current	Vcs=2V		0.5	10	µA
Leading edge blanking						
LEB	Delay to output	Vcs = 0 to 1 V Vcomp = 2 V		280		ns
Output						
VOL1	Output low voltage 1	Iosink=20mA		0.1	1.5	V
VOL2	Output low voltage 2	Iosink=200mA		0.8	2.2	V
VOH1	Output high voltage 1	Iosource=20mA	Vin-2.0	Vin-1.5		V
VOH2	Output high voltage 2	Iosource=200mA	Vin-3.0	Vin-1.7		V
tr	Rise time	CL=1nF, 10% to 90%		100	150	ns
tf	Fall time	CL=1nF, 90% to 10%		30	60	ns
VOL3	UVLO saturation	Vin=5V, Iosink=1mA		0.05	1.1	V
Dmax	Maximum duty cycle		54	60	66	%
Soft start						
Iiss	Source current	Vss=2V	8	10	12	µA
dIiss	Temperature stability	0°C ≤ Ta ≤ 70°C	7	10	13	µA
Idss	Sink current	Vss=2V, Vbr=2V	4			mA
VHss	Clamp voltage		4.2			V
VLss	Low voltage	Vbr=2V			0.2	V
Internal Under Voltage Lockout (UVLO)						
VH	UVLO top threshold		8.9	9.5	10.1	V
VL	UVLO bottom threshold		7.3	7.9	8.5	V
dVuvlo	UVLO hysteresis voltage	dVuvlo=VH-VL		1.6		V
Total current consumption						
Iin	Operating current	CL=3.3nF, Vin=12V		10	13	mA
Istby	Supply current in standby mode	Vbr ≤ 1V, Vin=12V		250	350	µA

4 Functional Description

TSM007: PWM Controller IC

Internal UVLO function

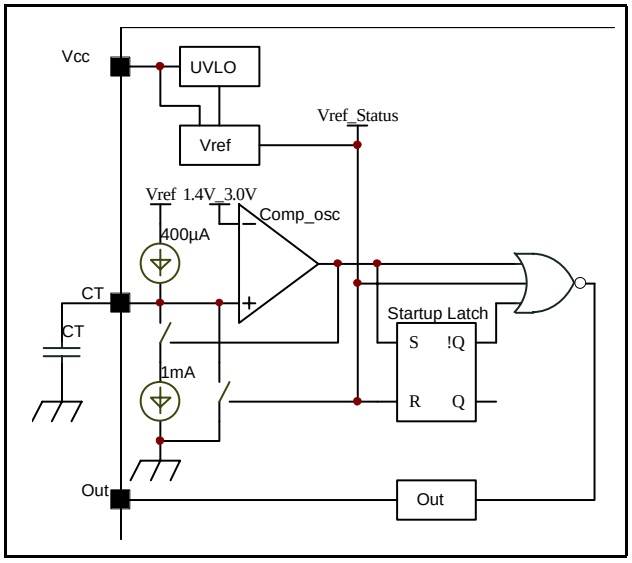
The Under Voltage Lock Out function disables the whole device when supply voltage is lower than the threshold.

Vref block

The Vref block provides an internal 5V reference voltage to the IC. An internal Vref status signal is active when Vref is lower than 4.7V and is used to drive the output driver low when Vref is not valid.

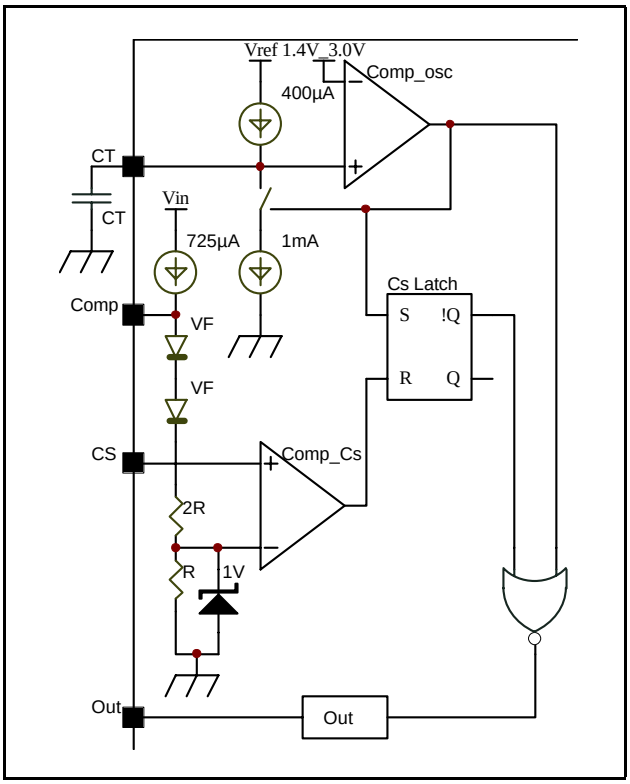
Startup latch

The startup latch is set when the IC exits from standby mode or UVLO state. It is reset when the CT capacitor is discharged for the first time.



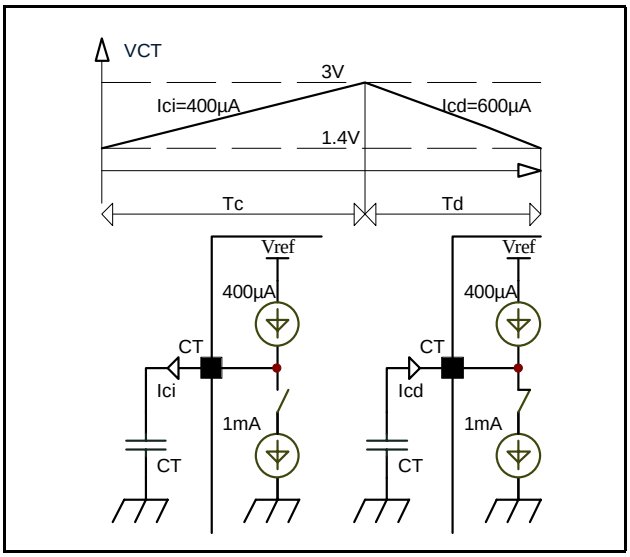
Current sense input

A voltage proportional to the transformer primary winding current is applied to the CS pin. The control IC uses this information to perform current mode control. The PWM function will be stopped if the CS pin voltage is greater than 1.0V.



Oscillator

A capacitor from the CT pin to GND sets the oscillating frequency.



T = Tc+Td

T = CTΔVct/Ici + CTΔVct/Icd

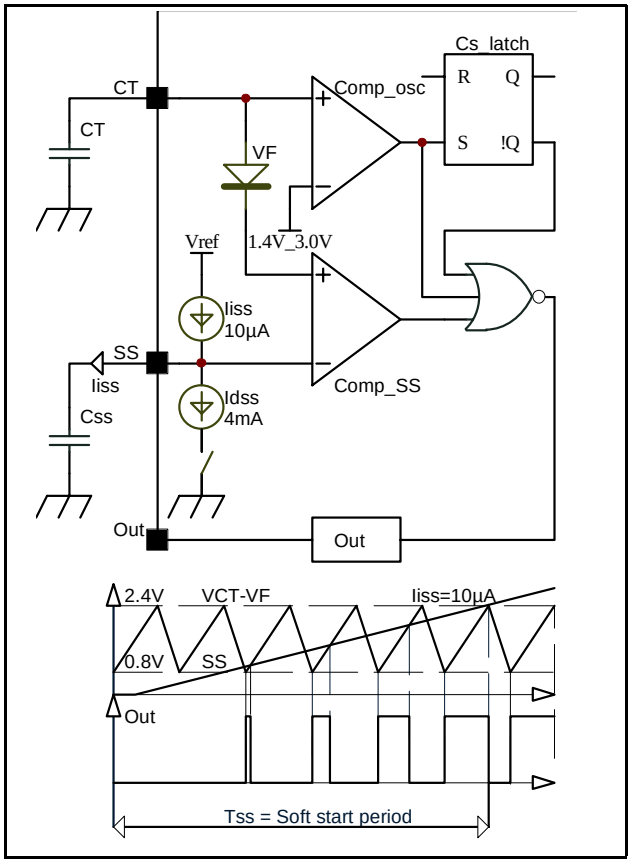
Let's assume F = 1/T =100KHz

==> CT = (IcixIcd) / (FxΔVct(Ici+Icd))

==> CT = 1.5nF

Soft start

A capacitor from the SS pin to GND provides the soft start function. The capacitor starts to charge when VIN reaches the UVLO threshold and Vref is good.The soft start block enables the IC to start with a progessive PWM duty cycle. The soft start period is set by the external capacitor Css. The soft start comparator drives the output driver low when the SS pin voltage is greater than the CT pin voltage minus one VF voltage..



Tss = Cssx(Vthct-VF)/Iiss

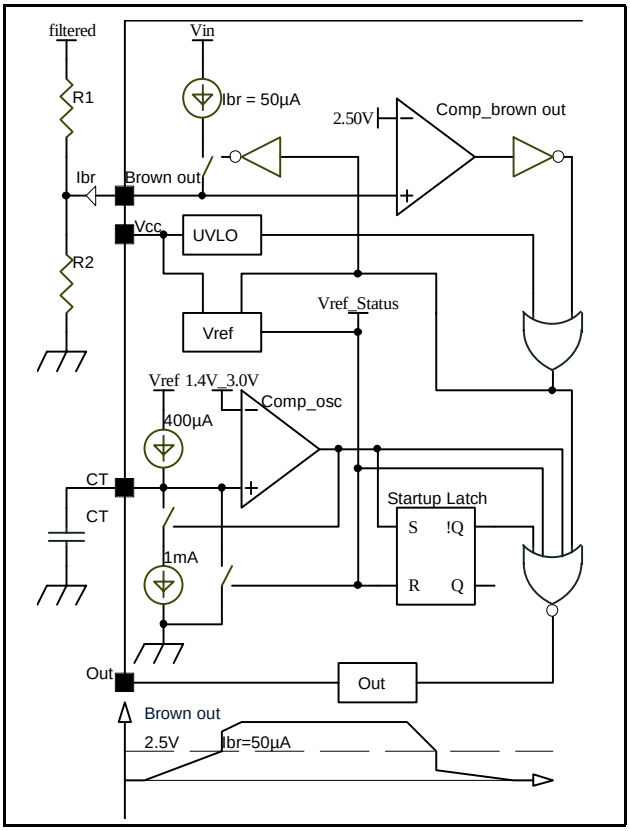
Let's assume Tss = 50ms

==> Css = TssxIiss/(Vthct-VF)

==> Css = 210nF

Brown out

A voltage proportionnal to the Bulk capacitor voltage is applied to the BRNOUT pin. When this pin signal is less than 2.5V, the IC is disabled: SS and CT pins go low, Vref is disabled and the IC goes to standby mode. All bias currents are switched off. The 2.5V voltage at the negative input of comparator Comp_Brown out is still active. When Brown out voltage goes higher than 2.5V, Vref is enabled again. A startup period is started, and then a soft start occurs..



Let's assume BRNOUT acts for Vfiltered = 200V

R2 = 15KΩ

R1 = R2(Vfiltered - UVLO) / UVLO

When BRNOUT is bellow 2.5V

IR2 = Vfiltered(R1+R2)

When BRNOUT is above 2.5V

IR2 = Ibr + Vfiltered(R1+R2)

BRNOUT = R2x(Ibr + Vfiltered(R1+R2))

R1 = 1185KΩ

R2 = 167µA

When BRNOUT is above 2.5V

IR2 = 237µA

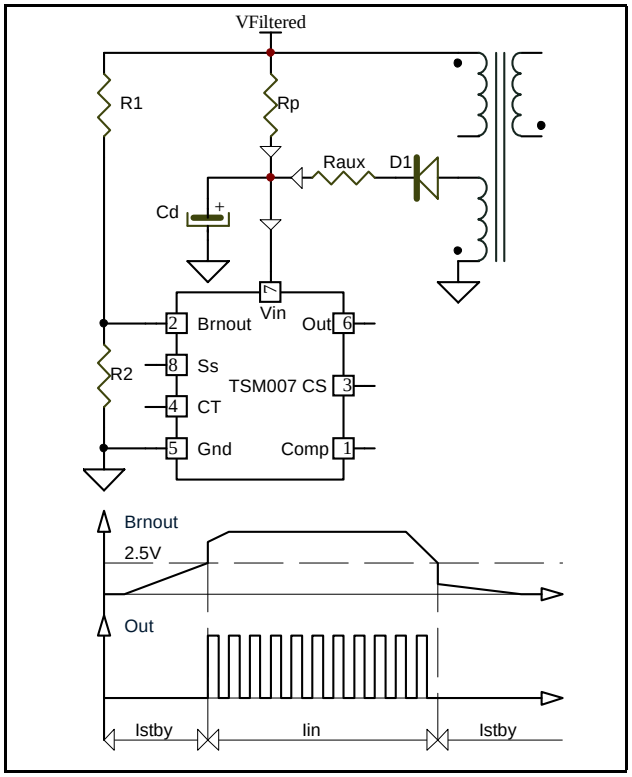
BRNOUT = 3.55V

COMP input

This pin is connected to the current comparator for current mode control. The pin should be connected to the collector (primary side) of an optocoupler which anode (secondary side) is driven by the output of error amplifier.
The COMP input is used to set the reference level for the current sense comparator. The current sense threshold is set to (Vcomp - 2 * Vbe) / 3.

Standby consumption

The low current value supply in stand by mode reduces the consumption ..



When Brnout is below 2.5V, Vflitered below 200V the PWM is off.

==> Icc = Istby.

RP = (Vfiltered-Vz)/Istby

In normal mode, the Vfiltered voltage can go up to 400V.

==> Rpmax dissipation = (Vfiltered-Vin)²/Rp

The Iin current is provided by the auxiliary winding.

Let's assume Vfiltered = 200V

Rp = 620KΩ

Rpmax dissipation = 220mW

Output driver

The OUT totem pole output is capable to sink and source more than 1.0A (peak) in order to direct drive a power MOSFET..

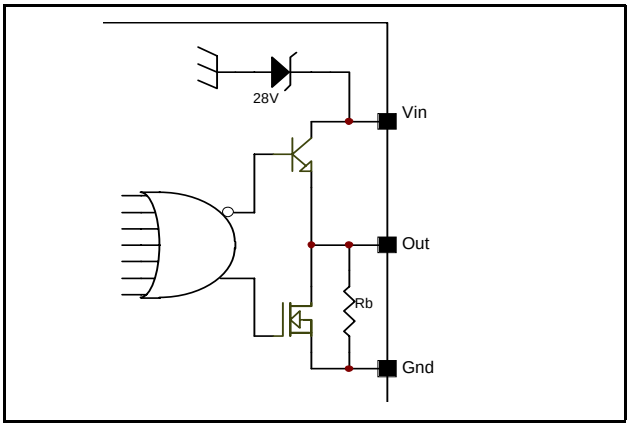
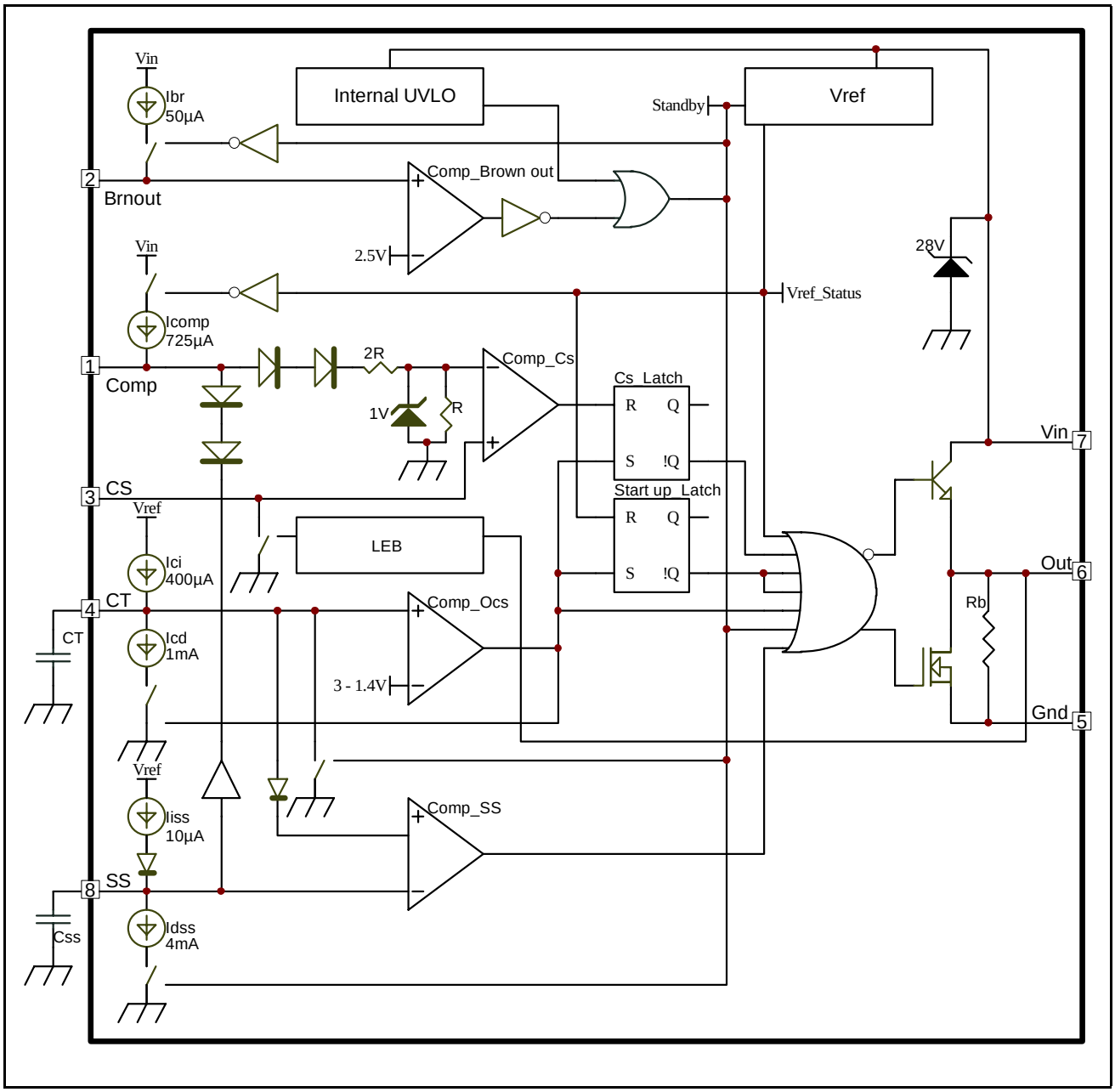
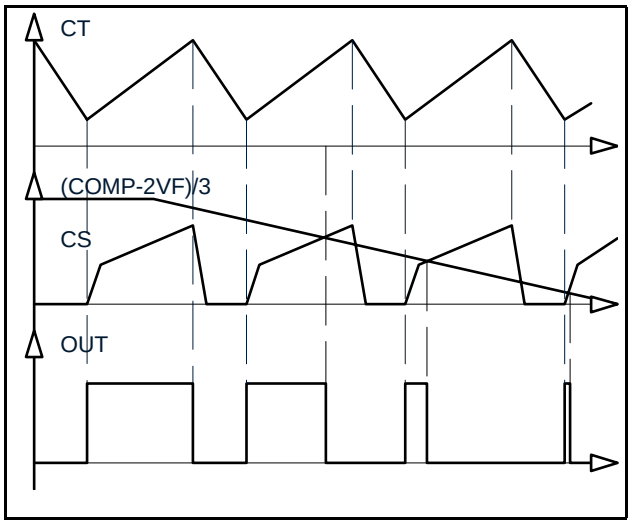


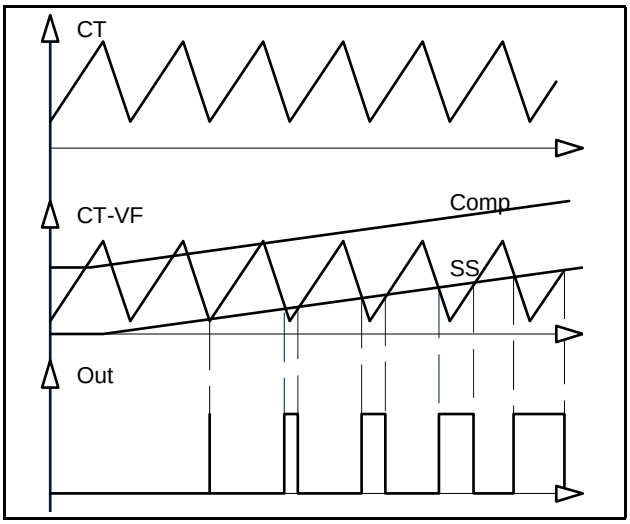
Fig. 1: Detailed Internal Schematic



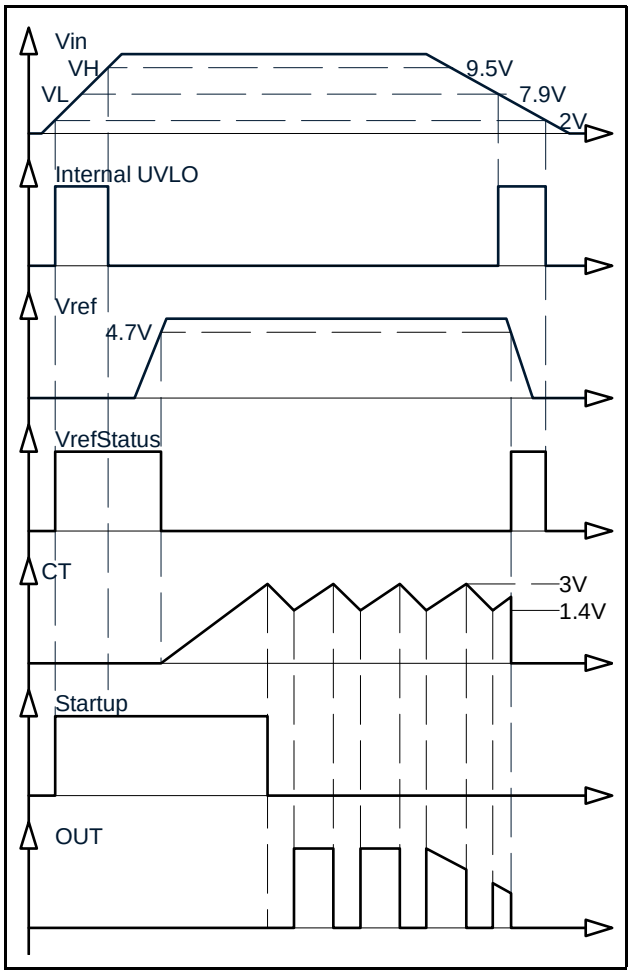
Timing for PWM function



Timing for Soft Start function



Timing at Vref rise up and shut down



Timing at UVLO rise up and shut down

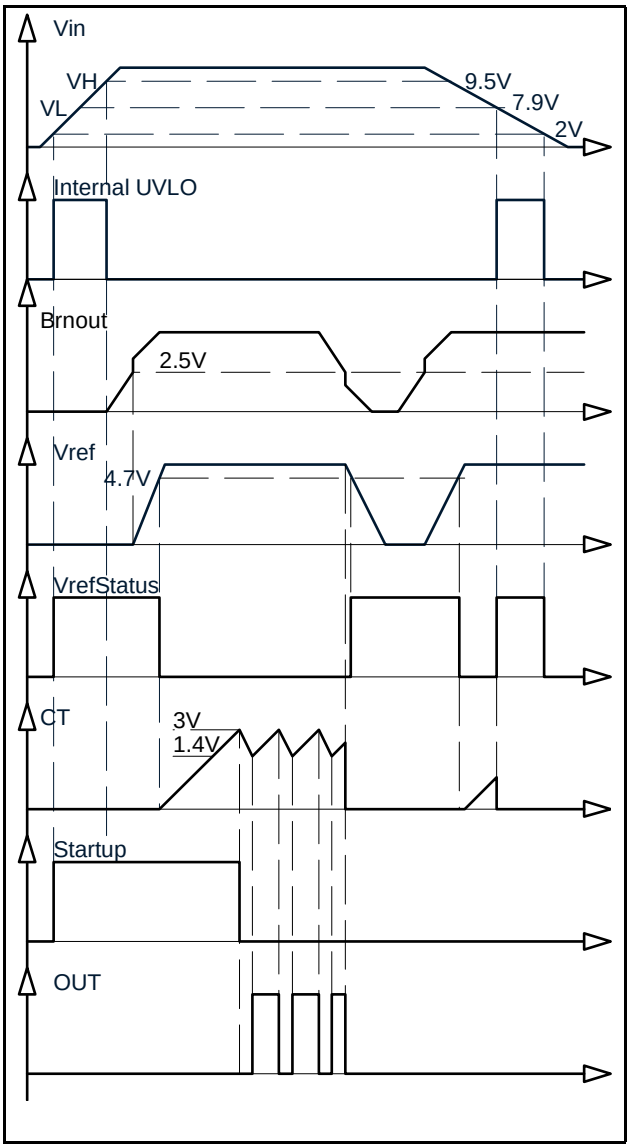
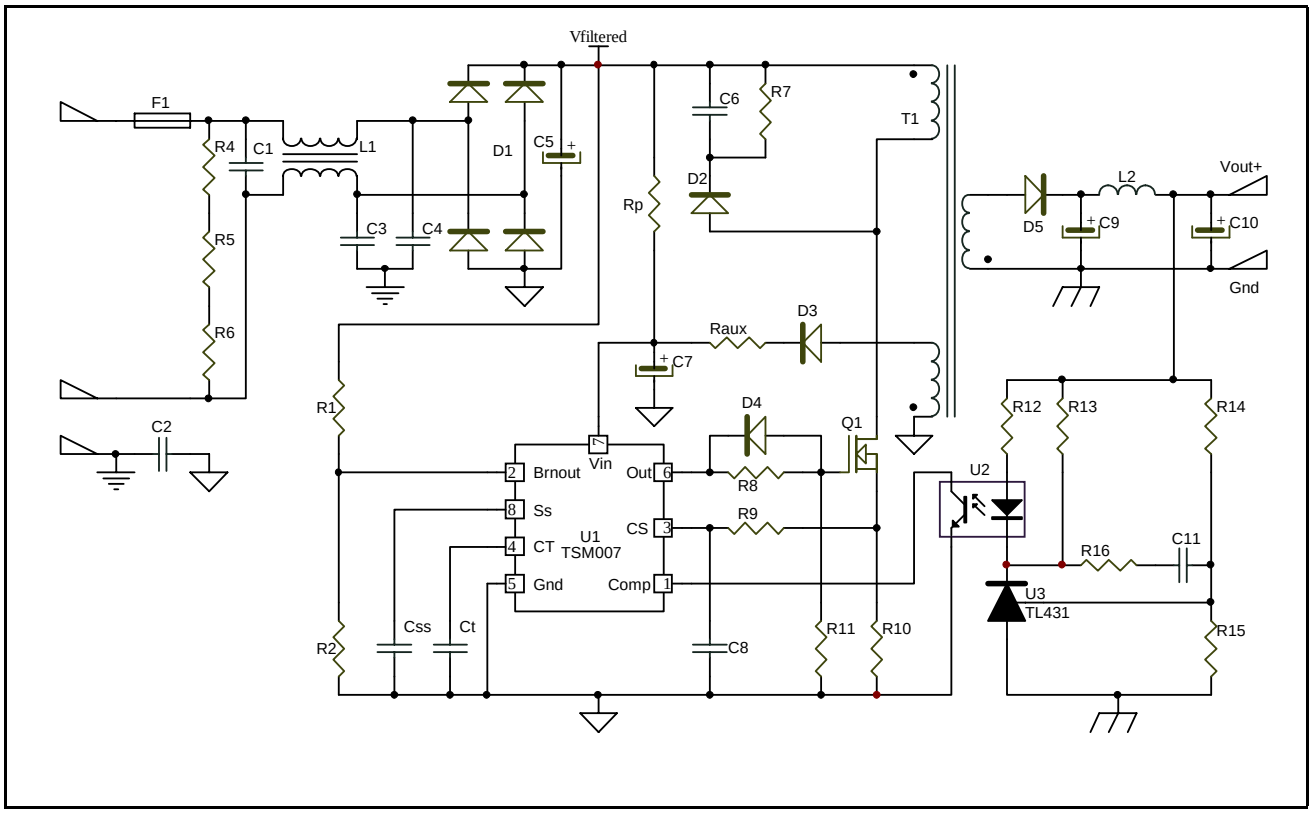


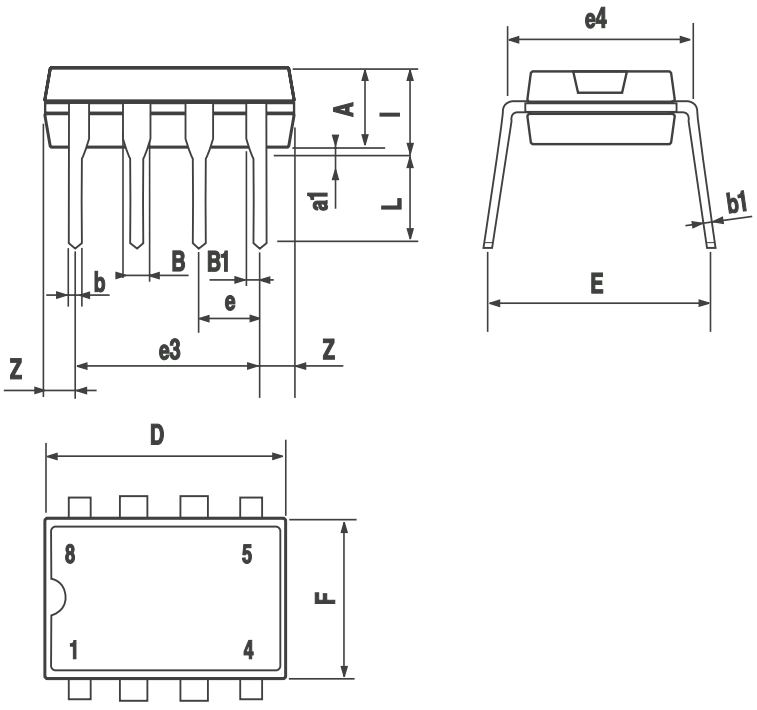
Fig. 2: Application schematic



5 Package Mechanical Data

Plastic DIP-8 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A		3.3			0.130	
a1	0.7			0.028		
B	1.39		1.65	0.055		0.065
B1	0.91		1.04	0.036		0.041
b		0.5			0.020	
b1	0.38		0.5	0.015		0.020
D			9.8			0.386
E		8.8			0.346	
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			7.1			0.280
I			4.8			0.189
L		3.3			0.130	
Z	0.44		1.6	0.017		0.063



P001F

SO-8 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.04		0.010
A2	1.10		1.65	0.043		0.065
B	0.33		0.51	0.013		0.020
C	0.19		0.25	0.007		0.010
D	4.80		5.00	0.189		0.197
E	3.80		4.00	0.150		0.157
e		1.27			0.050	
H	5.80		6.20	0.228		0.244
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
k	8° (max.)					
ddd			0.1			0.04