

# Current Mode PWM Controller

## Product Description

DK5502S is a current mode PWM controller with built-in high-voltage MOSFET for switching power supplies.

DK5502S has a built-in high-voltage starting circuit. Under light load, it will enter hiccup mode, effectively reducing the standby power consumption of the system. It has a frequency reduction function to further optimize the conversion efficiency under light load conditions. Equipped with frequency jitter function, it can improve EMI characteristics. It has a soft start function, which can reduce the stress of the device and prevent transformer saturation. Equipped with VDD hiccup function, it not only prevents VDD under-voltage restart, but also effectively reduces standby power consumption.

DK5502S also integrates various protection functions for abnormal states, including VDD under-voltage protection, VDD over-voltage protection, leading edge suppression, output short circuit protection, over-current protection, over temperature protection, etc. After triggering the protection, the circuit will continuously restart automatically until the system is working properly.

DK5502S adopts SOP-8 package.

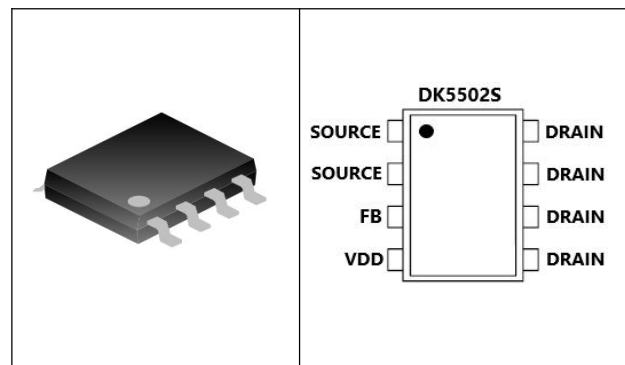
## Product Feature

- High voltage startup
- Hiccup under light load
- Frequency reduction
- Frequency jitter
- Soft start
- VDD Hiccup
- VDD under voltage protection
- VDD over voltage protection
- Leading edge blanking
- Output short circuit protection
- Over current protection
- Over temperature protection

## Applications

- Offline switching power supply
- Small household appliances
- Non - isolated buck/boost converter

## PINS



**Pins Function**

Pin No.	Pin Name	Description
1,2	SOURCE	Reference ground for power MOSFET source and control circuit
3	FB	Feedback input pin
4	VDD	Power supply for control circuits
5,6,7,8	DRAIN	Power MOSFET drain

**Typical Power**

Product Model	Input Voltage	Typical Power	Vds	Rds_on
DK5502S	85-265VAC	6W	650V	18 Ω

Remark: Test typical power in closed environment @45 °C ambient temperature. The system output rated current is recommended not to exceed the recommended current.

**Functional Structure Diagram**



**Absolute Maximum Rating**

Parameter	Symbol	Conditions	Unit
Drain-gate voltage ( $R_{GS}=1M\Omega$ )	$V_{DGR}$	650	V
Gate-source (ground) voltage	$V_{GS}$	$\pm 30$	V
Drain current pulse*	$I_{DM}$	2.8	A
Drain Continuous current ( $T_{amb}=25^{\circ}C$ )	$I_D$	0.8	A
Energy Avalanche Stress**	EAS	30	mJ
High voltage input	$V_{HV(MAX)}$	650	V
Power supply voltage	$V_{DD(MAX)}$	30	V
Feedback current	$I_{FB}$	3	mA
operating junction temperature	$T_J$	+150	$^{\circ}C$
Storage temperature range	$T_{STG}$	-55~+150	$^{\circ}C$
Dissipated power	$P_D$	0.65	W
Thermal resistance from IC surface to external environment	$R_{th(j-a)}$	150	$^{\circ}C/W$

Note:\*The pulse width is determined by the maximum junction temperature.\*\*L=51mH,  $T_J=25^{\circ}C$  (start)

**Electrical Characteristics** (Built in MOSFET part, unless specified,  $T_A = 25^{\circ}C$ )

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Drain-source breakdown voltage	$BV_{DSS}$	$V_{GS}=0V, I_D=50\mu A$	650			V
Drain-source conduction resistance	$R_{DS(ON)}$	$V_{GS}=10V, I_D=0.5A$	15	18	21	$\Omega$
Zero gate voltage drain current	$I_{DSS}$	$V_{DS}=650V, V_{GS}=0V$			50	$\mu A$
		$V_{DS}=480V, V_{GS}=0V, T_{amb}=125^{\circ}C$			200	$\mu A$
Input capacitance	$C_{ISS}$	$V_{GS}=0V, V_{DS}=25V, f=1MHz$		128		pF
Output capacitance	$C_{OSS}$	$V_{GS}=0V, V_{DS}=25V, f=1MHz$		16		pF
Reverse transmission capacitance	$C_{RSS}$	$V_{GS}=0V, V_{DS}=25V, f=1MHz$		0.6		pF
Turn on delay time	$T_{D(ON)}$	$V_{DD}=0.5BV_{DSS}, I_D=25mA$		13.4		ns
Rise time	$T_R$	$V_{DD}=0.5BV_{DSS}, I_D=25mA$		26.4		ns
Turn off delay time	$T_{D(OFF)}$	$V_{DD}=0.5BV_{DSS}, I_D=25mA$		23.8		ns
Fall time	$T_F$	$V_{DD}=0.5BV_{DSS}, I_D=25mA$		86.4		ns

**Electrical Characteristics** ( unless specified,  $V_{DD}=18V, T_A = 25^{\circ}C$  )

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
<b>Operating Voltage</b>						
Operating voltage range	$V_{DD}$	After startup	10		25	V
Current under protection	$I_{DD0}$	$I_{FB}=1.2mA$		0.7		mA
Current in switch state	$I_{DD1}$	$I_{FB}=0.55mA$		0.9		mA
VDD startup voltage	$V_{DD(on)}$	$I_{FB}=0.5mA$	13.6	14.3	15	V
VDD under-voltage protection point	$V_{DD(OFF)}$	$I_{FB}=0.5mA$	8.3	8.9	9.5	V
VDD start/under-voltage delay	$V_{DD(HYS)}$		4.1	5.4	6.7	V
VDD over-voltage protection voltage	$V_{DD(OVP)}$	$I_{FB}=0.5mA$		28		V
VDD clamping voltage	$V_{DD(CLAMP)}$			30		V
VDD Hiccup Point	$V_{DD(LOW)}$	$I_{FB}=1.5mA$		10.7		V
VDD hiccup point delay	$V_{DD(LOWHYS)}$	$I_{FB}=1.5mA$		0.7		V
<b>High voltage start</b>						
Charging current	$I_{HVC}$	$V_{DD}=0V, V_{DRAIN}=100V$		1		mA
Turn off leakage current	$I_{HVS}$	$V_{DD}=18V, V_{DRAIN}=700V$		3		$\mu A$
<b>Operating Frequency</b>						
Switching frequency for normal operation	$f_{SW1}$	$I_{FB}=0.5mA$	50	60	68	KHz
Frequency jittering range	$f_{JIT}$	$I_{FB}=0.5mA$	-2		2	KHz
Modulation frequency	$f_{MOD}$	$I_{FB}=0.5mA$		250		Hz
Maximum duty cycle	$D_{MAX}$	$I_{FB}=0.5mA$	70	80	85	%
FB frequency down start point	$IFB_{FD1}$			830		$\mu A$
FB frequency down end point	$IFB_{FD2}$			930		$\mu A$
Minimum switching frequency	$f_{SW2}$	$I_{FB}=0.95mA$		20		KHz
<b>Feedback input</b>						
FB input resistance	$R_{FB}$			1.15		$k\Omega$
FB turn off current	$IFB_{SD}$		0.8	1	1.3	mA
FB turn off current hysteresis	$IFB_{SDHYS}$			70		$\mu A$
FB overload protection detection current	$IFB_{OLP}$			500		$\mu A$
Operating current during FB overload protection	$IDD_{FBOLP}$	$I_{FB}=0.35mA$		3.2		mA
<b>Peak current limiting</b>						
Peak limit point	$I_{PKLIM}$	$I_{FB}=0mA$	400	470	540	mA
Current gain	$G_{ID}$			470		A/A
Current sampling turn off delay	$t_d$			250		ns

Leading edge blanking	$t_{LEB}$		300		ns
Minimum conduction time	$t_{ON(MIN)}$		550		ns
Soft start time	$t_{SS}$	$I_{FB}=0.55mA$	9		ms
<b>Over temperature protection</b>					
Temperature protection detection point	$T_{SD}$		145		°C
Temperature protection hysteresis	$T_{HYS}$		25		°C

## Operation **DESCRIPTION**

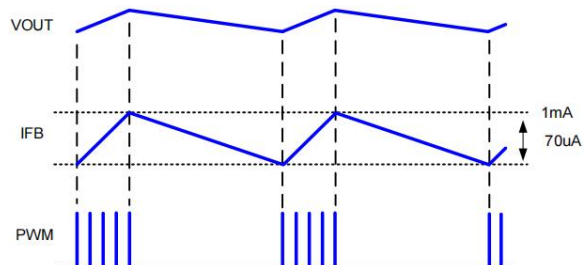
DK5502S is a current mode PWM controller with built-in high-voltage MOSFET for switch mode power supplies. It has a built-in high-voltage starting circuit and can enter hiccup mode under light load. It has functions such as frequency reduction, jittering, soft start, and VDD hiccup. It also integrates protection functions for various abnormal states such as VDD under-voltage protection, VDD over-voltage protection, leading edge blanking, output short circuit protection, over-current protection, and over temperature protection.

### High voltage startup

DK5502S has a built-in high-voltage starting circuit. When starting, the input voltage from the DRAIN charges the external capacitor of the VDD through the built-in high-voltage constant current source. The charging current is 1mA, causing the VDD voltage to rise. When the starting voltage rises to 14.3V, the high-voltage constant current source is switched off, and the DRAIN stops charging the VDD. The auxiliary winding L1 supplies power to the VDD through diode D1; If the VDD voltage drops to the under-voltage protection point of 8.9V, the high-voltage constant current source will be switched on again, and the DRAIN will charge the VDD, causing the VDD voltage to rise to the starting voltage of 14.3V.

### Hiccup under light load

Under light load, if the output VOUT is too high and the input current IFB fed back to the FB exceeds the turn off current by 1mA, DK5502S will turn off, causing VOUT to decrease; When VOUT decreases by IFB drops 70μA, DK5502S re-turn on, causing VOUT to rise; Repeat the above process to enter hiccup mode, which will reduce the number of switches and effectively reduce the standby power consumption of the system.



### Frequency reduction

In order to further optimize the conversion efficiency under light load conditions, DK5502S adopts a

frequency reduction mode, which adjusts the switching frequency by detecting the input current IFB at the FB pin. When the IFB is less than the starting point of frequency reduction of 830 $\mu$ A, the switching frequency is 60KHz; When IFB increases from **the frequency reduction starting point 830 $\mu$ A to the ending point 930 $\mu$ A**, the switching frequency linearly decreases from 60KHz to 20KHz; When the IFB is greater than the frequency reduction **e n d** point of 930 $\mu$ A, the switching frequency is 20KHz.

#### **Jittering**

In order to reduce EMI, DK5502S adopts jitter technology, which continuously changes the switching frequency within the jitter range of  $\pm 2$ KHz at a modulation frequency of 250Hz, reducing external radiation at a single frequency.

#### **Soft start**

DK5502S limits the maximum peak current at the DRAIN pin of the power transistor MOSFET during the soft start time, gradually increasing it, thereby greatly reducing the stress on the device and preventing transformer saturation.

#### **VDD Hiccup**

When DK5502S switches between light load or full load and no load, when the switch is turned off and causes the VDD voltage to drop to the burping point of 10.7V, the switch is opened to increase the VDD voltage; When the VDD voltage increases by 0.7V, the switch is turned off again, causing the VDD voltage to decrease; Repeat the above process to enter burping mode, and the VDD voltage will not drop to the under-voltage protection point of 8.9V. This not only prevents the VDD from restarting under voltage, but also effectively reduces standby power consumption.

#### **VDD under-voltage protection**

After the abnormal state of DK5502S causes the power MOSFET to turn off, the VDD voltage will continue to decrease due to lack of energy supply. When it drops to the under-voltage protection point of 8.9V, the built-in high-voltage constant current source will be turned on, and the AC input voltage will charge the VDD pin from the DRAIN pin, causing the VDD voltage to rise. When it reaches the starting voltage of 14.3V, the chip will start working normally, which allows the circuit to automatically restart after the abnormal state is eliminated.

#### **VDD over-voltage protection**

DK5502S turns off the switch and locks the protection state when the VDD voltage reaches the over-voltage protection point of 28V, causing the VDD voltage to decrease. After dropping to the under-voltage protection point of 8.9V, the circuit restarts.

#### **Leading edge blanking**

Due to parasitic capacitance at the DRAIN of DK5502S, there is a significant peak current in the power MOSFET at the moment of turn-on. If this signal is sampled, the circuit will enter an over-current protection state. To prevent this false triggering, the IC is set to sample after the power transistor MOSFET is turned on for a period of 300ns of LEB time.

#### **Output short circuit protection**

When DK5502S detects that the input current IFB at the FB is less than 500 $\mu$ A, it determines that the output load is short circuited and enters a protection state, causing the VDD voltage to drop to the under-voltage protection point of 8.9V and restarting the circuit.

#### **Over-current protection**

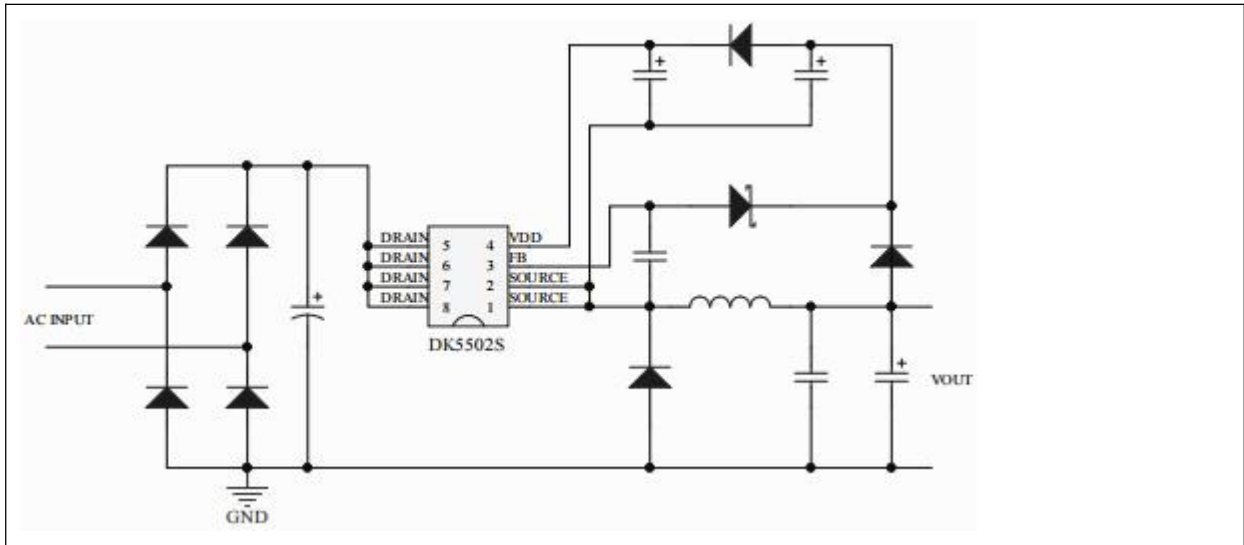
When DK5502S detects over-current at the DRAIN, reduce the number of switches until the abnormal state of over-current is eliminated before restoring normal switching.

**Over-temperature protection**

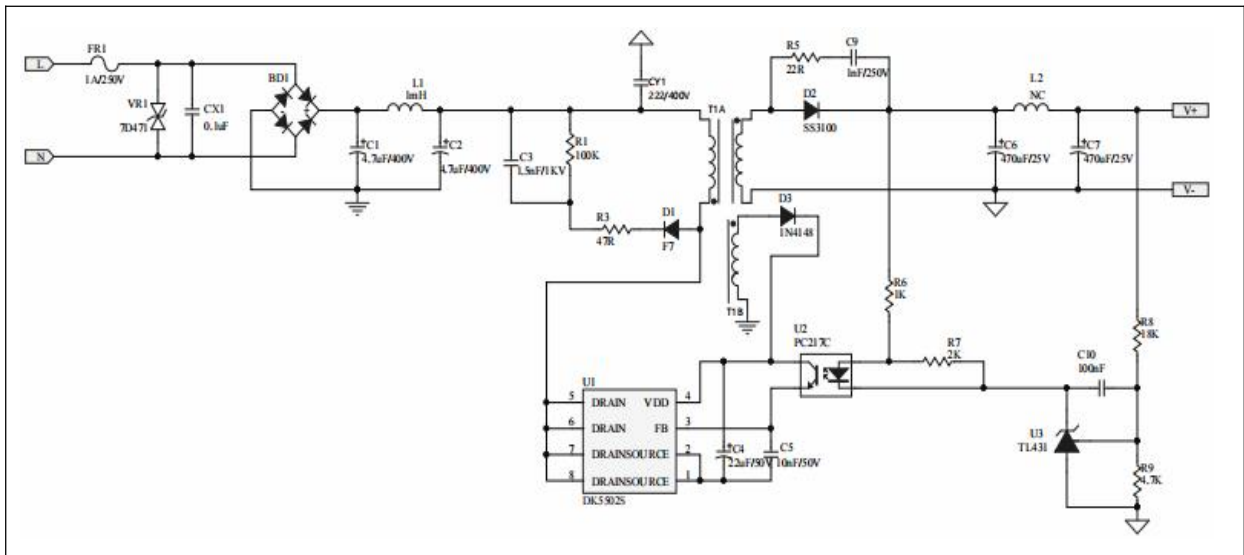
When DK5502S detects that the temperature has reached the over temperature protection point of 145°C, turn off the switch. When it detects that the temperature has dropped by 25°C, turn on the switch again.

**Typical Application Circuit Diagram**

**Non isolated application(Buck)**

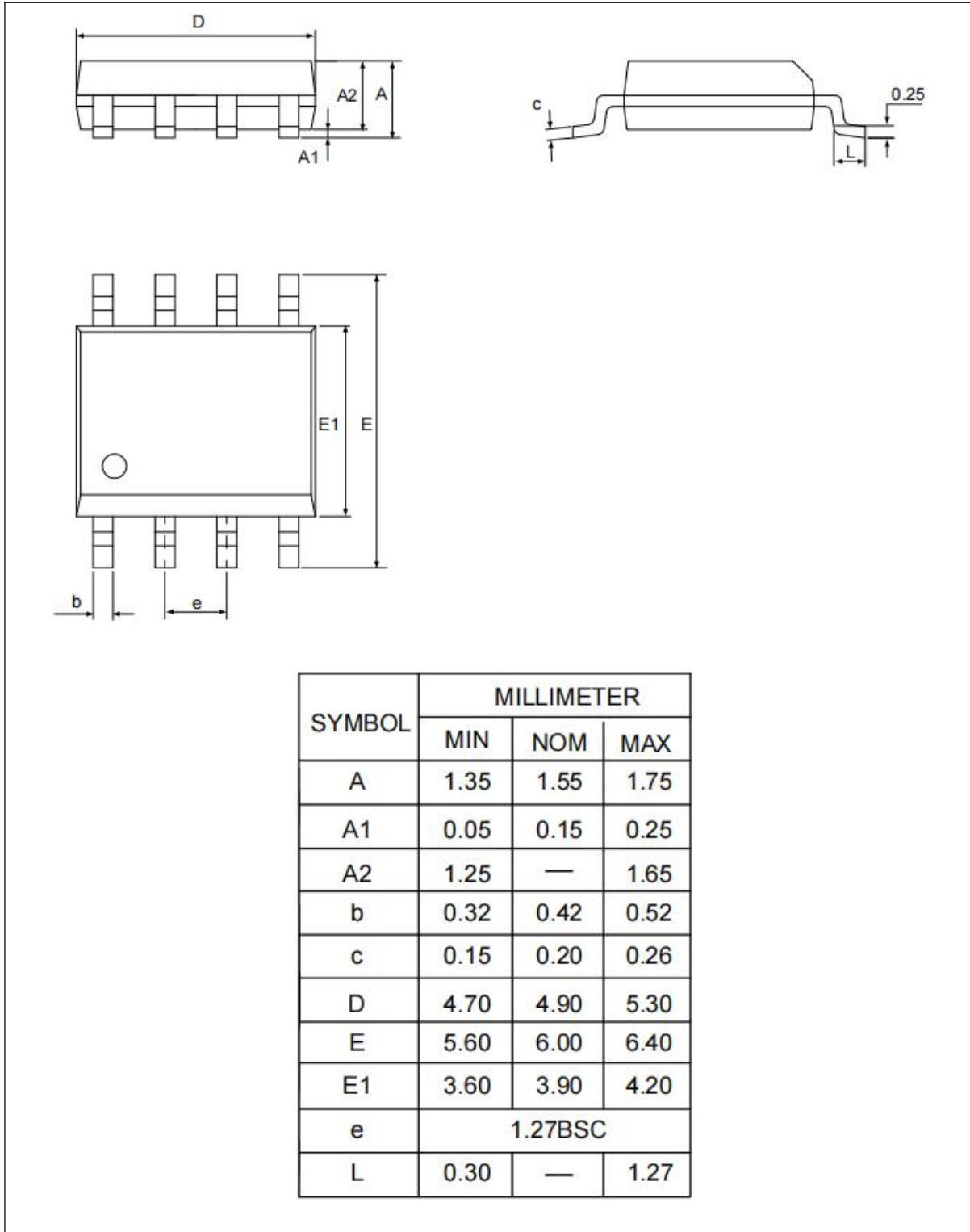


**Isolated application(Flyback)**



**PACKAGE OUTLINE DIMENSIONS**

**SOP-8**





**Caution: This product is a static sensitive component, please pay a attention to protect! The scope of ESD damage can be extpined from minor performance to equipment failure. Precision IC may be damaged, which may result in component parameters not meeting the published specifications.**

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