1. Features

- AC voltage range: 90Vac~265Vac
- Adjustable cable compensation
- Quasi-resonant turn on
- DoE(VI)/CoC tier2 compliant efficiency
- Low standby power
- Output short circuit protection
- Control loop open protection

2. Applications

- Chargers/adapters

3. Typical applications (12V/2A Adapter)

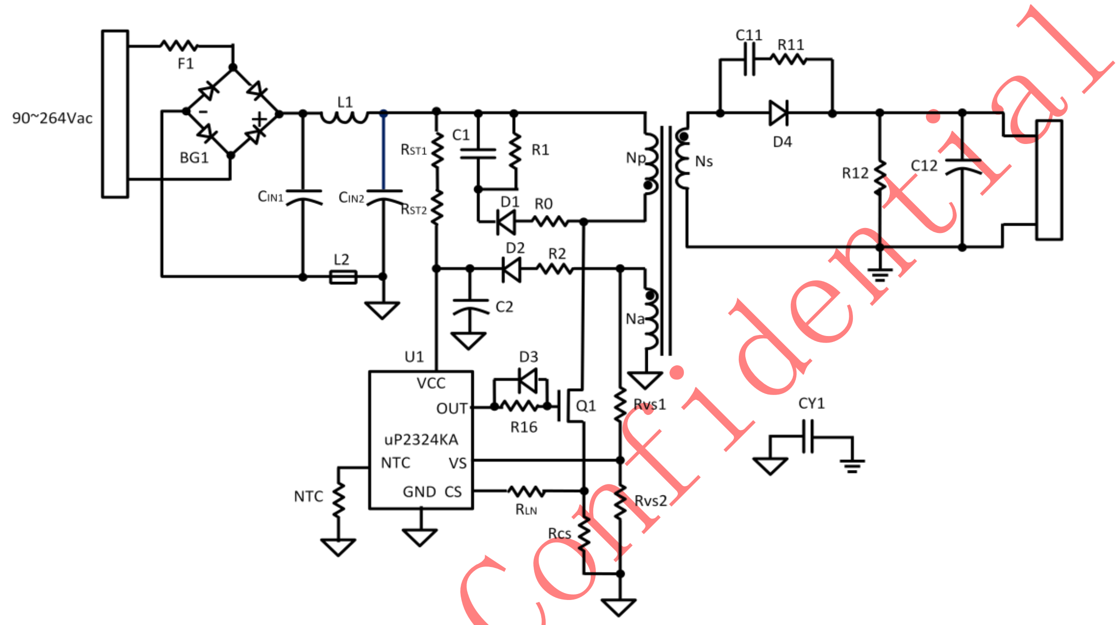
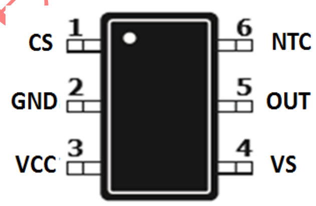


Fig.1, µP2324KA based on 12V2A solution

4. Pin definitions



µP2324KA

Pin Name	Pin Type	Pin number	Pin Functions
CS	Input	1	Current sense
GND	Ground	2	
VCC	Power	3	Supply of the controller
VS	Input	4	Voltage sense
OUT	Output	5	Gate drive of power transistor
NTC	Input	6	Connecting to GND via a NTC resistor

5. Absolute maximum ratings (Note 1)

Parameter	Name	Range	Unit
Voltage at VCC to Ground	VCC	-0.5 to 40	V
VS input voltage	VS	-30 to 6	V
Voltage at CS to Ground	CS	-0.5 to 6	V
Voltage at OUT to Ground	OUT	-0.5 to 15	V
Maximum junction temperature	T_{JMAX}	150	℃
Lead temperature	T_{LEAD}	260	℃
Storage temperature	T_{STG}	-55 to 150	℃
ESD rating per ANSI/STM5.1-2001	HBM	2000	V
ESD rating per JEDEC EIA/JESD22-C101F	CDM	1000	V
Latchup test per JEDEC NO. 78D		+/-200	mA

Note1: Stresses over those listed under "Absolute maximum ratings" may cause permanent damages to the device. These are stress ratings only. Functional operation beyond those under "Recommended operating conditions" is not implied.

6. Thermal parameter

Junction to ambient thermal resistance	θ JA(SOT23-6)	200	℃/W
Over temperature protection	T_{OTP}*	160	℃

*Typical, guarantee by design

7. Recommended operating conditions

Symbol	Parameter	Range	Unit
VCC	Supply voltage	8~30	V

8. Electrical parameter

(Ta=25 ℃, unless otherwise specified)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Power supply (VCC pin)						
VCC overvoltage protection	VCC_{OVP}		30	33	36	V
Quiescent current @ no load	I_{CC}	VCC=Vst-1V	210	270	330	µA
Startup voltage	V_{ST}		10.8	12.8	14.8	V
Minimum operating voltage	V_{UVLO}		6.3	7	7.7	V
Startup current	I_{ST}	VCC=Vst-0.5V		0.1	0.6	µA
Constant voltage control (VS pin)						
VS regulation voltage	V_{FB}		1.81	1.84	1.87	V
Cable compensation current	I_{CAB}	At no load		54		µA
Minimum discontinuous time	Toff_max			6		mS

Dynamic function section						
Delay Time for Dynamic Function	Td	–		136		µs
Trigger Voltage for Dynamic Function	Vtrigger	–		54		mV
Constant current control (CS pin)						
Shutdown voltage @full load	V_{CSMAX}		533	560	587	mV
Shutdown voltage @light load	V_{CSMIN}			300		mV
Leading edge blanking	T_{LEB}			600		nS
Maximum duty of secondary winding conduction	D_{SMAX}		0.47	0.50	0.53	
Line compensation current	I_{LN}	VS=-5V		33		µA
Drive (OUT pin)						
Gate clamp voltage	V_{GCLAMP}			11		
Output low voltage	V_{OL}				0.8	V
Output high voltage	V_{OH}		9			V
OUT rising time	T_R	CL=1nF		160	220	nS
OUT falling time	T_F	CL=1nF		40	60	nS
Protection functions						
Over temperature protection	T_{OTP}			160		℃
Output over voltage	V_{FBOVP}			2.9		V
Short circuit voltage	$V_{FBHICCUP}$			1.3		V
NTC shutdown (falling)				0.5		V
NTC recovery (rising)				1.0		V
NTC pull up current			90	100	110	µA

9. Functional block diagram

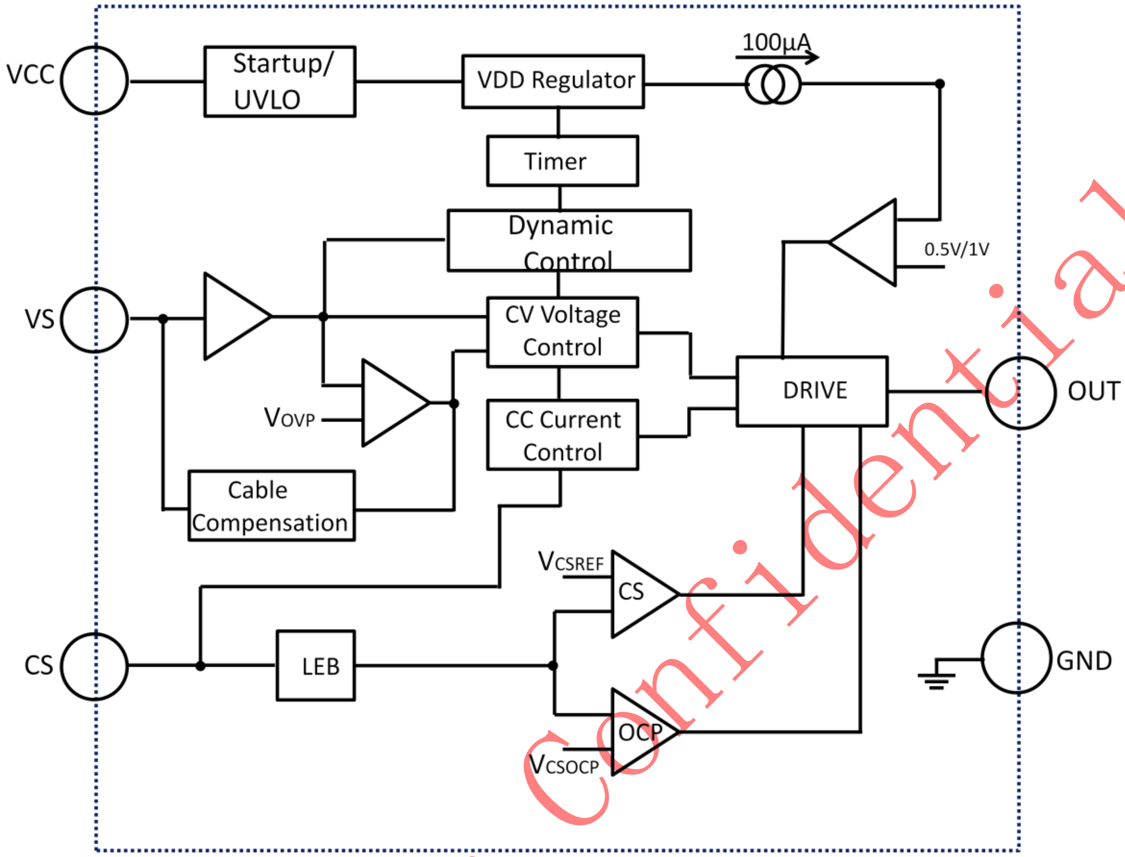


Fig.2, µP2324KA functional block diagram

10. Principle of operation

The µP2324KA is a high performance offline AC-DC controller for mobile phone charger and adapter applications. The device operates in Discontinuous Conduction Mode (DCM) with Primary Side Regulation (PSR) to achieve Constant Voltage (CV) and Constant Current (CC) in the whole load range.

10.1 Power up and power down sequences

Refer to Fig.1 and Fig.2, after AC power supply is applied to the converter, VCC capacitor C2 is charged via the startup resistors R_{ST1} and R_{ST2}. When VCC voltage reaches startup voltage V_{ST}, the controller U1 starts to work.

Then OUT pin generates driving current to turn on the power transistor Q1, and voltage on CS pin is ramping up as the current through the primary winding generates voltage drop across the current sense resistor R_{CS}. When the CS pin voltage reaches V_{CSREF} after the Leading Edge Blanking (LEB) time T_{LEB}, the controller turns off the power transistor, then generates next turn on event according to the load conditions of the charger.

When the AC power is removed, there is no sufficient energy in the input capacitor C_{IN1} and C_{IN2}, the VCC voltage continues dropping. When VCC voltage drops below V_{UVLO}, the power transistor Q1 is forbidden in on state, the controller waits for the VCC voltage to be higher than VST for a new round startup.

10.2 Constant Voltage (CV) operation

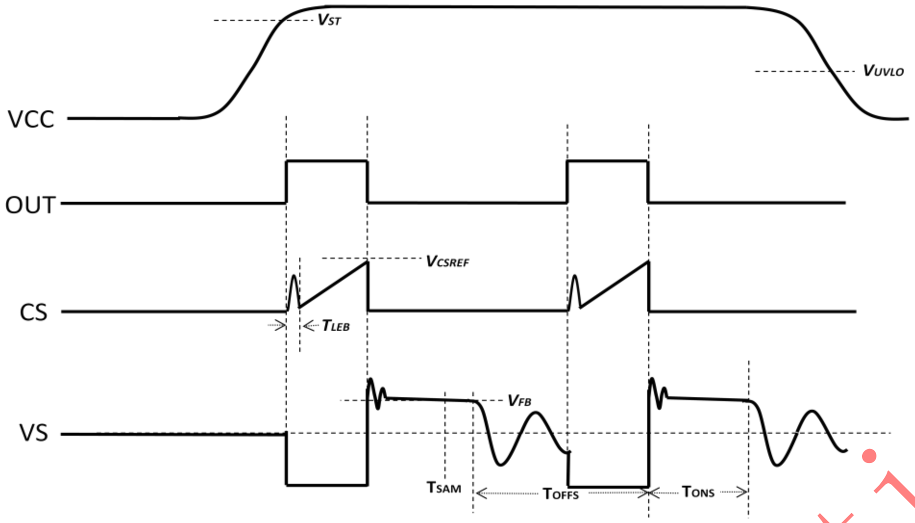


Fig.3, switching waveforms of typical application

Constant voltage operation occurs when the load is between no-load and full-load. Output voltage is sensed at the VS pin, which is connected to the auxiliary winding via resistors R_{VS1} and R_{VS2}. As shown in Fig.3, the VS waveform is sampled at T_{SAM} , around 2/3 duration of the secondary winding conduction time(T_{ONS}). The sampled voltage is regulated at V_{FB} by the voltage control loop. The CV output is determined by the resistors R_{VS1}, R_{VS2} and the turn ratio of secondary winding to auxiliary winding (N_S/N_A). The target output voltage at cable end is:

$$V_O=V_{FB}*(1+R_{VS1}/R_{VS2})*(N_S/N_A)$$

10.3 Cable Compensation

The VS pin sources a current which is inverse proportional to load current to generate cable drop compensation voltage. The cable drop compensation current at no load is I_{CAB}. The cable drop compensation voltage V_{CAB} can be adjusted by setting the R_{VS1} value. Neglecting the forward conduction voltage of the synchronous rectifier (K7215MB) in the secondary side, the cable compensation voltage at full load is approximately

$$V_{CAB} =I_{CAB}*R_{VS1}*(N_S/N_A)$$

The output voltage at PCB end is then

$$V_{OPCB}= V_O+V_{CAB}$$

The cable drop compensation percentage is therefore

$$V_{CAB}/V_O=I_{CAB}*(R_{VS1}//R_{VS1})/V_{FB}$$

10.4 Constant Current (CC) operation

Output current is limited by the maximum ratio of secondary winding conduction time (T_{ONS}) to the switching period (T_{SW}). So

$$I_{OMAX}=0.5*(V_{CSMAX}/R_{CS})*(N_P/N_S)*D_{SMAX}$$

Where $D_{SMAX}=T_{ONSMAX}/T_{SW}=0.5$ for µP2324KA.

During the constant current operation, if the output voltage is lower than a specified voltage V_{SC} for 48mS (typical), the output is regarded as shorted to ground. The controller will go into hiccup mode (startup then shutdown repeatedly) until the output voltage is higher than V_{SC} again. V_{SC} can be estimated as

$$V_{SC}=V_{FBHICCUP}*(1+R_{VS1}/R_{VS2})*(N_S/N_A)+I_{CAB}*R_{VS1}*(N_S/N_A)$$

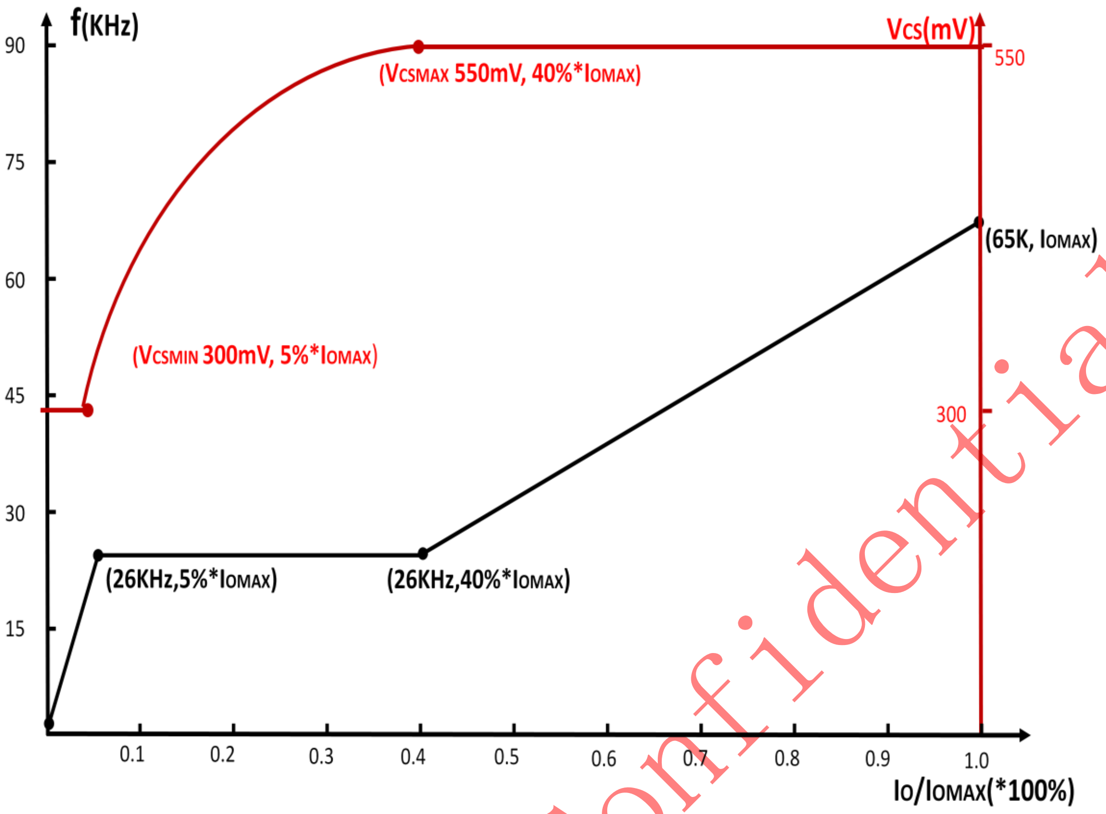


Fig.4, switching frequency and CS voltage v.s. load current

10.5 Switching frequency control

The µP2324KA operates in Pulse Frequency Modulation (PFM) mode to control output voltage and output current. As shown in Fig.4, the CS voltage (VCS) at the power transistor turnoff instant varies from V_{CSMIN} to V_{CSMAX} when the load increases from no load to full load. Operating frequencies varies from around 200Hz at no load to 80KHz at full load. The power transistor Q1 turns on when the ring voltage is down to its valley (quasi-resonant switching). This can reduce turn on losses of the power transistor. It can also generate switching period jittering to reduce EMI.

10.6 Built-in output over voltage protection

When the output voltage is over a specified value V_{OVP} for 5 successive switching cycles, the output over voltage protection function is triggered; power transistor will be turned off until a new startup event begins. V_{OVP} can be estimated as

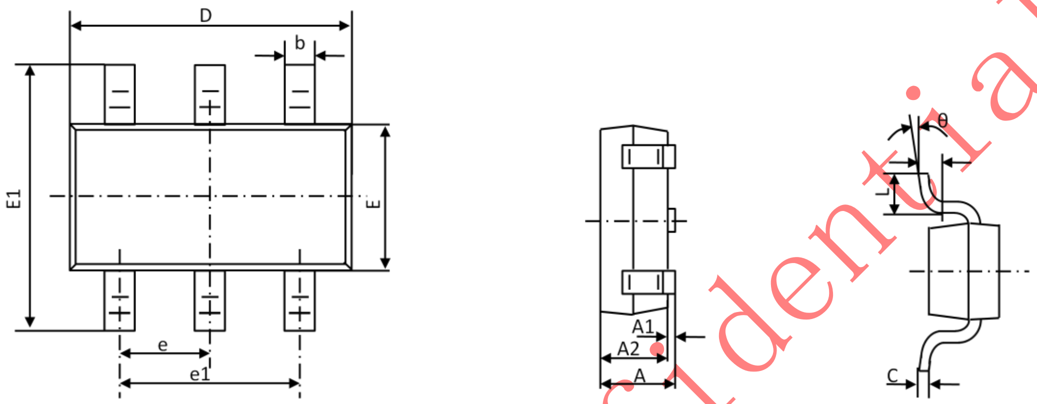
$$V_{OVP}=VFBOVP*(1+RVS1/RVS2)*(NS/NA)+ICAB*RVS1*(NS/NA)$$

11. Ordering information

Part number	Package	Marking ID	Packing
µP2324KA	SOT23-6	24K	3000 / Reel

12. Mechanical dimensions

SOT23-6



UNIT	A	A1	A2	b	c	D	E	E1	e	e1	L	θ
mm	1.45MAX	0 0.15	0.9 1.3	0.3 0.5	0.1 0.2	2.82 3.02	1.5 1.7	2.65 2.95	0.95	1.8 2	0.3 0.6	0 ° 8 °