28V, 6A Current Limit Switch with True Reverse Blocking and Fast Role Swap

Description

The MT7231 is an advanced 28V 6A rated current limit switch which provides overload, short circuit, input voltage surge, excessive inrush current, over-temperature and reverse current protections to power the system. The built-in 24mΩ ultra low $R_{DS(ON)}$ power switch helps reducing power loss during normal operation. Current limit level can be set 1A to 6A with an external resistor. The MT7231 integrates thermal fold-back function and over temperature shutdown protection. The MT7231 has all time reverse current blocking function regardless of the enable signal EN logic states. A fast role swap function is also implemented to comply the timing requirement defined in the USB Power Delivery Specification. The integrated input and output discharge function which allows the voltage levels at the input and output ports to be discharged to meet the requirement of the USB Power Delivery Specification. The MT7231 is available in low profile 16 leads QFN 2.5mm x 3.2mm package.

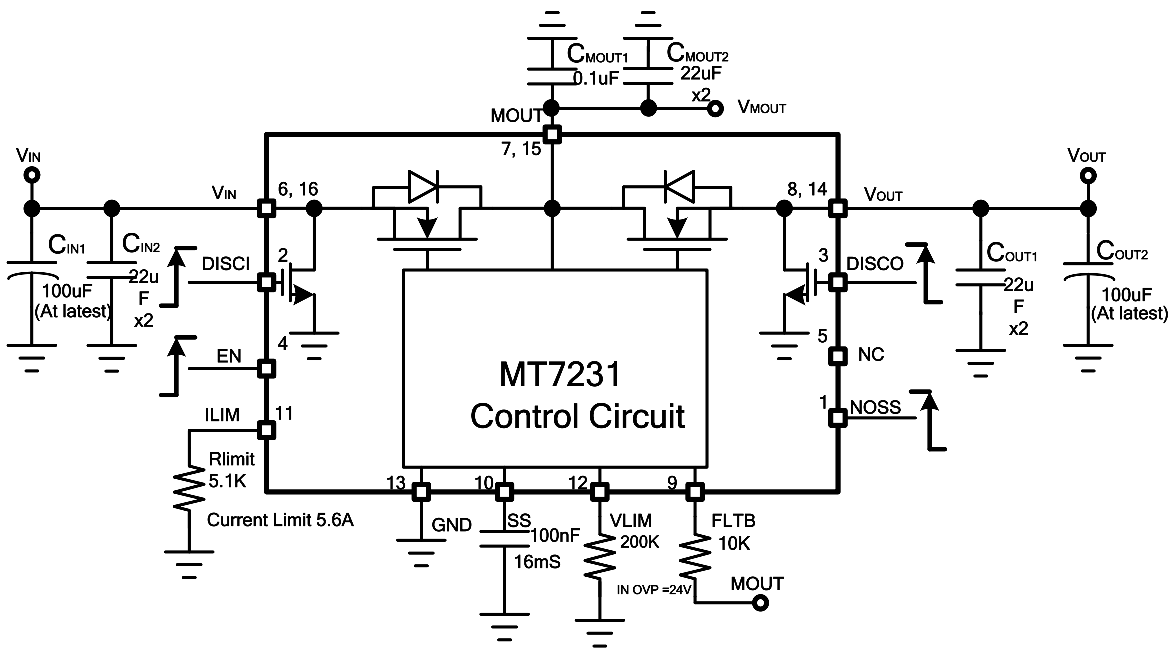
Features

- Wide Input Voltage Range from 3V to 24V with Surge Up to 28V
- Integrate a 24mΩ Ultra Low On Protection Switch
- External Adjustable Current Limit 1A~6Amp
- External Adjustable Input Over- voltage Protection (OVP) Threshold
- External Adjustable Soft-start (SS) Time
- Support Fast Role Swap Function through a logic signal to bypass Soft-start Time
- All Time True Reverse Current Blocking
- Short-circuit Protection
- Fault Indicator
- Input and Output Discharge Function
- Thermal Shutdown Protection and Auto Recovery
- QFN2.5×3.2_16L Packages
- Pb-Free ROHS compliant

Application

- Notebook, Desktop, Servers and Tablets
- Dongle and Docking Stations
- Power Accessories
- Thunderbolt/USB Type-C PD power switch

Typical Application

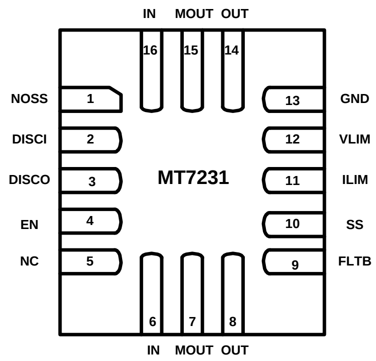


Ordering Information

Part No.	Marking	Temp. Range	Package	MOQ
MT7231NQJR	MT7231 YWWXX	-40°C ~85°C	QFN2.5X3.2mm_16L	3000/Tape & Reel

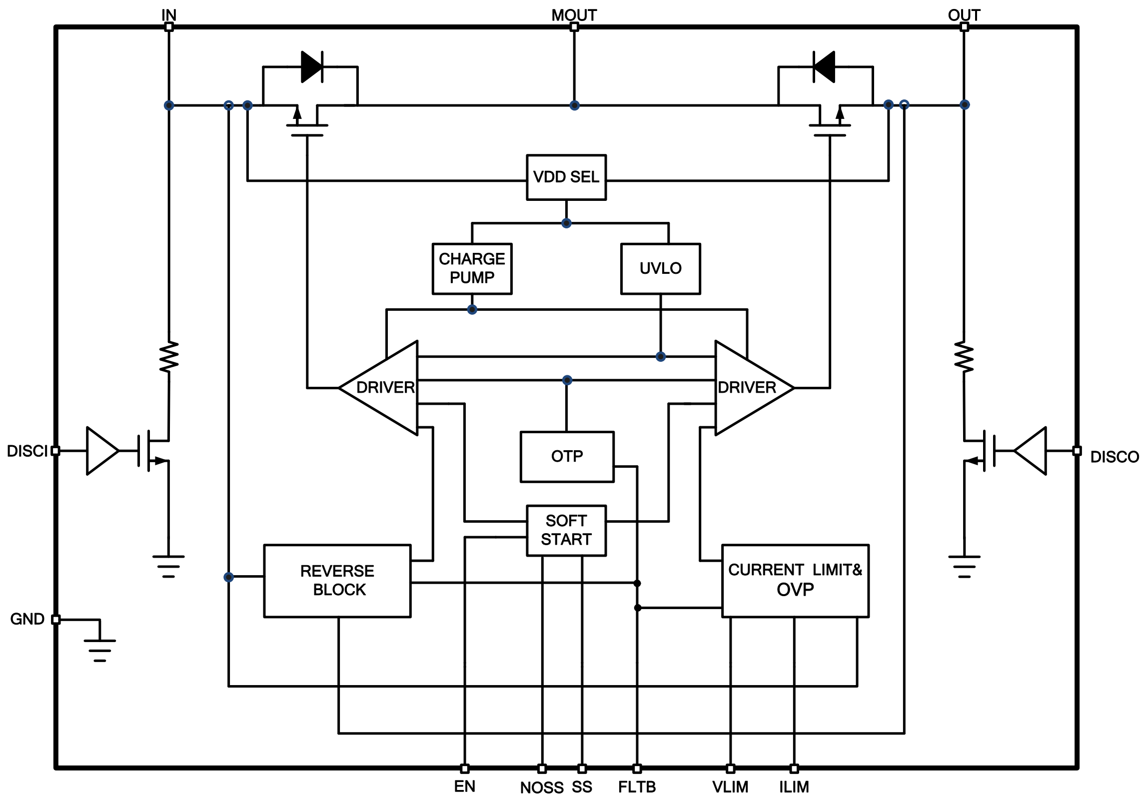
Note: Y:Year, WW:Week, XX:Control Code

Pin Configuration



MT7231 TOP VIEW

Functional Block Diagram



Pin Description

PIN NO	PIN NAME	DESCRIPTION
1	NOSS	Fast Role Swap Function enable pin. Logic Low enables soft-start during startup. The output voltage ramping up rate is set by the capacitor value on the SS pin. Logic High disables soft-start function during startup.
2	DISCI	IN port discharge control input. Logic High discharges IN port to GND through an internal 350Ω pull down resistor.
3	DISCO	OUT port discharge control input. Logic High discharges OUT port to GND through an internal 350Ω pull down resistor.
4	EN	The enable control pin of the MT7231 chip. To enable the device this pin needs to be pulled high. Pulling this pin low disables the device. This pin has an pull-down resistor of typically 1MΩ when the device is disabled.
5	NC	Not Connection. Recommend to leave the pin float or connect to GND. Don't connect the pin to the voltage above 1V.
6,16	IN	Input Supply pin.
7,15	MOUT	The middle voltage pin between IN and OUT. Leave this pin float if it is not used. Although MOUT pin can provide power to the other circuitry when EN pin is pulled high, need to pay extra attention when use it. MOUT pin does NOT have short circuit protection, and the current drawn from MOUT pin also affects current limit setting accuracy at ILIM pin. See Application Notes how to take power from the MOUT pin.
8,14	OUT	Output pin.
9	FLTB	Fault event indicator open drain output pin. A pull-up resistor is connected from FLTB pin to any voltage less than 28V. Active Low indicates input over-voltage, over-current, over-temperature and reverse current fault events.
10	SS	Soft-start time program pin. Connect a capacitor to ground to program the soft start time.
11	ILIM	Current limit program pin. Program the switch current limit by connecting a resister to ground. ILIM pin can't be shorted to GND. If the system requires a single component fail safe, choose 2 resistor in series to program current limit.
12	VLIM	Input over-voltage protection threshold set pin. Program input over-voltage protection threshold by connecting a resister to ground. Recommend to set input over-voltage protection threshold range 5V to 24V.
13	GND	Ground pin.

Absolute Maximum Rating (Note1)

IN, MOUT and OUT to GND ……………………-0.3V~+28V
EN and FLTB to GND ……………………… -0.3V~+28V
IN to OUT ………………………………… -28V~+28V
The other pins to GND ……………………… -0.3V~+6.5V
ESD ………………………………………… Class 2
Lead Temperature(Soldering 10s) ……………+260°C
Junction Temperature Range ………… -40°C to +150°C
Storage Temperature Range ………… -65°C to +150°C

Recommend Operating Conditions

IN, MOUT and OUT ……………………………+3V~+24V
Maximum Switch Continuous Current ………………6A
Ambient Temperature Range ………… -40°C to +85°C
Junction Temperature Range ………… -40°C to +125°C

Thermal information (Note3, Note4)

Maximum Power Dissipation(T_A=25°C) ………… 2.6W
Thermal Resistance(θ_{JA}) ……………… 55.12°C/W
Thermal Resistance(θ_{JC}) ………………15.6°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 = +27°C, V_{IN}= V_{EN} =5V, R_{ILIM}=5.6kΩ, R_{VLIM}=200kΩ and C_{SS}=10nF, unless otherwise specified.

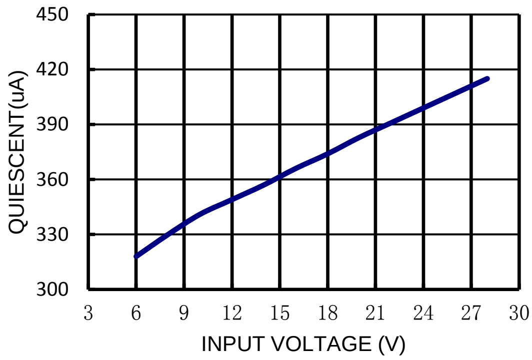
PARAMETER	Symbol	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input Voltage Range	V_{IN}		3		24	V
Quiescent Current	I_Q	V_{IN}=5V~24V, V_{EN}=V_{IN}		450	600	μA
Shutdown Current	I_{SHDN}	V_{IN}=24V, V_{EN}=0V		10	20	μA
EN Turn-on Threshold	V_{EN_ON}	EN Rising	1.5		24	V
EN Turn-off Threshold	V_{EN_OFF}	EN Falling			0.4	V
EN Pull-Down Resistance	R_{ENPD}			1		MΩ
Input Under-voltage (UVLO) Threshold	V_{UVLO}	V_{IN} Rising		2.75		V
Input Under-voltage Hysteresis	$V_{UVLOHYS}$	V_{IN} Falling		300		mV
Power On Delay Time	t_{pwrdly}			500		us
Power Switch On Resistance	$R_{DS(ON)}$	V_{IN}=5V~24V, I_{OUT}=1A		24		mΩ
Power Switch Leakage Current	I_{LKG}	V_{MOUT} =24V, V_{IN} = V_{OUT} =V_{EN} =0V		0.1	10	uA
Reverse Current Blocking Threshold	$V_{RVBINTH}$	V_{IN}-V_{OUT}	-10	-15	-20	mV
Reverse Current Blocking Response time	t_{RVB}				5	μs
Current Limit ILIM Setting Factor	K_{ILIM}	I_{ILIM}=1A~6A		28		A*kΩ
Current Limit	I_{ILIM}	R_{ILIM}=28 kΩ		1		A
		R_{ILIM}=9.33kΩ		3		
		R_{ILIM}=5.6 kΩ		5		
Input Over-voltage Threshold VLIM Setting Factor	K_{OVP}	V_{OVP} =K_{OVP}*V_{VLIM} V_{OVP}=5V~24V		1200		
VLIM Source Current	I_{VLIM}	V_{IN}=5V, R_{VLIM}=50kΩ		10		μA
Input Over-voltage Threshold	V_{OVP}	V_{IN} Rising, R_{VILIM}=50kΩ		6		V
		V_{IN} Rising, R_{VLIM}=200kΩ		24		

PARAMETER	Symbol	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input Over-voltage Threshold Hysteresis	V_{OVPHYS}	V_{IN} Falling, R_{VILIM}=50kΩ		5.3		V
		V_{IN} Falling, R_{VLIM}=200kΩ		23.3		
Soft-start Time	T_{SS}	C_{SS}=100nF		16		msec
		SS floating		0.8		msec
SS bias current	I_{SS}	V_{IN}=5V, SS short to GND		2.5		µA
FLTB Output Low Voltage	V_{FOL}	Fault Event, I_{FLTB}=1mA			350	mV
FLTB Leakage Current	I_{Flkg}	No Fault Event, V_{FLTB}=5V		0.01	1	µA
FLTB delay time	TFLTB	Over current or short circuit event		3		mS
FLTB release delay time		Fault Event remove		1.5		mS
NOSS, DISCI, DISCO Logic High Threshold	V_{IH}	V_{IN}=5V~24V	1.5		5.5	V
NOSS, DISCI, DISCO Logic Low Threshold	V_{IL}	V_{IN}=5V~24V			0.4	V
NOSS, DISCI, DISCO Input Leakage Current	I_{LKG}	$V_{NOSS/DISCI/DISCO}$=0V and 5V	-1		1	uA
IN, OUT Discharge resistance	R_{DISC}	$V_{DISCI/DSICO}$=5V		350		Ω
Thermal Shutdown Temperature	T_{SD}			150		°C
Thermal Shutdown Hysteresis	T_{HYS}			25		°C

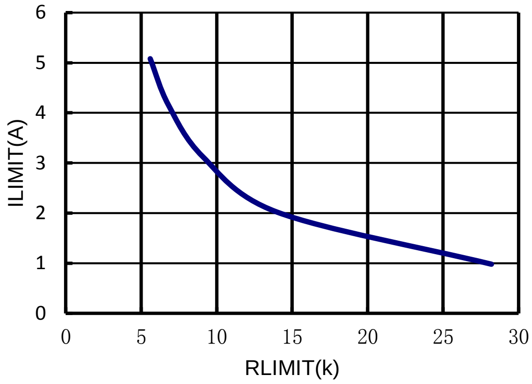
Typical Performance Characteristics

(C_{IN}=22uF*2+100uF_Al, C_{MOUT} =22uF*2+0.1uF, C_{OUT} = 22uF*2+100uF_Al, T_A =+25℃, unless otherwise noted.)

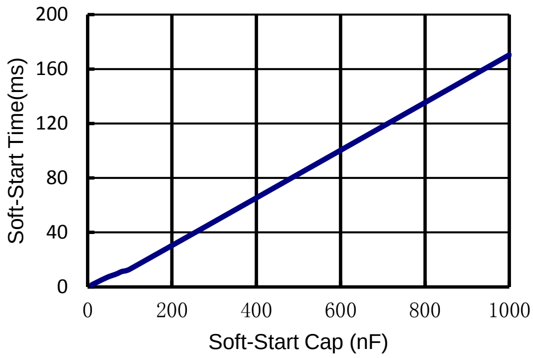
Quiescent Current Vs. Input Voltage



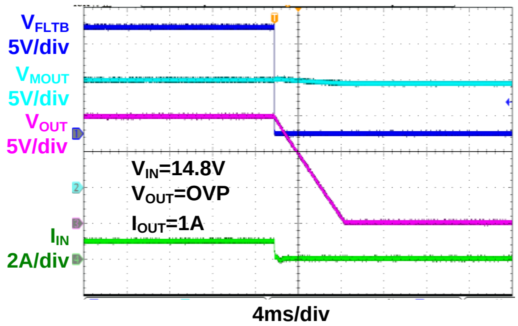
Current Limit Vs. R_{ILIM} Resistor Value



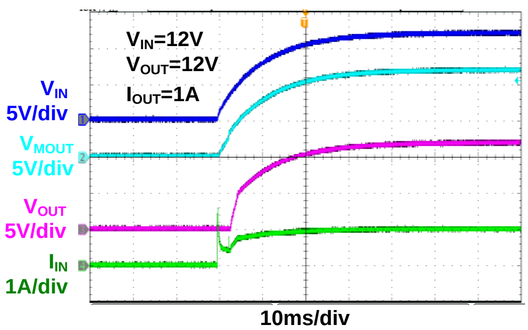
Soft-Start Time Vs. SS Capacitance



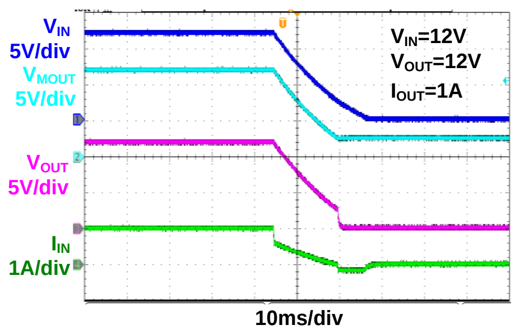
Input Over Voltage Protection



Vin Power On



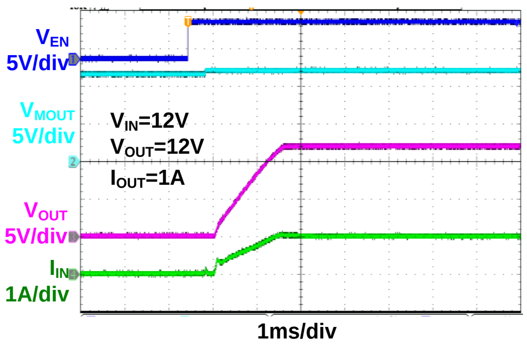
Vin Power Off



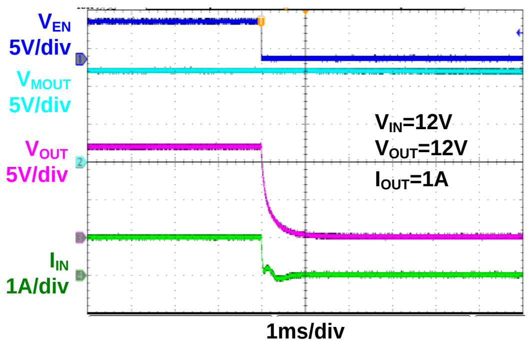
Typical Performance Characteristics

(C_{IN}=22uF*2+100uF_Al, C_{MOUT} =22uF*2+0.1uF, C_{OUT} = 22uF*2+100uF_Al, T_A =25 ℃, unless otherwise noted.)

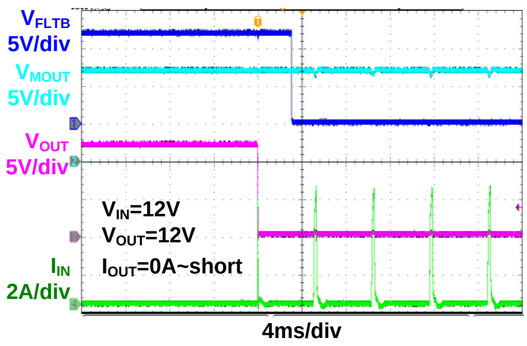
EN On



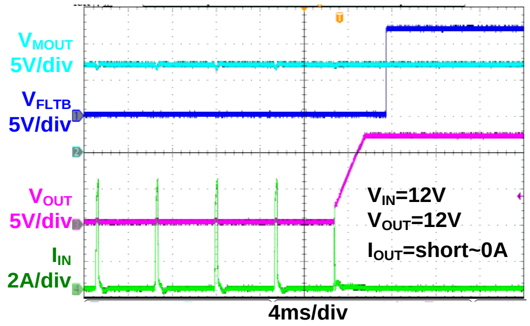
EN Off



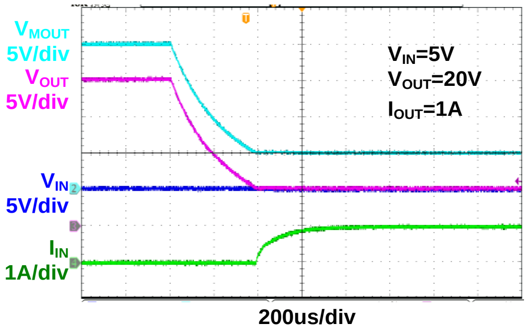
Short Circuit Protection



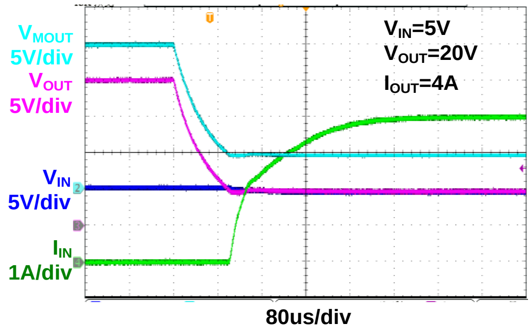
Short Circuit Protection Recovery



Fast Role Swap With No Soft-Start



Fast Role Swap With No Soft-Start



Detailed Description

The MT7231 is an advanced current limit power switch with adjustable soft-start, adjustable current limit threshold, input under-voltage, adjustable input over-voltage, over-temperature and short circuit protections. The integrated back to back power switch has true reverse blocking function regardless of the enable pin EN logic states. When EN pin is pulled low, the power switch is turned off to prevent current flowing back from output OUT voltage to input IN voltage. A high level on EN pin enables the power switch. The power switch is turned off when the output voltage exceeds the input voltage. The power switch resumes on when the output OUT voltage drops below the input IN voltage. A low level on NOSS pin enables the power switch soft-start function. While the input IN voltage rises, the power switch starts conducting and allows current to flow slowly from IN to OUT. Users have the ability to control the output voltage ramp up time by connecting a capacitor between SS pin and GND. A high level on NOSS pin bypasses the power switch soft-start function and turns on the power switch quickly to power the system with fast role swap requirement. After a successful start-up sequence, the device actively monitors its load current to ensure that the overload current limit I_{LIMT} programmed by pin ILIMT is not exceeded. The device monitors input voltage and turns off the power switch if the input voltage spike exceeds the input over-voltage threshold which is set by pin VLIM. Both current limit and input over-voltage protection keep the output device safe from the harmful input voltage and current transients. The device has a built-in thermal sensor. If the device junction temperature (T_J) exceeds the thermal regulation point +125°C, the current limit will be decreased until T_J is regulated around +125°C. In some deadly output short circuit events, and the device junction temperature (T_J) quickly rises and exceeds the thermal shutdown threshold T_{SHDN}, typically +150°C, the device will shut down the power switch and disconnect the load from the input supply. The MT7231 device remains off during a cooling period until the junction temperature falls below T_{SHDN} –20°C, after the device will attempt to restart.

Application Information

Enable

Enable interface pin EN has ON/OFF threshold of 1.5V(Min) and 0.4V(Max) respectively. Pull EN pin low below OFF threshold (<0.4V) to disable the power switch and all protection circuits, and the device is in the low power shutdown mode and draws only 10µA current from the input supply. Pull EN pin High above ON threshold (>1.5V) to enable the power switch and all protection circuits. There is an internal 1MΩ pull-down resistor to ensure the power switch OFF if EN pin is floated. EN pin can tolerate maximum 28V voltage spike.

Input Under-voltage Lockout

When EN pin is Logic Hi, the MT7231 monitors the input supply voltage V_{IN} and allows the power switch turning on if the input voltage is above input under-voltage lockout threshold V_{UVLO} (Typical 2.75V). If the input voltage is below input under-voltage lockout threshold V_{UVLO}, the device turns off the power switch.

Input Over-voltage Protection

When EN pin is Logic Hi, the MT7231 monitors the input supply voltage V_{IN}. The input over-voltage protection circuit disables the power switch and pulls FLTB pin LOW to report the fault condition If the input voltage is above input over-voltage threshold V_{OVP}. Once the input voltage drops below input over-voltage threshold V_{OVP} and no other protection circuit is active, the power switch resumes ON.

An external resistor R_{VLIM} is connected from VLIM pin to GND to set the input over-voltage protection threshold V_{OVP}. The device sources typical 10μA to VLIM pin. The voltage drop V_{VLIM} across the R_{VLIM} resistor externally adjusts the input over-voltage threshold from 5V to 24V using Equation (1):

$$V_{OVP} = K_{OVP} \times V_{VLIM} = 1200 \times 10\mu A \times R_{VLIM} \quad \text{......................................(1)}$$

The recommended input over-voltage threshold setting is shown in the Table 1.

R_{VLIM} (kΩ)	45.8	82.5	137.5	183.3
Input Over-voltage Threshold (V)	5.5	9.9	16.5	22

Table 1. Input Over-voltage Setting by An External Resistor R_{VLIM}

Soft Start and Fast Role Swap (FRS)

When EN pin is asserted high, and NOSS pin is asserted low, the soft start control circuitry controls the gate voltage of the power switch in a manner such that the output voltage is ramped up linearly until it reaches input voltage level during power on. The in-rush current at power-on is limited by the regulated output voltage ramp up rate through the soft-start time. The built-in internal soft-start time is typical 0.8msec. If users prefers the soft-start time longer than 0.8msec, connect an external capacitor C_{SS} between SS pin and ground to re-adjust the soft-start time. The external soft-start time is approximately calculated by Equation (2):

$$T_{SS} = C_{SS} \times 1.67 \times 10^5 \quad \text{..(2)}$$

The recommended soft-start time setting is shown in the Table 2.

C_{SS} Value (nF)	None or < 4.7nF	10	33	47	100
Soft-start Time T_{SS} (msec)	0.8	1.6	5.5	7.8	16.7

Table 2. Soft-start Time Setting by An External Capacitor C_{SS}

When both EN pin and NOSS are asserted high, the MT7231 bypasses soft start time and turns on the power switch immediately. This features allows the MT7231 acting as a new power source to support the system with Fast Role Swap (FRS) requirements. Figure 2 shows the FRS timing requirement defined in the USB PD revision 3.0. To support Fast Role Swap operation, connect the MT7231 input supply pin IN to a 5V power source and connect the MT7231 output pin OUT to another power source V_{BUS} which supply voltage range is from 0V to 24V. When the MT7231 output voltage is above the input voltage (V_{OUT} - V_{IN} > 15mV), the power switch is turned off to prevent reverse current flowing from V_{OUT} to V_{IN}. Once the output voltage falls below the input voltage (V_{IN}>V_{OUT}), the reverse current condition is not valid. The Fast Role Swap function is triggered, and the MT7231 power switch is quickly switched ON within 100µs. Figure 3 show the MT7231 FRS control sequence.

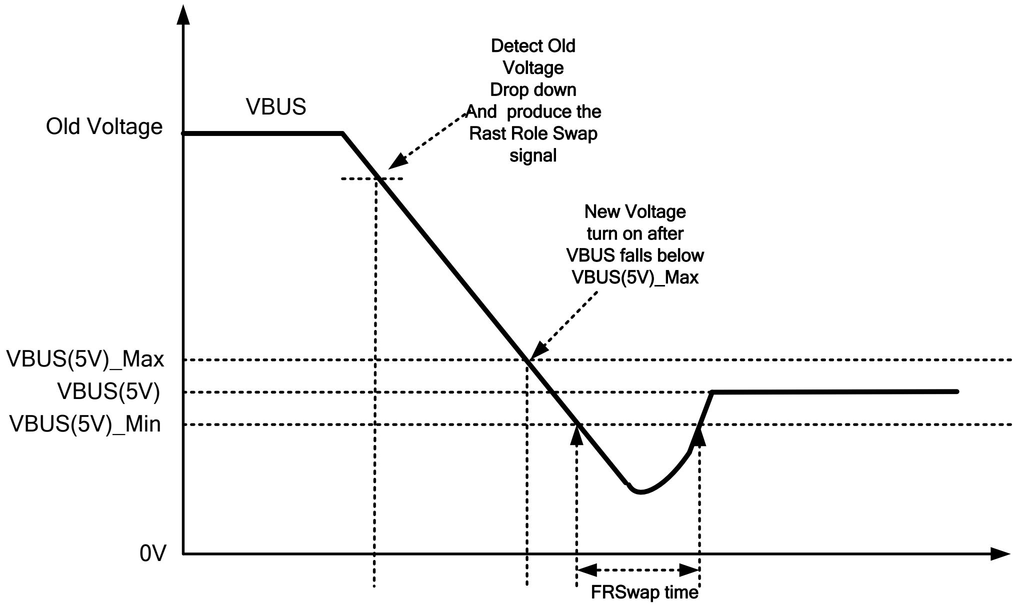


Figure 2. V_{BUS} Detection and Timing during Fast Role Swap

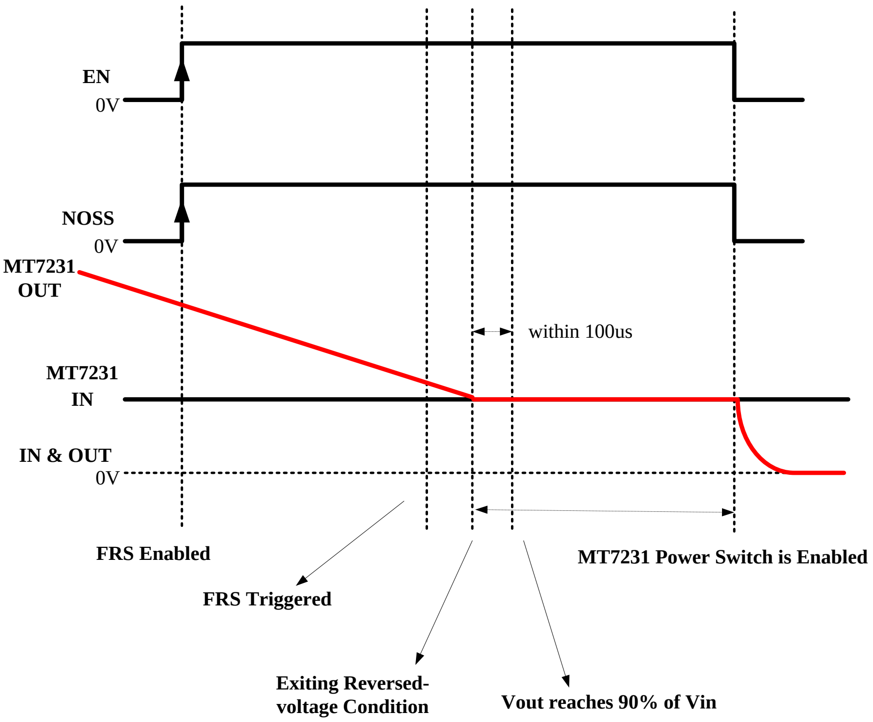


Figure 3. Fast Role Swap Control Sequence

Current Limit and Short Circuit Protection

For current limited adaptors or power sources, users can program the input current limit level to prevent the load current overload the source. The MT7231 current limit is set with an external resistor R_{ILIM} connected between ILIM and GND. If over-load occurs, the internal circuitry limits the input current based on the value of R_{ILIM} and pulls FLTB pin LOW to report the fault condition. ILIM pin can't be short to GND. If the system requires a single component fail safe, choose 2 resistor in series to program input current limit. The current limit resistor R_{ILIM} is selected with Equation (3).

$$R_{ILIM} = \frac{K_{ILIM}}{I_{ILIM}} = \frac{28A * k\Omega}{I_{ILIM}} \quad \text{...(3)}$$

The common current limit threshold setting is shown in the Table 3.

R_{ILIM} (kΩ)	28	14	9.33	7	5.6	4.6
Current Limit I_{ILIM} (A)	1.0	2.0	3.0	4.0	5.0	6.0

Table 3. Current Limit Setting by An External Resistor R_{ILIM}

The MT7231 also integrates a fast-trip comparator to quickly turn off the power switch when the output voltage is shorted to ground. The device operates hiccup mode in short circuit protection. Once the short circuit fault is detected, the power switch is turned off and is forced off for a given time. At the end of the predetermined time, a restart attempt is made by soft-starting the power switch. If the over-load condition has been removed, the power switch will turn on and operate normally; otherwise, the device will see another over-current event and shut off the power switch again, repeating the previous cycle. The excess heat due to overload lasts for only a short duration in the hiccup cycle, hence the junction temperature of the power devices is much lower.

Thermal Foldback and Thermal Shutdown Protection

The device continuously monitors the load current and keeps it limited to the value programmed by R_{ILIM}. In the normal operation or current limit protection mode, If power dissipation in the internal MOSFET $P_D = (V_{IN} – V_{OUT}) \times I_{OUT}$ is too high, MT7231 will engage thermal foldback to reduce the current limit value so that the junction temperature (T_J) is maintained around +125°C. Figure 4. shows thermal foldback current limit. In some deadly output short circuit events, the output voltage drops with current limit I_{ILIM}. It will result in the increasing junction temperature T_J with the increased power consumption and the device junction temperature (T_J) quickly rises and exceeds the thermal shutdown threshold T_{SHDN}, typically +150°C, the device will shut down the power switch and disconnect the load from the input supply. The MT7231 device remains off during a cooling period until the junction temperature falls below T_{SHDN} –20°C, after the device will attempt to restart.

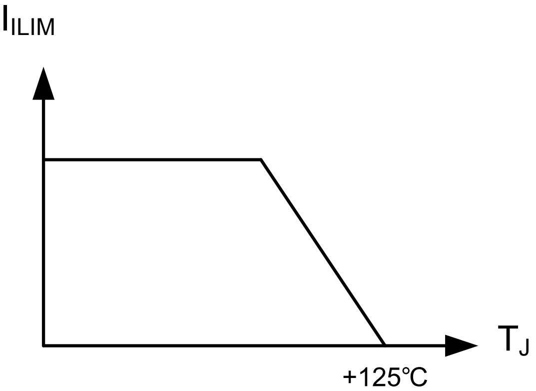


Figure 4. Thermal Foldback Current Limit

Reverse Current Protection

The MT7231 has all time reverse current protection regardless of the EN logic level. The voltage difference V_{IN} - V_{OUT} between the IN and OUT port is monitored continuously. Once the input voltage drops below the output voltage, the device immediately turns off the power switch to prevent the current flowing from the opposite direction and pulls FLTB pin LOW to report the fault condition. When the reverse current condition is no longer valid, the input voltage rises above the output voltage, the power switch resumes ON, and FLTB pin becomes high impedance HiZ.

Fault Indicator FLTB

The FLTB is an open-drain output that requires an external pull-up resistor connected to any voltage less than 28V. The pull up resistor value is recommend to be 10kΩ to 1000kΩ. FLTB pin indicates the state of the power switch. When no fault is detected and power switch is conducting, FLTB stays at high impedance HiZ. The device generates a warning flag and FLTB output low whenever one of the following fault event occurs: input over-voltage, current limit, short circuit, reverse current and over-temperature. And FLTB output change to be low with typical 3msec de-glitch time when over current or short circuit event occurs. The FLTB signal remains at ‘low’ until the device exits from the fault events with typical 1.5msec de-glitch time.

IN and OUT Port Discharge Function

The input IN and output OUT port discharge function is controlled via two external control inputs DISCI and DISCO, and the internal discharge resistance is around 350Ω. DISCI=Hi discharges the input IN port to GND, and DISCI=Lo disables the input discharge function. DISCO=Hi discharges the output OUT port to GND, and DISCO=Lo disables the output discharge function.

Take Power from MOUT Pin

The MT7231 power switch consists of 2 back-to-back connected N-channel MOSFETs. MOUT is the middle voltage pin between IN and OUT. Although MOUT pin can provide power to the other circuitry when EN pin is pulled high, need to pay extra attention when use it. Bypass MOUT to GND with a minimum 0.1μF MLCC capacitor if MOUT pin is used. The current drawn from MOUT pin affects input current limit setting accuracy at ILIM pin. Due to body diode of the power MOSFETs in MT7231, MOUT pin is NOT protected from over-load and short circuit fault events. Whenever the input voltage is applied on IN pin, MOUT will follow the input voltage through either the power MOSFET M1 or M1 body diode. When a short circuit occurs on the MOUT pin, the current can NOT be limited by the MT7231. If over load or short circuit protection is required for the MOUT pin, recommend to add a load switch MT7236 between MOUT pin and any downstream circuits. The MT7236 will protect over load and short circuit fault events, and the system reliability and fault tolerance can be guaranteed. Figure 5. Shows the MT7231 MOUT pin short circuit protection with the MT7236.

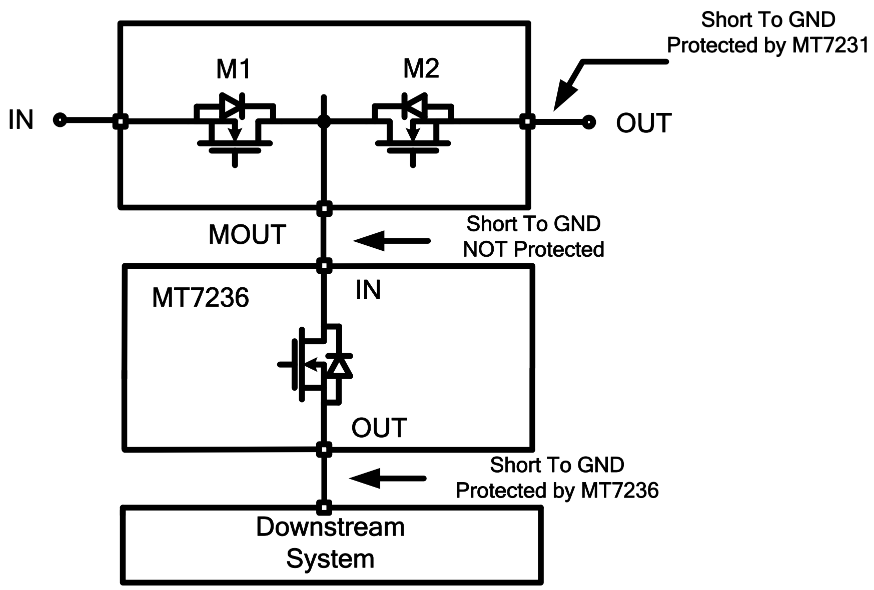


Figure 5. MOUT Pin Short Circuit Protection with the MT7236 Load Switch

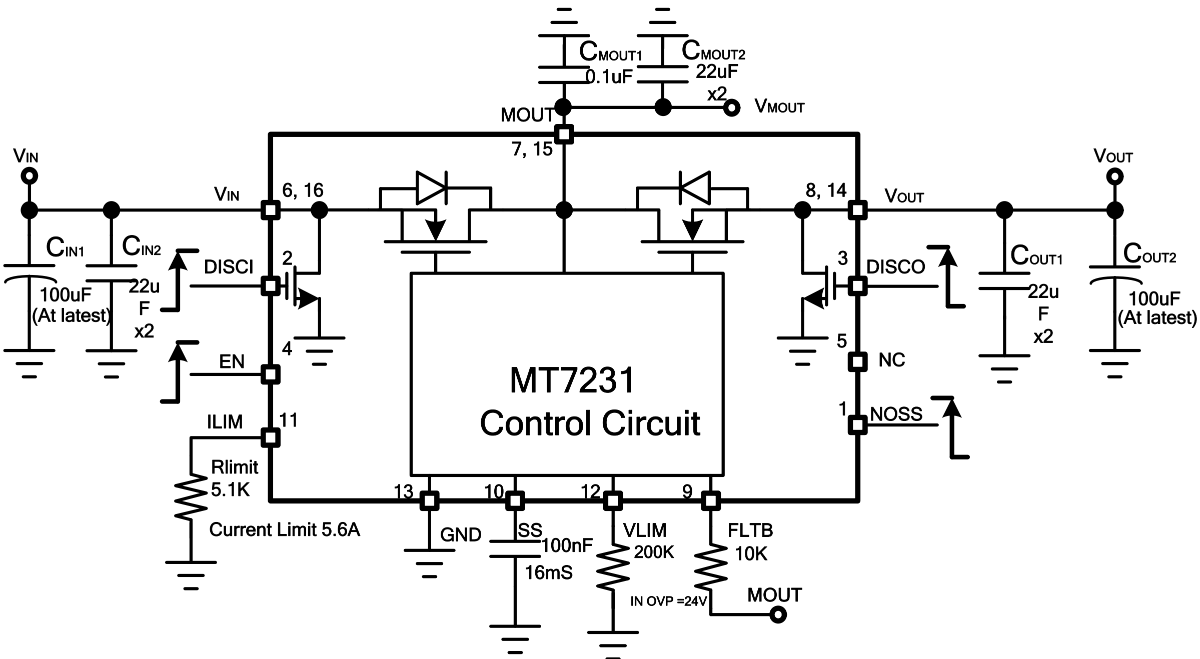
Input Capacitor Selection

Place a high quality 0.1μF in parallel with at least a 22μF or higher ceramic type X5R or X7R bypass capacitor at the IN pin to ground GND for proper decoupling. The input capacitor voltage rating should exceed the maximum input voltage range.

Output Capacitor Selection

Place a high quality 0.1μF in parallel with at least 22μFx2 or higher ceramic type X5R or X7R bypass capacitor at the OUT pin to ground GND for proper decoupling. The output capacitor voltage rating should exceed the maximum input voltage range. In the event of the output short circuit with a long cable, the cable parasitic inductance and the output ceramic forms high Q LC-Tank. The short circuit high current slew rate di/dT causes the output OUT pin going negative voltage up to -10V. The OUT pin negative voltage spike triggers ON the OUT pin ESD diode and put voltage stress on the internal power switch. If the voltage difference between IN pin and OUT pin exceeds 28V, the power switch will be permanently damaged. In order to limit OUT pin negative voltage spike in the short circuit event, recommend to add an additional 100μF or 220μF Electrolytic capacitor in parallel with output ceramic capacitors. Due to high ESR value of Electrolytic capacitor, the output parasitic L-C tank Q is damped.

MT7231 Application Schematic



EVB BOM List

Qty	Ref	Value	Description	Package
2	C_{IN2}	22μF	Ceramic Capacitor, 50V, X5R	1206
2	C_{MOUT2}	22μF	Ceramic Capacitor, 50V, X5R	1206
2	C_{OUT1}	22uF	Ceramic Capacitor, 50V, X5R	1206
2	C_{IN1}, C_{OUT2}	100uF (or 220uF)	Electrolytic Capacitor, 50V	8x12mm
1	C_{MOUT1}	100nF	Ceramic Capacitor, 10V, X5R	0603
1	C_{SS}	100nF	Ceramic Capacitor, 10V, X5R	0603
1	R_{LIMIT}	5.1KΩ	Resistor, ±1%	0603
1	R_{FLTB}	10KΩ	Resistor, ±1%	0603
1	Power IC	MT7231	Load Switch	QFN2.5x3.2

Layout Guidelines

Good PCB layout is important for improving the thermal and overall performance of MT7231. To optimize the switch response time to output short-circuit conditions, keep all traces as short as possible to reduce the effect of Power/GND trace parasitic inductance (as below red line) and add the EC capacitor (At latest 100uF) at VOUT to GND to compensate the unwanted parasitic inductance of power line (ex: USB Type C line).

- Place the input and output bypass capacitors as close as possible to the VIN and VOUT and MOUT pins.
- IN, MOUT and OUT pins connected as below Figure 7 pattern to reduce impedance improving the power loss
- Use a ground plane to enhance the power dissipation capability of the MT7231.

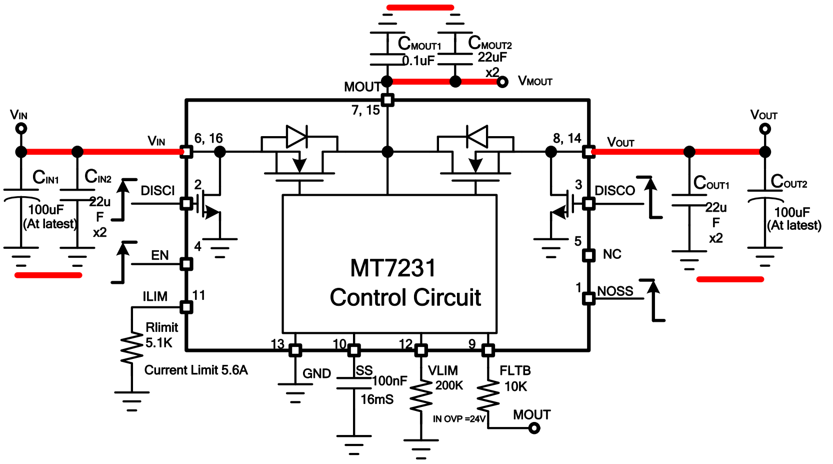


Figure 6. Keep all red line traces as short as possible to reduce the effect of trace parasitic inductance.

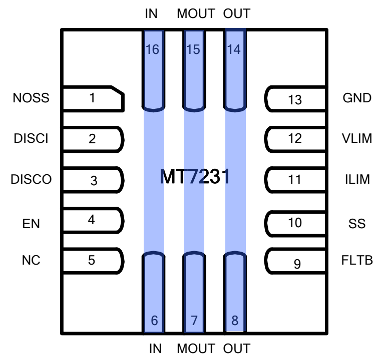
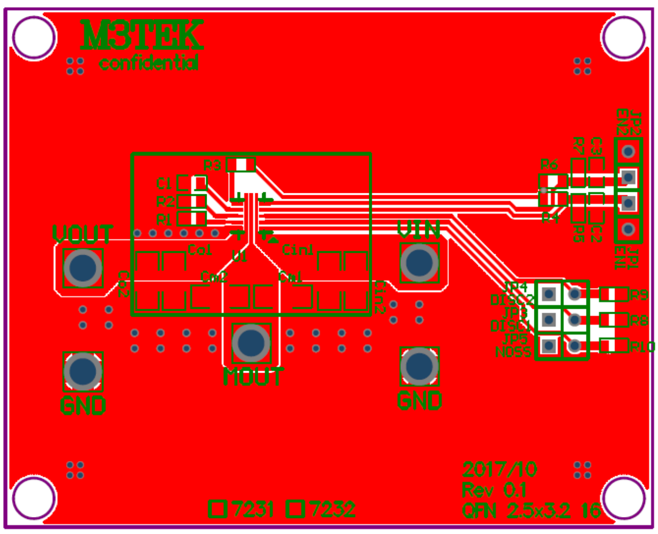
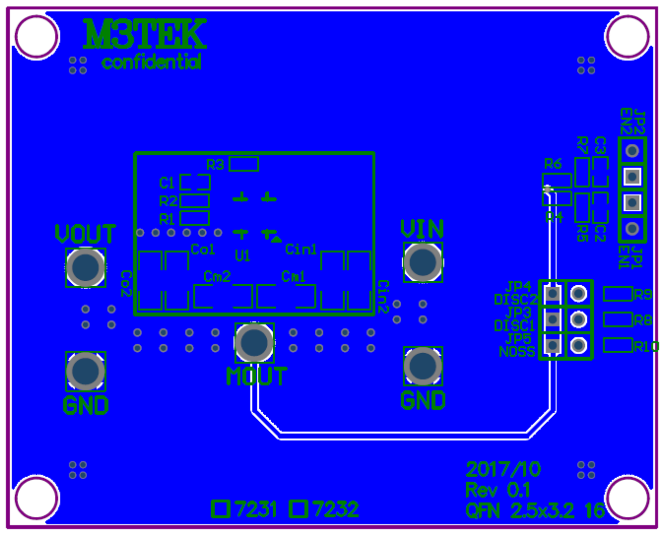


Figure 7. IN, MOUT and OUT pins connected to reduce impedance improving the power loss.

Top layer

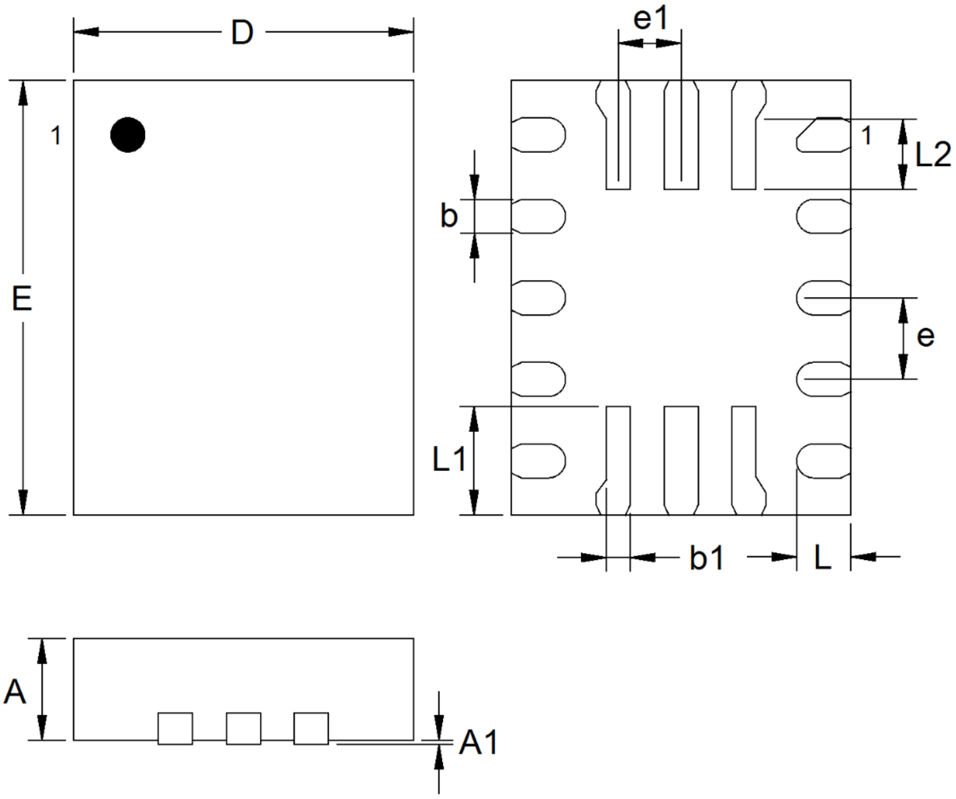


Bottom Layer



Package Information

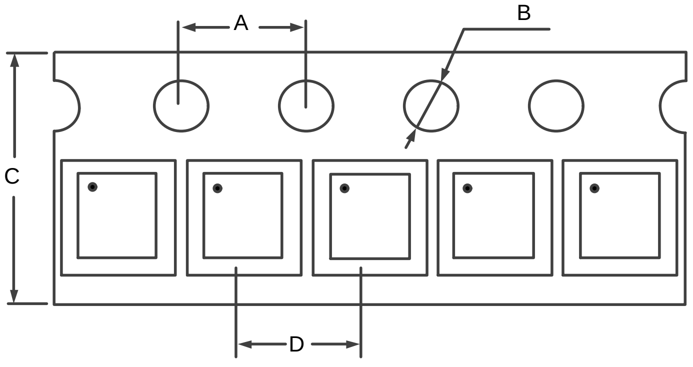
QFN 16L 2.5x3.2mm Package Outline Dimensions
Unit: inches/mm



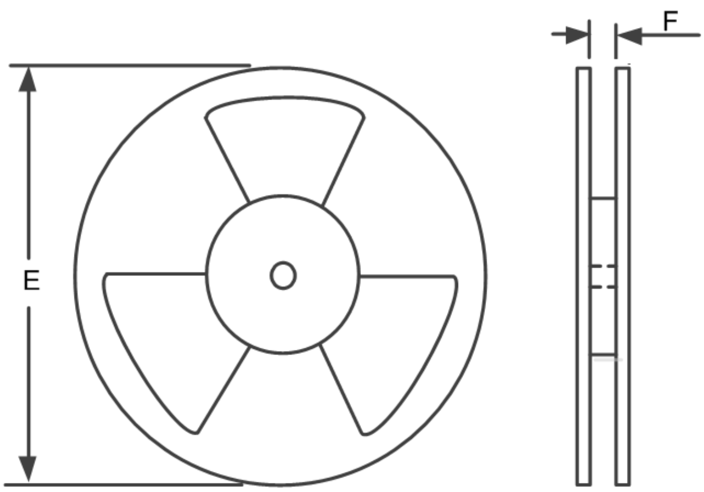
SYMBOLS	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	0.70	0.80	0.028	0.031
A1	0.00	0.05	0.000	0.002
b	0.20	0.30	0.008	0.012
b1	0.12	0.23	0.005	0.009
D	2.40	2.60	0.094	0.102
E	3.10	3.30	0.122	0.130
e	0.60 BSC.		0.024 BSC	
e1	0.50 BSC.		0.020 BSC	
L	0.30	0.50	0.012	0.020
L1	0.70	0.90	0.028	0.035
L2	0.52 REF.		0.020 REF.	

Tape & Reel Carrier Dimensions

1. Orientation / Carrier Tape Information :



2. Rokreel Information :



3. Dimension Details :

PKG Type	A	B	C	D	E	F	Q'ty/Reel
QFN 2.5x3.2 mm	4.0 mm	1.5 mm	8.0 mm	4.0 mm	7 inches	9.0 mm	3,000

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 ts ts_{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-freeProcess –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.