

## Accurate CV/CC Primary Side PWM Power Switch

### Product Description

WT5528D is a series of high efficiency Primary Side Regulator and highly integrated PWM Power Switch for AC/DC power supply applications. It simplifies conventional CC/CV charger/adaptor designs by eliminating the opto-coupler and secondary control circuitry. Very tight output voltage and current regulation is realized as shown in the Fig.1 below.

During operation, multi-mode operations are utilized to achieve low standby power, high efficiency and audio & noise free. The integrated Power MOSFET could reduce external components and system cost.

WT5528D also offers rich protection features including Cycle-by-Cycle peak current limiting, UVLO, OVP. The switch continues attempting start-up until the fault condition is removed. Every restart is a soft start.

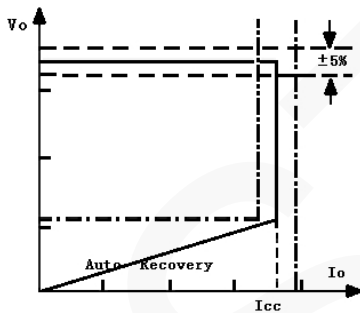
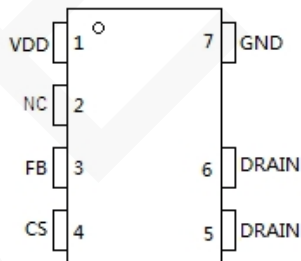


Fig.1. Typical CC/CV Curve

### Pin Configuration



WT5528D

### Key Features

- Built-in Integrated Power MOSFET
- +/-5% Constant Voltage Regulation
- Accurate Constant Current Regulation at Universal AC input
- Eliminates Opto-coupler and all Secondary CV/CC Control Circuitry
- Built-in Line Compensation for Tighter CC Regulation
- Built-in Compensation for Transformer Inductance Tolerances
- Adjustable Output Cable Compensation
- Adaptive Multi-mode PWM/PFM Control for Improving Efficiency
- Low Start-up Current
- Built-in Leading Edge Blanking (LEB)
- Cycle-by-Cycle Current Limiting
- VDD Under Voltage Lockout with Hysteresis(UVLO)
- Built-in Output Overvoltage Protection
- Good dynamic response

### Applications

- Cell/Cordless Phone Charger
- PDA/Portable Audio Device Charger
- Small Power Adaptor/Charger
- Standby Supply for Consumer Electronics



## 1 Overview

WT5528D is a primary side CC/CV regulator designed for high performance offline Switch Mode Power Supplies with minimal external components. The device is integrated high voltage power switching regulators which combines an avalanche rugged Sense FET with a primary side control block.

WT5528D is designed for AC/DC applications. And it provides accurate current/voltage without requiring the opto-coupler and the secondary control circuitry. It also eliminates the need of loop compensation circuitry while maintaining stability. thus, very tight output voltage and current regulation is achieved.

WT5528D's multi-mode operations are utilized

to achieve low standby power, high efficiency and audio & noise free. in CC mode as well at large load condition, it operations in PFM mode, while at light load or medium load, WT5528D works in PWM with frequency reduction. This green-mode function assists the power supply meeting the power conservation requirements.

A complete set of integrated protection functions allows WT5528D to protect against all fault conditions including Cycle-by-Cycle peak current limiting, VDD UVLO, OVP . The switch continues attempting start-up until the fault condition is removed.

WT5528D is offered in DIP7 package.

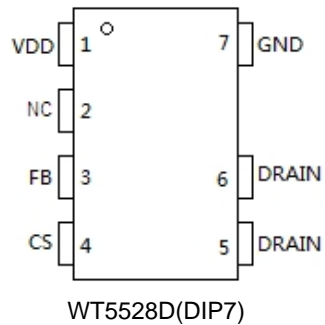
## 2 Features

- Built-in Integrated Power MOSFET
- +/-5% Constant Voltage Regulation
- Accurate Constant Current Regulation at Universal AC input
- Eliminates Opto-coupler and all Secondary CV/CC Control Circuitry
- Built-in Line Compensation for Tighter CC Regulation
- Built-in Compensation for Transformer Inductance Tolerances
- Adjustable Output Cable Compensation
- Adaptive Multi-mode PWM/PFM Control for Improving Efficiency
- Low Start-up Current
- LEB
- OCP
- OVP
- Good dynamic response
- UVLO

## 3 Pin Diagrams

---

The pin map is shown as below .



#### 4 Pin Description

Pin	Description
VDD	IC power supply.
NC	Floating pin.
FB	Through two dividing resistors connecting to the bias winding, this pin could get the information of output to realize the CV/CC regulation.
CS	This pin could detect the primary current by the voltage of sensing resistor connected from CS to GND.
DRAIN	HV MOSFET Drain Pin. The Drain pin is connected to the primary lead of the transformer.
GND	IC ground.

#### 5 Absolute Maximum Ratings

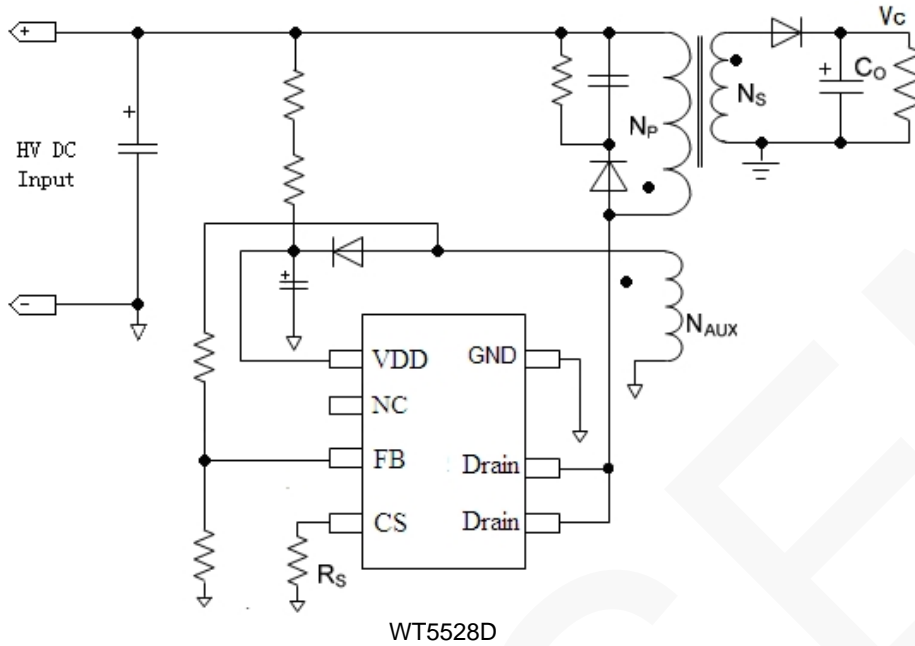
Absolute maximum ratings are the parameter values or ranges which can cause permanent



**(VDD =16V, TA = 25°C, unless otherwise specified)**

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>Supply Voltage (VDD) Section</b>						
Standby Current	I <sub>DD_sd</sub>	VDD=16V		2	20	μA
Operating Current	I <sub>DD_op</sub>	Operating supply current FB=2V, CS=0V, VDD=20V		1	1.5	mA
VDD Under Voltage Enter Threshold	UVLO(ON)	VDD falling	5	6.5	8	V
VDD Under Voltage Exit Threshold	UVLO(OFF)	VDD rising	14.5	16	18.5	V
VDD over voltage threshold	VDD_OVP			27.2		V
<b>Current Sense Section</b>						
Turn on LEB Time	TLEB			300		ns
Over Current Threshold	Vocp			500		mV
<b>CC/CV Control Section</b>						
Reference Voltage for EA	Vref_EA		2.465	2.5	2.535	V
Minimum off time	Toff_min			2		us
Minimum frequency	Fosc_min			550		Hz
Maximum frequency	Fosc_max		120			kHz
Maximum cable compensation current	Icable_max			41		μA
Output over voltage threshold	Vfb_ovp			3		V
<b>Over Temperature Protection</b>						
Protection trigger point	T_otp			160		°C
<b>Power Mosfet Section</b>						
MOSFET Drain-Source Breakdown Voltage	BVdss	Id=250μA/VGS=0 V	650			V
On Resistance	Rdson	Id=3.5A/VGS=10 V		1.14		Ω

## 9 Application



### Application Notes

WT5528D provides a cost effective solution for low power adaptor/charger applications. The innovative CV and CC control can remove the need for secondary feedback circuitry while achieving excellent CV/CC for much more strict requirements.

#### 9.1 Startup & Operating Current

WT5528D has very slight startup current, thus the larger value startup resistor and smaller VDD capacitor can be used to minimize the power loss in application.

The operating current of WT5528D is as low as 1mA. Together with 'Multi-mode' control features we could get high efficiency especially in light load.

#### 9.2 Under Voltage Lockout (UVLO)

An UVLO detector is implemented in it to detect the voltage on the VDD pin. It would assure the supply voltage enough to turn on the PWM controller and further to drive the power mos. a

hysteresis is built in to prevent the shutdown from the voltage dip during startup. The turn-on and turn-off threshold level are set at 16 V and 8 V, typically.

#### 9.3 Realization of CV/CC

The CV/CC control is based on the system working in DCM.

In the DCM fly-back converter, the output voltage can be sensed via the auxiliary winding. During MOSFET turn-on time, the current in the primary winding ramps up. When MOSFET turns off, the primary current transfers to the secondary at the amplitude of

$$I_{Spk} = \frac{N_P}{N_S} \cdot I_{Ppk} \quad (1)$$

$I_{Ppk}$  is the current in the primary winding at the point MOSFET turns off.

Through coupling between the secondary and auxiliary winding the output voltage is given by

$$V_o = \frac{N_s \cdot V_{aux}}{N_{aux}} - \Delta V \quad (2)$$

Where  $V_{aux}$  is the voltage of the auxiliary winding and  $\Delta V$  indicates the drop voltage of the output diode.

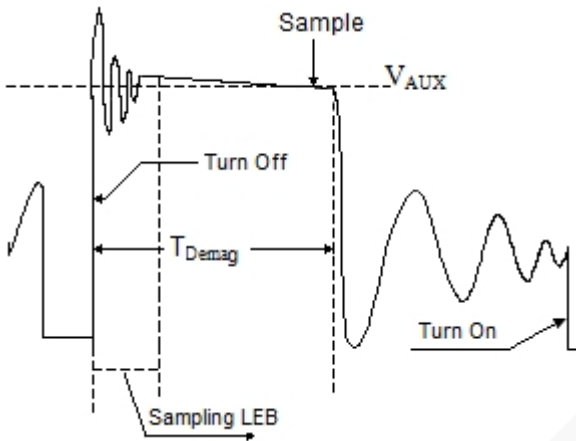


Fig.2. Voltage of Auxiliary-winding Waveform

Via a resistor divider connected between the auxiliary winding and FB, the auxiliary voltage is sampled based on the internal timing control. Through the built-in error amplifier the sampled voltage could be regulated at a preset level, thus constant output voltage can be achieved.

During the CC mode of operation WT5528D will regulate the output current at a constant level regardless of the output voltage, while avoiding continuous conduction mode.

### 9.4 Adjustable CC Point and Output Power

In application of AC/DC, we could change the  $R_s$  to get different CC points and the maximum output power only using one model. The larger  $R_s$ , the smaller CC point is, and the smaller output power becomes.

### 9.5 Switching Frequency and Lm Tolerance Compensation

The system load condition and the operation mode decide the switching frequency of WT5528D. The maximum switching frequency is set by system design. In DCM assuming the efficiency to 100%, the output power is given by

$$P_o = \frac{1}{2} L_m f_{sw} I_{Ppk}^2 = V_o \cdot I_o \quad (3)$$

Where  $L_m$  indicates the inductance of the primary winding and  $I_{Ppk}$  is the peak current of the primary winding.

Refer to the equation 3, the change of  $L_m$  results in the change of  $P_o$  and the constant output current in the CC mode. The tolerance of  $L_m$  will make CC worse in mass production. To smooth it away, we use an internal  $L_m$  compensation circuit to correct the offset of inductance.

Whatever  $L_m$  is changed to, the CC point is constant.

### 9.6 Adjustable Cable Drop Compensation

Built-in cable drop compensation is used to get better load regulation. In this way, the voltage at the end of the cable of no load and full load is nearly the same.

In different applications using different cables, we could adjust the resistance of the divider connected to the FB pin. The larger impedance of the cable, the larger divider will be used.

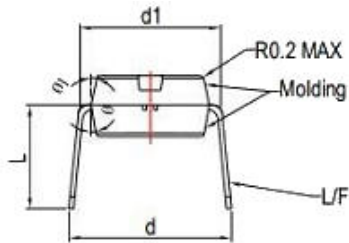
### 9.7 Protection Control

WT5528D has built-in rich protection features including Cycle-by-Cycle Current Limiting, Power on Soft Start, Under Voltage Lockout on VDD and Open-loop Protection.

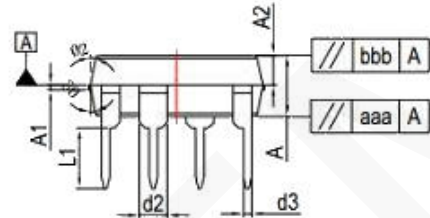
WT5528D is shut down when VDD drops below the UVLO (ON) limit and the power converter enters the power on start-up sequence thereafter.

## 10 Packaging Information

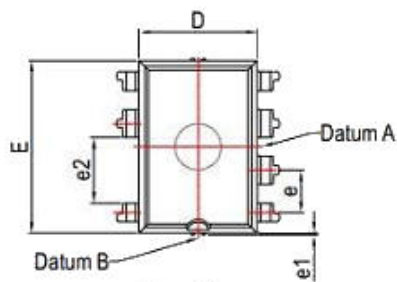
### DIP7



Front View



Right View



Top View



ISO View

#### Dimensional References unit:mm

Ref.	MIN	NOM	MAX	Ref.	MIN	NOM	MAX
A	3.224	3.274	3.324	e	2.54 BSC		
A1	0.254 BSC			e1	/	/	0.1
A2	1.54	1.59	1.64	e2	3.556 BSC		
D	6.33	6.38	6.43	L	5.57 REF		
d	8.42	8.72	9.02	L1	3.0	3.3	3.6
d1	7.32	7.62	7.92	Φ	9°	10°	11°
d2	1.524 BSC			Φ1	11°	12°	13°
d3	0.457 BSC			Φ2	11°	12°	13°
E	9.2	9.25	9.3	Φ3	9°	10°	11°
aaa	0.10			bbb	0.10		