DESCRIPTION

The MT2600 is a complete solution for system with backup storage capacitor or capacitor bank. It integrated input over voltage; over current protection circuit; a reverse blocking switch and super capacitor charging control circuit. It also has built-in cell balance to provide protection over two cell super capacitor system.

When the main supply is present and above the minimum system supply voltage, system will draw power from input supply. At the same time, integrated linear charger charges the storage element at up to 300mA current. Once the storage element is charged, the circuit draws only 2.5μA of current while it maintains the super capacitor or other storage element in its ready state. When the main supply is removed, the integrated reverse blocking switch will block current flow from system rail to input. Linear charger will be turned on to provide power to system rail with low resistance path with up to 2A current.

Integrated cell balancing circuit will keep monitoring the cell voltage when charging and keep the two cells voltage at same level.

The MT2600 is externally programmable for input current limit, input over voltage, charge current limit, charge voltage limit. It provides a flag signal when input supply is unplugged so that main system can taking action.MT2600is available in DFN3X3-10 package.

FEATURES

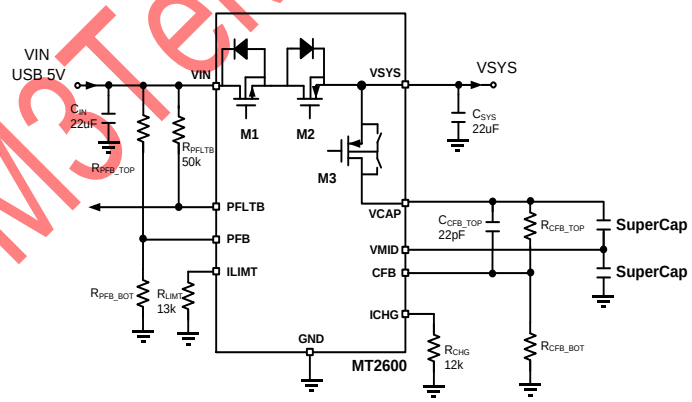
- 2.5V to 5.5V System Voltage
- 12V Input Rating with Over-Voltage Protection
- Programmable 1.1V to 5.3V Cap Voltage Range
- Programmable Super Cap Charge Current
- Programmable Input Over Current Protection
- Automatic Cell Balancing
- Automatic Main/Backup Switchover
- Up to 2A Discharge Current
- Programmable Voltage and Current Thresholds
- ±2% Threshold Accuracy
- 2.5μA Ready Quiescent Current
- Small Solution Size
- DFN Package

APPLICATIONS

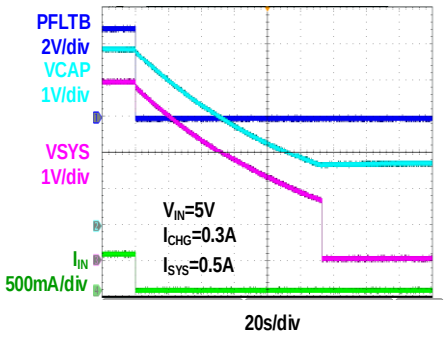
- Handheld Industrial Equipment
- Portable Computers
- Portable Devices with a Removable Battery

TYPICAL APPLICATIONS

Super Capacitor Power Manager for Backup Power Applications



Backup Power Application with Two-series 20F Supercapacitors

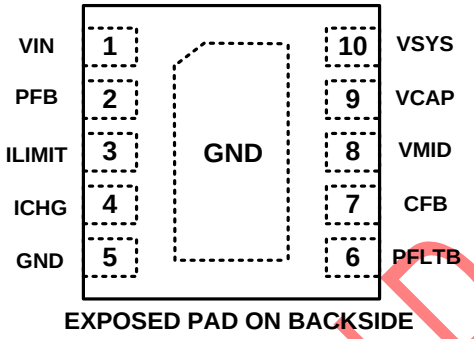


Ordering Information

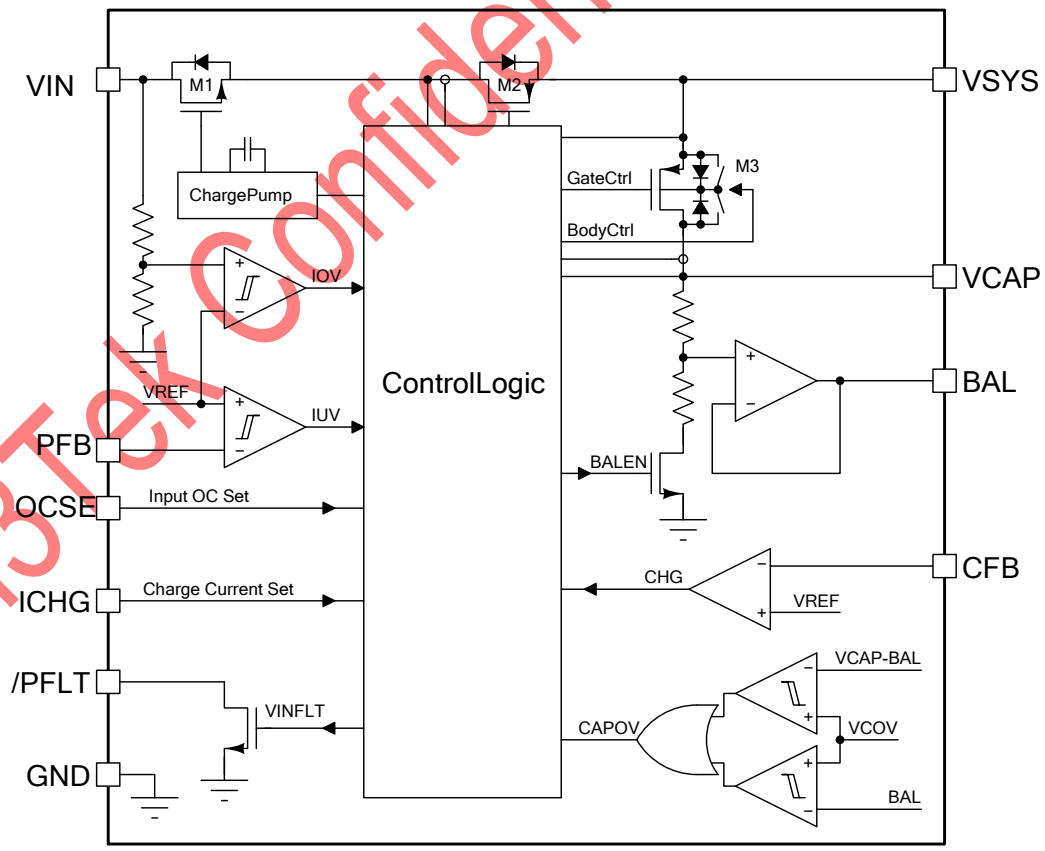
Part No.	Marking	Temp. Range	Package	MOQ
MT2600NDCR	MT2600 YWWXX	-40°C ~+85°C	DFN3X3_10L	5000/Tape & Reel

Note: Y: Year, WW: Week, xx: Manufacture Control Code

PIN CONFIGURATION



Functional Block Diagram



Pin Description

PIN NAME	PIN NO.	DESCRIPTION
VIN	1	Input Power Supply. Connect to a 5V system supply rail and bypass with a 10μF capacitor to GND.
PFB	2	Input voltage sensing input. Connect to the center point of a resistor divider from VIN to GND. It is compared with internal 1.2V reference. When PFB is below1.2V, PFLTB will pull high to indicate input power failure.
ILIMT	3	Input over current protection setting pin. Connect a resistor to ground the set the input over current protection level. If ILIMT is short to GND, input current limit is set to 3A. If ILIMT is floating, input current limit is 0A. The Limit current is determined by the equation: $\mathrm{ILIMT} = 30\mathrm{A} * \mathrm{k\Omega}/\mathrm{RLIMIT}$
ICHG	4	Charge Current Input. This pin sets the maximum current level for charging super capacitor. The charger current recommend <350mA (RCHG>10k). The Charge Current is determined by the equation: $\mathrm{ICHG} = 3.3\mathrm{A} * \mathrm{k\Omega}/\mathrm{RCHG}$
GND	5	Ground.
PFLTB	6	Open-Drain input power failure indicator. PFLTB goes low when the PFB drop below 1.2V or (VIN-VSYS) exceed 360mV. Connect to an external pull up resistor.
CFB	7	VCAP Feedback. Connect to the upper point of a resistor divider from VCAP to GND. Part stops charging super capacitor when CFB voltage is above 1.1V.
VMID	8	Super capacitor balance point. Connect to center point of stacked two super capacitors.
VCAP	9	Super Cap. Connect to top point of two super cap stacks.
VSYS	10	Supply rail for internal system. Power is draw from VIN when valid input supply is present. When input power failed, power will be provided by super capacitor connected to VCAP.
EP	EP	Note: EP use conductive glue and GND PAD has no down bonding.

Absolute Maximum Rating (Reference to GND) (Note1)

VCAP, VSYS, PFLTB to GND ..... -0.3V to 6V	ESD ..... Class 2
VIN to GND .....-0.3 to 12V	Lead Temperature(Soldering 10s) ..... 260°C
VMID, CFB to GND.....-0.3V to VCAP+0.3V	Junction Temperature Range .....-40°C to 150°C
PFB, ILIMT, ICHG to GND ..... -0.3V to VSYS+0.3V	Storage Temperature Range ..... -65°C to 150°C

Recommend Operating Conditions (Note2)

Input Voltage (V_{IN}).....4.0V to 5V	Operating Temperature Range ..... -40°C to 85°C
Cap Voltage (V_{CAP})..... +0.8V to5.4V	Junction Temperature Range, T_J ..... -40°C to 125°C

Thermal information (Note3, 4)

Maximum Power Dissipation (T_A=25°C)	
DFN3x3_10L 2.3W	Thermal Resistance (θ_{JA}) .....53°C/W
	Thermal Resistance (θ_{JC}) .....25°C/W

Note(1): Stress exceeding those listed “Absolute Maximum Ratings” may damage the device.

Note(2): The device is not guaranteed to function outside of the recommended operating conditions.

Note(3): Measured on JESD51-7, 4-Layer PCB.

Note(4): The maximum allowable power dissipation is a function of the maximum junction temperature T_{J_MAX}=125°C, the junction to ambient thermal resistance θ_{JA}, and the ambient temperature T_A. The maximum allowable continuous power dissipation at any ambient temperature is calculated by $P_{D\_MAX}= (T_{J\_MAX}-T_A)/\theta_{JA}$. Exceeding the maximum allowable power dissipation will cause excessive die temperature, and the regulator will go into thermal shutdown. Internal thermal shutdown circuitry protects the device from permanent damage.

Electrical Characteristics

T_A=+25℃,V_{IN} = 5V, V_{CAP} = 5V(Note 5).

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input Voltage Range		2.5		5.5	V
VSYS Charging Supply Current	PFB>1.2V, VIN=5V		650		uA
VSYS Backup Supply Current	PFB=0, VCAP=5V		1.5		uA
VCAP UVLO Threshold	V_{CAP} falling	1.45	1.65	1.85	V
VCAP UVLO Hysteresis			200		mV
INPUT OVP OCP Switch					
Input Overvoltage Protection Threshold voltage	V_{IN} Rising		6.0		V
Input Overvoltage Hysteresis			0.4		V
Input Overcurrent level	R_{ILIMT}=25.5k		1.2		A
Max Input Overcurrent Level	Vin>4.2V,ILIMT connect to GND		2.7		A
Input Overvoltage Switch Rdson			0.1		Ohm
Ideal Diode					
Drain Source regulation voltage			25		mV
Source Drain fast reverse blocking threshold voltage(Note 6)			-20		mV
PMOS Rdson			50		mOhm
PMOS Leakage Current				0.1	uA
Super Capacitor Charger/Discharger					
V_{CFB} Threshold voltage to stop charging		1.04	1.08	1.12	V
V_{CFB} Hysteresis			40		mV
CFB regulation reference voltage		1.05	1.1	1.15	V
CFB leakage current				50	nA
Charge current	R_{ICHG}=33K, VCAP=3V	75	100	125	mA
	R_{ICHG}=33K, VCAP=0V	30	45	60	mA
Charging/Discharging PMOS Rdson			100		mOhm
Capacitor voltage clamp for each capacitor		2.44	2.65	2.76	V
Maximum capacitor stack voltage		4.88	5.3	5.52	V
V_{MID} Balance Source Current Threshold	V_{CAP}=4V, V_{MID} Rising	1.93	1.99	2.04	V
	V_{CAP}=4V, V_{MID} Falling	1.92	1.98	2.03	
V_{MID} Balance Sink Current Threshold	V_{CAP}=4V, V_{MID} Rising	1.96	2.02	2.07	V
	V_{CAP}=4V, V_{MID} Falling	1.95	2.01	2.06	
PMOS body diode switch (VCAP-VSYS) threshold voltage	VCAP ramp up from below VSYS		100		mV
PMOS Charge Mode and Switch Body V_{DS} threshold voltage	VCAP ramp down from above VSYS		250		mV
V_{CAP} charge mode threshold (V_{SYS}-V_{CAP}) voltage	V_{CAP} ramp down from above V_{SYS}		10		mV
V_{CAP} charge threshold (V_{SYS}-V_{CAP}) hysteresis voltage	V_{CAP} ramp up from below V_{SYS}		-100		mV

Input Power Fail Comparator					
V_{PFB} Threshold voltage (Falling)			1.2		V
V_{PFB} Hysteresis			85		mV
V_{SYS} power good threshold	V_{IN}-V_{SYS}		260		mV
V_{SYS} power fail threshold	V_{IN}-V_{SYS}		320		mV
PFLT Output Low Voltage	I_{SINK}=1mA		100		mV
PFLT High Impedance Leakage	V_{PFLT}=5V			0.1	uA
PFLT deglitch time			3.5		ms
Thermal Shutdown Temperature	T_J rising, 30°C typical hysteresis		150		°C
Thermal Shutdown Hysteresis			30		°C

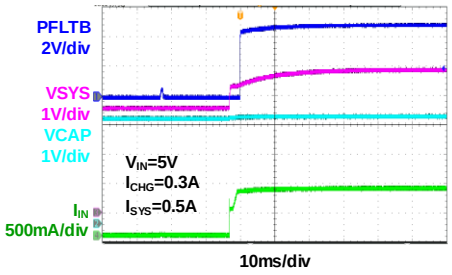
Note 5: Limits are 100% production testes @T_A=+25℃, unless otherwise noted. Limits over the temperature range are guaranteed by design.

Note 6: Guaranteed by design, not production tested.

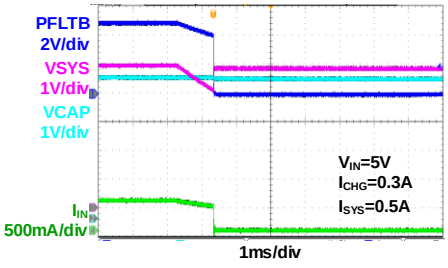
TYPICAL PERFORMANCE CHARACTERISTICS

(C_{IN}=22uF, C_{SYS}=22uF, R_{LIMT}=13k, R_{CHG}=12k,T_A=+25℃)

Charger VIN Power on

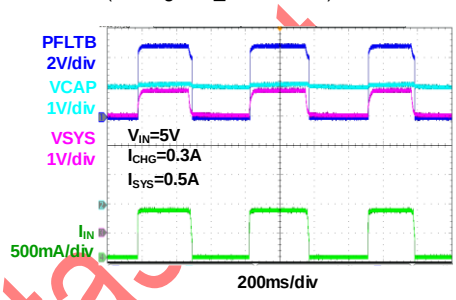


Charger VIN Power off



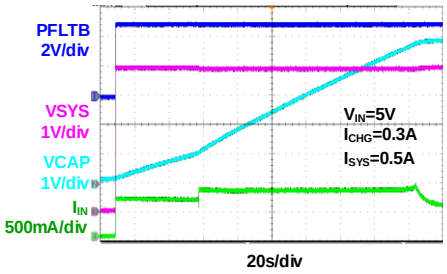
Charger 4Vin Switch to 5Vin

(Setting VIN_UVLO 4.1V)



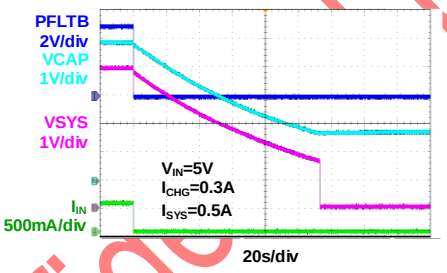
Charging Time

(SuperCap1=SuperCap2=20F)

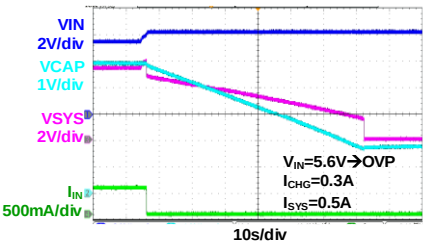


Discharger Time

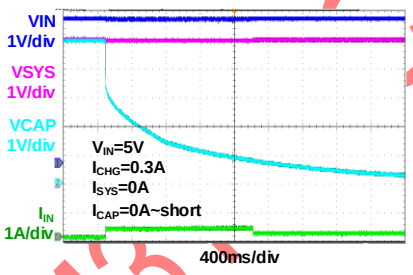
(SuperCap1=SuperCap2=20F)



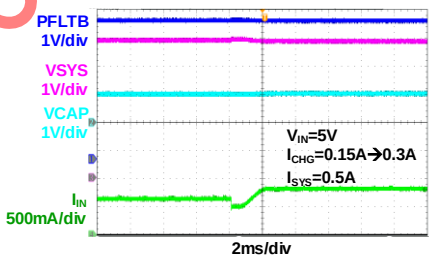
VIN OVP Protection



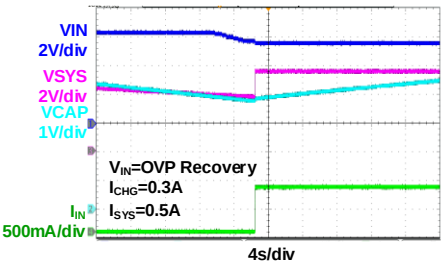
Charger Mode VCAP Short



Charger TC Mode→CC Mode



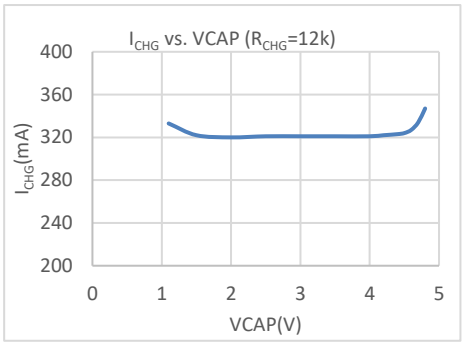
VIN OVP Recovery



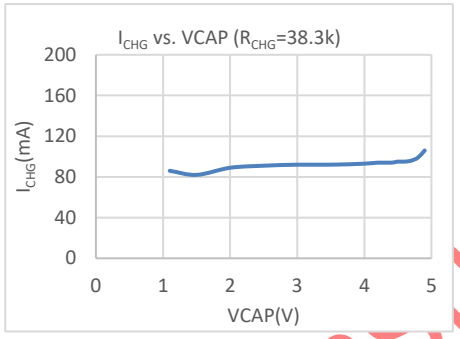
TYPICAL PERFORMANCE CHARACTERISTICS

(C_{IN}=22uF, C_{SYS}=22uF, R_{LIMT}=13k, R_{CHG}=12k,T_A=+25℃)

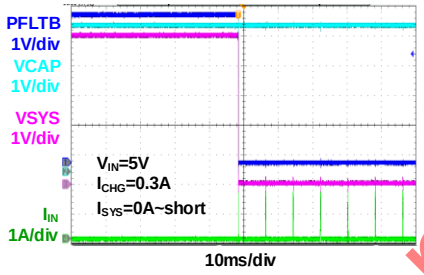
Charger Current vs. Vcap Voltage



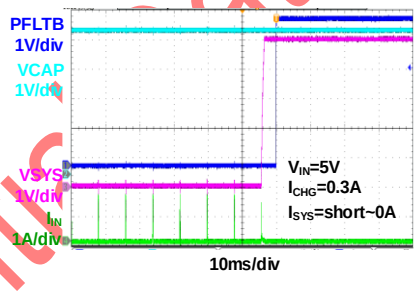
Charger Current vs. Vcap Voltage



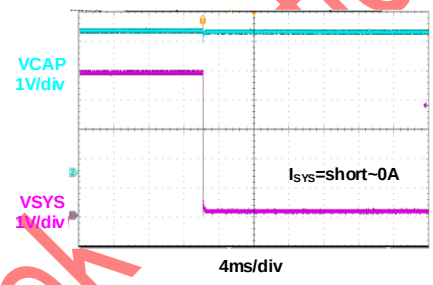
Charger Mode VSYS Short



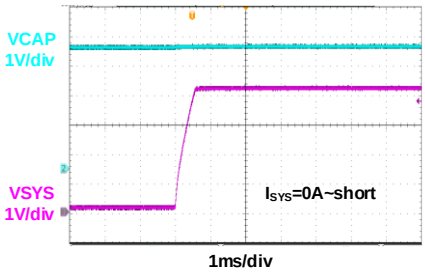
Charger Mode VSYS Short Recovery



Discharger Mode VSYS Short



Discharger Mode VSYS Short Recovery



DESCRIPTION

For applications require backup power in harsh environment, Lithium-Ion battery cannot be used duty to limited temperature range. Super capacitor with wide operating temperature range and high power/energy density, provides a safe and compact solution. For many systems, the high operating voltage (>3V) requires a power management system for super capacitor with two stacked cells or use a BOOST converter with inductor. Many systems also require long standby time (weeks of time), this need can only be realized with very low quiescent current.

MT2600 provides a flexible, integrated and compact storage capacitor or capacitor bank backup solution with extensive protection function to ensure a safe, efficient, compact and low cost solution for these applications. MT2600 integrated input over voltage/current protection to prevent damage to following system. It also integrated an ideal diode for reverse blocking when input voltage is lost.

MT2600 integrated a linear charger to charge super capacitor with as high as 350mA current to achieve fast and safe charging. The charging devices also act as power path control switch. When input power is lost, this switch can be turned on to keep the system rail stable in Backup Mode. In backup mode, quiescent current draw from super capacitor is only 2.5uA. This ensures very long standby time of the system with low capacitance super capacitor.

MT2600 integrated a programmable Input voltage monitor. When input voltage drops below certain voltage set by resistor divider connected to PFB pin. A flag signal on PFLTB will inform the following system about the event so that preventative actions can be taken like process and save data in DRAM.

With 2 super capacitors in stack, MT2600 integrated cell balancing function. During charging mode, voltage between two stack capacitor is compared with half of total capacitor voltage. Current is diverted to keep these two voltages close to each other. MT2600 also integrated cell monitoring and protection circuit. This circuit monitors voltage for each capacitor. During charging mode, if any capacitor voltage reaches 2.65V, charging will be stopped until this fault is gone. Same way, during discharge mode, if any of the capacitor voltage drop below ground, discharging will be stopped to protect the capacitors.

OPERATION

The system should have three states: STANDBY State, CHARGE State, DISCHARGE State and UVLO State.

STANDBY State:

1.VCAP > VSYS, VIN is still available and PFB higher than threshold voltage. Or,

2.VCAP reaches setting point by CFB and VIN is still available and PFB higher than threshold. Or,

3.Any of the two super capacitor voltage reaches internal protection point and VIN is still available.

In STANDBY State, M3 FET should be kept OFF. M3 body diode need to be switches according to VSYS-VCAP voltage.

CHARGE State:

VSYS > VCAP, VIN is available and healthy; VCAP is below setting point by CFB. Both super capacitors are below over voltage protection point. In this state, we will turn of M3 with current limit set by ICHG.

Two possible features need to be evaluated:

1.Input DPPM. If input voltage drop and PFB voltage drops close to set point, we can fold back charge current to limit current drain from weak input source

2.Soft charging ending. When VCAP is charged and CFB voltage getting close to set point, we can fold

back charge current so that when charge stops, voltage drop on any impedance in series with capacitor doesn't cause oscillation between charge mode/standby mode.

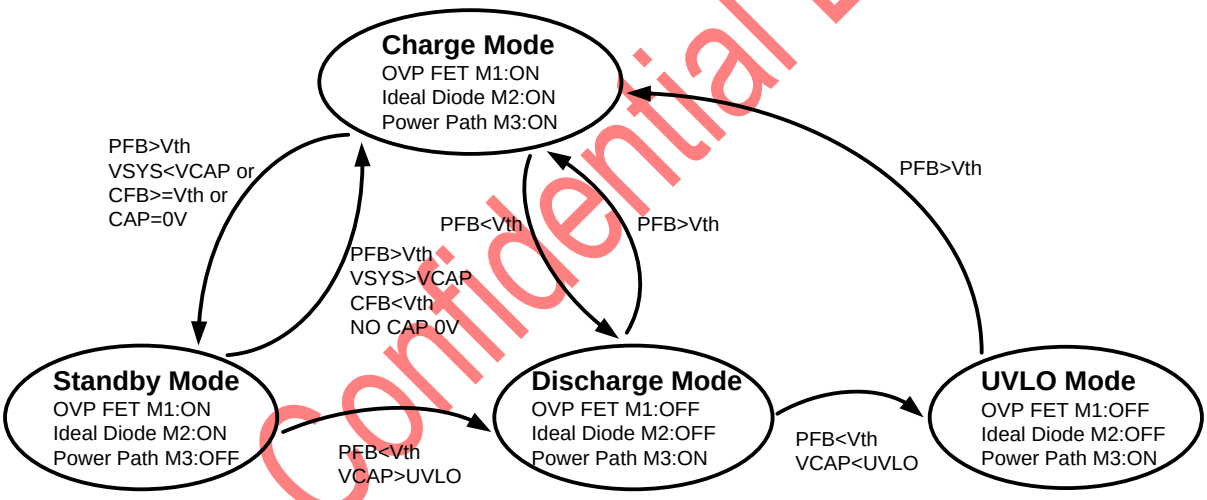
DISCHARGE State:

When PFB is below threshold, we consider input power source is gone. In this case, OVP FET is turned off. Ideal diode should be turned off too. Power path control FET M3 is turned on to connect VCAP to VSYS. Transition from Charge Mode or Standby Mode to Discharge Mode need to be smooth without huge inrush current, at the same time, it cannot let VSYS drop too much which might cause downstream system to shut down.

In Discharge mode, all the bias current is supplied by VCAP. To extend operating time, quiescent current need to be below 1uA in this case. Circuits need to be alive are: 1. M3 over current detection circuit; 2. UVLO detection circuit for VCAP.

UVLO State:

In case the system runs on Super Capacitor for long time without recharge, eventually VCAP will drop too low to sustain the function of the whole system When VCAP drops too low, we will enter UVLO state. In this state, all the circuit is shut down. This state can only be cleared if VIN is supplied.



PCB Layout Instruction

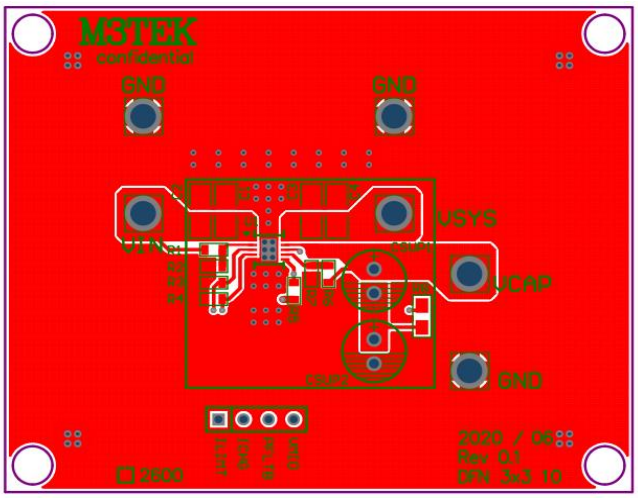
(1) The high current paths (GND, VIN, VSYS and VCAP)should be placed very close to the IC with short, direct and wide traces.

(2) Put the input capacitors and VSYS capacitors as close to the VIN/VSYS and GND pins as possible.

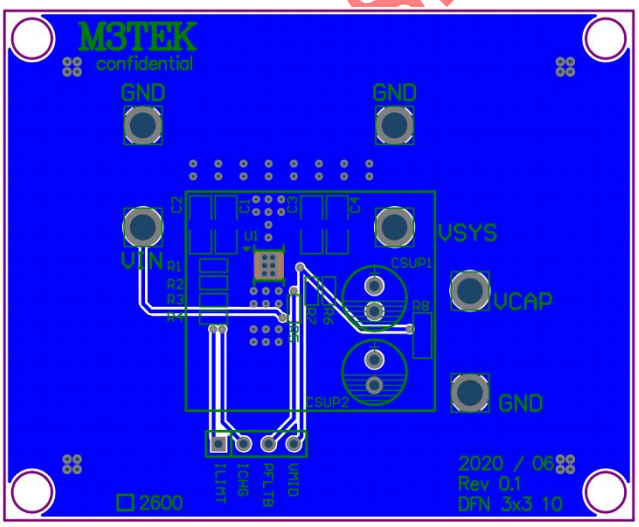
(3) Keep the VIN and GND pads connected with large copper and use at least two layers for IN and GND trace to achieve better thermal performance. Also, add several Vias with 10mil_drill/18mil_copper_width close to the VIN and GND pads to help on thermal dissipation.

(4) Four-layer layout is strongly recommended to achieve better thermal performance.

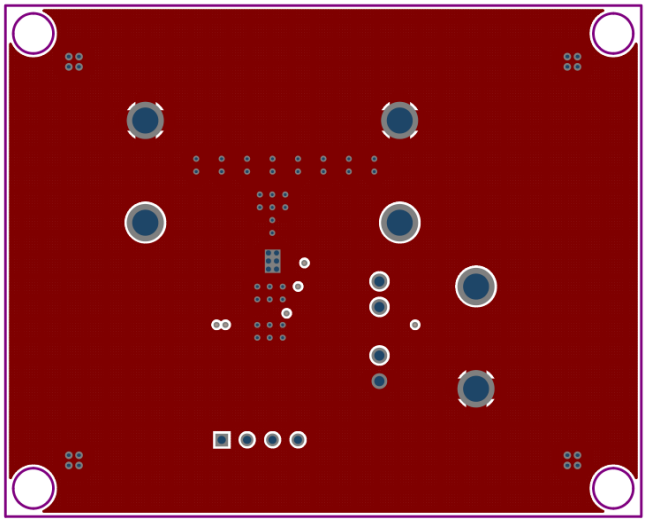
MT2600_DFN3x3_10L



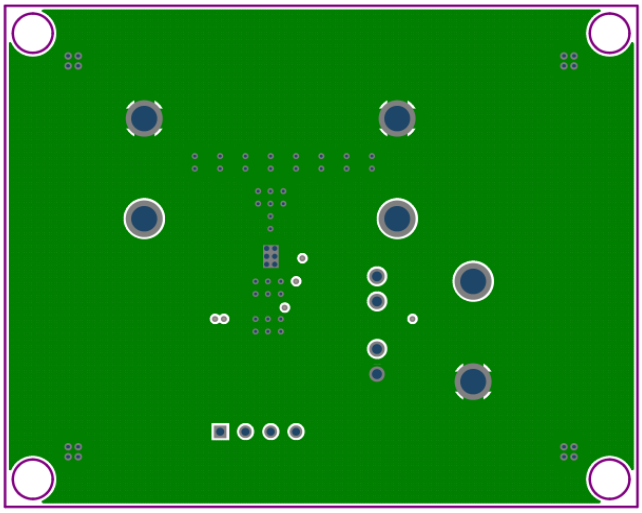
Top Layer



Bottom Layer

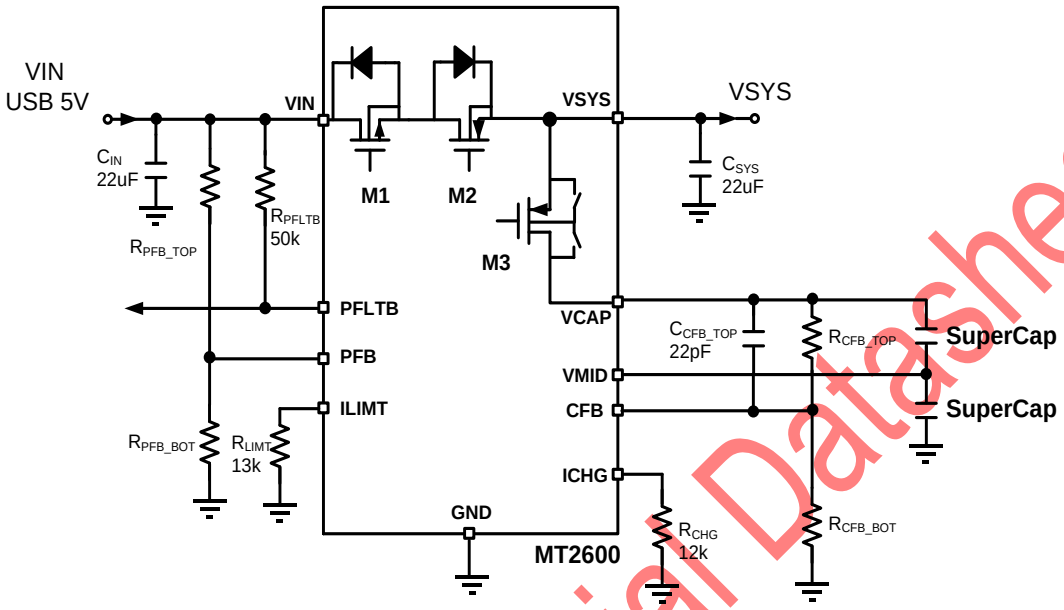


Mid-1 Layer



Mid-2 Layer

MT2600 Application Schematic



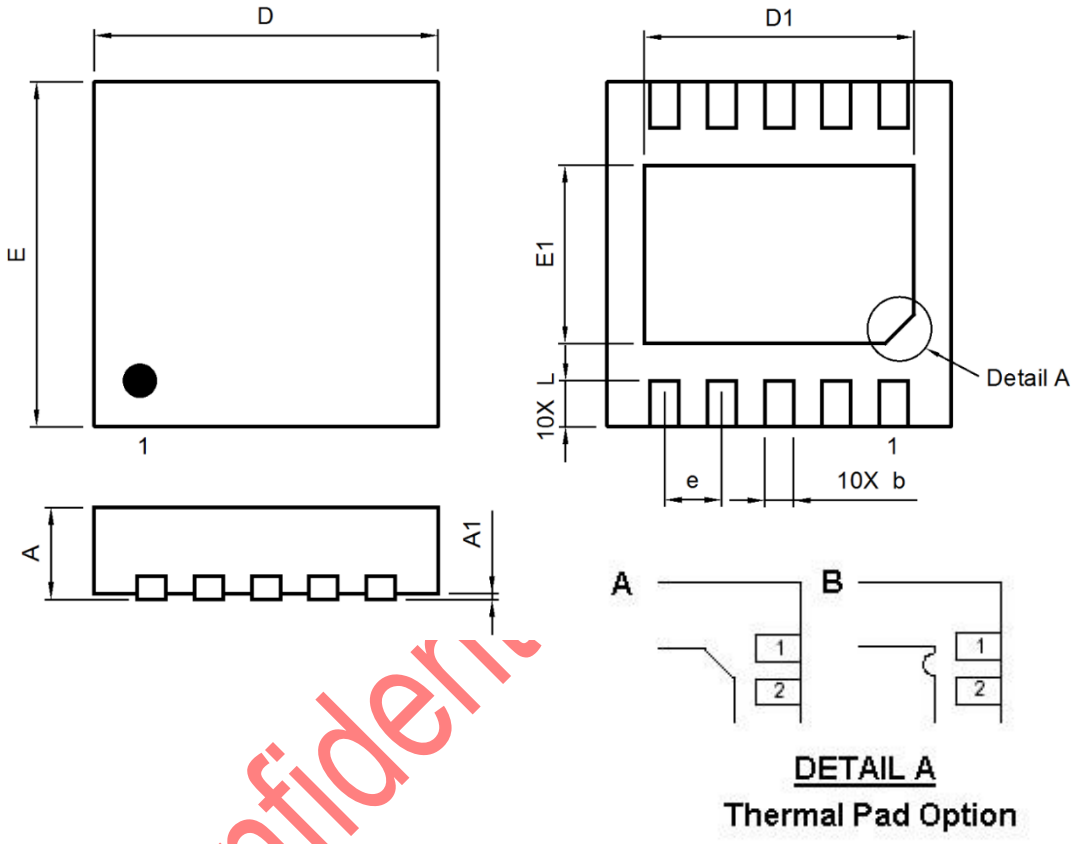
EVB BOM List

Qty	Ref	Value	Description	Package
1	C_{IN}	22μF	Ceramic Capacitor, 25V, X5R	0805
1	C_{SYS}	22μF	Ceramic Capacitor, 25V, X5R	0805
1	R_{PFB_TOP}	120KΩ	Resistor, ±1%	0603
1	R_{PFB_BOT}	50KΩ	Resistor, ±1%	0603
1	R_{CFB_TOP}	3.3MΩ	Resistor, ±1%	0603
1	R_{CFB_BOT}	931kΩ	Resistor, ±1%	0603
1	C_{CFB_TOP}	22pF	Ceramic Capacitor, 25V, X5R	0603
1	R_{CHG}	12KΩ	Resistor, ±1%	0603
1	R_{LIMT}	13KΩ	Resistor, ±1%	0603
1	R_{PFLTB}	50KΩ	Resistor, ±1%	0603
1	Power IC	MT2600	Super Capacitor Power Manager for Backup Power Applications	DFN3x3_10L

Package Information

DFN3x3_10L Outline Dimensions

Unit: inches/mm



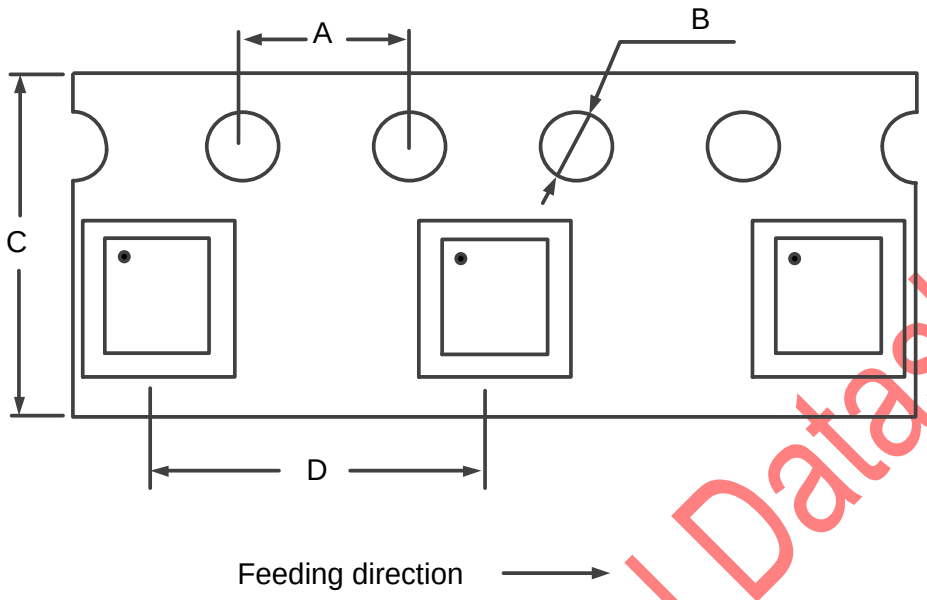
DETAIL A

Thermal Pad Option

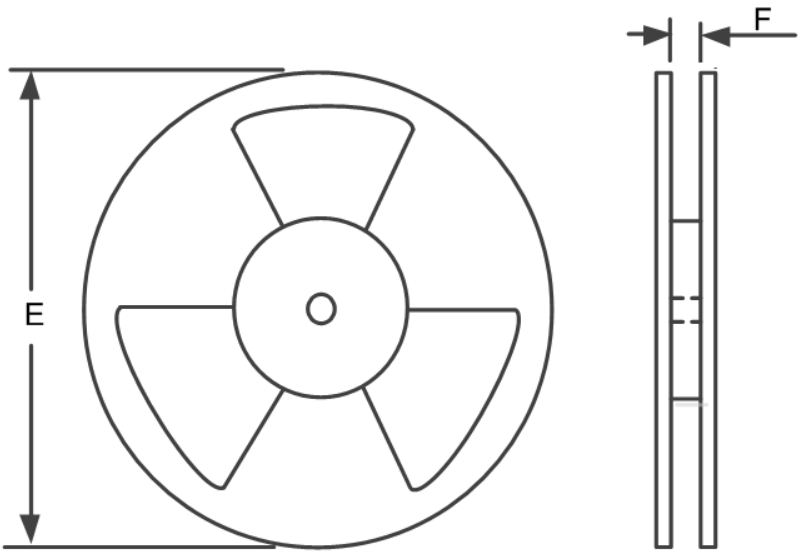
SYMBOLS	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	0.70	0.80	0.028	0.031
A1	0.00	0.05	0.000	0.002
b	0.18	0.30	0.007	0.012
D	2.90	3.10	0.114	0.122
D1	2.10	2.60	0.083	0.102
E	2.90	3.10	0.114	0.122
E1	1.35	1.80	0.053	0.071
e	0.50		0.020	
L	0.30	0.50	0.012	0.020

Carrier Tape & Reel Dimensions

1. Orientation / Carrier Tape Information:



2. Reel Information:



3. Dimension Details:

PKG Type	A	B	C	D	E	F	Q'ty/Reel
DFN3x3	4.0 mm	1.5 mm	12.0 mm	8.0 mm	13 inches	13.0 mm	5,000

Reflow Profile

Classification Of IR Reflow Profile

Reflow Profile	Green Assembly
Average Ramp-Up Rate (Ts_{min} to Tp)	1~2℃/second, 3℃/second max.
Preheat & Soak -Temperature Min(Ts_{min}) -Temperature Max(Ts_{max}) -Time($ts_{min}$to $tsts_{max}$)	 150℃ 200℃ 60~120 seconds
Time maintained above: -Temperature(T_L) -Time(t_L)	 217℃ 60~150 seconds
Peak Temperature(Tp)	See Classification Temp intable1
Time within 5℃of actual Peak Temperature(tp)	30 seconds max.
Ramp-Down Rate	6℃/second max.
Time 25℃ to Peak Temperature	8 minutes max.

* Tolerance for peak profile Temperature(T_p) is defined as a supplier minimum and a user maximum.
** Tolerance for time at peak profile temperature (t_p)is defined as a supplier minimum and a user maximum.

Table 1. Pb-free Process –Classification Temperatures (Tc)

Package Thickness	Volume mm^3 <350	Volume mm^3 350-2000	Volume mm^3 >2000
<1.6mm	260℃	260 ℃	260℃
1.6mm–2.5mm	260℃	250℃	245℃
≥2.5mm	250 ℃	245℃	245℃

Note: For all temperature information, please refer to topside of the package, measured on the package body surface.