High Efficiency Off-Line PSR CC/CV Control

FEATURES

- Constant-Current (CC) and Constant-Voltage (CV) with Primary Side Control
- Proprietary technology enabling high efficiency and fast dynamic response
- Satisfy DoE Level 6 requirements
- No audible noise over entire operating range
- Optimization for capacitive loading
- Built-in power MOS
- Built-in Cable Compensation
- Built-in Line Compensation
- Primary-side feedback eliminates opto-coupler and TL431
- Cycle-by-Cycle Current Limiting
- Over Temperature Protection
- VCC Over Voltage Protection
- CV Open-loop Protection
- Excellent capacitive loading start-up performance
- Excellent capacitive loading start-up performance
- FT8370 Awaking Signal Detection

TYPICAL APPLICATION

- Adapter/Charger for Cell/Cordless Phones, PDAs, MP3 and Other Portable Apparatus
- Standby and Auxiliary Power Supplies Set Top Boxes (STB)
- Adapter for ADSL / WiFi Wireless

DESCRIPTION

The FT8393xx is a Flyback controller targeting at high-performance Constant Current/Constant Voltage applications. The FT8393xx facilitates CC/CV charger design by eliminating an opto-coupler and TL431. FT8393xx operates in quasi-resonant mode and adaptive PFM control for highest average efficiency for AC/DC power applications.

Power supplies built with FT8393xx can achieve both highest average efficiency, fast dynamic load response and super low standby power. FT8393xx satisfy DoE Level VI requirements with production margin for 5V/2.4A and 5V/4A applications, respectively.

Furthermore, FT8393xx features fruitful protections like Open Circuit Protection and Over Temperature Protection to eliminate the external protection circuits and provide reliable operations.

When FT8393xx is used with FT8370, good under-shoot performance and higher conversion efficiency can be achieved

TYPICAL APPLICATION CIRCUIT

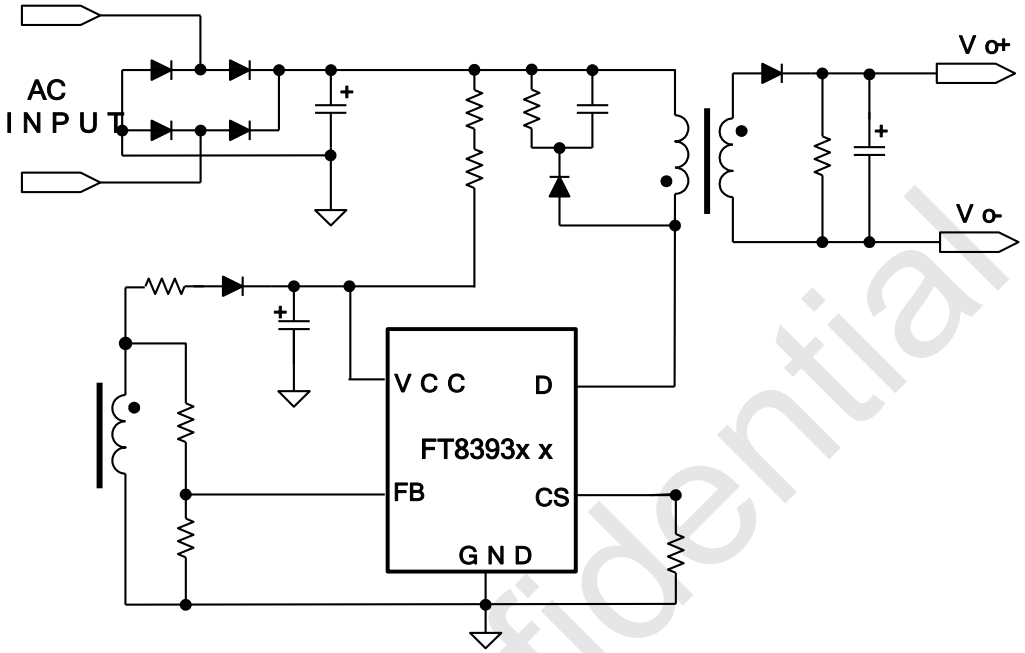


Figure 1: FT8393Mxx Typical Application Circuit(Internal MOS)

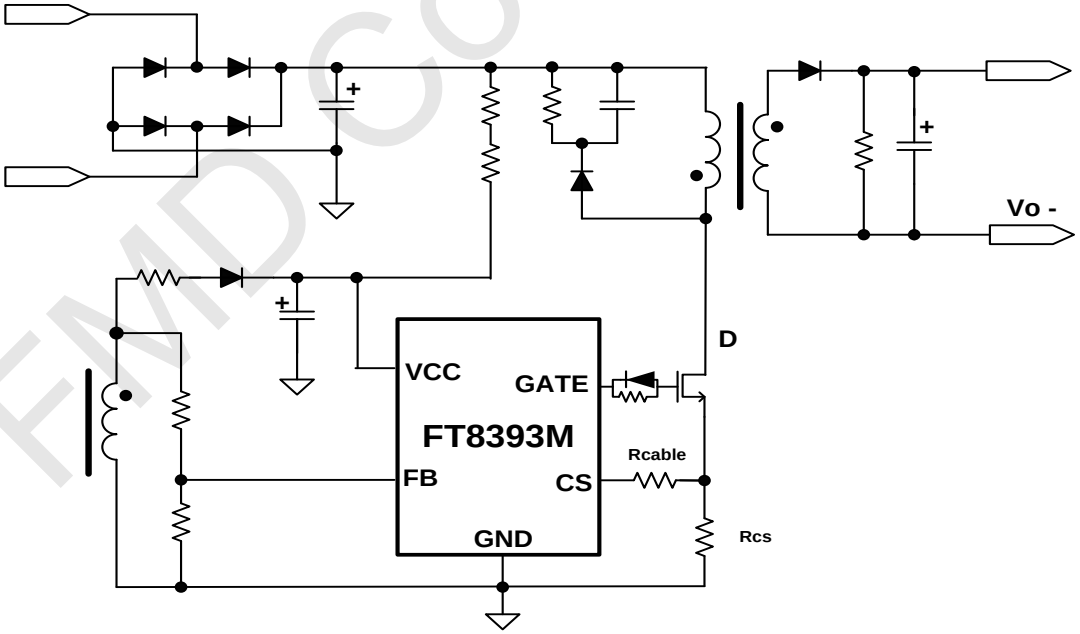


Figure 2: FT8393M Typical Application Circuit(External MOS)

ABSOLUTE MAXIMUM RATINGS

VCC to GND……-0.3V to +25V
FB to GND……-0.3V to +7V
CS to GND……-0.3V to +7V
GATE to GND……-0.3V to +12V
D to GND……-0.3V to +650V
Operating Temperature Range……-40℃ to +125℃
Junction Temperature……-40℃ to +150℃
Thermal resisitance junction-to ambient :
SOP7,θ_{JA}…… 150℃/W
DIP7,θ_{JA}…… 90℃/W
SOT23-5,θ_{JA}……250℃/W
Storage Temperature Range ……-60℃ to +150℃
ESD Protection HBM……2000V
ESD Protection MM……200V

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

PIN CONFIGURATION

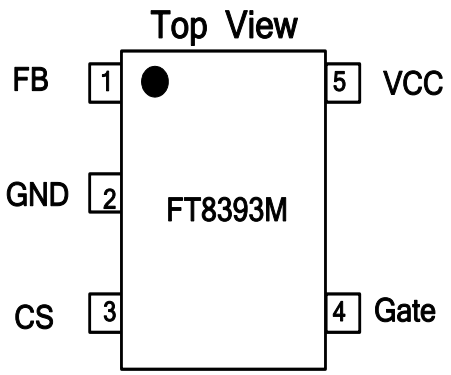


Figure 3: FT8393M

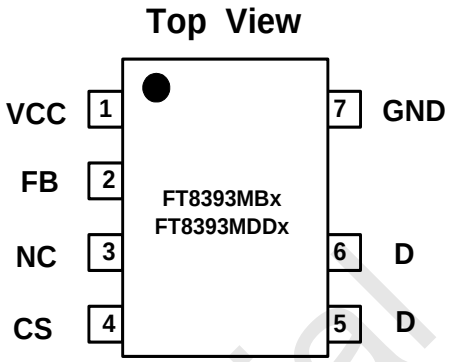


Figure 4:FT8393MBx/FT8393MDDx

TERMINAL DEFINITION

FT8393M(SOT23-5,External MOS)

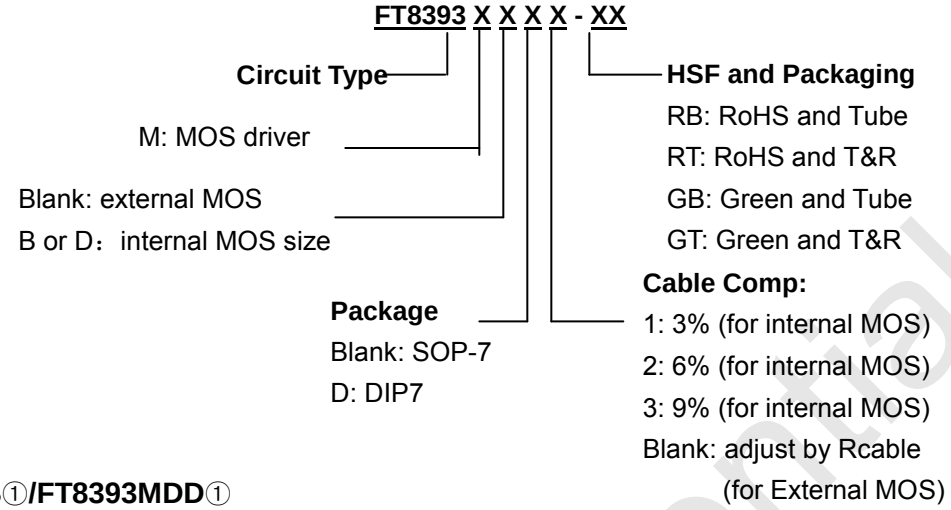
Pin	Name	Description
1	FB	Output voltage feedback pin
2	GND	Ground
3	CS	Primary current sense
4	GATE	MOS gate driver
5	VCC	Supply voltage

FT8393MBx/FT8393MDDx(SOP7/DIP7,Internal MOS)

Pin	Name	Description
1	VCC	Supply voltage
2	FB	Output voltage feedback pin
3	NC	No connection
4	CS	Primary current sense
5	D	D: the Drain of the power MOS for FT8393xx. This pin is connected to the primary lead of the transformer
6		
7	GND	Ground

Table 1

ORDERING INFORMATION



FT8393MB①/FT8393MDD①

Device	DESIGNATOR	SYMBOL	Options(fixed)
FT8393MB① FT8393MDD①	①	1	Cable Comp = 3%
		2	Cable Comp = 6%
		3	Cable Comp = 9%

Table 2

FT8393M (Adjust by Rcable)

Device	DESIGNATOR	Rcable(Ω)	Options
FT8393M	blank	0	Cable Comp = 3%
		39	Cable Comp = 6%
		120	Cable Comp = 9%
		300	Cable Comp = 0%

Table 3

Block Diagram

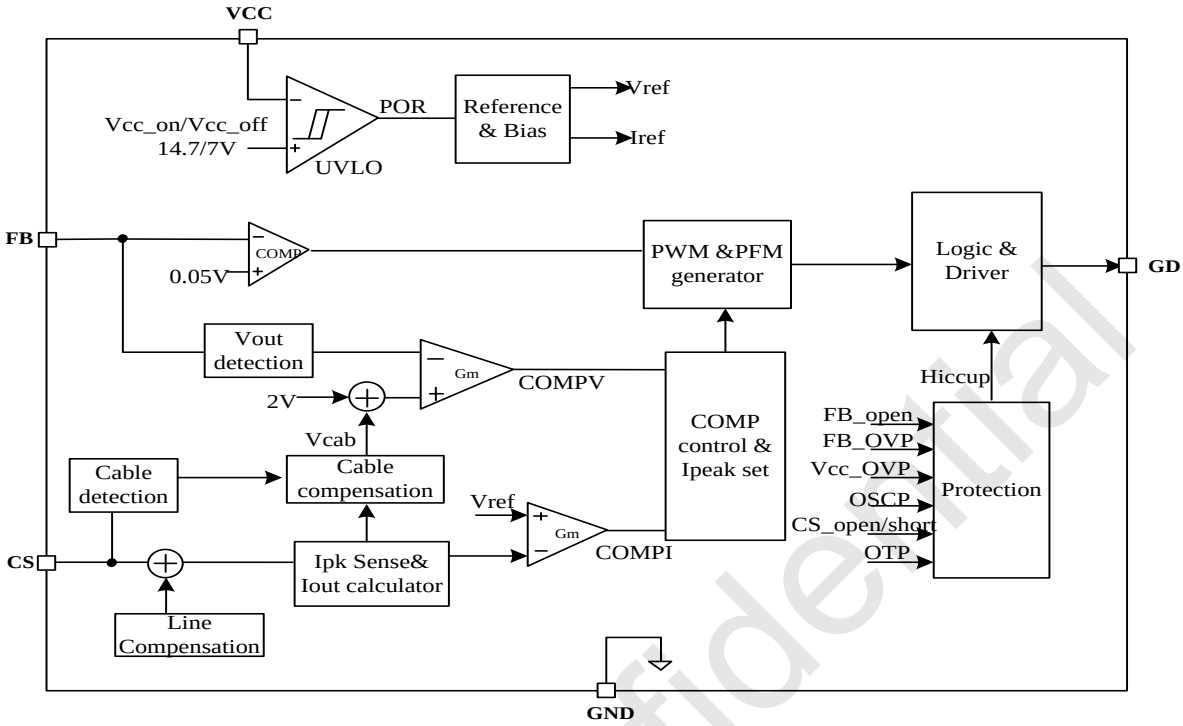


Figure 5: FT8393xx Block Diagram

ELECTRICAL CHARACTERISTICS

(For typical values Tj=25℃, Vcc=12V, unless otherwise noted**)**

Characteristic	Symbol	Min	Typ	Max	Unit
Current Sense					
Maximum Current Threshold	Vcs_max		1		V
Minimum Current Threshold	Vcs_min		250		mV
Internal constant current feedback reference voltage	Kcc		500		mV
Leading Edge Blanking Duration	Tleb		350		ns
Feedback Section					
Feedback Voltage Threshold	V_{FB}	1.97	2	2.03	V
OVP voltage threshold	Vfb,ovp		2.675		V
Supply Section					
Start Up Threshold Voltage	Vcc_on		14.7		V
Under Voltage Lockout Voltage	Vcc_off		7		V
VCC Start Up Current	Istart_up		3		uA
Operating Current	Iop		0.4		mA
Protection Section					
Feedback Loop Open Protection	Ifb_open		30		uA
VCC Over Voltage Protection	Vcc_OVP		26		V
Over Temperature Protection	T_OTP		155		℃
Compensation					
Line Compensation ratio (Ifb=1mA)	k1		33		mV/mA
Gate Driver Section					
Gate driver voltage	VGD		12		V
Max. source current	$I_{SOURCE,MAX}$		90		mA
Max. sink current	$I_{SINK,MAX}$		200		mA
Max. OFF Time	$t_{OFF,MAX}$		1.5		ms
Maximum switching frequency	f_{MAX}		115		kHz

Power MOS Section (FT8393MDDx)

Characteristic	Test condition	Symbol	Min	Typ	Max	Unit
Static drain-source on-resistance	R_{DS_ON}	V_{GS}=10V, I_{DS}=0.5A		2		Ω
Drain-source breakdown voltage	BV_{DSS}	V_{GS}=0V, I_{DS}=250uA	650			V
Drain-source leakage current	I_{DSS}	V_{GS}=0V, V_{DS}=650V			10	uA
Maximum Drain Current	I_{DMAX}	Vd=4V		1.4		A

Power MOS Section (FT8393MBx)						
Characteristic	**Test condition**	**Symbol**	**Min**	**Typ**	**Max**	**Unit**
Static drain-source on-resistance	R_{DS_ON}	V_{GS}=10V, I_{DS}=0.5A		4.6		Ω
Drain-source breakdown voltage	BV_{DSS}	V_{GS}=0V, I_{DS}=250uA	650			V
Drain-source leakage current	I_{DSS}	V_{GS}=0V, V_{DS}=650V			10	uA
Maximum Drain Current	I_{DMAX}	Vd=4V		0.8		A

Table 4

FUNCTIONAL DESCRIPTION

Operating Description

FT8393xx is a high efficiency, high-performance AC-DC power supply controller for off-line applications including battery chargers, adaptors. The constant voltage (CV) and constant current (CC) control are achieved accurately without the secondary feedback circuit. In order to reduce the switching losses and improve EMI performance, Quasi-Resonant switching mode is applied; the start up current of the device is rather small (2μA typically) to reduce the standby power loss further.

FT8393xx satisfy DoE Level VI requirements with production margin for 5V/2.4A and 5V/4A applications.

Start up Control

Start-up current of FT8393xx is very low so that a resistor with high resistance and low-wattage is allowed to supply the start-up power for the controller. The large value startup resistor minimizes the power loss in operations and allows quick start up. With a special fast startup technology, FT8393xx starts up easily in capacitive loading applications.

Operating current

The operating current of FT8393xx is as low as 400uA. Good efficiency is achieved with the low operating current. Low operating current also reduces the Vcc hold-up capacitance requirement.

Constant current (CC) Operation

The output current is regulated by FT8393xx with primary side detection technology without secondary side feedback circuits, the maximum output current I_{OUT} can be set by

$$I_{OUT} = \frac{1}{2} * \frac{Kcc}{RS} * N_{PS}$$

Kcc is the constant internal reference voltage, R_S is the current sense resistor, N_{PS} is Transformer turn ratio of primary winding and secondary winding, I_{OUT} can be programmed by N_{PS} and R_S.

When over current operation or short circuit operation happens, the output current will be limited at I_{OUT}.

The IC provides line regulation modification function to improve line regulation performance of the output current.

Due to the sample delay of V_{CS} pin and other internal delay, the output current increases with increasing input BUS line voltage. A small compensation voltage ΔV_{CS} is added to CS pin during ON time to improve such performance. This ΔV_{CS} is adjusted by the upper resistor of the divider connected to FB pin.

$$\Delta V_{CS} = V_{BUS} * \frac{N_{AUX}}{N_P} * \frac{1}{R_{FBU}} * k_1$$

R_{FBU} is the upper resistor of the divider; k1 is an internal constant as the modification coefficient.

The compensation is mainly related with R_{FBU}, larger compensation is achieved with smaller R_{FBU}.

Constant voltage (CV) Operation

FT8393xx operates in CV mode to regulate the output voltage by capturing the auxiliary winding feedback voltage at FB pin. The auxiliary winding feedback voltage is proportional to secondary winding, so it provides controller the feedback signal from secondary side and achieves

constant-voltage output.

The voltage at the load differs from the secondary voltage by a diode drop and IR losses. Thus, if the secondary voltage is always read at a constant secondary current, the difference between the output voltage and the secondary voltage is a fixed ΔV. Furthermore, if the voltage can be read when the secondary current is small, ΔV is also small. The output voltage can be calculated by:

$$V_{OUT} = V_{FB} * \frac{R_{FBU} + R_{FBD}}{R_{FBD}} * \frac{N_S}{N_{AUX}} - V_{Df}$$

R_{FBD} is the down resistor of FB resistor divider, V_{Df} is the forward voltage drop of the power diode.

Leading edge blanking

Each time the power MOS transistor is switched on, a turn-on spike occurs at the sense resistor. To avoid premature termination of the switching pulse, a 350ns leading edge blanking time is built in. Conventional RC filtering can therefore be omitted. During this blanking period, the current limit comparator is disabling and cannot switch off the base driver.

Under voltage lockout (UVLO)

FT8393xx turn-on Vcc_on and turn-off Vcc_off are 14.7 V and 7 V, respectively. During start-up, the hold-up capacitor must be charged to 14.7V through the start-up resistor. The hold-up capacitor continues to supply Vcc until power can be delivered from the auxiliary winding of the transformer. Vcc must not drop below 7V during this start-up process. This UVLO hysteresis window ensures that hold-up capacitor is sufficient to supply Vcc during start-up.

Protection control

With rich protection features of FT8393xx, excellent power supply system reliability can be achieved. The protection features include Vcc over voltage protection and clamp, over temperature protection, feedback loop open circuit protection, Output Short Circuit Protection, CS short or open Protection and Vcc under voltage lockout, etc.

Cable compensation

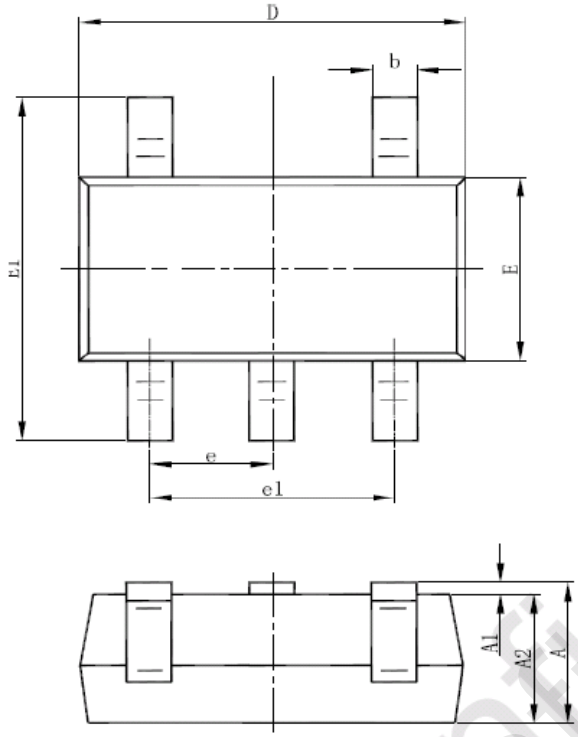
FT8393Mxx output cable compensation provides a constant output voltage at the end of the cable over the entire load range in constant voltage mode. As the converter load increases from no-load to the peak current load, the voltage drop introduced across the output cable is compensated by increasing the feedback pin reference voltage. The cable compensation ratio is internal fixed as table 2.

FT8393M cable compensation adjusts by Rcable value as table3.

Over Temperature Protection

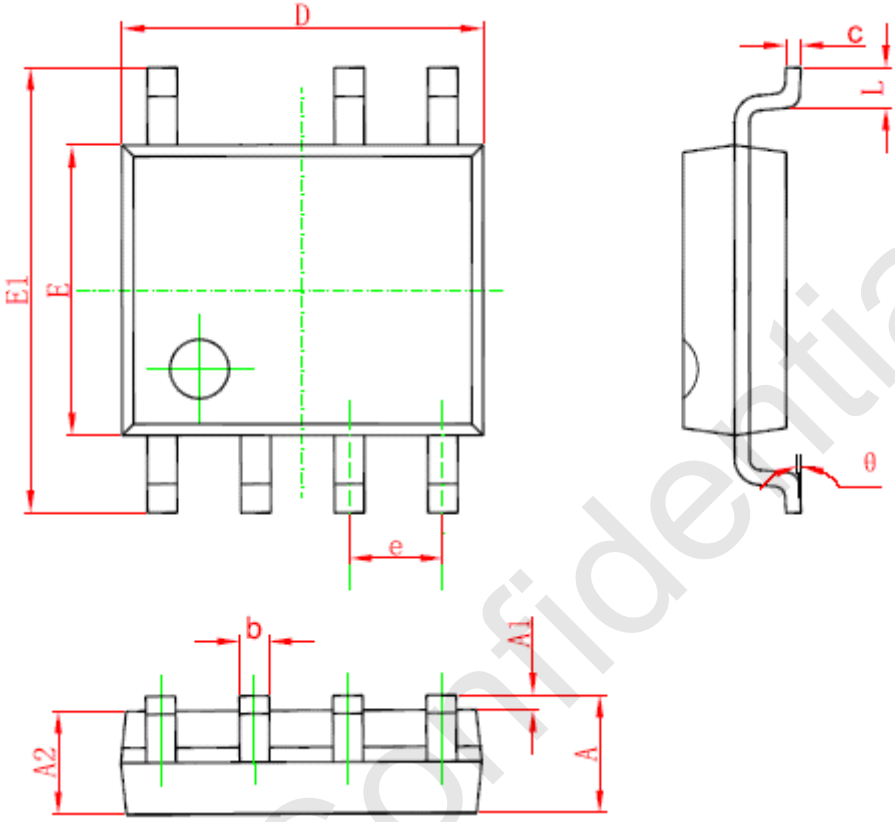
If temperature keeps rising beyond 155℃ even with temperature compensation described above, Over Temperature Protection will kick in. The OTP threshold is set to 155℃ with 10℃ hysteresis. When temperature reaches 155℃, FT8352x will stop switching until the IC temperature falls 10℃ below the thermal protection trigger point.

SOT23-5 Package



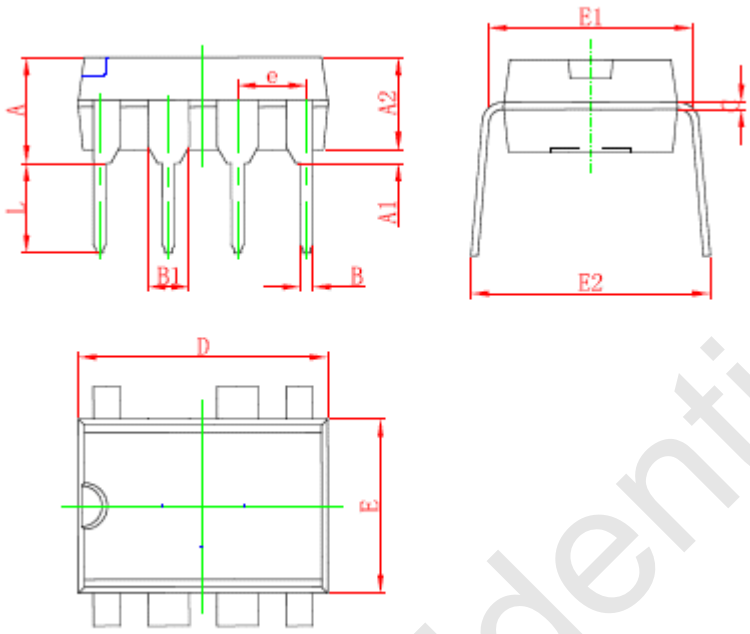
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.95 (BSC)		0.037 (BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	6°

SOP7 PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

DIP8 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	9.000	0.331	0.354

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