High Efficiency, 7-A Synchronous Boost Converter

Description

ME2177 is a high power density synchronous boost converter which integrates two low $R_{DS(ON)}$ MOSFETs to reduce conduction loss. It provides tiny and high efficiency solution for portable electronics. ME2177 has wide input voltage ranging from 2.7(ME2177A)/ 2.0(ME2177B) to 12V and can provide output voltage up to 12.6 V. It has 7 A switch current capability and is capable of delivering more than 20 W power.

ME2177 uses current mode COT control to regulate the output voltage. It works in PWM mode in moderate to heavy load. In light load, the chip adopts PFM to save quiescent power consumption. The switching frequency is adjustable ranging from 200 kHz to 2.2 MHz by an external resistor. ME2177 is also capable of programming peak current limit. In addition, ME2177 integrates input UVLO, output OVP, soft-start control and thermal shutdown protection.

Applications

- Quick Charge Power Bank
- E-Cigarette
- Bluetooth™ Speaker
- Portable POS terminal

Feature

- Input voltage range: 2.7 V ~ 12 V（ME2177A）
  2.0 V ~ 12 V（ME2177B）
- Output voltage range: 4.5 V ~ 12.6 V
- Low shutdown current: 1 uA ~ 4 uA（ME2177A）
  1 uA ~ 7uA（ME2177B）
- Low $R_{DS(ON)}$ MOSFETs (LSD/HSD): 20 mΩ/28 mΩ
- Up to 89% efficiency @ V_{IN} = 3.3 V, V_{OUT} = 9 V and I_{OUT} = 2 A
- Adjustable switching frequency: 200 kHz~2.2MHz
- Programmable peak switch current limit: cycle by cycle, I_{LIM} = 10 A @ R_{ILIM} = 150 kΩ
- Internal soft-start time: 2.5 ms
- Output over-voltage protection @ 13.4 V
- Thermal shutdown @ 150 °C

Package

- 11-pin QFN2.5*2.0-11L、QFN2.0*2.0-11L

Typical Application

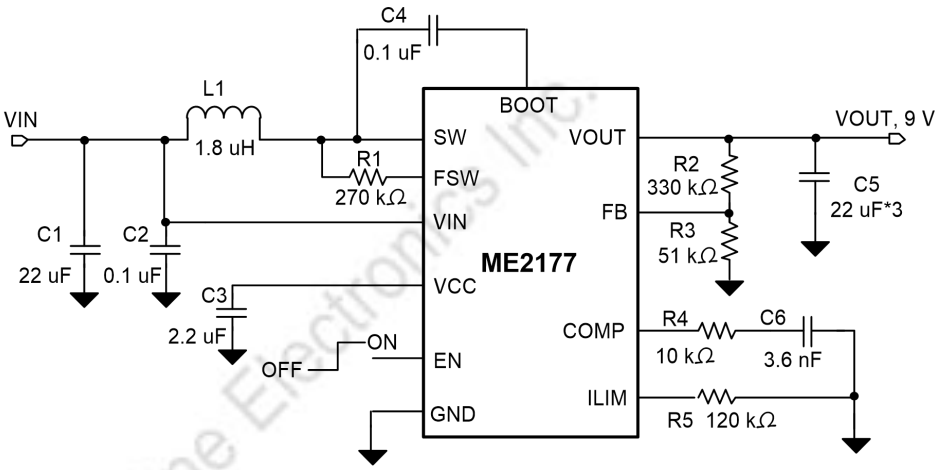


Fig 1. ME2177 Typical Application Schematic

Selection Guide

ME 21 77 X XX G

- G: Environment mark
- XX: Package
  - QF11B：QFN2.5*2.0-11L
  - QF11C：QFN2.0*2.0-11L
- X: Series or Function
- 77: Product Type
- 21: Product Series
- ME: Microne

product series	product description
ME2177AQF11BG	Package：QFN2.5*2.0-11L;Start Voltage：2.7V
ME2177BQF11BG	Package：QFN2.5*2.0-11L;Start Voltage：2.0V
ME2177BQF11CG	Package：QFN2.0*2.0-11L;Start Voltage：2.0V

Pin Configuration

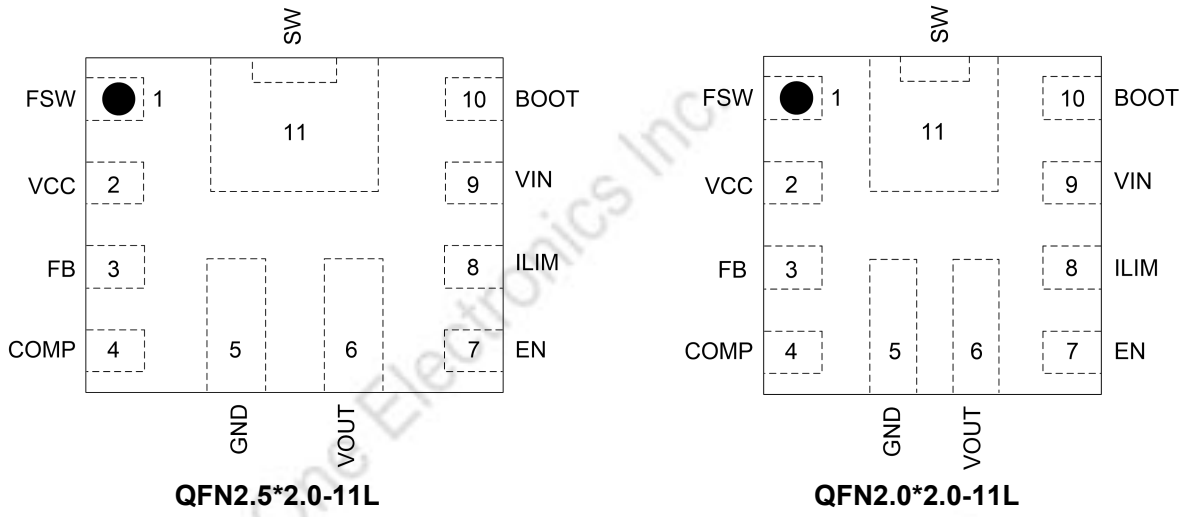


Fig. 2. ME2177 Package（TOP View）

Pin Assignment

Pin		Description
Name	Number	
FSW	1	Use external resistor between the FSW pin and the SW pin to set switching frequency
VCC	2	Output of the internal LDO. A ceramic capacitor of more than 1 uF is required between VCC pin and ground.
FB	3	Voltage feedback. This pin is connected to the tape of a resistor divider.
COMP	4	Output of internal error amplifier. Loop compensate network is required between the COMP pin and GND.
GND	5	Reference ground.
VOUT	6	Output of boost converter.
EN	7	Enable logic input. Logic high enables IC and logic low disables IC.
ILIM	8	Use external resistor between the ILIM pin and GND to set peak current limit.
VIN	9	Power supply for IC.
BOOT	10	Power supply for the HSD gate driver. A ceramic capacitor of more than 0.1 uF is required between the BOOT pin and SW.
SW	11	Switching node of the boost converter. It is connected to the drain of LSD and the source of HSD.

Block Diagram

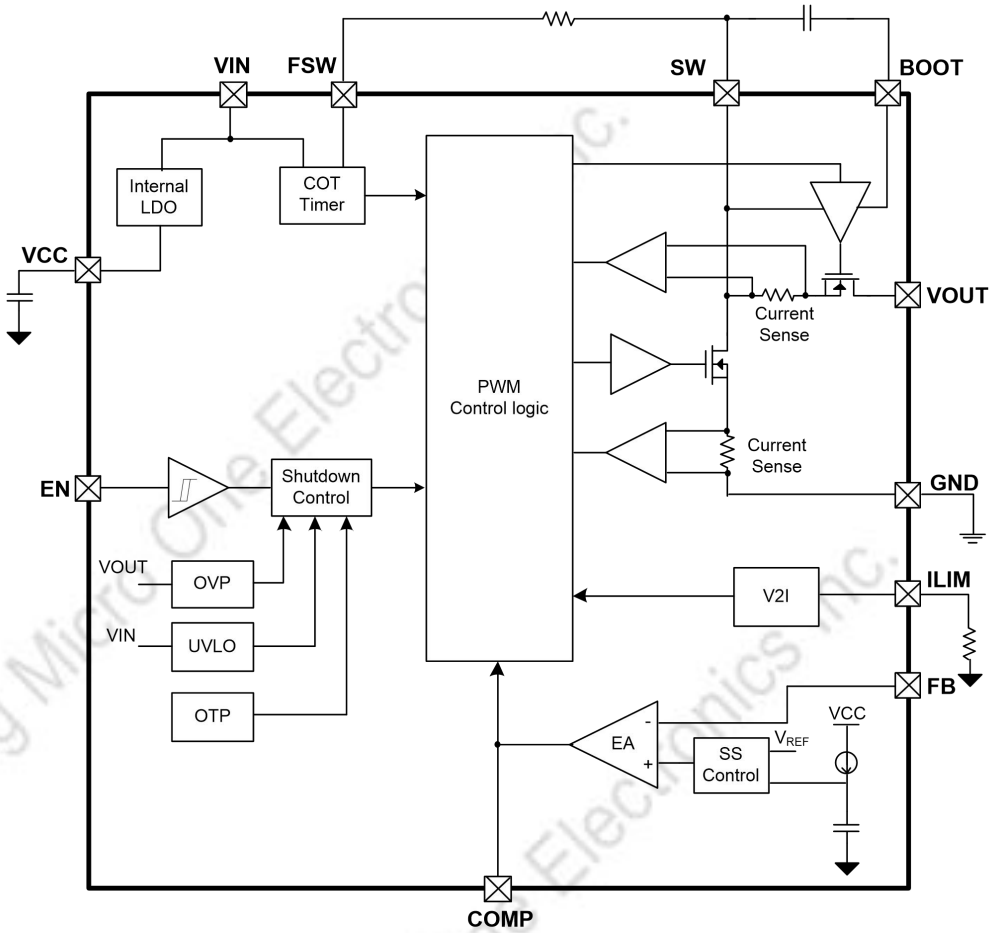


Fig. 3. ME2177 Block Diagram

Absolute Maximum Ratings (Note1)

Symbol		Description	Value	Unit
V_{PIN}	BOOT	Voltage between each pin and ground.	-0.3 ~ 20	V
	VIN, SW, FSW, VOUT		-0.3 ~ 14	V
	EN, VCC, COMP, ILIM, FB		-0.3 ~ 6	V
T_J		Operating junction temperature	-40 ~ 150	ºC
T_{stg}		Storage temperature	-55 ~ 150	ºC
T_A		Operating Ambient Temperature Range	-40 ~ 85	ºC
T_{lead}		Lead temperature	260	ºC
P_D		Power Dissipation	2.4	W
θ_{JA}		Package thermal resistance (Junction to air)	52	ºC/W

Note 1: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device.

ESD Ratings

Model	Value	Unit
Human body mode(HBM), all pins	± 2000	V
Charged device model (CDM), all pins	± 500	V

Recommended Operating Conditions

Symbol	Description		Min	Typ	Max	Unit
V_{IN}	Input voltage range	ME2177A	2.7	-	12	V
		ME2177B	2.0	-	12	V
V_{OUT}	Output voltage range		4.5	-	12.6	V
L	Inductance, effective value		0.6	1.8	10	uH
C_O	Output capacitance, effective value		30	60	1000	uF
T_A	Operating ambient temperature		-40	-	85	ºC

Electrical Characteristics

(T_A = 25 ºC, V_{IN} = 3.6 V, V_{OUT} = 9 V, L = 1.8 uH, R_{ILIM}= 150 kΩ, R_{FSW} = 270 kΩ, unless otherwise specified)

Symbol	Description	Test Conditions		Min	Typ	Max	Unit
V_{IN}	Input Voltage range	ME2177A		2.7	-	12	V
		ME2177B		2.0		12	
V_{UVLO}	Input UVLO threshold voltage	Input voltage rising	ME2177A	-	2.6	2.7	V
			ME2177B	-	1.83	1.94	
V_{UVLO_HYS}	UVLO hysteresis			-	0.2	-	V
I_{SD}	Shutdown current into the VIN pin	IC disabled, no feedback resistor and load connected to VOUT pin	ME2177A	-	1	4	uA
			ME2177B	-	1	7	
I_Q	Input quiescent current in PFM mode and empty load	IC enabled, no feedback resistor and load connected to the VOUT pin, V_{FB} = 1.4 V		-	120	200	uA
V_{CC}	Output voltage of internal LDO	V_{IN} = 8 V, I_{VCC} = 10 mA		-	5	-	V
V_{ENH}	EN logic high threshold voltage	VCC = 5 V		-	-	1.2	V
V_{ENH}	EN logic low threshold voltage	VCC = 5 V		0.4	-	-	V
R_{EN}	EN internal pull-down resistor	VCC = 5 V		-	800	-	kΩ
V_{OUT}	Output voltage range			4.5	-	12.6	V
V_{REF}	Feedback reference voltage			1.188	1.206	1.224	V
I_{FB}	Leakage current into FB pin	V_{FB} = 1.5 V		-	-	100	nA
$R_{DS(ON)\_LSD}$	LSD on-resistance			-	20	30	mΩ
$R_{DS(ON)\_HSD}$	HSD on-resistance			-	28	42	mΩ
I_{LIM_PFM}	Peak switch current limit in PFM mode	R_{ILIM} = 150 kΩ	ME2177A	-	10	-	A
		R_{ILIM} = 100 kΩ	ME2177B	-	7.8	-	
f_{SW}	Switch frequency	R_{FSW} = 270 kΩ		-	500	-	kHz
t_{min_ON}	Minimum on time			-	100	200	ns
t_{min_OFF}	Minimum off time			-	90	200	ns
t_{SS}	Soft-start Time			-	2.5	-	ms
V_{OVP}	Output over-voltage protection threshold voltage	Output voltage rising		-	13.4	-	V
V_{OVP_HYS}	Output over-voltage protection hysteresis			-	0.3	-	V
T_{SD}	Thermal shut down threshold	Junction temperature rising		-	150	-	°C
T_{SD_HYS}	Thermal shut down hysteresis			-	25	-	°C

Type Characteristics

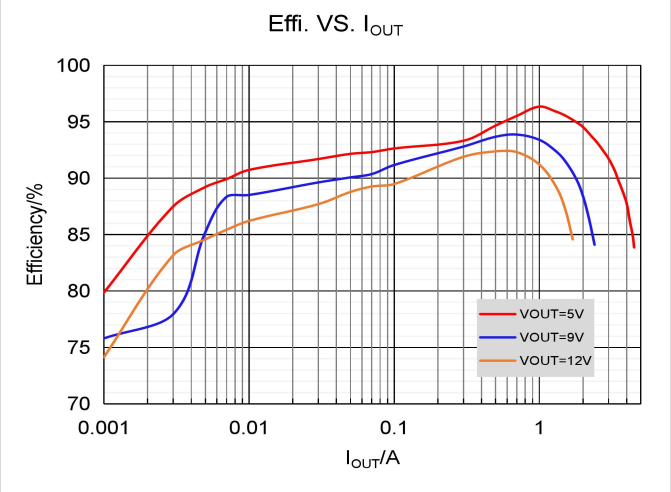


Fig. 4. Efficiency vs. I_{OUT} @ V_{IN}=3.3V

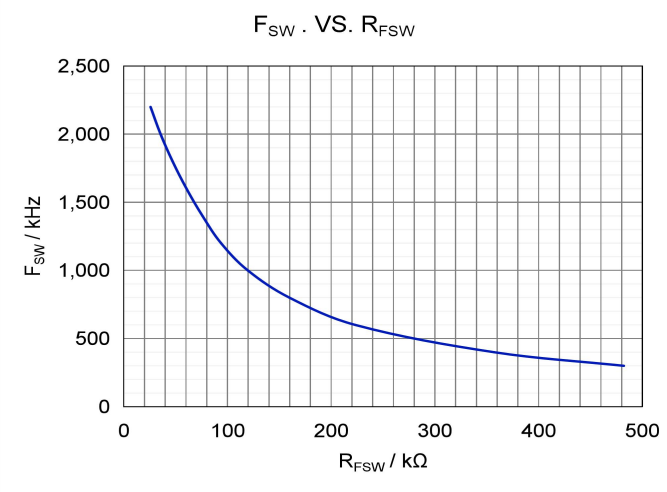


Fig. 5. Switching Frequency Setting

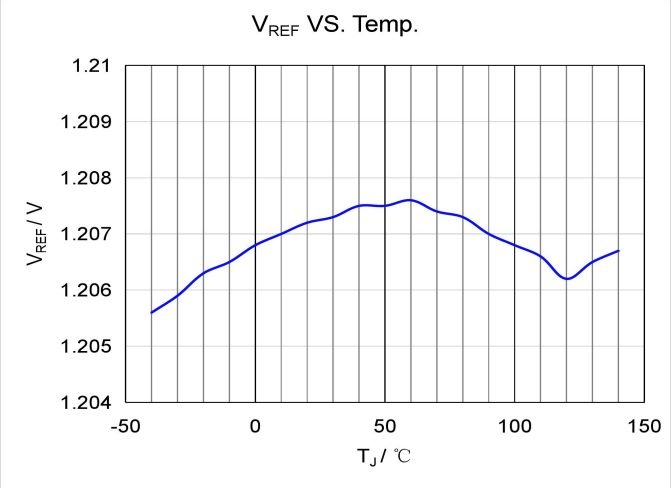


Fig. 6. Reference Voltage vs. Temperature

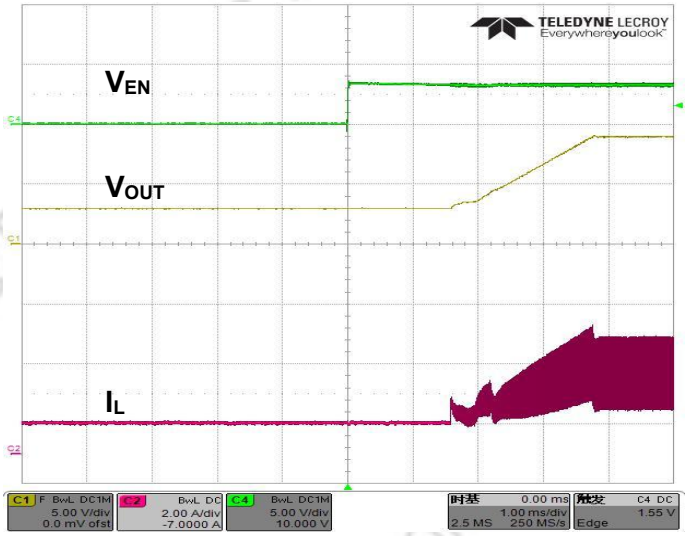


Fig. 7. Startup Waveforms

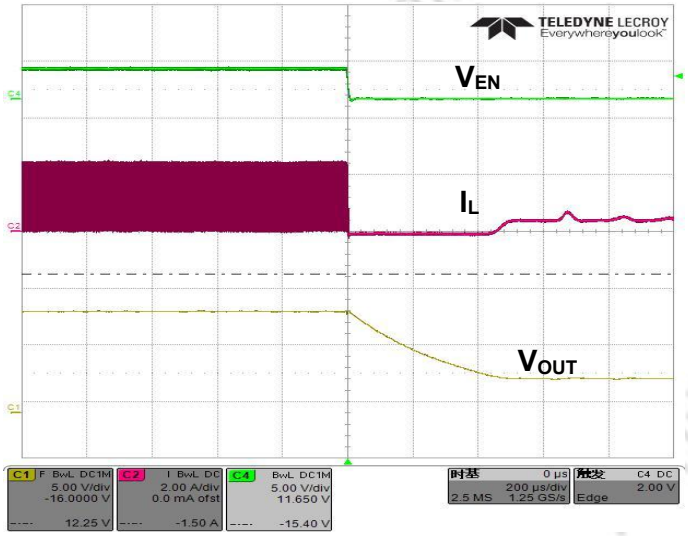


Fig. 8. Shutdown Waveforms

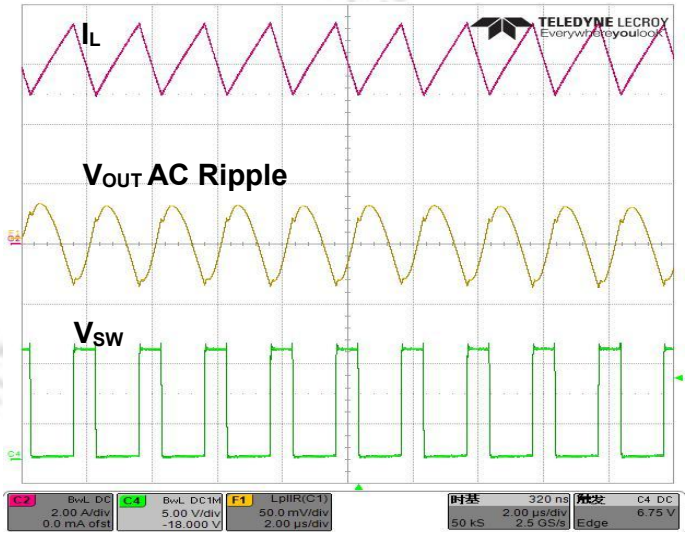


Fig. 9. Switching Waveforms in CCM

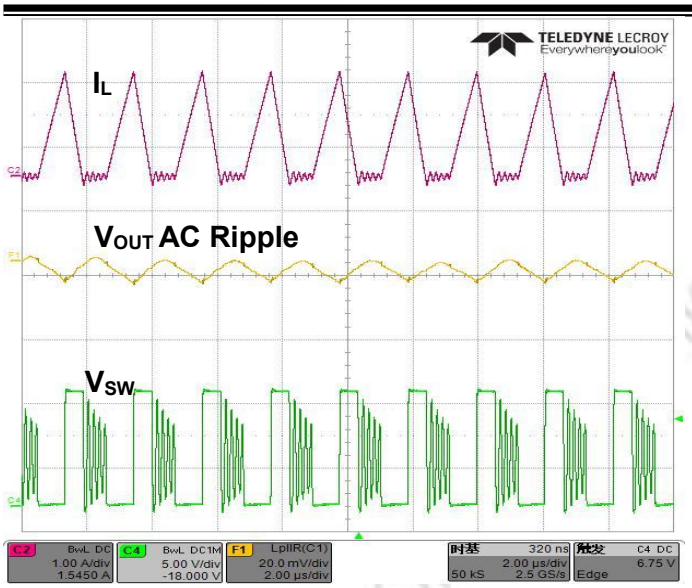


Fig. 10. Switching Waveforms in DCM

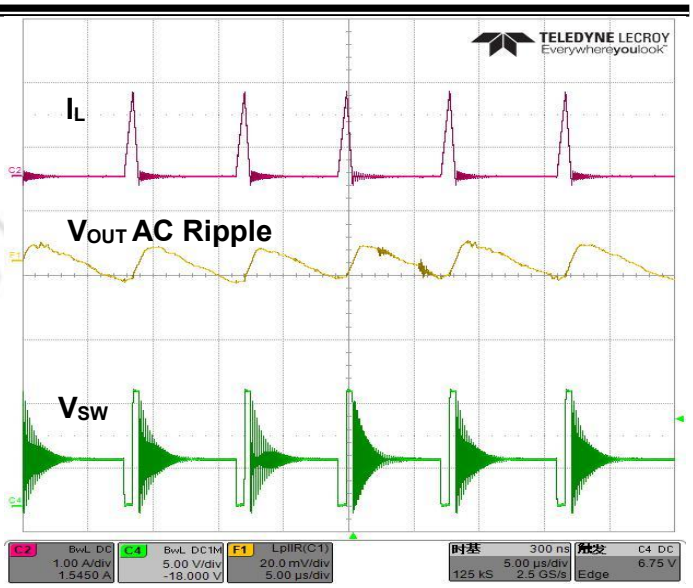


Fig. 11. Switching Waveforms in PFM

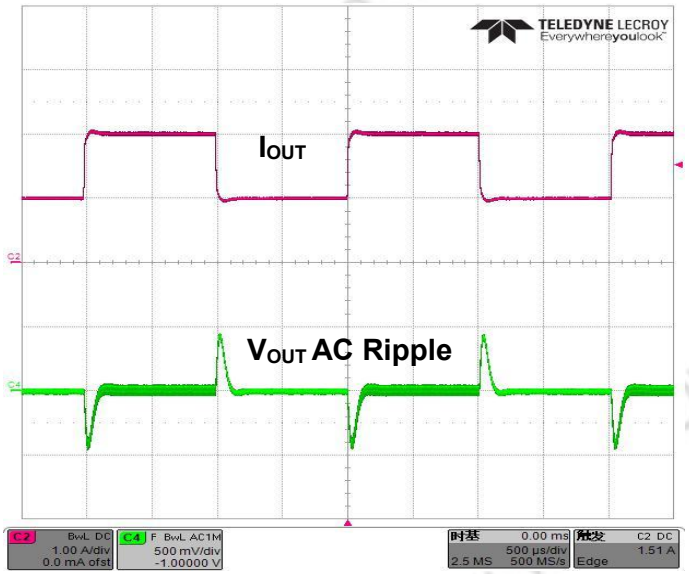


Fig. 12. Load Transient Response, I_{OUT}=1 A to 2A

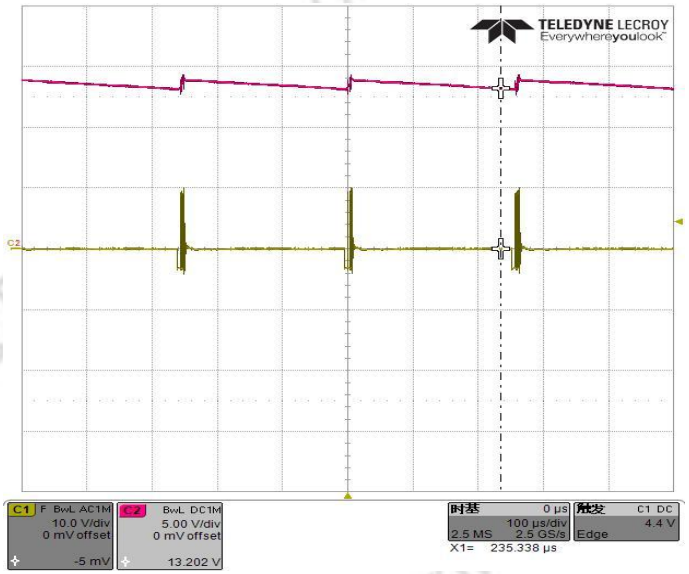


Fig. 13. OVP Waveforms

Operation Description

ME2177 is a synchronous step-up DC-DC converter which integrates two very low $R_{DS(ON)}$ power switches to improve efficiency. It adopts current mode COT control topology to regulate output voltage. In moderate to heavy load, during every switching period, low-side MOSFET is turned on until switch current ramps up to a certain peak current determined by error amplifier. During dead time, inductor current flows through body diode of the high-side MOSFET. After dead time, the high-side MOSFET is turned on and will be turned off after adaptive constant off time is reached. In light load, ME2177 works in PFM mode and extends off time of switching period to reduce delivered energy.

Application Information

ME2177 has wide input voltage range and is capable of providing 12.6 V output voltage. It integrates two internal 7A power switches and can deliver more than 20 W power. ME2177 can change modulation mode automatically between PWM and PFM in different load conditions. In addition, ME2177 integrates OVP, OTP, UVLO and internal soft start control function and support external setting of the switching frequency.

Setting Output Voltage

The output voltage can be programmed by external resistor divider (R1 and R2 in typical application schematic) connected to VOUT pin. For reducing quiescent current in empty load, it is recommended to use large resistance between 10 kΩ and 1 MΩ for R1 and R2. The resistance of R1 can be calculated by following equation.

$$R_1 = \frac{(V_{OUT} - V_{REF}) \times R_2}{V_{REF}}$$

Setting Switching Frequency

The switching frequency can be programmed by external resistor R_{FSW} between the FSW pin and the SW pin. The R_{FSW} required for desired switching frequency can be calculated using the following equation.

$$R_{FSW} = \frac{4 \times (\frac{1}{f_{SW}} - t_{Delay} \times \frac{V_{OUT}}{V_{IN}})}{C_{FSW}}$$

Where V_{IN} is input voltage, V_{OUT} is output voltage, f_{SW} is the switching frequency, C_{FSW} is 25 pF, t_{Delay} is 90 ns.

Setting Peak Current Limit

The peak switch current limit can be set by external resistor R_{ILIM}. To guarantee normal operation of the boost converter, peak switch current limit should be higher than maximum inductor peak current. Peak current limit can be calculated using following equation.

$$I_{LIM} = \frac{1500000}{R_{ILIM}} \text{（ME2177A）} \qquad I_{LIM} = \frac{780000}{R_{ILIM}} \text{（ME2177B）}$$

External Component

1）High-side MOSFET driver is powered using external bootstrap capacitor. A ceramic capacitor of 100 nF should be connected between the SW pin and the BOOT pin.

2）The effective capacitance is decreased with DC bias. So it is necessary to leave margin to guarantee adequate effective capacitance especially for C_{IN} and C_{OUT}.

3）When the inductor current approaches its saturation current, its inductance can decrease 30% from the value at 0-A current. The saturation current of used inductor should be higher than the maximum peak inductor current. And to improve efficiency of the boost converter, a inductor with low DCR is necessary.

Layout Guideline

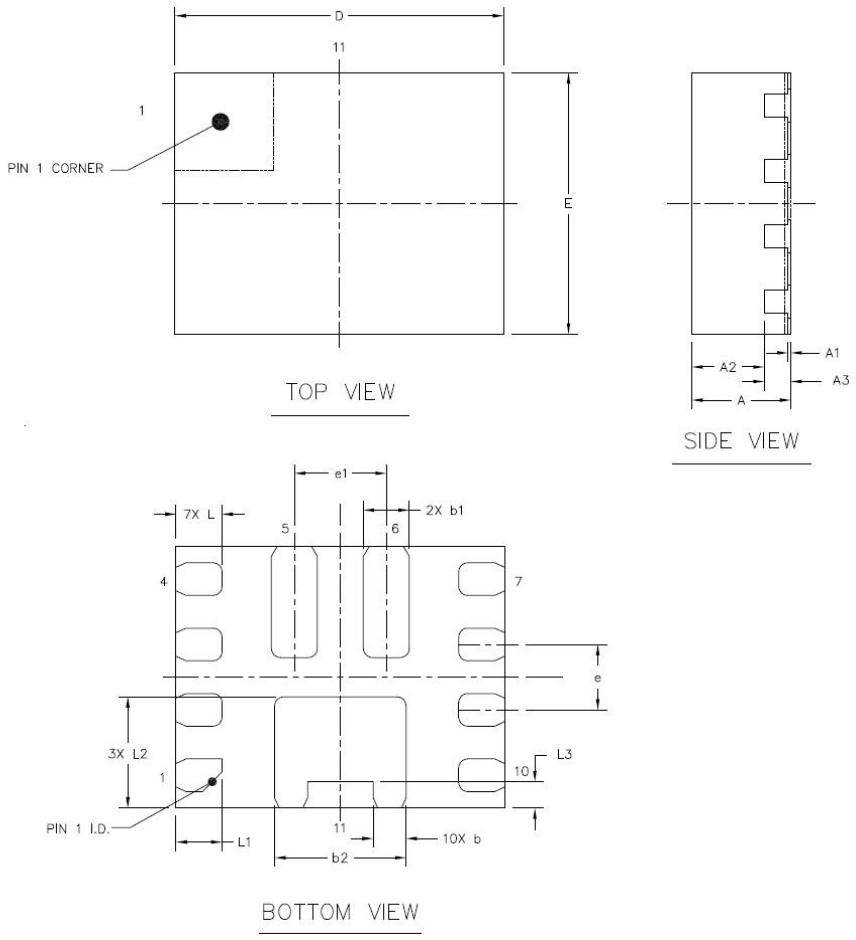
1）Boost converter implemented by ME2177 is sensitive to PCB layout. For reducing non-ideality, external component such as inductor, input capacitor, output capacitor, compensation network and resistor divider should be placed as nearly as possible to the chip.

2）For reducing EMI caused by high frequency switching, the trace connected to SW pin should be as short as possible. It is recommended to use ground plane to shield signal from interplane coupling.

3）To improve thermal dissipation and power efficiency, it is recommended to use thick copper PCB(recommending 2 OZ copper thickness). More thermal vias near the chip are desirable. And the traces with large current should be placed on both the front side and reverse side of PCB.

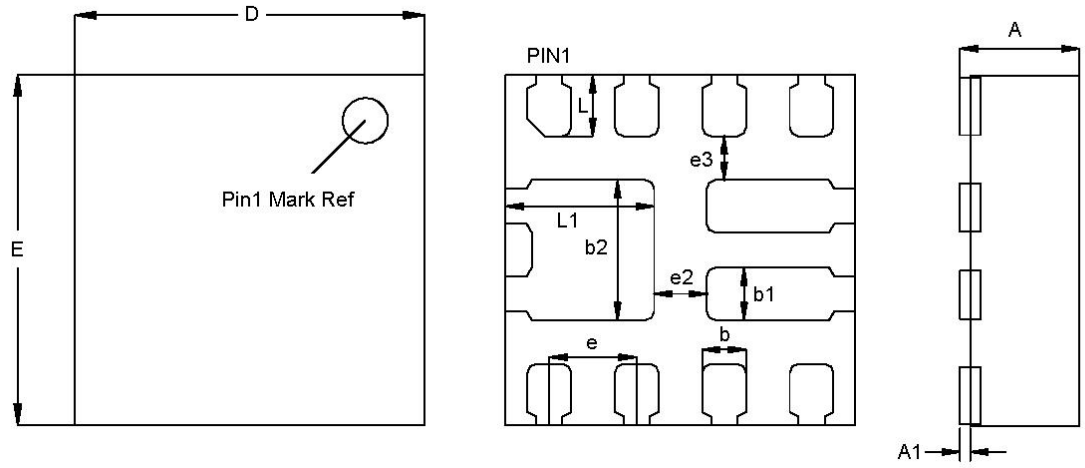
Packaging Information

- **Package Type: QFN2.5*2.0-11L**



DIM	Millimeters		Inches	
	Min	Max	Min	Max
A	0.7	0.8	0.0276	0.0315
A1		0.05		0.0020
A2	0.55		0.0216	
A3	0.203		0.0080	
b	0.2	0.3	0.0079	0.0118
b1	0.3	0.4	0.0118	0.0157
b2	0.95	1.05	0.0374	0.0413
D	2.5 BSC		0.0984 BSC	
E	2 BSC		0.0787 BSC	
e	0.5 BSC		0.0197 BSC	
e1	0.7 BSC		0.0276 BSC	
L	0.3	0.4	0.0118	0.0157
L1	0.25	0.45	0.0098	0.0177
L2	0.8	0.9	0.0315	0.0354
L3	0.2 REF		0.0079 REF	

- **Package Type: QFN2.0*2.0-11L**



DIM	Millimeters		Inches	
	Min	Max	Min	Max
A	0.5	0.6	0.0197	0.0236
A1	0.007	0.017	0.0003	0.0007
D	1.9	2.1	0.0748	0.0827
E	1.9	2.1	0.0748	0.0827
e1	0.45	0.55	0.0177	0.0217
e2	0.25	0.35	0.0098	0.0138
e3	0.2	0.3	0.0079	0.0118
b	0.2	0.3	0.0079	0.0118
b1	0.25	0.35	0.0098	0.0138
b2	0.75	0.85	0.0295	0.0335
L	0.3	0.4	0.0118	0.0157
L1	0.8	0.9	0.0315	0.0354

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