

1. Features

- Built-in 6m Ω 50V MOSFET
- High efficiency and low case temperature
- Fewer external components

2. Applications

- Smart phone chargers
- 5V adapters

3. Typical applications (5V/3.3A charger)

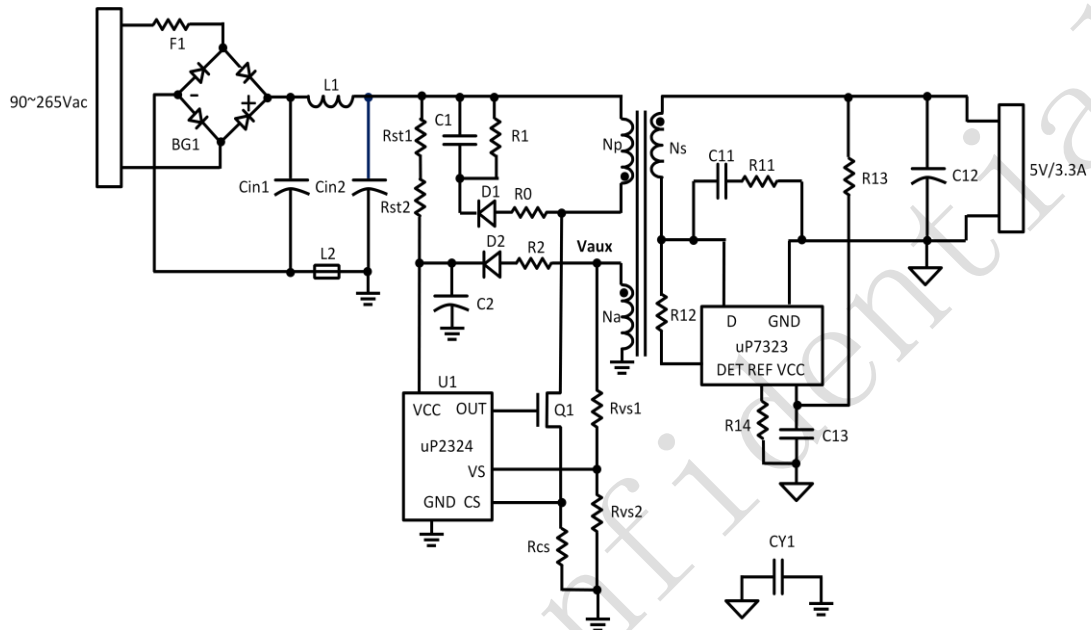
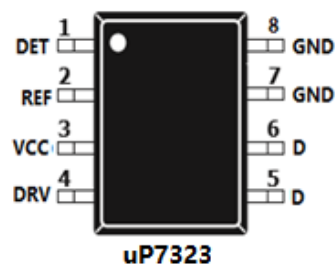


Fig.1 Typical applications

4. Pin definitions



μ P7323	Pin Name	Pin Type	Pin Functions
1	DET	Input	Drain voltage detection of SR MOSFET
2	REF	Output	Voltage setting for SR MOSFET turn on
3	VCC	Power supply	Power supply of the rectifier
4	DRV	Output	Gate drive of SR MOSFET
5,6	D	Input/Output	Drain of SR MOSFET
7,8	GND	Ground	

5. Absolute maximum ratings (Note 1)

Parameter	Name	Range	Unit
Voltage at VCC to Ground	VCC	-0.3 to 6.5	V
Voltage at DRV to Ground	DRV	-0.3 to 6	V
Voltage at DET to Ground	DET	-2 to 50	V
Voltage at D to Ground	D	-2 to 50	V
Voltage at REF to Ground	REF	-0.3 to 6	V
Power dissipation @ $T_A=25\text{ }^{\circ}\text{C}$	P_D	0.5	W
Maximum junction temperature	T_{JMAX}	150	$^{\circ}\text{C}$
Lead temperature	T_{LEAD}	300	$^{\circ}\text{C}$
Storage temperature	T_{STG}	-55 to 150	$^{\circ}\text{C}$
ESD rating per ANSI/STM5.1-2001	HBM	2000	V
ESD rating per JEDEC JESD22-C101F	CDM	1000	V
Latchup test per JEDEC 78D		+/-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	$\theta_{JA}(\text{SOP8})$	90	$^{\circ}\text{C/W}$
Junction to case thermal resistance	$\theta_{JC}(\text{SOP8})$	45	$^{\circ}\text{C/W}$

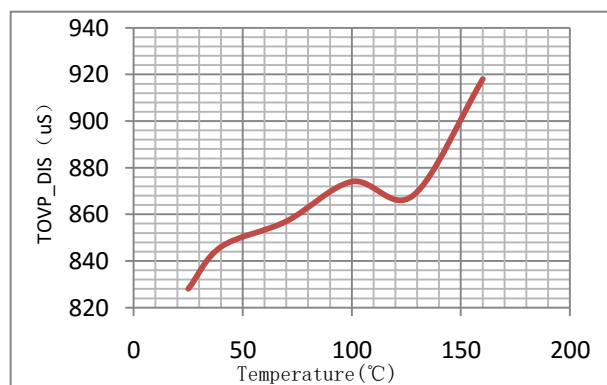
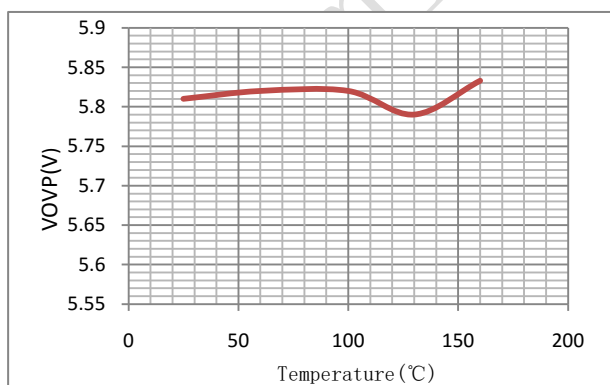
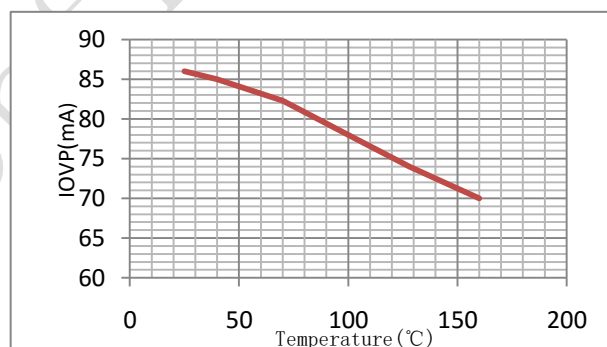
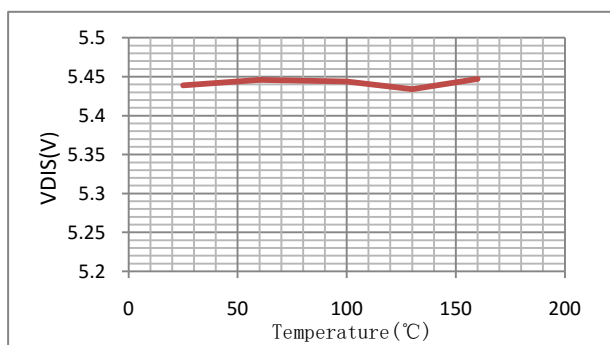
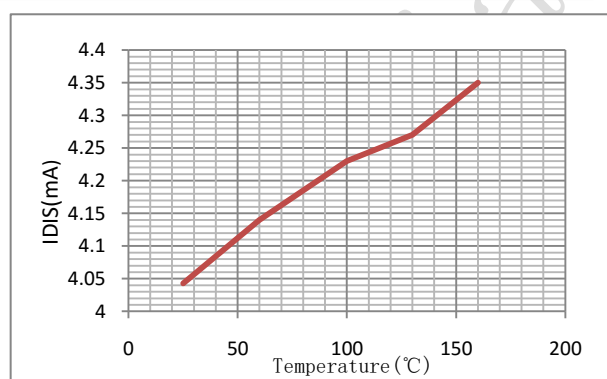
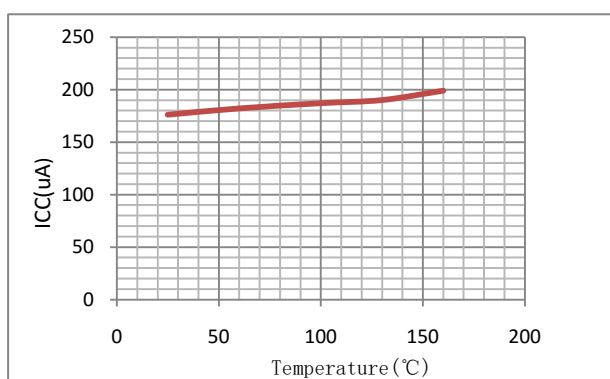
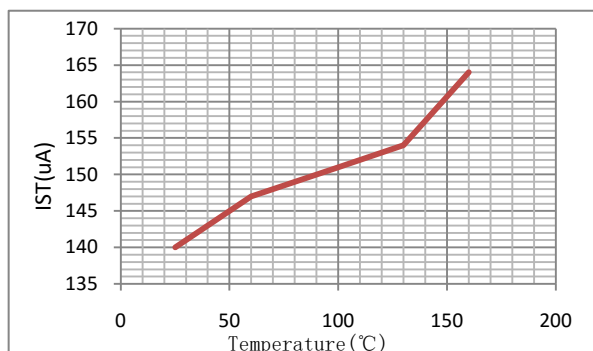
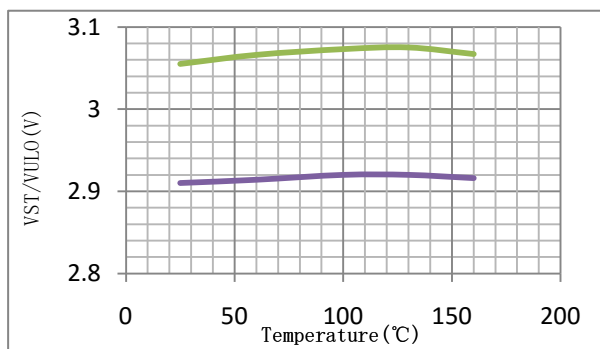
7. Recommended operating conditions

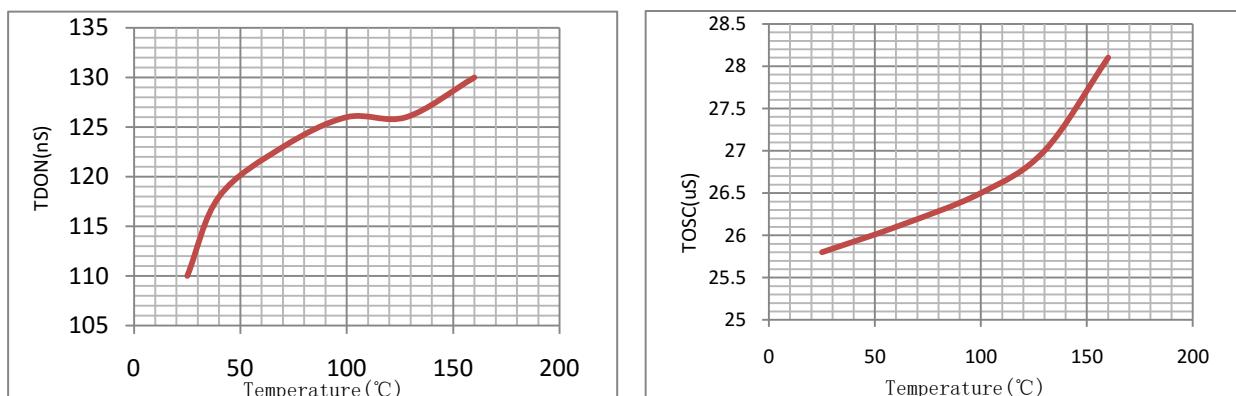
Parameter	Symbol	Min	Max	Unit
Supply voltage	VCC	3.3	6	V
Ambient Temperature	T_A	-40	85	$^{\circ}\text{C}$

8. Electrical parameters (TA =25 °C, unless otherwise specified)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Power supply(VCC pin)						
Operating current	ICC		170	200	230	μA
Startup voltage	V _{ST}		2.67	2.98	3.29	V
Minimum operating voltage	V _{UVLO}		2.49	2.80	3.11	V
Startup current	I _{ST}	VCC= V _{ST} -0.1V	110	150	170	μA
Output voltage monitor						
Output low voltage	V _{TRG}		5.24	5.30	5.36	V
VCC discharge voltage	V _{DIS}		5.38	5.47	5.56	V
VCC discharge current	I _{DIS}	VCC= V _{DIS} +0.1V		4	6	mA
VCC protection voltage	V _{OVP}		5.74	5.85	5.96	V
VCC over voltage discharge current	I _{OVP}	VCC= V _{OVP} +0.1V	39	85	131	mA
VCC OVP discharge time	T _{OVPDIS}			80		μS
Internal oscillator period	T _{OSC}		20	25	30	μS
Synchronous rectification control						
SR turn on voltage	V _{THON}			75		mV
SR turn off voltage	V _{THOFF}		-6	-4	2	mV
SR turn on delay time	T _{DON}			70	130	nS
SR turn off delay time	T _{DOFF}			100	150	nS
SR turn on rising time	T _R	C _L =4.7nF		50	100	nS
SR turn on falling time	T _R	C _L =4.7nF		50	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	BV _{dss}		50			V
Gate threshold voltage	V _{GS(TH)}	V _{DS} = V _{GS} , I _D =0.25mA	1.2	1.8	2.5	V
Static Drain-to-Source On Resistance($\mu P7323C$)	R _{DS(on)}	V _{GS} =5.5V, I _D =10A		6	8	m Ω
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. Typical Characteristics





10. Functional block diagram

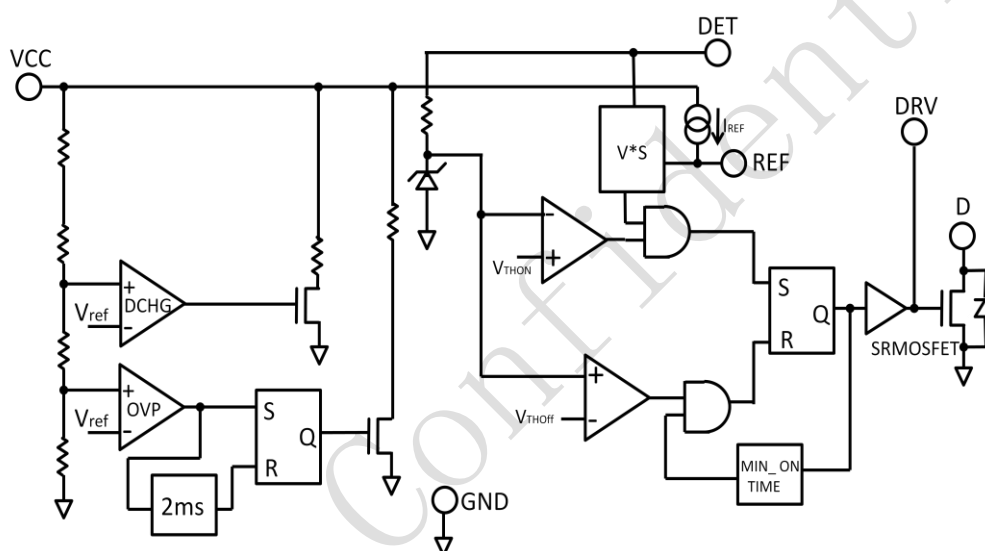


Fig.2, μ P7323 block diagram

11. Principle of operation

The μ P7323 has two major functions: output voltage monitor (discharge of output capacitor at certain conditions) and synchronous rectification. The device must work in Discontinuous Conduction Mode (DCM).

11.1 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 μ P2324 (U1) starts to deliver energy to the output capacitor C12, the output voltage begins rising from 0V.

When the VCC voltage of μ P7323 (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 μ P2323(U2) is larger than the startup voltage V_{ST} , the synchronous rectifier starts to work, as described in 10.4. When the AC power supply is removed from the converter, the VCC voltage of μ P7323 (U2) falls below V_{UVLO} , the synchronous rectifier stops working, the body diode of the SRMOSFET acts again as the rectification diode.

11.2 Discharge of output capacitor

When the VCC voltage of μ P7323 (U2) is higher than a specified voltage V_{DIS} , μ P7323 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 μ P7323 (U2) is further higher than a specified voltage V_{OVP} , such as in case of load transient from full load to no load, μ P7323 will turn on another discharge path from VCC to GND with typical 70mA current capacity to limit the system output over shoot voltage.

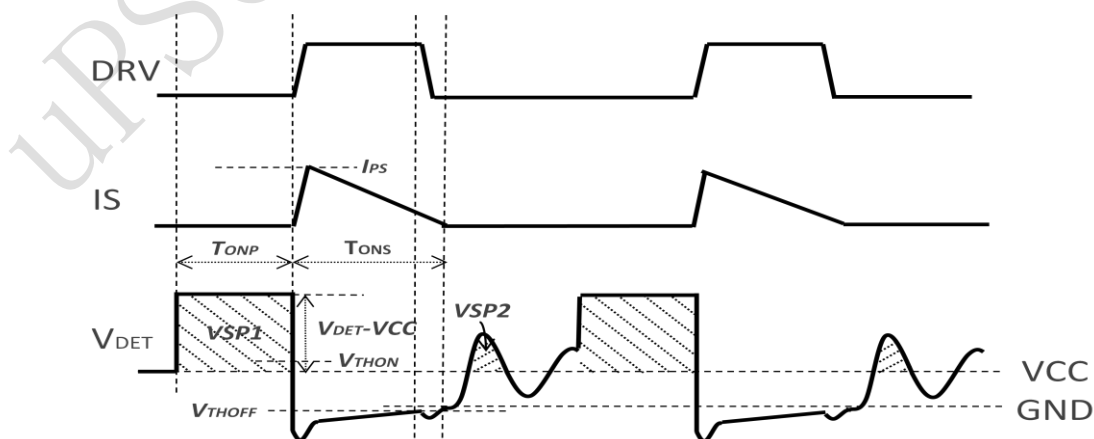


Fig.3, μ P7323 SR operation

11.3 Synchronous rectification

Refer to Fig3, μP7323 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} , μP7323 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} , μP7323 DRV pin generates a pull down signal after a turn-off delay (T_{DOFF}).

During the SR MOSFET 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 $(V_{DET}-V_{CC}) \cdot T_{ONP}$. Given $(V_{DET}-V_{CC}) \cdot T_{ONP} = 25V \cdot \mu S$, the minimum on time is about 1.8μS.

As the convertor operates in DCM, 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, μP7323 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, μP7323 judges if the detected volt-second product of V_{DET} voltage above V_{CC} 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

$$VSP = \int (V_{DET} - V_{CC}) \cdot dt = R_{VSP} \cdot C_{VSP} \cdot V_{VSP}$$

Where R_{VSP} is an internal resistor to convert the $(V_{DET}-V_{CC})$ 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 μP7323, the V_{VSP} judges 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} (R14 in Fig.1). So, the judging volt-second product

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

Where $ASP = (R_{VSP} \cdot C_{VSP} \cdot I_{REF})$ is an μP7323 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.

μP7323 also sets a minimum line voltage to operate the SR MOSFET. The value of $V_{DET}-V_{CC}$ 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

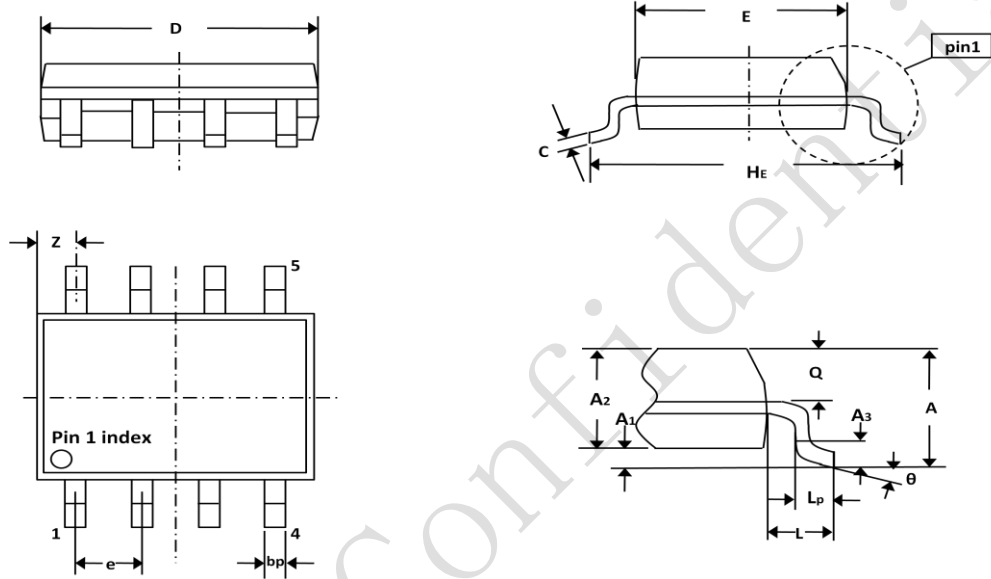
$$V_{IN_MIN} = (V_{DET} - V_{CC}) * (N_P / N_S)$$

12. Ordering information

Part number	Package	Marking ID	Packing	Output power
μ P7323	SOP8	7323M	3000 / Reel	15W~20W

13. Mechanical dimensions

SOP8



UNIT	A	A1	A2	A3	bp	c	D	E	e	H _E	L	L _p	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°