High Performance AC-DC Converter Chip

■ *PRODUCT DESCRIPTION*

DK22xMP/DK22xMD is a high performance, low power PWM controller chip with built-in 650V high voltage power MOSFET for power supply solutions up to 30W. In PWM mode, the switching frequency of the chip is fixed, and this frequency is set internally by the chip. The chip works in green mode at no load or light load to reduce the switching loss and improve the efficiency of the whole machine, and the hopping frequency of DK22xMP/DK22xMD is set at 25KHz to avoid audio noise when working. The chip's internal integrated totem pole drive structure can effectively improve the EMI characteristics of the system and the soft start control of the switch.

■ *MAIN FESTURE*

- Full voltage input $85V_{AC}$—$265V_{AC}$
- Built-in 650V high voltage power tube
- Soft start technology
- Frequency jittering to improve EMI performance
- Frequency hopping mode to improve light load efficiency and reduce standby power consumption
- No-load standby power consumption less than 75mW @$230V_{AC}$
- Built-in ramp compensation
- Low startup current, low operating current
- Built-in leading edge blanking (LEB) function
- Over load protection , Cycle by Cycle current limit protection , VDD over voltage protection , Under voltage protection,Over temperature protection
- 4KV ESD

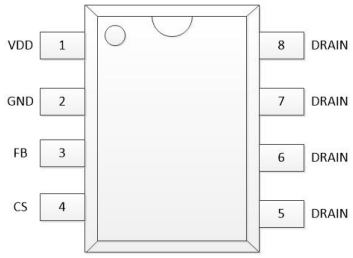
■ *TYPICAL APPLICATION*

- Charger, PD Fast Charge
- PDA,Digital Camera, Camcorder power adapter
- Set-top Box Power Supply
- Open Frame Switching Power Supply
- Personal Computer Auxiliary Power Supply

■ *PACKAGE/ORDER INFORMATION*

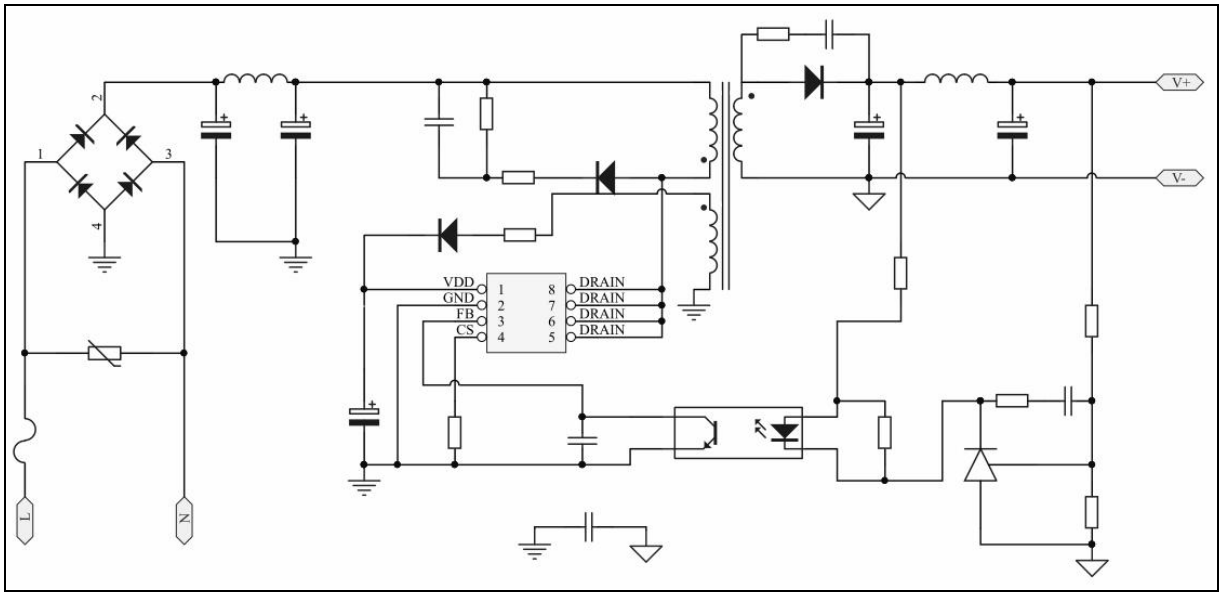
Order Codes	Package	Typical Power
		85~265VAC
DK220MP	SOP-8	20W
DK220MD	DIP-8	24W
DK225MP	SOP-8	22W
DK225MD	DIP-8	30W

■ *PIN CONFIGURATION*

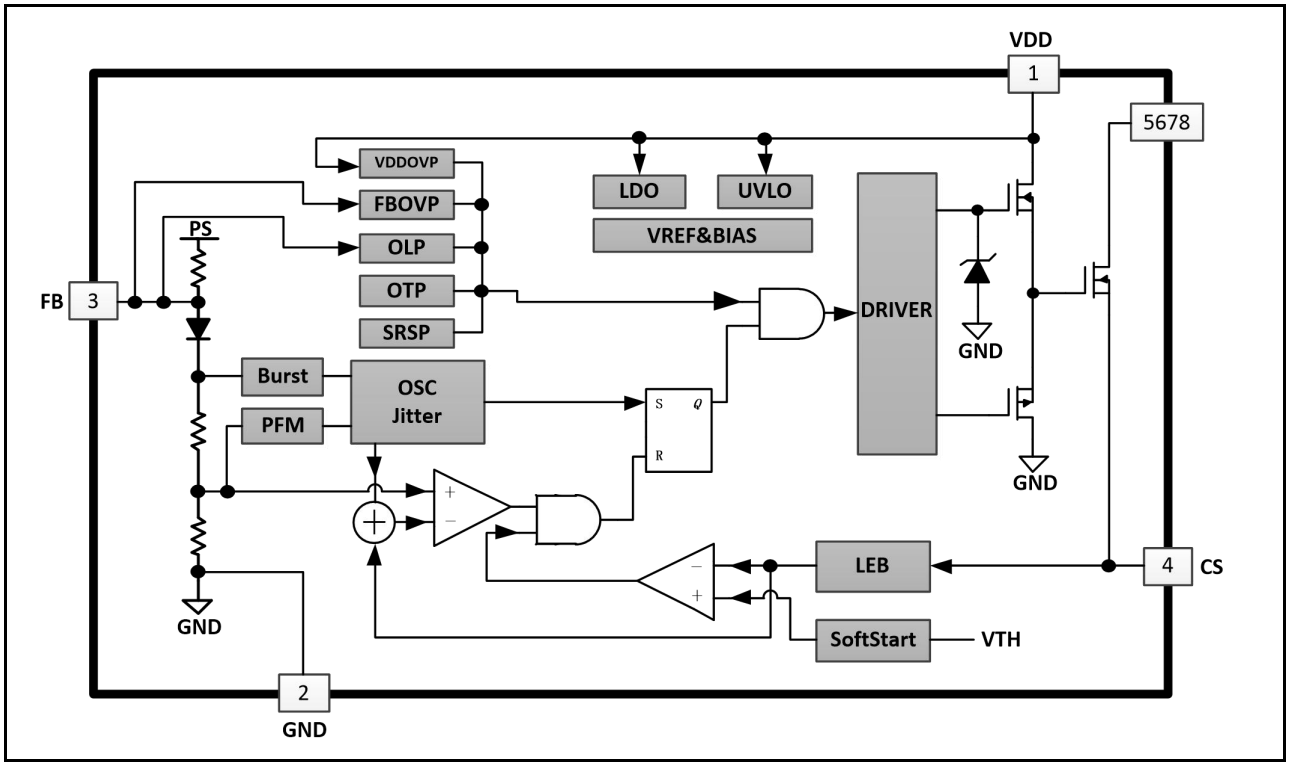


Pin No.	Pin Name	Description
1	VDD	Power supply pin.
2	GND	Ground.
3	FB	Primary side feedback pin.
4	CS	Current sense pin.
5,6,7,8	DRAIN	Drain of high voltage MOSFET.

■ *TYPICAL APPLICATION CIRCUIT*



■ *BLOCK DIAGRAM*



■ *ABSOLUTE MAXIMUM RATINGS (T_A=25℃ Unless otherwise noted)*

Parameter	Symbol	Min	Typ	Max	Unit
Power tube drain-source voltage	V_{DRAIN_MAX}		650	700	V
VDD power supply voltage	V_{DD}			40	V
IDD power supply current	I_{DD}			10	mA
FB input voltage	V_{FB}	-0.3		8	V
CS input voltage	V_{CS}	-0.3		8	V
Storage temperature range	T_{STG}	-55		155	℃
Junction temperature	T_J		150		℃
Soldering temperature	T_W		280/5S		℃

■ *ELECTRIC CHARACTERISTICS (T_A=25℃ Unless otherwise noted)*

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DD}	VDD Operation Voltage	AC input 85V-----265V	9.5	17	32	V
I_{DD_ST}	Starting current	V_{DD}=11V, test VDD terminal current		1.5	2	uA
I_{OP}	Operation Current	V_{DD}=17V, V_{FB}=3V, V_{CS}=0V		0.83		mA
$V_{uvlo(ON)}$	Undervoltage protection turn-on voltage	VDD drops to IC off	7.5	8.1	8.7	V
$V_{uvlo\ (OFF)}$	Undervoltage protection shutdown voltage	VDD rises until IC turns on	16.3	18.1	19.9	V
V_{DD_ET}	Frequency hopping protection voltage	FB=0V，CS=0V	7.7	8.5	9.1	V
V_{OVP}	Overvoltage protection	V_{DD}=17V, V_{CS} =0V, V_{FB} =3V, VDD rises until the DRAIN pin frequency disappears	37	40	43	V
V_{FB_OPEN}	FB open loop voltage		6.4	7.1	7.7	V
V_{TH_PL}	When overloaded, FB detects the voltage	V_{DD}=17V, FB rises	4.5	5	5.5	V
V_{TH_GREEN}	Green mode	V_{DD}=17V, V_{CS}=0V, V_{FB}=3V, FB decreases, when the frequency of DRIAN terminal is less than 35KHz		2.2		V

V_{TH_BM}	Frequency hopping mode	V_{DD}=17V, FB drops		1.2		V
T_{LEB}	Leading edge blanking time			400		ns
T_{stop}	Power tube turn-off dwell time when abnormal	V_{DD}=17V, the output secondary diode is shorted	1.8	2	2.2	s
Z_{CS_IN}	CS pin input impedance			40		kΩ
V_{cs_opph}	When the maximum rate of 85V_{AC}, CS pin overcurrent protection threshold	V_{DD}=17V, V_{FB}=4.2V, CS rises to turn off the power tube	690	720	750	mV
V_{cs_oppL}	265V_{AC} maximum rate, CS pin overcurrent protection threshold	V_{DD}=17V, V_{FB}=3.6V, CS rises to turn off the power tube	540	560	580	mV
V_{cs_max}	Over-power, CS pin over-current protection threshold	V_{DD}=17V, V_{FB}=6V, CS rises to turn off the power tube	770	800	830	mV
T_{D_OC}	Overcurrent protection delay time	Delay time from overcurrent protection to power tube start to turn off		120		ns
$F_{OSC(fast)}$	The fastest oscillation frequency	V_{DD}=17V, V_{FB}=3V, V_{CS}=0V	60	65	70	KHz
$F_{OSC(slow)}$	Slowest oscillation frequency	V_{DD}=17V, V_{FB}=1.4V, V_{CS}=0V	23	25	27	KHz
D_{MAX}	maximum duty cycle	V_{DD}=17V, V_{FB}=3.3V, V_{CS}=0V		75		%
F_{BURST}	hopping frequency			25		KHz
ΔF_{OSC}	Frequency jitter range		-5		5	%
$R_{DS(ON)}$	Power tube on-resistance	DK220MP	1.8	2		Ω
		DK220MD	1.8	2		Ω
		DK225MP	1.2	1.3	1.4	Ω
		DK225MD	1.2	1.3	1.4	Ω
T_{OTP}	Chip over temperature protection			150		℃

■ *OPERATION DESCRIPTION*

DK22xMP/DK22xMD is a high-performance, low-power switching power supply controller chip for power supply solutions up to 30W. With built-in frequency hopping and dithering functions, it can effectively reduce standby power consumption, improve system EMI performance, and meet EU Class VI energy efficiency standards.

1. Start up

DK22xMP/DK22xMD has a very low start-up current and a built-in high-voltage start-up circuit to meet start-up requirements while reducing losses. For most AC/DC solutions, with the right VDD capacitor, the whole system can be quickly started up in the full voltage range ($85V_{AC}$ - $265V_{AC}$).The DK22xMP/DK22xMD has a typical operating current of about 0.83mA, and the unique hopping mode control mode improves overall efficiency.

2. Soft start

The DK22xMP/DK22xMD has a built-in 2mS soft-start circuit that buffers the switching stress on the MOSFETs during circuit startup. Once the VDD voltage reaches UVLO(OFF) the soft-start is activated and the peak current limit voltage gradually reaches 0.8 V from 0. Each restart follows the occurrence of a soft-start.

3. Frequency jitter

The DK22xMP/DK22xMD has a built-in frequency jittering function that can effectively improve the EMI characteristics of the system and simplify the circuit design.

4. Frequency hopping

At no load or light load, most of the losses in the system are made up of the switching losses of the MOSFET, the core losses of the transformer and the losses in the buffer network. The largest loss comes from the switching losses, so reducing the switching frequency of the system can effectively reduce the losses.

During normal system operation, the frequency is regulated by the loop and the IC. At no load or light load, the switching frequency will be reduced to improve efficiency, and when the FB voltage drops below 1.2V, the IC will enter the frequency hopping mode. In the frequency hopping mode, the gate driver of the IC will work only when the VDD voltage is lower than the preset level or the FB voltage is higher than 1.2V, otherwise the gate driver circuit will remain off to reduce the switching loss and reduce the standby power consumption. The frequency of frequency hopping is set outside the audio range to ensure no audio noise during normal operation.

5. Oscillation frequency

The DK22xMP/DK22xMD has the fastest switching frequency of 65KHz and requires no peripheral circuitry for setup.

6. Current sampling and leading edge blanking

The DK22xMP/DK22xMD uses current mode PWM and variable frequency PFM control to provide cycle-by-cycle current limit protection. The power tube current is

detected by a sampling resistor connected to the CS pin. When the internal power tube is just turned on, the reverse recovery current of the diode in the buffer network and the discharge current of the power tube drain capacitor cause a high voltage spike on the sampling resistor, which causes the chip to misjudge the current, while the DK22xMP/DK22xMD has a 400ns fading time on the CS pin to shield the chip from this spike, so there is no need for an RC filter network outside the CS pin. During the frontier fading time, the current limit comparator does not work and cannot turn off the power tube. The PWM duty cycle of the chip is determined by the voltage on the sampling resistor together with the voltage on the FB.

7. slope compensation

The DK22xMP/DK22xMD provides ramp compensation to superimposes the voltage sawtooth signal on the sampled current signal. When the chip operates in CCM mode, especially when the duty cycle is greater than 50%, it avoids subharmonic oscillations in the loop.

8. Power tube driver

The DK22xMP/DK22xMD adopts a unique drive technology. Too weak driving ability will make higher switching losses, driving too strong is prone to EMI problems. DK22xMP/DK22xMD adopts an optimized totem pole structure to obtain better EMI characteristics and lower losses through reasonable output drive capability and dead time.

9. Protective function

The DK22xMP/DK22xMD has comprehensive protection functions, including cycle-by-cycle current limit protection (OCP), over load protection (OLP), over temperature protection (OTP), VDD over voltage protection, under voltage protection (UVLO) and output Schottky anomaly protection.

The DK22xMP/DK22xMD has a built-in current limit point line voltage compensation function to ensure that the circuit has a constant current limit point over the full operating voltage range ($85V_{AC}$-$265V_{AC}$), which also ensures constant power.

When overload or short circuit occurs, the FB voltage will exceed V_{TH_PL} (overload protection FB threshold). When the VDD voltage is lower than $V_{uvlo(ON)}$, the chip's overload protection circuit starts to work, the chip turns off the power tube, and after delaying T_{stop}, the circuit can resume normal operation only after entering the end of VDD restart.

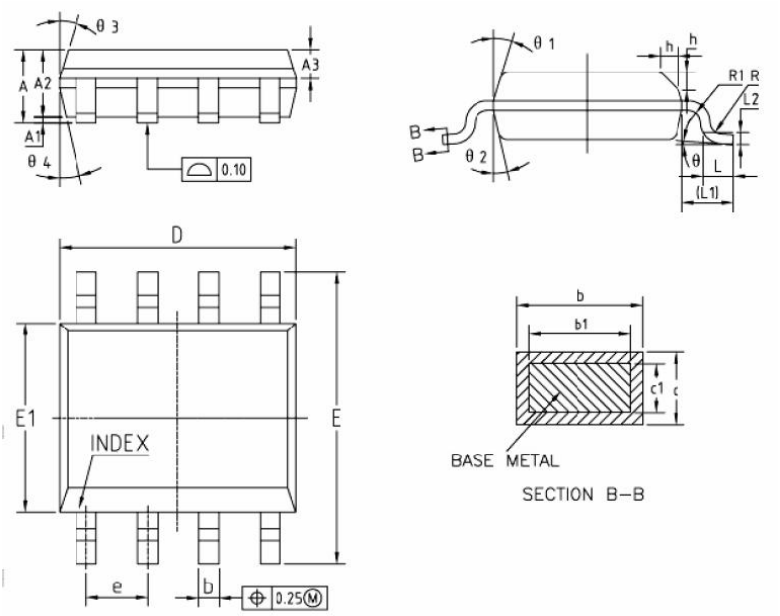
When the circuit starts , the transformer auxiliary winding provides energy to the VDD capacitor. When the VDD voltage exceeds V_{OVP}, the overvoltage protection circuit works, the chip turns off the power tube, and after delaying T_{stop}, the circuit can resume normal operation only after entering the need of VDD restart.

When the FB voltage falls below V_{TH_PL} and the VDD voltage drops below V_{UVLO}, the chip's undervoltage protection (UVLO) circuit works to shut down the chip and enter the end of VDD restart before the circuit can resume normal operation.

10. Design Points

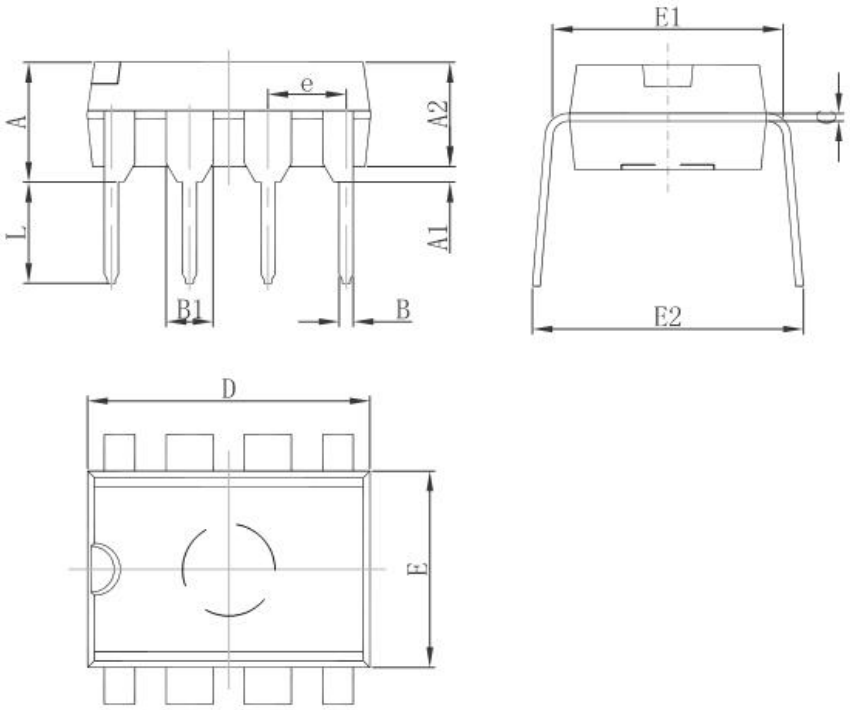
- Power devices are required to dissipate heat, the main heat of the chip from the power switch tube, power switch tube and pin DRAIN connected, so the PCB wiring, the pin DRAIN external copper foil area should be increased and tinned to increase the heat dissipation capacity, appropriate and transformers and other heat generating components to pull away from the distance to reduce the thermal effect; at the same time, this part is also the AC signal part, in EMI/EMC design this position as far away as possible from the input part, to minimize electromagnetic / capacitive coupling ;
- The DRAIN pin of the chip is the high-voltage part of the chip, with a maximum voltage of 650V or more, so in the line layout, to ensure a safe distance of more than 1.5mm from the low-voltage part to avoid circuit breakdown discharge phenomenon;
- Leakage inductance of transformer: Since transformer is not an ideal device, there must be leakage inductance in the manufacturing process,leakage inductance will affect the quality and safety of the product, so it should be reduced. Leakage inductance should be controlled within 5% of the inductance, sandwich winding method can reduce leakage inductance;

■ *SOP-8 PACKAGE OUTLINE DIMENSIONS*



Symbol	Dimensions In Milimeters	
	Min	Max
A	1.35	1.75
A1	0.10	0.25
A2	1.25	1.65
A3	0.50	0.70
b	0.38	0.51
b1	0.37	0.47
c	0.17	0.25
c1	0.17	0.23
D	4.70	5.10
E	5.80	6.20
E1	3.80	4.00
L	0.45	0.80
L1	1.04REF	
L2	0.25BSC	
e	1.270(BSC)	
θ	0°	8°

■ *DIP-8 PACKAGE OUTLINE DIMENSIONS*



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	3.710	4.310	0.146	0.170
A1	0.510		0.020	
A2	3.200	3.600	0.126	0.142
B	0.380	0.570	0.015	0.022
B1	1.524(BSC)		0.060(BSC)	
C	0.204	0.360	0.008	0.014
D	9.000	9.400	0.354	0.370
E	6.200	6.600	0.244	0.260
E1	7.320	7.920	0.288	0.312
e	2.540(BSC)		0.100(BSC)	
L	3.000	3.600	0.118	0.142
E2	8.400	9.200	0.331	0.354