1. Features

- *Built-in 18mΩ on-resistance and 45V breakdown voltage MOSFET*
- *Programmable resistor to filter resonant ringing signals*
- *Fewest components counts*
- *Excellent system ESD and EFT performance*

2. Applications

- *Smart phone chargers*
- *Power strip with USB ports*
- *5V adapters*

3. Typical applications (5V/2.4A charger)

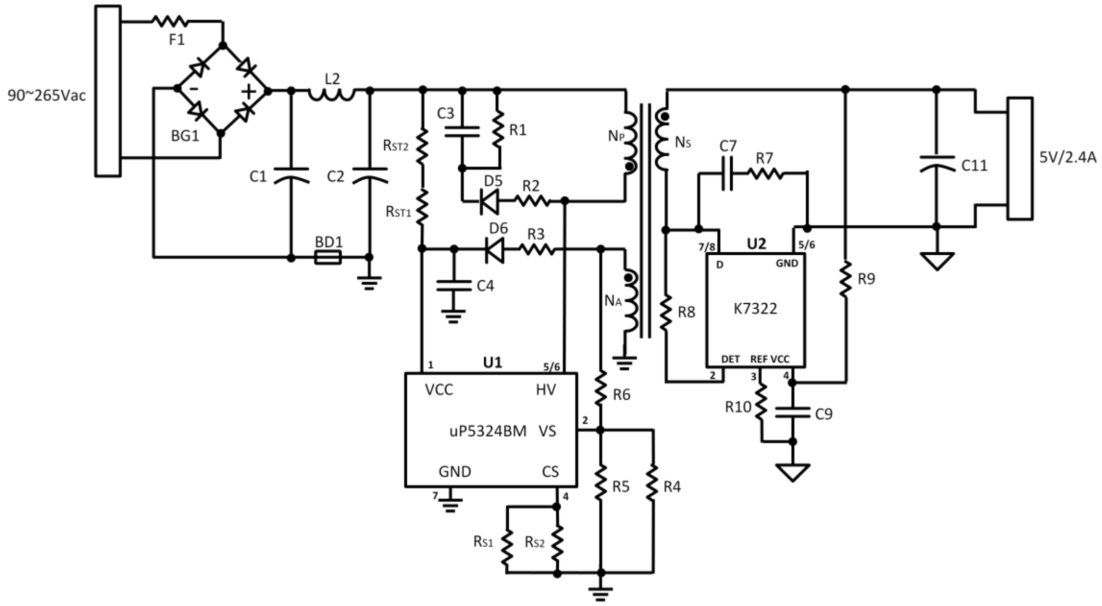
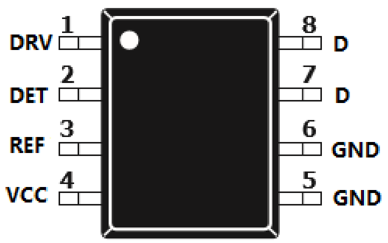


Fig.1 Typical applications

4. Ordering information

Part number	Mark ID	Package	Quantity per reel	Output power
K7322M-45	7322M-45	SOP-8	3,000	10~12W

5. Pin definitions



K7322M-45

Pin Name	Pin Type	Pinout	Pin Functions
DRV	Output	1	Gate drive of SR MOSFET
DET	Input	2	Drain voltage detection of SR MOSFET
REF	Output	3	Volt-second setting for SR MOSFET turn on
VCC	Power supply	4	Power supply of the rectifier

GND	Ground	5，6	Source of the SR MOSFET and the power ground.
D	Drain	7，8	Drain of the SR MOSFET

5. Absolute maximum ratings *(Note 1)*

Parameter	Name	Range	Unit
Voltage range	VCC	-0.3 to 7	V
Voltage range	DRV	-0.3 to 6	V
Voltage range	DET	-2 to 50	V
Voltage range	REF	-0.3 to 6	V
Voltage range	D	-2 to 45	V
Continuous drain current	I_D	10	A
Pulse drain current	I_{DP}	40	A
Power dissipation @ T_A=25 ℃	P_D	0.8	W
Maximum junction temperature	T_{JMAX}	150	℃
Lead temperature	T_{LEAD}	300	℃
Storage temperature	T_{STG}	-55 to 150	℃
ESD rating per JEDEC JESD22-A114	HBM	2000	V
ESD rating per JEDEC JESD22-C101C	CDM	1000	V
Latchup test per JEDEC 78		+/-200	mA

Note1: Stresses over those listed under "Absolute maximum ratings" may cause permanent damages to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Conditions" is not implied. Exposure to "Absolute Maximum Ratings" for extended periods of time may affect device reliability.

6. Thermal parameter

Junction to ambient thermal resistance	θ_{JA}(SOP-8)	90	℃/W
Junction to case thermal resistance	θ_{JC}(SOP-8)	45	℃/W

7. Recommended operating conditions

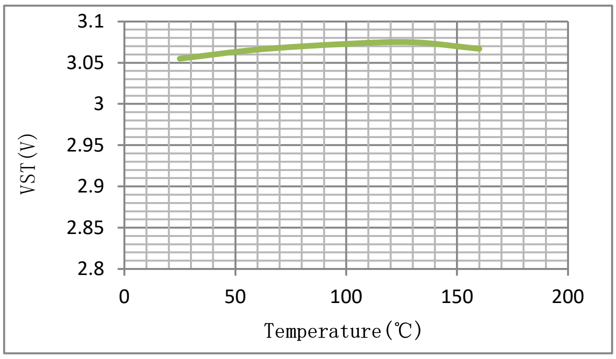
Parameter	Symbol	Min	Max	Unit
Supply voltage	VCC	3.3	6	V
Ambient Temperature	T_A	-40	85	℃

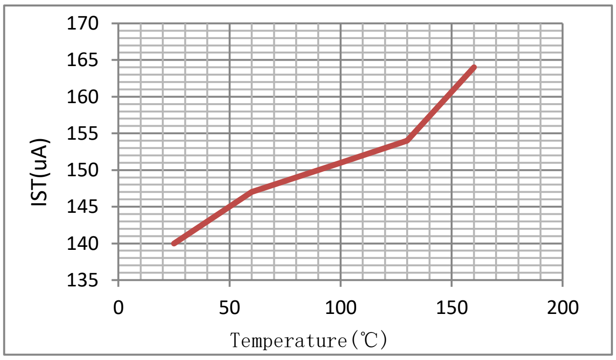
8. Electrical parameters

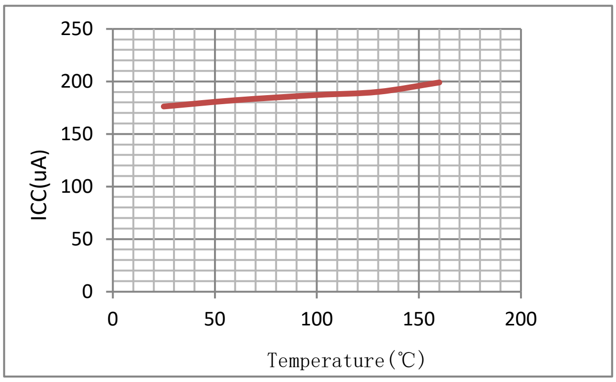
T_A =25 ℃, unless otherwise specified

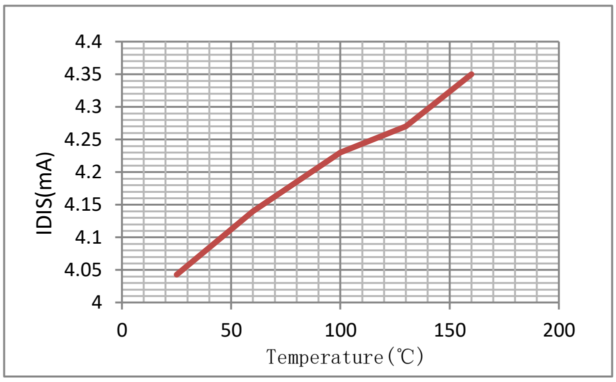
Parameter	Symbol	Condition	Min	Typ	Max	Unit
Power supply(VCC pin)						
Operating current	I_{CC}		180	200	220	μA
Startup voltage	V_{ST}		2.68	2.98	3.28	V
Minimum operating voltage	V_{UVLO}		2.5	2.8	3.1	V
Startup current	I_{ST}	VCC= V_{ST} -0.1V	110	140	170	μA
Output voltage monitor						
VCC discharge voltage	V_{DIS}		5.39	5.47	5.55	V
VCC discharge current	I_{DIS}	VCC= V_{DIS}+0.1V	1.5	3	4.5	mA

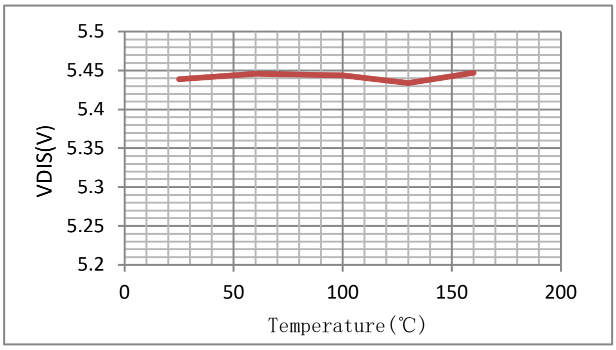
VCC protection voltage	V_{OVP}		5.75	5.85	5.95	V
VCC over voltage discharge current	I_{OVP}	VCC= V_{OVP}+0.1V	40	97	130	mA
VCC OVP discharge time	T_{OVPDIS}		672	800	928	µS
Internal oscillator period	T_{OSC}		21	25	29	µS
Synchronous rectification control						
SR turn on voltage	V_{THON}			75		mV
SR turn off voltage	V_{THOFF}		-6	-2	2	mV
SR turn on delay time	T_{DON}		10	70	130	nS
SR turn off delay time	T_{DOFF}		10	100	150	nS
SR turn on rising time	T_R	C_L=4.7nF	10		100	nS
SR turn off falling time	T_F	C_L=4.7nF	10		100	nS
SR minimum on time	T_{LEB_S}	(V_{DET}-VCC)*T_{ONP} =30V*µS		2.2		µS
SR minimum operating voltage(V_{DET}-VCC)	V_{S_MIN}	Minimum DET pin voltage@VCC=5V		3.0		V
Ampere Second Product	ASP	(V_{DET}-VCC)*T_{ONP} =25V*µS	0.5	0.7	0.9	mA*µS
SR MOSFET characteristics						
Drain to source breakdown	BVdss	V_{GS}=0V, I_D=0.25mA	45			V
Gate threshold voltage	$V_{GS(TH)}$	V_{DS} = V_{GS}, I_D=0.25mA	1.0	1.5	2.0	V
Static Drain-to-Source On Resistance	R_{DSON}	V_{GS}=5.5V, I_D =15A		18	25	mΩ
Drain-to-Source leakage	I_{DSS}	V_{GS}=0V, V_{DS}=50V			1	µA
Gate to source leakage	I_{GSS}	V_{GS}=+/-20V	-100		100	nA

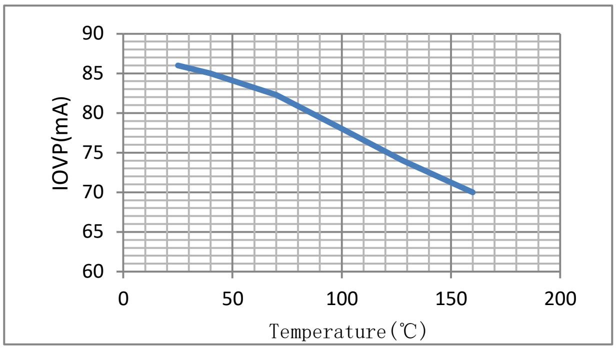


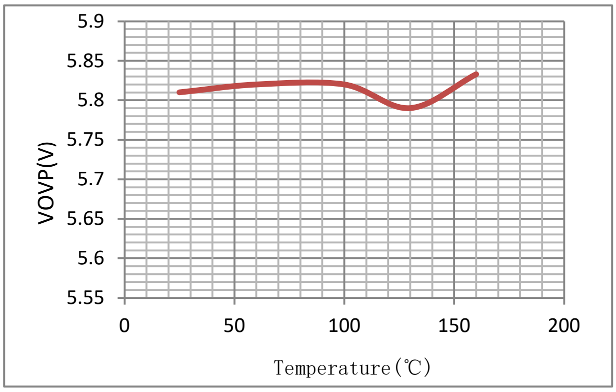


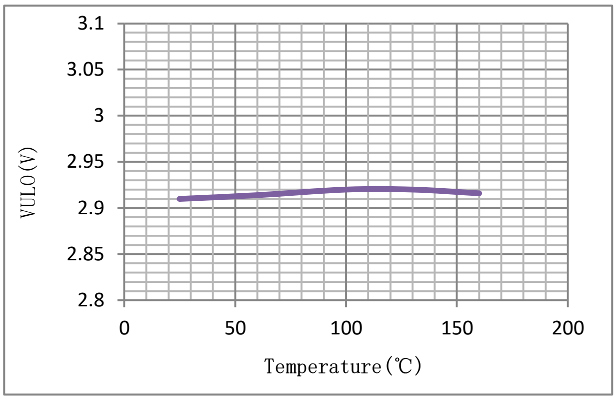


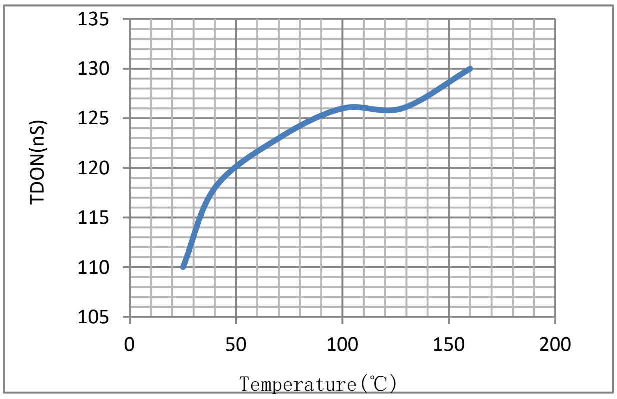


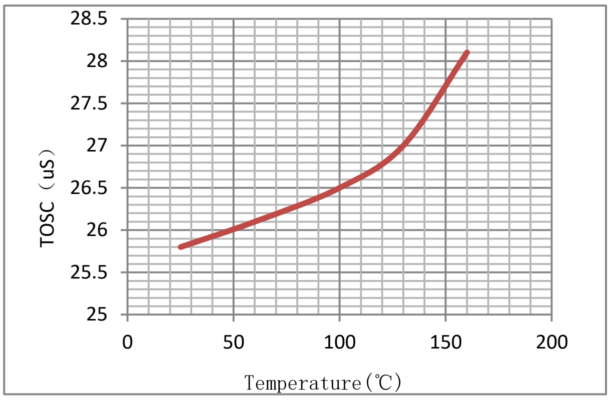












9. Functional block diagram

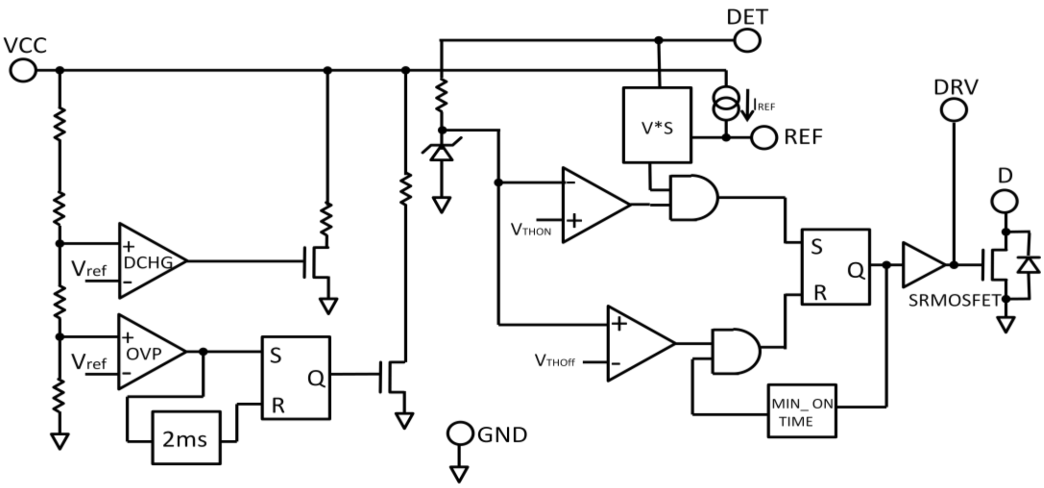


Fig.2, K7322 block diagram

10. Principle of operation

The K7322 has two major functions: output voltage monitor to discharge output capacitor at certain conditions and synchronous rectification. The device must work in Discontinuous Conduction Mode (DCM) or Quasi-Resonant Mode (QRM).

10.1 Power up and power down sequences

Refer to Fig.1 and Fig.2, after AC power supply is applied to the converter, the primary controller UP5324A (U1) starts to deliver energy to the output capacitor C11, the output voltage begins rising from 0V. When the VCC voltage of K7322 (U2) is lower than the startup voltage V_{ST}, the synchronous rectifier does not work, the body diode of the SR MOSFET acts as the rectification diode, with around -1.5V forward conduction voltage since the body diode of the SRMOSFET is just an ordinary PN junction. When the VCC voltage of K7322 (U2) is larger than the startup voltage V_{ST}, the synchronous rectifier starts to work, as described in 10.3. When the AC power supply is removed from the converter, the VCC voltage of K7322 (U2) falls below V_{UVLO}, the synchronous rectifier stops working, the body diode of the SRMOSFET acts again as the rectification diode.

10.2 Discharge of output capacitor

When the VCC voltage of K7322 (U2) is higher than a specified voltage V_{DIS}, K7322 will turn on a discharge path from VCC to GND with typical 3mA current capacity to make the system output voltage stay around V_{DIS}. When the VCC voltage of K7322 (U2) is further higher than a specified voltage V_{OVP}, such as in case of load transient from full load to no load, K7322 will turn on another discharge path from VCC to GND with typical 70mA current capacity to limit the system output over shoot voltage.

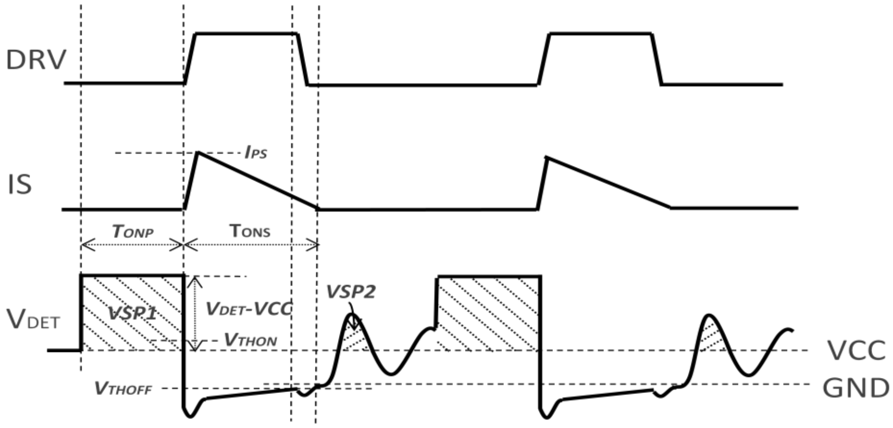


Fig.3, K7322 SR operation

10.3 Synchronous rectification

Refer to Fig3, K7322 monitors the SR MOSFET drain to source voltage at DET pin. When the V_{DET} is lower than the turn-on threshold voltage V_{THON}, K7322 DRV pin generates a positive drive voltage after a turn-on delay time (T_{DON}). The SR MOSFET will turn on and the current will transfer from the body diode to the channel of the SR MOSFET.

After the conduction of the SR MOSFET, the V_{DET} rises linearly. When it rises over the turn off threshold voltage V_{THOFF}, K7322 DRV pin generates a pull down signal after a turn-off delay (T_{DOFF}).

During the SRMOSFET turn on process, some ringing noise may be generated. The minimum on-time block blanks the output of V_{THOFF} comparator, keeping the SR MOSFET on for at least the *minimum on time. The minimum on time is proportional to the volt second product (VSP)of the primary side power switch on state, which is equal to (V_{DET}-VCC)*T_{ONP}. If (V_{DET}-VCC)*T_{ONP} =30V*µS, the minimum on time is about 2.2µS.*

As the convertor operates in DCM or QRM, after synchronous rectifier stops conduction, resonant ringing is resulted due to the primary inductance and power switch parasitic capacitance. This ringing waveform may leads to the error conduction of the synchronous rectifier. To avoid this fault, K7322 judges the primary power switch turn on by the Volt-Second Product (VSP) of the system. The volt-second product (VSP1) of a primary switch turn on is much higher than the volt-second product (VSP2) of the resonant ringing waveform, as illustrated in Fig.3. Thus, before to turn on the synchronous rectifier, K7322 judges if the detected volt-second product of V_{DET} voltage above VCC is higher than a threshold (VSP_{REF}) and then turn on synchronous rectifier if the detected VSP is larger than VSP_{REF} . The purpose of REF resistor is to set the volt-second product threshold (VSP_{REF}). The detected volt-second product

$$VSP = \int (V_{DET} - VCC) * dt = R_{VSP} * C_{VSP} * V_{VSP}$$

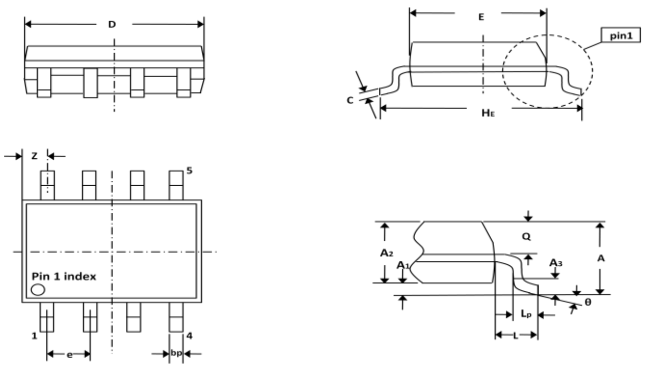
Where R_{VSP} is an internal resistor to convert the (V_{DET}-VCC) voltage to charge an internal capacitor C_{VSP}, and V_{VSP} is the voltage rise on C_{VSP} when the charging phase is completed. In K7322, the V_{VSP} to judge whether the VSP is generated by primary side power switch or not is set by an internal current source I_{REF} and outside resistor R_{REF} (R10 in Fig.1). So, the judging volt-second product

$$VSP_{REF} = (R_{VSP} * C_{VSP} * I_{REF}) * R_{REF} = ASP * R_{REF}$$

*Where ASP=(R_{VSP}*C_{VSP}*I_{REF}) is a K7322 determined "Ampere Second Product" to set system VSP_{REF} with R_{REF}. VSP_{REF} depends on system design and are always fixed after system design is frozen. R_{REF} resistor should be considered for the worst case, that is, the minimum primary peak current condition. VSP_{REF} should be designed in the middle of VSP1 and VSP2. K7322 also sets a minimum line voltage to operate the SR MOSFET. The value of V_{DET}–VCC during primary side power switch turn on time (T_{ONP}) must be higher than V_{S_MIN} to enable the synchronous rectifier. That is, the minimum rectified input line voltage (V_{IN_MIN})to enable the SR is*

$$V_{IN\_MIN} = V_{S\_MIN} * (N_P / N_S)$$

11. Mechanical dimensions



UNIT	A	A1	A2	A3	bp	c	D	E	e	HE	L	Lp	Q	θ
mm	1.75	0.1/ 0.25	1.25/ 1.5	0.25	0.33/ 0.51	0.19/ 0.25	4.7/ 5.1	3.8/ 4.0	1.27	5.8/ 6.2	1.05	0.4/ 1.0	0.6/ 0.7	8°