26.8V, 15A Asynchronous Boost Converter

Features

- Input Voltage Range: 2.7V to 25V.
- Output Voltage Range: up to 26.8V
- Internal Fixed PWM frequency: 350KHz
- Programmable Switch peak current limit: up to 15A
- High Efficiency:95%(P_{VIN}=12V, V_{OUT}=25V, I_{OUT}=2A)
  93% (P_{VIN}=7.2V, V_{OUT}=12V, I_{OUT}=1.5A)
  96% (P_{VIN}=12V, V_{OUT}=18V, I_{OUT}=1.5A)
- 1.0uA Current Consumption During Shutdown
- Two modes with different tr/tf for EMI solution
- Programmable Soft start
- Output overvoltage protection(at 28V), thermal shutdown protection

Applications

- Portable Speaker
- Wireless/Speaker
- Power Bank
- Chargers
- Power Interface(USB Type-C, Thunderbolt)
- POS Terminal
- Tablet PC/Note Book

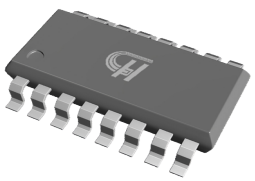
General Description

The HCR6679 is a high-power density, asynchronous boost converter with a 20mΩ power switch to provide a high efficiency and small size solution in portable systems. The HCR6679 has wide input voltage range from 2.7V to 25V to support applications with single cell, two cell Lithium batteries and 12V lead-acid batteries. The device has 15A switch current capability and can provide an output voltage up to 26.8V.

The HCR6679 also implements a programmable soft-start function and an adjustable switching peak current limit function. The HCR6679 integrates two modes with different t_r/t_f to balance different requirements of EMI and efficiency.

In addition, the device provides 28V output overvoltage protection, and thermal shutdown protection.

The HCR6679 is available in Green SOP-16(EP) package. It operates over an ambient temperature range of -40'C to +125'C.



SOP-16(EP)

Figure 1. Package Type of HCR6679

26.8V, 15A Asynchronous Boost Converter

Pin Configuration

(Top View of SOP-16(EP))

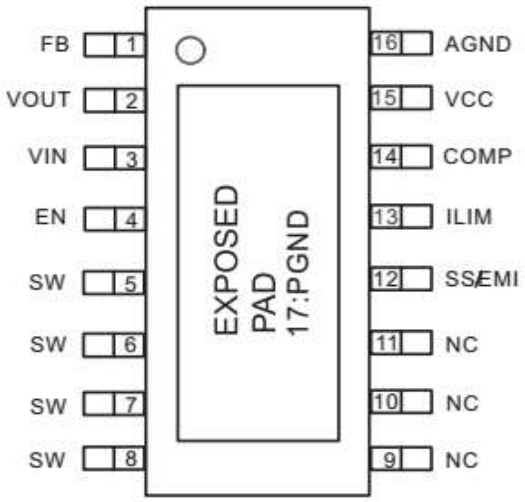
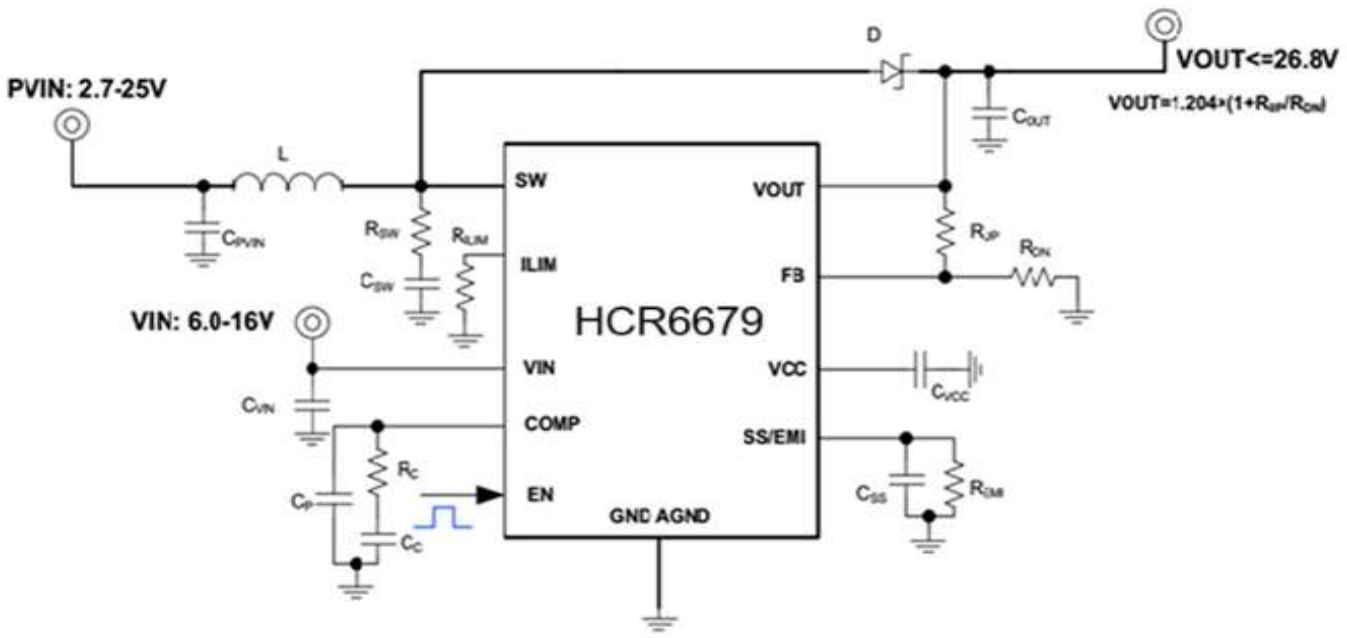


Figure 2. Pin Configuration of HCR6679 (Top View)

Pin Function Table

PIN	NAME	I/O	FUNCTION
1	FB	I	Voltage Feedback. Connect to the center tape of a resistor divider to program the output voltage.
2	VOUT	P	Output Pin.
3	VIN	P	IC Power Supply Input.
4	EN	I	Enable Logic Input. Logic high level enables the device. Logic low level disables the device and turns it into shutdown mode.
5,6,7,8	SW	P	The switching node pin of the converter.
9,10,11	NC	/	No internal connection, connect to GND
12	SS/EMI	O	Soft-start programming pin. An external capacitor Css connected to ground sets the ramp rate of the internal error amplifier's reference voltage during soft-start, 100nF is usually recommended. Also used as mode setting for different tr/tf, an external 390K resistor connected to ground sets a flatter tr/tf.
13	ILIM	I	Adjustable switch peak current limit. An external resister should be connected between this pin and the AGND pin.
14	COMP	O	Output of the internal error amplifier, the loop compensation network should be connected between this pin and the AGND pin.
15	VCC	O	Output of the internal regulator. A ceramic capacitor of 1uF is required between this pin and ground.
16	AGND	G	Analog ground of the IC.
17	Exposed Pad	G	Provides both electrical and thermal connection from the device to the board. A matching ground pad must be provided on the PCB and the device connected to it via solder. For proper electrical operation, this ground pad must be connected to the system ground.

Typical Application Circuit

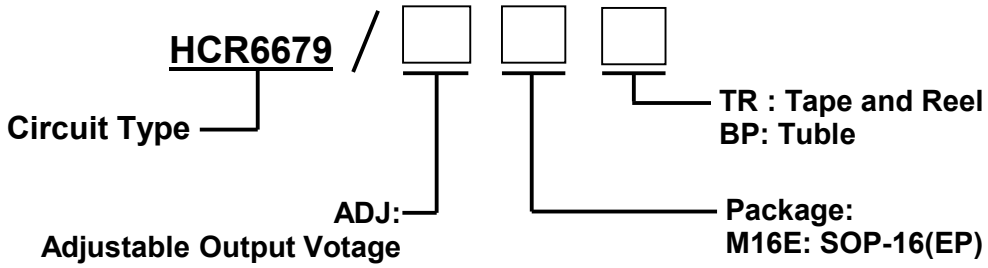


Note: a1. L1 is 4.7uH, it's saturation current is above 15A base on Power Inductor.

a2. The D1 and D2 location use the Schottky Barrier Rectifiers Diodes of SK54LS with star-wing brand

Figure 3. Typical Application Circuit of HCR6679

Ordering Information



Ordering Code

Part Number	Marking [2]	Temperature Range	Package	Quantity per Reel
HCR6679/ADJM16ETR	HCR6679Exx	-40'C to +125'C	SOP-16(EP)	2500pcs/TR
HCR6679/ADJM16EBP	HCR6679Exx	-40'C to +125'C	SOP-16(EP)	50pcs/Tuble

Note [2]. The HCR6679E is product type and "xx' is date code

Absolute Maximum Ratings Note 1

Parameter	Symbol	MIN.	MAX.	Unit
Voltage Range of VOUT/SW/VIN	VOUT	-0.3	28	V
	SW	-0.3	34	
	VIN	-0.3	18	
Voltage Range of EN/VCC/COMP	EN	-0.3	7	V
	VCC	-0.3	7	
	COMP	-0.3	7	
Voltage Range of FB	VFB	-0.3	3.6	V
Thermal Resistance Junction to Ambient	RθJA	45		'C/W
Thermal Resistance Junction to Case	RθJC	10		'C/W
Operating Junction Temperature Range	TJ	-40 to 150		'C
Storage Temperature Range	TSTG	-65 to 150		'C
Lead Temperature (Soldering, 10s)	TLEAD	260		'C

Recommend Operating Conditions note2

Parameter	Symbol	MIN.	MAX.	Unit
Input Voltage Range	VIN	2.7	25	V
Output Voltage Range	VOUT	-	26.8	V
Operating Temperature Range	TA	-40	85	'C
Operating Junction Temperature Range	TJ	-40	125	'C

Note 1: Stresses beyond those listed under"Absolute maximum Ratings" may damage the device.

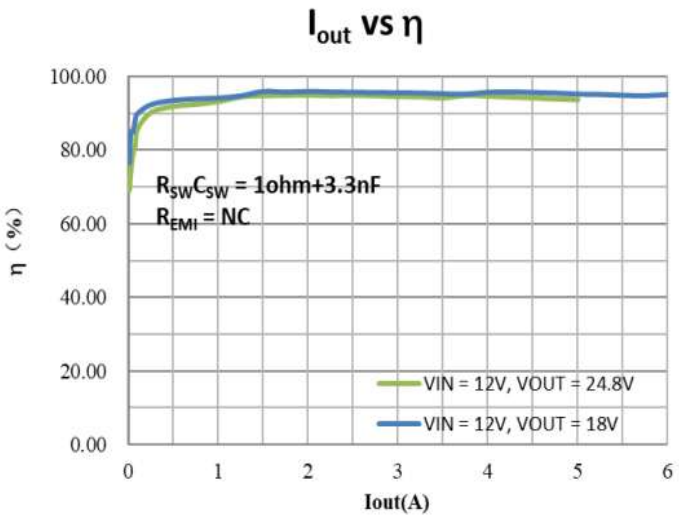
2: The device is not guaranteed to function outside the recommended operating conditions.

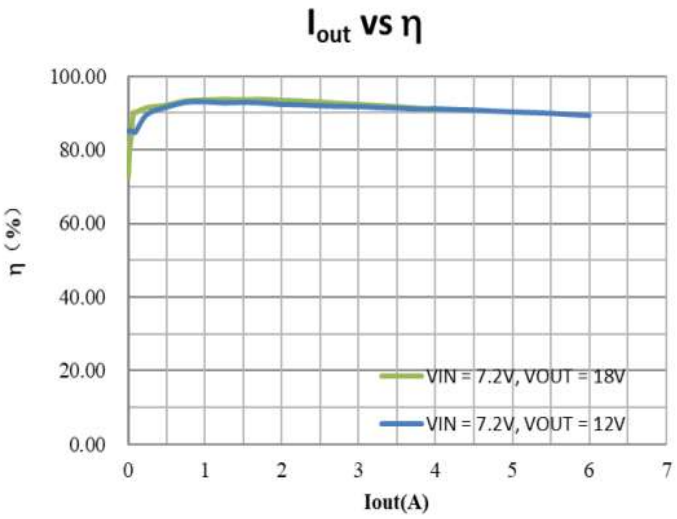
Electrical Characteristics

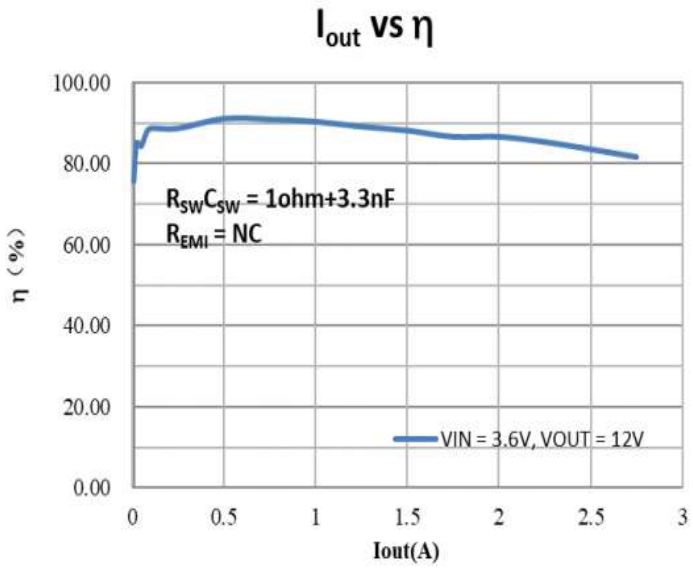
TA=25'C, VIN=2.7V-13.2V, VOUT=4.5V-26.8, unless otherwise specification

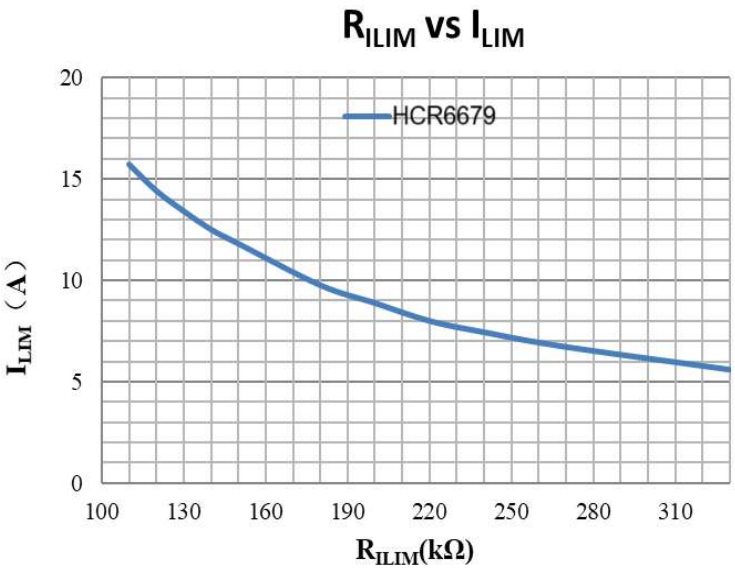
Parameter	Symbol	Test Condition	Min	Type	Max	Unit
Power Supply Input						
Input Voltage Range	V_{IN}	VIN Pin	2.7	-	25	V
Under-voltage Lockout (UVLO) Threshold	V_{UVLO}	V_{IN} rising	-	2.7	-	V
		V_{IN} falling	-	2.5	-	
Quiescent Current	I_{QC}	V_{FB}=1.3V, No switching	-	0.35	-	mA
Shutdown Supply Current	I_{SHDN}	IC Disabled, no load, no feedback resistor divider	-	1	-	uA
Oscillator						
Operation Frequency	F_{OSC}		300	350	400	KHz
Frequency Change with Voltage	Δf/ΔV	V_{IN}=2.7V to 16V	-	5	-	%
Maximum Duty Cycle	T_{DUTY}		-	93	-	%
Reference Voltage						
Reference Voltage	V_{REF}		-	1.204	-	V
Line Regulation		V_{IN}=2.7V to 16V	-	0.2	-	%/V
Enable Control						
EN High Threshold Voltage	V_{ENH}	V_{IN}=5V	1.5	-	-	V
EN Low Threshold Voltage	V_{ENL}	V_{IN}=5V	-	-	0.4	V
EN internal Pull-down resistance	R_{EN}		-	800	-	KΩ
Power Switch						
MOSFET On-Resistance	$R_{DS(ON)}$	Including Wire bond	-	20	-	mΩ
Operation Frequency	FOSC		-	350	-	KHz
OUTPUT						
Output Voltage Range	V_{OUT}	VOUT Pin	3.5	-	26.80	V
VCC Regulation	VCC	PV_{IN}=3.6V, V_{OUT}=12V, light load	-	5.7	-	V
		PV_{IN}=3.6V, V_{OUT}=12V, I_{LOAD}=0.5A	-	5.7	-	V
Output Overvoltage Protection	V_{OVP}			28		V
FB Pin Leakage Current	I_{LKG_FB}	V_{FB}=1.204V	-	0.1	-	nA
Soft-Start Charging Current	I_{SS}		-	5.0	-	uA
CURRENT LIMIT						
Peak Switch Current Limit	I_{LIM}		-	-	15.0	A
THERMAL SHUTDOWN						
Thermal Shutdown Threshold	T_{SD}	T_A rising	-	150	-	'C
Thermal Shutdown Hysteresis	T_{SD_HYS}	T_A falling below T_{SD}	-	20	-	'C

Typical Performance Characteristics









Application Information

Application Message

The HCR6679 is a high-power density, asynchronous boost converter with a 20mΩ power switch to provide a high efficiency and small size solution in portable systems. The switching frequency frequency is 360KHz. The HCR6679 operates with pulse width modulation(PWM), and improves the efficiency at light load with the pulse frequency modulation(PFM).

Enable, Startup, and tr/tf(EN and SS/EMI pin)

The HCR6679 has an adjustable soft start function to prevent high inrush current during start-up.To minimize the inrush current during start-up,an external capacitor, connected to the SS/EMI pin and charged with a constant current, is used to slowly ramp up the internal positive input of the error amplifier. The larger the capacitance at the SS/EMI pin, the slower the ramp of the output voltage and the longer the soft-start time. A 100nF capacitor is usually sufficient for most applications.

The HCR6679 integrates two modes with different tr/tf. with a single capacitor(CSS) connected between SS/EMI pin and Ground, the mode with steep tr/tf will be selected, The HCR6679 operates with a high efficiency and poorer EMI performance. However, if a capacitor(CSS) paralleled with a resistor 390K (REMI) is placed between SS/EMI pin and Ground, the mode with flatter tr/tf is selected, HCR6679 operates with a lower efficiency and better EMI performance. When the EN pin is pulled into logic low (below 0.4V), the HCR6679 goes into the shutdown mode and stops switching. Only when EN pin is pulled into logic high (above 1.5V), the HCR6679 works.

Adjustable Peak Current Limit(ILIM pin)

To avoid an accidental large peak current, an internal cycle-by-cycle current limit is adopted. The low-side switch is turn off immediately as soon as the switch current touches the limit. The peak switch current limit can be set by a resistor(RILIM) at the ILIM pin to ground. The relationship between the current limit and the resistance is as the following figure 4. The current limit should be set lower than 15A.

Adjustable Peak Current Limit(ILIM pin)(Con.)

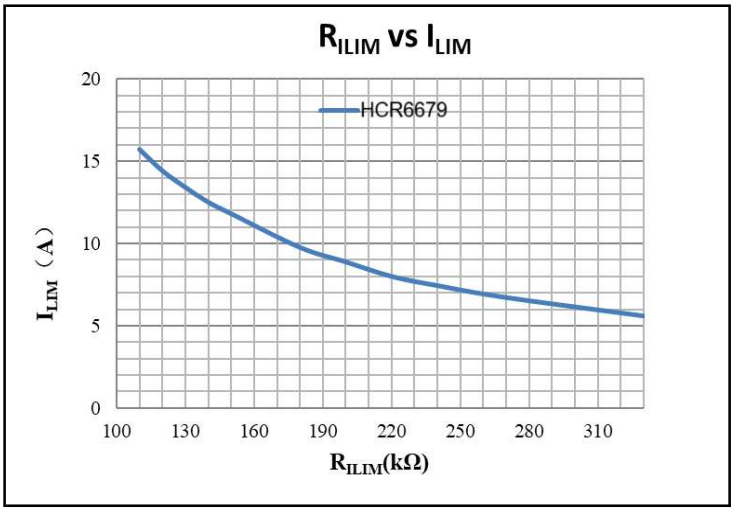


Figure 4. Peak Current Limit(ILIM) VS ILIM terminal resistor(RILIM)

Output Voltage Setting(FB pin)

The output voltage is set by an external resistor divider (RUP, RDN in the Typical Application Circuit). To get the output voltage VOUT, the Value of RUP and RDN can be calculated as:

$$V_{OUT} = V_{REF} \times (1 + \frac{R_{UP}}{R_{DN}})$$

Where VREF=1.204V.

Some typical output voltages can be set as the following parameters

Table 1. Output Voltage Settings

VOUT(V)	RUP(Ω)	RDN(Ω)
9.4	510K	75K
12.2	510K	56K
15.5	510K	43K
23.9	510K	27K

Under-Voltage Lockout(UVLO)

The UVLO circuit prevents the device from malfunctioning at low input voltage and the battery from excessive dis--charge. The HCR6679 has both VOUT UVLO function and VCC UVLC function. It disables the device from switching when the falling voltage at the VOUT pin trips the UVLO threshold VUVLO, which is typically 2.5V. The device starts operating when the rising voltage at the VOUT pin is above the VUVLO, which is typically 2.7V. It also disables the device when the falling voltage at the VCC pin trips the UVLO threshold, which is typically 2.1V.

Application Information(Con.)

Over-voltage Protection

If the output voltage at the VOUT pin is detected above 28V (typical value), the HCR6679 stops switching immediately until the voltage at the VOUT pin drops the hysteresis value lower than the output overvoltage protection threshold. This function prevents overvoltage on the output and secures the circuits connected to the output from excessive overvoltage.

Thermal Shutdown

A thermal shutdown is implemented to prevent damages due to excessive heat and power dissipation. Typically, the thermal shutdown happens at a junction temperature of 150'C. When the thermal shutdown is triggered, the device stops switching until the junction temperature falls below typically 130'C, then the device starts switching again.

Application Note

Inductor Selection

Because the selection of the inductor affects the power supply's steady state operation, transient behavior, loop stability and boost coverter efficiency, the inductor is the most important component in switching power regulator design. Three most impotant specifications to the perfor--mance of the inuctor are the inductor value, DC resistance, and saturation current.

To be simplified, the inductor value can be set as 4.7uH which can be used in most cases.

The rated current, especially the saturation current should be larger than the peak current during the whole operation. The peak current can be calculated as follows.

$$I_{Lpeak} = I_{DC} + \frac{I_{PP}}{2}$$

$$I_{DC} = \frac{V_{OUT} \times I_{OUT}}{V_{IN} \times \eta}$$

$$I_{PP} = \frac{1}{L \times (\frac{1}{V_{OUT} - V_{IN}} + \frac{1}{V_{IN}}) \times f_{SW}}$$

Boost converter efficiency is affected significantly by the inductor's DC resistance(DCR), equivalent series resistance (ESR) at the switching frequency, and the core loss. An inductor with lower DCR and ESR would increase the efficiency significantly.

Inductor Selection (Con.)

The inductor should be placed as close as possible to the SW pin. For a lower EMI radiation, connecting a resistor and a capacitor in series to the ground would be helpful. 1Ω resistor and 3.3nF capacitor (the package of resistor and capacitor is recommended to be not samller than 1206) would be recommended in most cases.

Output Capacitor Selection (COUT)

To be simplified, we recommend low-ESR capacitors of 1uF//10uF//10uF//470uF("//"represents paralleled) be placed as close as possible to the Schottky diode for small output voltage ripple.

Capacitors can lose most of their capacitance at rated voltage. Therefore, leave margin on the voltage rating to ensure adequate effective capacitance.

In detail, for the require output voltage ripple, use the following equations to calculate the minimum required effective capacitance COUT.

$$V_{ripple_dis} = \frac{(V_{OUT} - V_{IN_{MIN}}) \times I_{OUT}}{V_{OUT} \times f_{SW} \times C_{OUT}}$$

$$V_{ripple_ESR} = I_{Lpeak} \times R_{C_ESR}$$

Where

- Vripple_dis is output voltage ripple caused by charging and discharging of the output capacitor.
- Vripple_ESR is output voltage ripple caused by ESR of the output capacitor.
- V_{IN_MIN} is the minimum input voltage of boost converter.
- V_{OUT} is the output voltage
- I_{OUT} is the output current
- I_{Lpeak} is the peak current of the inductor.
- f_{SW} is the converter switching frequency.
- R_{C_ESR} is the ESR of the output capacitors.

Diode Selection

Schottky diode with fast recovery times and low forward voltages are recommended. Ensure the diode average and peak current rating exceed the average output current and peak inductor current. In addition, the diode's reverse breakdown voltage must exceed the output voltage.

Application Information(Con.)

Loop Stability

The HCR6679 requires external compensation, which allows the loop response to be optimized for each application. The COMP pin is the output of the internal error amplifier. An external compensation network comprised of resister RC, ceramic capacitors CC and CP is connected to the COMP pin. To be simplified, RC is 33KΩ, CC is 3.3nF, and CP is 47pF. But notice that this setting can only be adopted in most cases. In detail, the compensation network parameters can be calculated as follows.

- Set the cross over frequency, fC

The first step is to set the loop crossover frequency, fC. The higher crossover frequency, the faster the loop response is. It is generally accepted that the loop gain cross over no higher than the lower of either 1/10 of the switching frequency, fSW, or 1/5 of the RHPZ frequency, fRHPZ. It's proper to use a fixed parameter of 10KHz for fC.

$$f_{RHPZ} = \frac{R_O \times (1-D)^2}{2\pi \times L}$$

Set the compensation resistor, RC

$$R_C = \frac{2\pi \times V_{OUT} \times R_{sense} \times f_C \times C_O}{(1-D) \times V_{REF} \times G_{EA}}$$

Set the compensation Zero capacitor, CC

$$C_C = \frac{R_O \times C_O}{2 \times R_C}$$

Set the compensation Pole capacitor, CP

$$C_P = \frac{R_{ESR} \times C_O}{R_C}$$

If the CP is less than 10pF, It can be left open

- RO is the output load resistance.
- D is the switching duty cycle. 1-D = VIN / VOUT
- Rsense is the equivalent internal current sense resistor, which is 0.084Ω
- CO is output capacitor.
- VREF is reference voltage at the FB pin, which is 1.204V.
- GEA is the amplifier's transconductance, which is 190uA/V.
- RESR is the equivalent series resistance of the output capacitor.

Layout Considerations

As for all switching power supplies, especially those running at high switching frequency and high currents, layout is an important design step. If layout is not cargfully done, the regulator could suffer from instability and noise problems.

- Use integral GND ground plane under the chip
- Minimize the length and area of all traces connected to the SW pin.
- The power traces, consisting of the GND trace, the SW trace, the PVIN trace and the VOUT trace should be kept short, direct and wide.
- The input capacitor needs to be close to inductor L and GND pin in order to reduce the input supply ripple. The output capacitor needs to be close to Diode and GND pin in order to reduce the output supply ripple.
- The resistor divider RUP and RDN must be connected to FB pin directly as closely as possible.
- The layout should also be done with well consideration of the thermal as this is a high-power density device. A thermal pad that improves the thermal capabilities of the package should be soldered to the large ground plate, using thermal vias underneath the thermal pad.

Typical Circuit Diagram

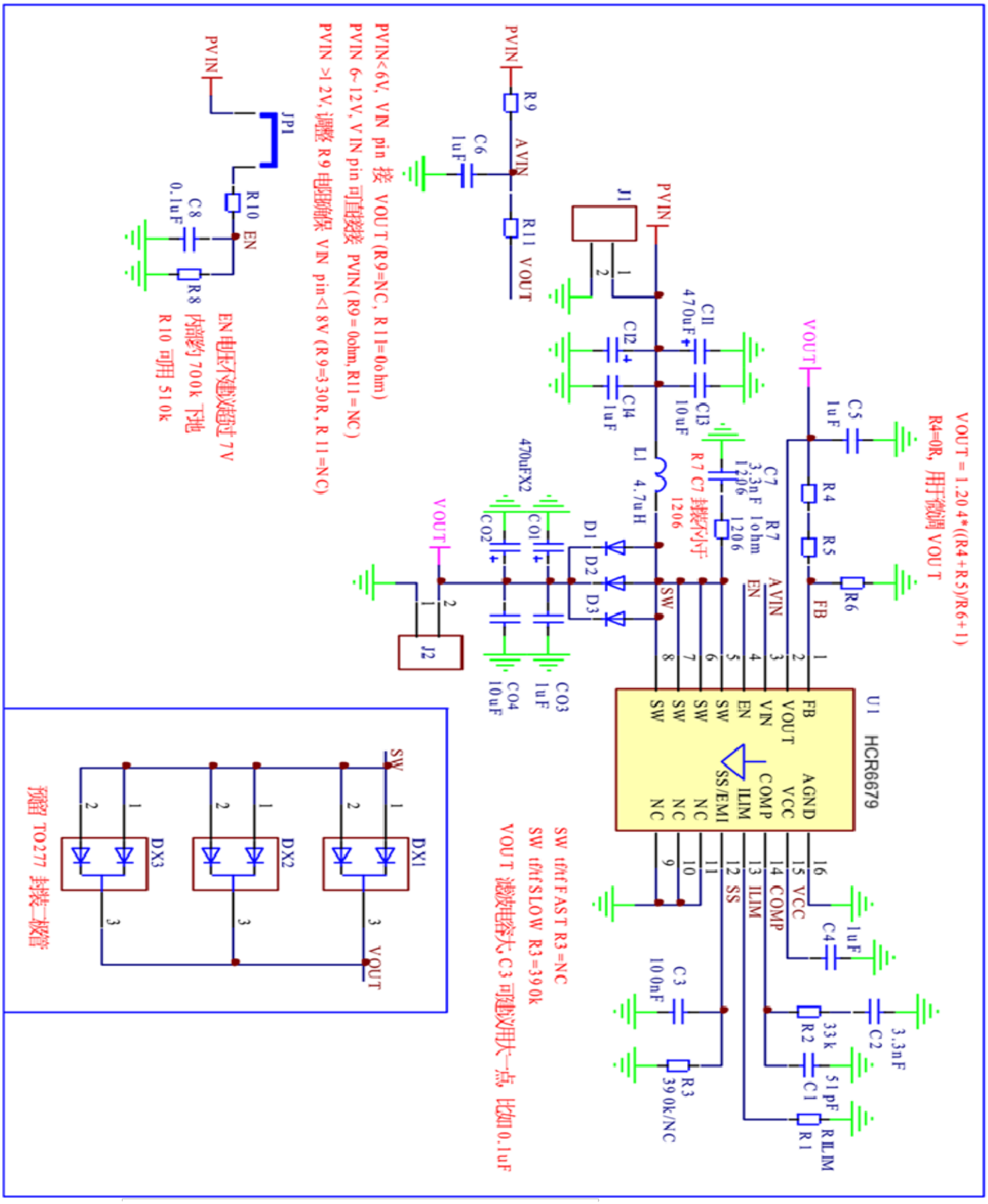


Figure 5. Typical Circuit Diagram of HCR6679

PCB Layout of Top Layer

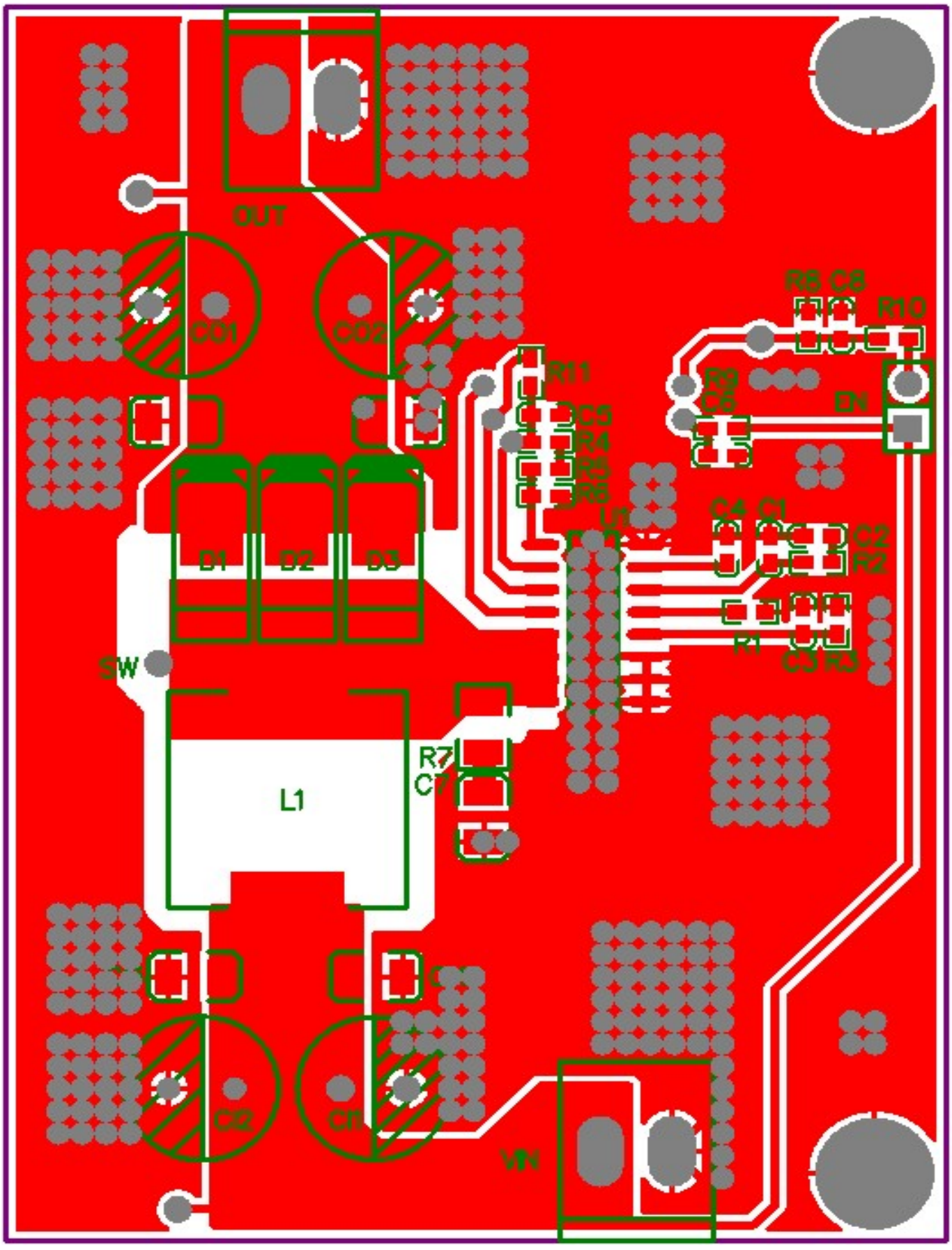


Figure 6. DEMO PCB of Top Layer

PCB Layout of Top Layer

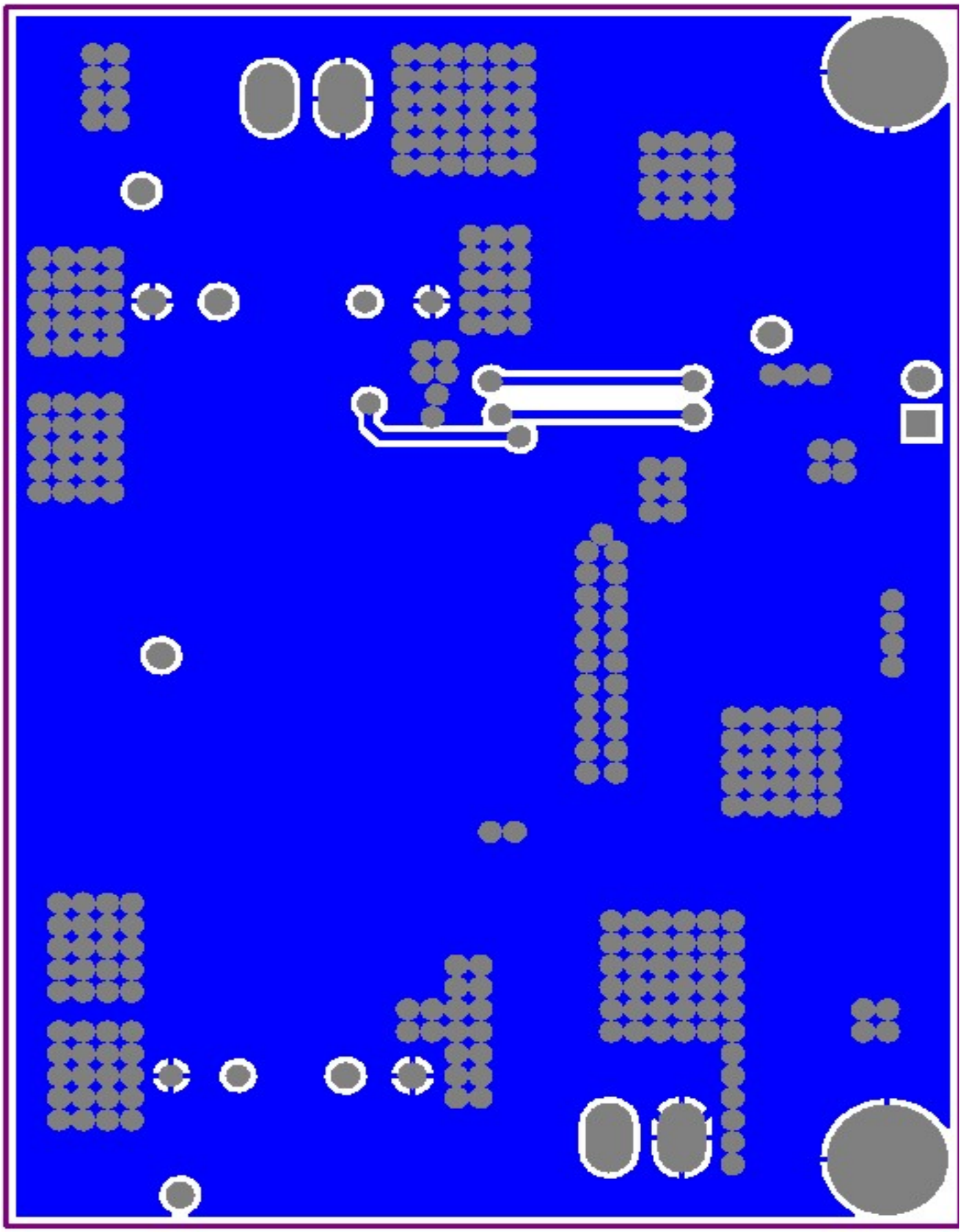
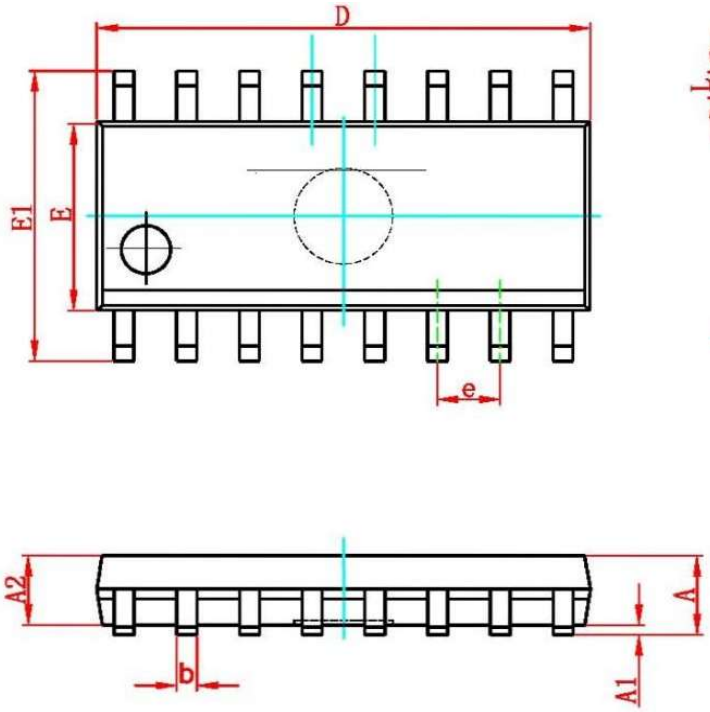


Figure 7. DEMO PCB of Botton Layer

PACKAGE OUTLINE DIMENSIONS

M16E Package: SOP-16(EP)

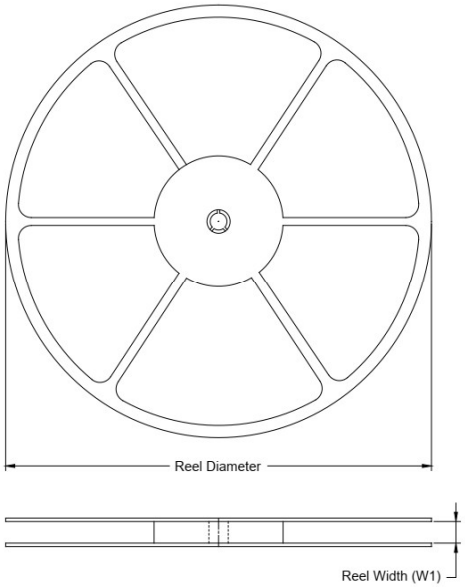
unit:mm



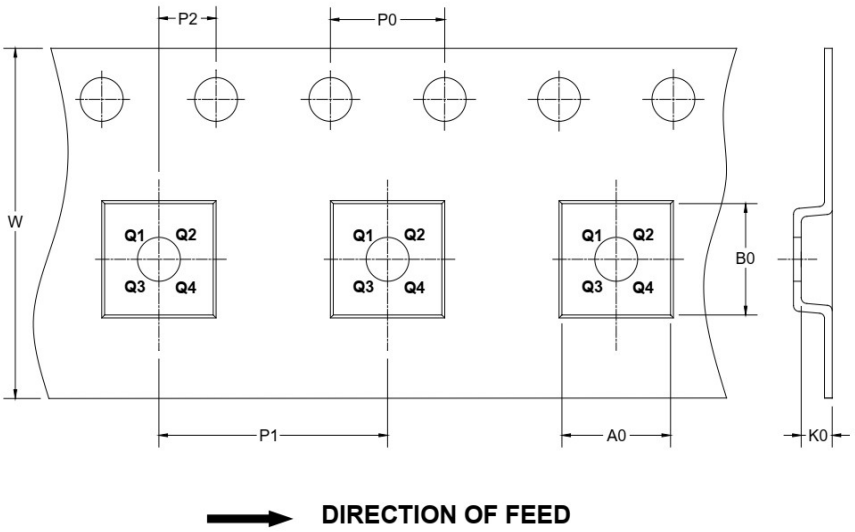
Symbol	Size (mm)	
	MIN	MAX
A	-	1.75
A1	0.05	0.15
A2	1.30	1.50
b	0.39	0.48
c	0.21	0.26
D	9.70	10.10
D1	4.57(REF)	
E	3.70	4.10
E1	5.80	6.20
E2	2.41(REF)	
e	1.27(BSC)	
L	0.50	0.80
θ	0°	8°

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



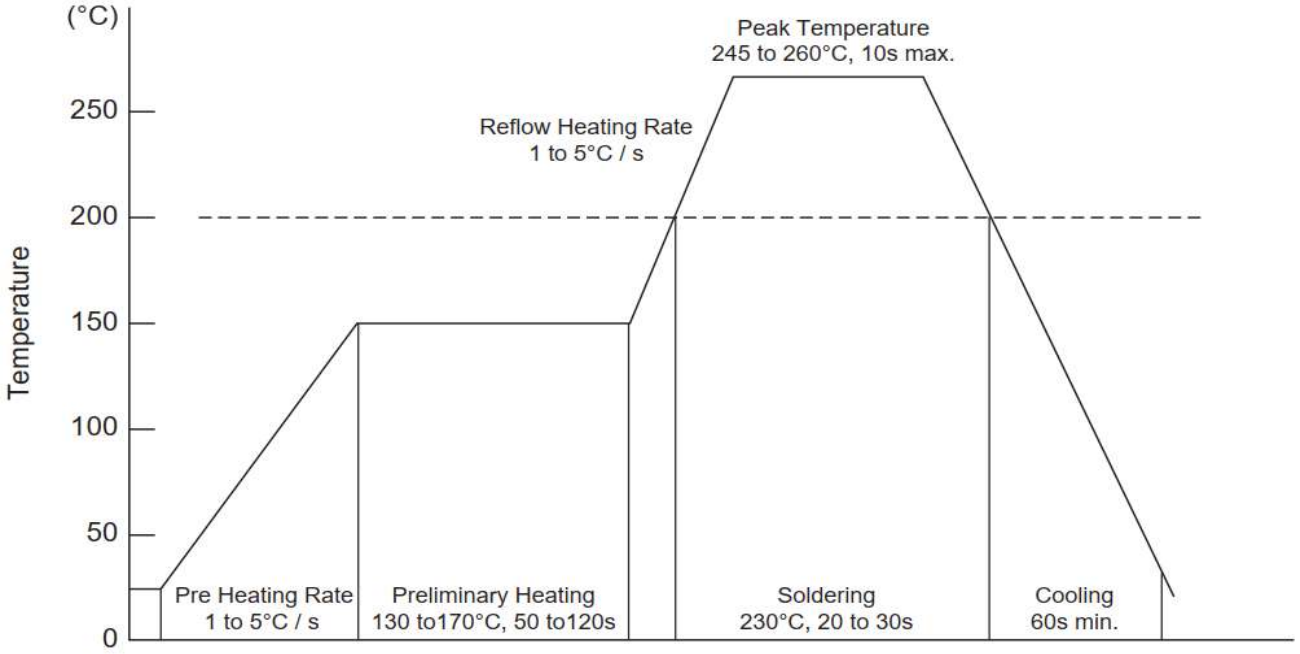
NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOP-16(EP)	13"	16.4	6.50	10.03	2.10	4.0	4.0	8.0	16.0	Q1

Conditins of Soldering and Storage

* Recommended condition



Recommended peak temperature is over 245'C, if peak temperature is below 245'C, you may adjust the following parameters:

* Time length of peak temperature (longer)
* Time length of soldering (longer)
* Thickness of solder paste (thicker)

* Conditions of hand soldering
  * Temperature : 300'C
  * Time : 3s max
  * Times : one time

* Storage conditions
  * Temperature
    5 to 40'C
  * Humidity
    30 to 80% RH
  * Recommended period
    One year after manufacturing