Accurate CV/CC Primary Side Controller

1 Description

The CN1810 simplifies CV/CC mode switching power supply design by eliminating the need for optocouplers and secondary side control circuits through primary side voltage and current sampling techniques. It also features precise output voltage and current regulation.

CN1810 multiple operation modes can realize 30mW standby power consumption, high efficiency and no noise. Frequency dithering technology can greatly reduce the cost of EMI filters.

CN1810 can precisely adjust CV/CC, featuring low cost and high reliability. It also provides rich protection functions: including cycle-by-cycle peak current limit, VCC undervoltage lockout (UVLO), overvoltage protection (OVP) and clamp. When an exception occurs, the controller continuously attempts a soft restart until the fault condition is removed.

CN1810 is available in a small SOT23-6 package and drives an external MOSFET or high voltage BJT.

2 Features

- CV/CC adjustment error ±5%
- Control circuits without optical coupling and all secondary CV/CC component
- Quasi resonant working mode
- Built-in line compensation for more precise CC regulation
- Lead Edge Blanking (LEB)
- Periodic Current Limit
- VCC undervoltage locking (UVLO) with hysteresis
- Built-in short circuit protection and output overvoltage protection
- Built-in over-temperature protection
- Output power up to 30 W

3 Applications

- Industrial Instrument: Single-phase watt-hour meter/three-phase watt-hour meter
- Outdoor monitoring/protection equipment
- AC-DC of high input volt

4 Pinout
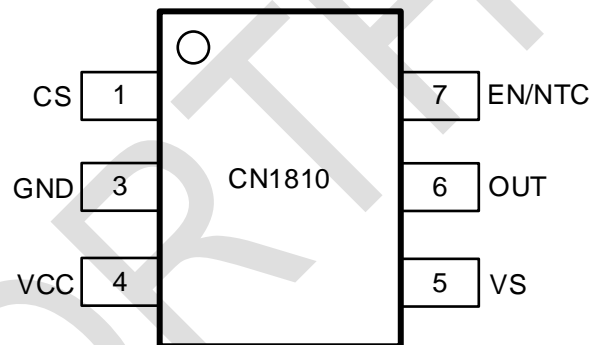
5 Ordering information

| Product Number	Package	Quantity/Tape
CN1810	SOT23-6	3000/Tape

6 Marking

Product Number	Marking
CN1810	10YW

Note: 10 is a fixed character, YW is the product production year and month. y is the last digit of the year, such as 2018, then Y = 8, 2019, then Y = 9; W is the product production of the week, 01 week ~ week 26, W is a lowercase letter a ~ z, 27 weeks ~ 52 weeks, W is A ~ Z, encountered the year there are 53 weeks of the W is 0.
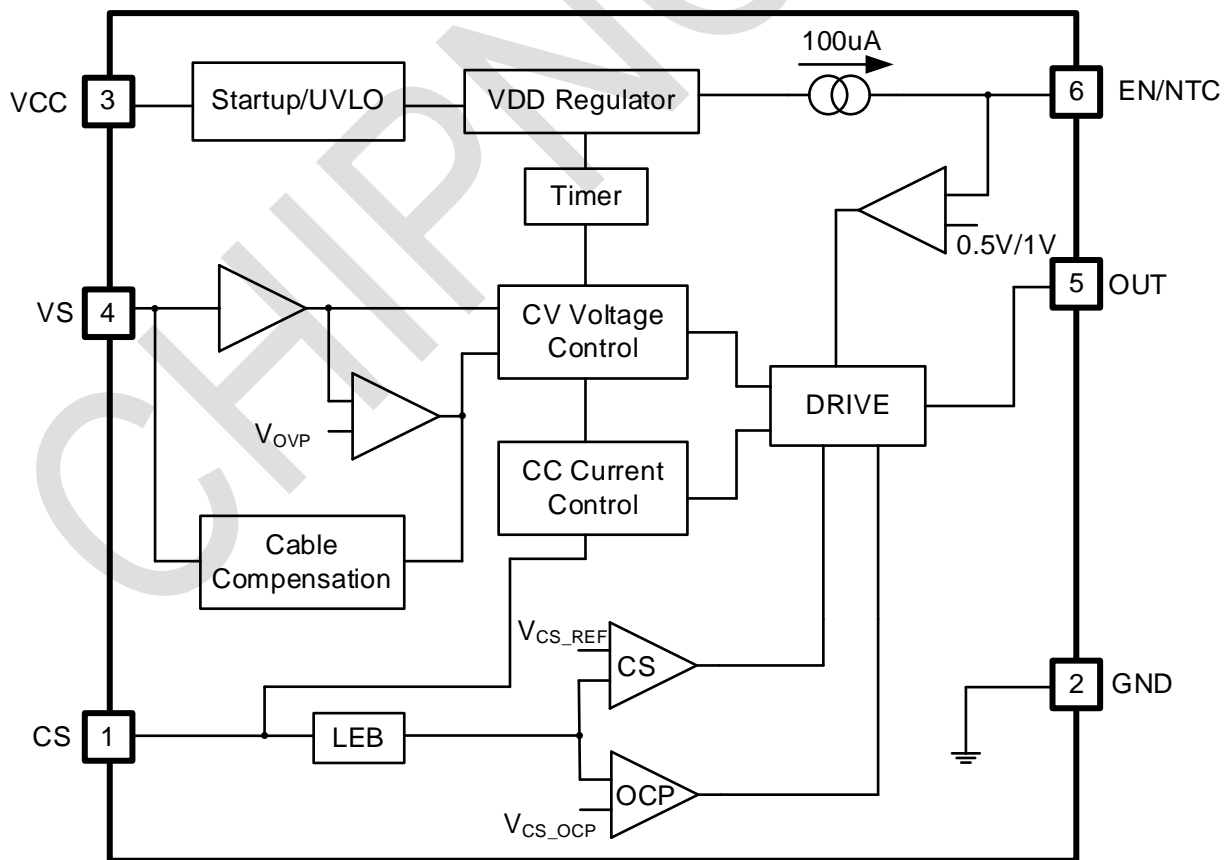
Green (RoHS & HF): CHIPNORTH defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your CHIPNORTH representative directly.

Moisture sensitivity level(MSL):3

7 Typical Application
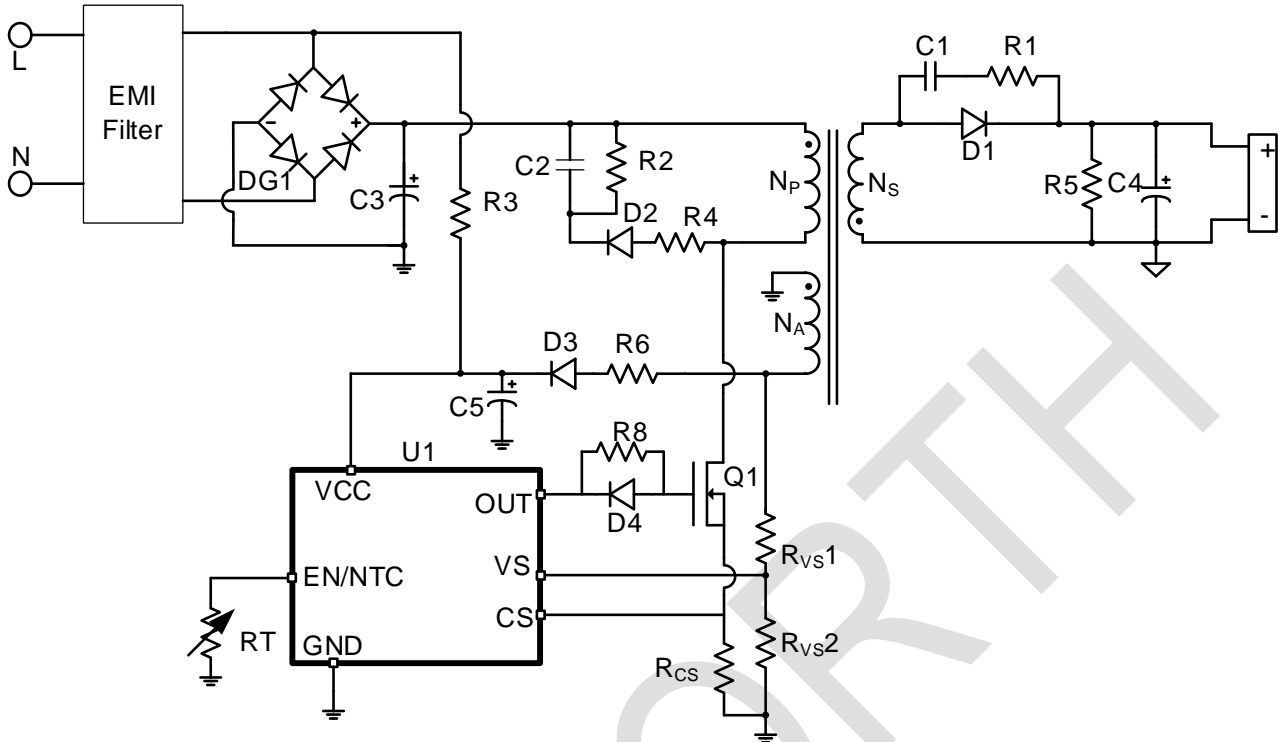
8 Block Diagram

9 Pin Descriptions

Pin No.	Pin Name	Descriptions
1	CS	Current sense
2	GND	Chip Reference ground
3	VCC	Chip supply power input pin
4	VS	The auxiliary winding voltage sampling input pin is connected with the auxiliary winding through resistance
5	OUT	Gate drive of power transistor
6	EN/NTC	Enable control pin to connect to ground NTC resistor or low level off control

10 Specifications

10.1 Absolute Maximum Ratings

Parameter	Symbol	Value	Units
Chip supply power input voltage	VCC	-0.5~40	V
Feedback voltage sampling input	VS	-30~6	V
Current sampling pin ground voltage	CS	-0.5~6	V
Voltage at OUT to Ground	OUT	-0.5~15	V
Ambient temperature	T_A	-40~105	°C
Storage temperature	T_{STG}	-55~150	°C
Welding temperature	T_{LEA}	260 (soldering, 10s)	°C

Note 1: The limit parameter is a threshold that can not be exceeded under any condition (even an instant). Once the chip runs beyond the limit parameters, it may cause aging or permanent damage. The limit parameter only emphasizes numerical values and does not necessarily indicate that the chip can work properly under these limits

10.2 ESD Ratings

Discharge mode	Standard	Value	Units
HBM	ANSI/STM5.1-2001	±2000	V
CDM	JEDECEIA/JESD22-C101F	±1000	V
Latch up	JEDEC NO. 78D	±200	mA

10.3 Recommended Operating Range

Parameter	Symbol	Min.	Max.	Units
Supply voltage	VCC	8	35	V

10.4 Thermal Information

Parameter	Package	Value	Unit
θ_{JA}	SOT23-6	200	°C/W

10.5 Electrical Characteristics

Test conditions: TA=25°C, unless otherwise specified

Parameters	Symbol	Test conditions	Value			Unit
			Min	Typ	Max	
Power supply (VCC pin)						
VCC Overpressure	V_{CC_OVP}		33	36	39	V
Protection	I_{CC}	$V_{CC}=V_{ST}-1V$	240	300	360	µA
Static current @ no load	V_{ST}		10.8	12.8	14.8	V
Start-up voltage	V_{CC_MIN}		6.8	7.5	8.2	V
Minimum operating voltage	I_{ST}	$V_{CC}=V_{ST}-0.5V$		0.1	0.6	µA
Voltage control (VS pin)						
VS reference voltage	V_{VS}		1.97	2.0	2.03	V
Minimum break time	T_{MIN}			1.5		mS
Current control (CS pin)						
Turn-off voltage @ full load	V_{CS_MAX}		580	600	620	mV
Off voltage @ light load	V_{CS_MIN}			200		mV
Front blanking time	T_{LEB}		330	360	420	nS
Secondary maximum duty cycle	D_{MAX}		0.47	0.50	0.53	
Protection function						
Over-temperature protection	T_{OTP}		130	150		°C
Overtemperature hysteresis temperature				30		°C
NTC thermal protection off voltage				0.5		V
NTC thermal protection recovery voltage				1.0		V
NTC pull up current				100		µA
Output overvoltage protection	V_{VS_OVP}		2.2	2.5	2.8	V
Short-circuit voltage	V_{VS_HICCUP}		0.7	0.85	1	V
Drive (OUT pin)						
Gate clamp voltage	V_{G_CLAMP}			11		V
Output low voltage	V_{OL}				0.8	V
Output high voltage	V_{H}		9			V
OUT rising time	T_{R}	$C_{L}=1nF$		160	220	nS
OUT falling time	T_{F}	$C_{L}=1nF$		40	60	nS

# 11 Detailed Description

11.1 Overview

CN1810 is an innovative AC-DC controller that employs proprietary primary side control technology to eliminate the optocoupler isolated feedback and secondary control circuits required in traditional design. effectively improve cost effectiveness and enhance reliability. furthermore, CN1810 used some new technologies to further improve the performance.

11.2 Function Description

11.2.1 Start

When the system circuit built by CN1810 is powered on, the voltage of the energy storage capacitor of VCC pin can be charged to be higher than UVLO (off) through the starting resistance (> 6m Ω) with large resistance value, so that CN1810 can be started and reach the normal working state.

The starting process is as follows: in the initial stage of starting, the starting current consumed by CN1810 is supplied by the starting resistor to charge the VCC pin energy storage capacitor. When the voltage of the VCC pin energy storage capacitor is charged from the starting resistor to the starting voltage of the chip (UVLO off), the chip starts to start, thus starting from the VCC in an instant Pin energy storage capacitor draws current, then CN1810 starts to vibrate, and the system starts to operate. In no abnormal state, the energy storage capacitor of VCC pin changes to supplement energy from auxiliary coil, and then maintains a normal working voltage. For details, please refer to CN1810 startup sequence diagram in Figure.
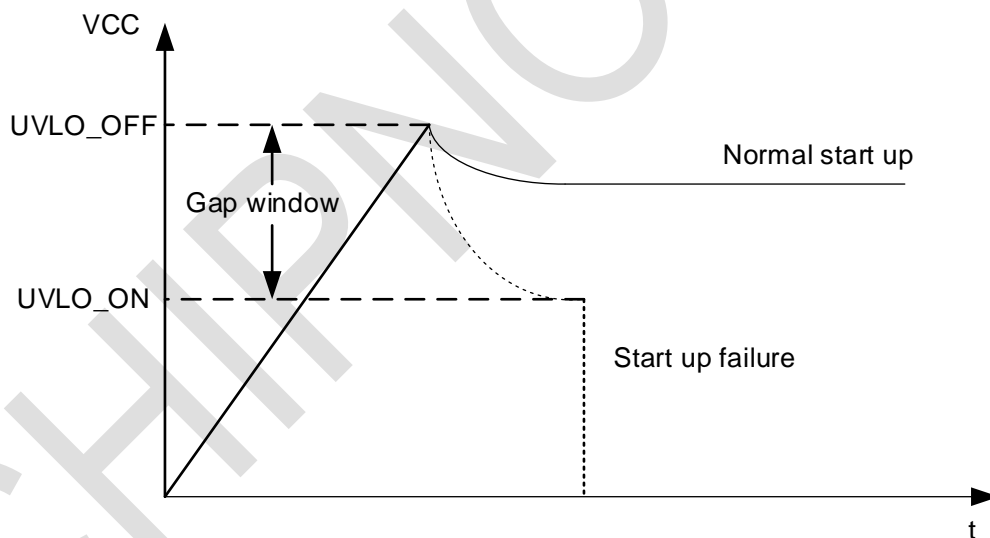
11.2.2 Constant (CV) mode

In order to achieve accurate output voltage regulation, it is necessary to detect the change of output and load. The vs pin of CN1810 detects the feedback signal of the auxiliary winding through rvs1 and rvs2. During power on, the power output voltage vs is mapped to the auxiliary coil turns ratio of N_{AUX}/N_S. The voltage can be expressed as:

$$V_{AUX} = V_s * N_{AUX}/N_S$$

Among them, N_{AUX} is the number of turns of the auxiliary winding and N_S is the number of turns of secondary output.

During power off, the voltage of the secondary winding is mapped to the auxiliary winding, denoted as:

$$V_{AUX} = (V_O + V_D) \times \frac{N_{AUX}}{N_S}$$

Among them, NS are turns of secondary windings, V_D is the voltage drop of the rectifier diode.

In the typical application diagram, the auxiliary winding voltage V_{AUX} is sent to the VS pin of CN1810 through Rvs1 and Rvs2. Compared with the reference voltage V_{VS} inside the chip, the duty cycle is adjusted to keep the output voltage constant.

The adjusted final output voltage is equal to:

$$V_O = \frac{N_S}{N_{AUX}} \times V_{VS} \times \left(1 + \frac{R_{VS1}}{R_{VS2}}\right) - V_D$$

Where the internal reference voltage V_{VS} equal to 2V (typical values)

11.2.3 Constant Current (CC) operation

The chip detects the peak current of the transformer on a periodic basis. The CS terminal is connected to the input of the internal peak current comparator to compare with the internal threshold voltage. When the CS external voltage reaches the internal detection threshold, the power tube is turned off.

The expression of peak inductance current at full load is as follows:

$$I_{P\_PK} = \frac{V_{CS}}{R_{CS}}(mA)$$

There is one 300nS leading edge blanking function in comparator.

Output current calculation formula:

$$I_O = \frac{1}{4} \times I_{P\_PK} \times \frac{N_P}{N_S}$$

Among them N_P is the number of turns of the main stage of the transformer, N_S is the number of turns of the secondary stage of the transformer, I_{P_PK} is the peak current on the main stage side.

11.2.4 PWM/PFM mixed mode

In order to make a trade-off between efficiency, no-load and standby, noise, ripple and other different characteristics, CN1810 adopts PWM/PFM hybrid mode. In constant voltage (CV) mode, CN1810 system works in pure PWM mode from medium load to full load; from medium load to no load, the system operates in mixed PWM/PFM mode. The figure shows the trend of frequency and output current after load change.
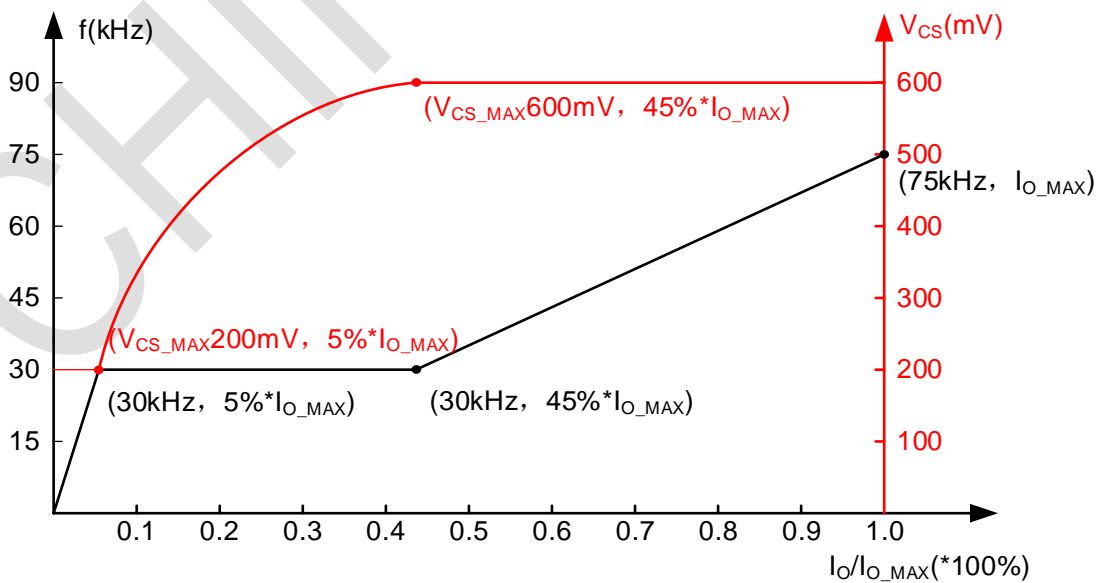
f_{OSC} and I_O Relation to load

11.2.5 Protection function

CN1810 integrated complete protection features including built-in OVP, OTP, UVLO, OCP, output short/open protection and open loop protection.

CN1810 is able to monitor the primary measured peak current through the CS pin. CN1810 allows control and limitation of the cycle-by-cycle peak current. When the voltage of the CS pin reaches the internal OCP threshold, the overcurrent is detected by CN1810 and the power MOSFET switch is turned off immediately until the next pulse is generated.

VCC protection is achieved by UVLO and OVP. When the VCC voltage drops below the UVLO (on) threshold or rises above the OVP threshold and the power system enters the automatic restart sequence. The output of the CN1810 is turned off. In case of output short circuit or disconnection, UVLO (on) and OVP can also be triggered, and CN1810 can be shut down and enter the automatic restart sequence.

Over temperature protection (OTP) circuit detects chip temperature. OTP threshold is usually set at 150°C. When the chip temperature rises above the threshold. The device turns off and enters the automatic restart sequence.

In case of open loop, CN1810 can detect the fault status, close and enter the automatic restart sequence.

12 Package Information

SOT23-6
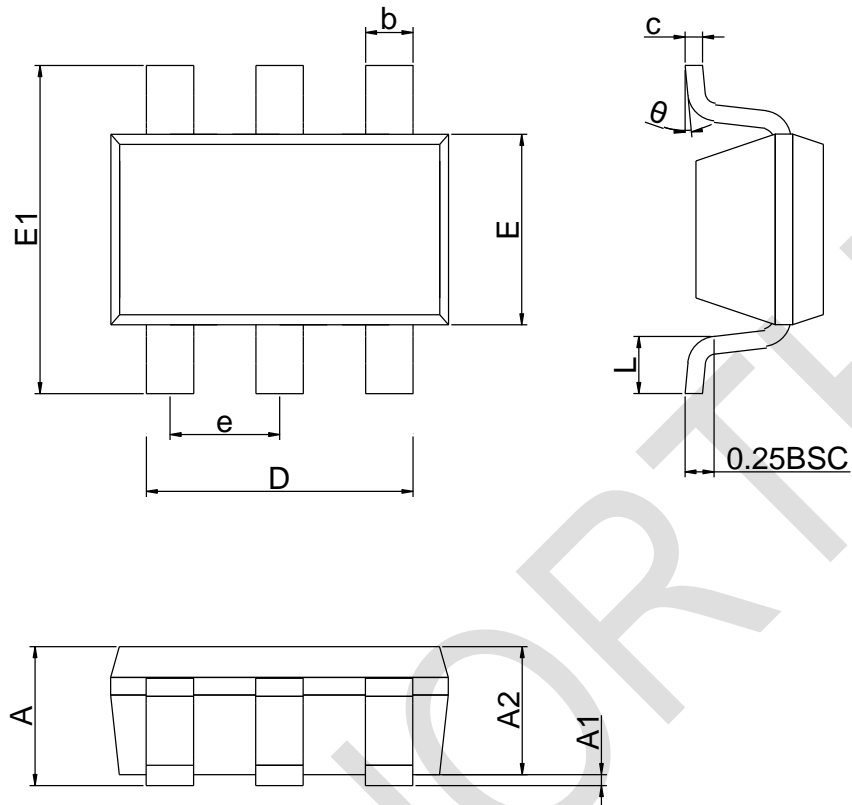
Dimension Symbol	Min (mm)	Nom (mm)	Max (mm)
A	-	-	1.45
A1	0	-	0.15
A2	0.9	-	-1.3
b	0.3	-	0.5
c	0.1	-	0.2
D	2.82	-	3.02
E	1.5	-	1.7
E1	2.65	-	2.95
e	0.95		
L	0.3	-	0.6
θ	0	-	8°

13 Important Statement

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