Automotive uPOL Module

1A, High Efficiency Automotive uPOL Module

VUN12AD01-SH

FEATURES:

- High Density Automotive uPOL Module
- 1A Output Current
- Input Voltage Range from 4.5V to 28V
- Output Voltage Range from 3.0V to 8.5V
- 91% Peak Efficiency (@Vin=12V)
- Automatic Power Saving/PWM Mode
- Switching Frequency 420KHz
- Protections (OCP: Non-latching, OTP)
- Internal Soft Start
- Compact Size: 3.5mm*3.5mm*1.7mm(Max)
- Pb-free for RoHS compliant
- MSL 2, 260°C Reflow
- AECQ-100 Package available

APPLICATIONS:

- Automotive Systems
- ADAS Camera/Radar Modules
- LED Modules
- Infotainment/Instrument Cluster ECU

GENERAL DESCRIPTION:

The uPOL module is non-isolated DC-DC converters that can deliver up to 1A of output current. The PWM switching regulator, high frequency power inductor are integrated in one hybrid package. It only needs some passive component to use this uPOL module easily.

The module has automatic operation with PWM mode and power saving mode according to loading. Other features include remote enable function, internal soft-start, non-latching over current protection.

The low profile and compact size package (3.5mm × 3.5mm x 1.7mm) is suitable for automated assembly by standard surface mount equipment. The uPOL module is Pb-free and RoHS compliant.

The wide input voltage range offers high tolerance to the extreme automotive working conditions (e.g. cold-crank, load-dump).

TYPICAL APPLICATION CIRCUIT & PACKAGE SIZE:

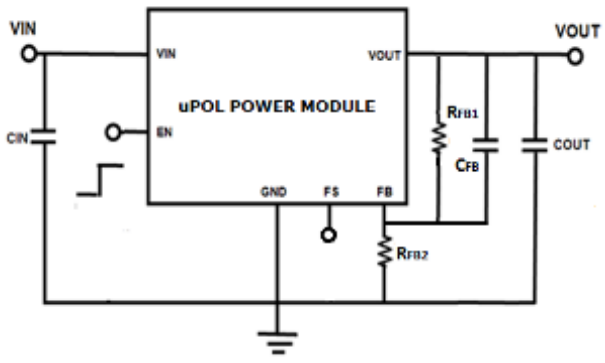


FIG.1 TYPICAL APPLICATION CIRCUIT

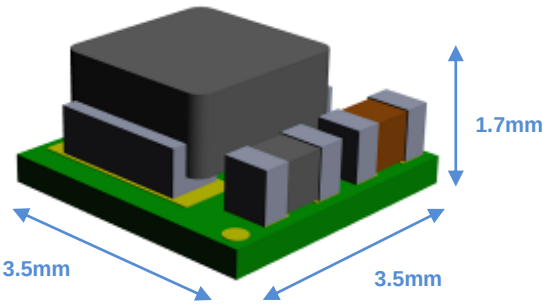


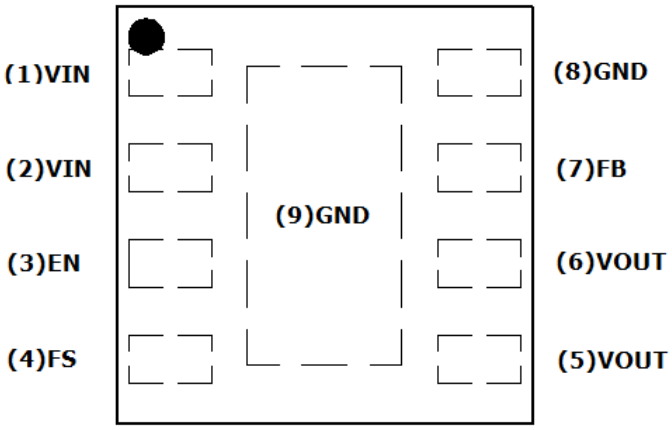
FIG.2 HIGH DENSITY POWER MODULE

ORDER INFORMATION:

Part Number	Ambient Temp. Range (°C)	Package (Pb-Free)	MSL	Note
VUN12AD01-SH	105	DFN	Level 2	-

Order Code	Packing	Quantity
VUN12AD01-SH	Tape and reel	1000

PIN CONFIGURATION:



TOP VIEW

PIN DESCRIPTION:

Symbol	Pin No.	Description
VIN	1, 2	Power input pin. Place the ceramic type input capacitor as closely as possible to this pin. At least 10uF input capacitance is needed.
EN	3	On/Off control pin for module. Pull high to turn on. Pull low to turn off. Do not leave this pin floating.
FS	4	Frequency programming pin. The pin left floating if this function is not used
VOUT	5, 6	Power output pin. Place the output capacitors as closely as possible to this pin. At least 22uF output capacitance is needed.
FB	7	Feedback input. Connect an external dividing resistor R_{FB1} and R_{FB2}, refer to TABEL 1 output voltage setting.
GND	8, 9	Power ground pin. Connect to thermal exposed pad of (9)GND for heat transferring.

ELECTRICAL SPECIFICATIONS:

CAUTION: Do not operate at or near absolute maximum rating listed for extended periods of time. This stress may adversely impact product reliability and result in failures not covered by warranty.

Parameter	Description	Min.	Typ.	Max.	Unit
■ Absolute Maximum Ratings					
VIN to GND		-0.2	-	+40.0	V
SW to GND		-0.2		+40.0	V
EN to GND		-0.2	-	+40.0	V
FS to GND		-0.2		+40.0	V
FB to GND		-0.2	-	+40.0	V
Tc	Case Temperature of Inductor	-	-	+165	°C
Tj	Junction Temperature	-40	-	+150	°C
Tstg	Storage Temperature	-40	-	+125	°C
■ Recommendation Operating Ratings					
VIN	Input Supply Voltage	+4.5	-	+28.0	V
VOUT	Adjusted Output Voltage	+3.0	-	+8.5	V
Ta	Ambient Temperature	-40	-	105	°C
■ Thermal Information					
$Rth(j_{choke}\text{-}a)$	Thermal resistance from junction to ambient (Note 1)	-	32	-	°C/W

NOTES:
1. $Rth(j_{choke}\text{-}a)$ is measured with the component mounted on an effective thermal conductivity test board on 0 LFM condition. The test board size is 30mm×30mm×1.6mm with 4 layers, 1 oz per layer. The test condition is complied with JEDEC EIJ/JESD 51 Standards.

ELECTRICAL SPECIFICATIONS: (Cont.)

Conditions: T_A = 25 ºC, unless otherwise specified. Test Board Information: 30mm×30mm×1.6mm, 4 layers 1 oz. The output ripple and transient response measurement is short loop probing and 20MegHz bandwidth limited. Vin=12V, Vout=5.0V, Cin=10uF/50V/1210/X7R*2, Cout=22uF/16V/1210/X7R*2, Cfb=22pF / 50V / 0402 / X7R, Switching frequency=420KHz

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
■ Input Characteristics						
I_{SD}	Input shutdown current	EN = GND and no pull up resistance connect to VIN	-	2	-	uA
I_{IN}	Input supply bias current	EN = VIN, Iout = 0A	-	50	-	uA
I_S	Input supply current	EN = VIN, Iout = 1A		0.46		A
■ Output Characteristics						
$I_{OUT(DC)}$	Output continuous current range		0	-	1	A
$V_{O(SET)}$	Ouput Voltage Set Point At PWM Mode	With 0.1% tolerance for external resistor used to set output voltage	-3	-	+3	% $V_{O(SET)}$
$\Delta V_{OUT}/\Delta V_{IN}$	Line regulation accuracy	Vin = 8V to 16V, Iout = 1A	-	0.5	-	% $V_{O(SET)}$
$\Delta V_{OUT}/\Delta I_{OUT}$	Load regulation accuracy	Iout = 0A to 1A	-	3	-	% $V_{O(SET)}$
■ Control Characteristics						
OCP	Protection Output Current		3.5	-	4.5	A
OTP	Over temp protection			150		°C
F_{OSC}	Oscillator frequency (Frequency programmable)		340	-	510	KHz
V_{ENL}	EN Low threshold		0.4	-	-	V
V_{ENH}	EN High Threshold		-	-	1.7	V
UVLO	Input under voltage lockout threshold				4.35	V

TYPICAL PERFORMANCE CHARACTERISTICS: 3.3 Vout

Conditions: T_A = 25 ºC, unless otherwise specified. Test Board Information: 30mm×30mm×1.6mm, 4 layers 1 oz.
The output ripple and transient response measurement is short loop probing and 20MegHz bandwidth limited.
Fsw=420KHz, Cin=10uF/50V/1210/X7R*2, Cout=22uF/16V/1210/X7R*2, Cfb=22pF / 50V / 0402 / X7R.
The following figures provide the typical characteristic curves at 3.3Vout.

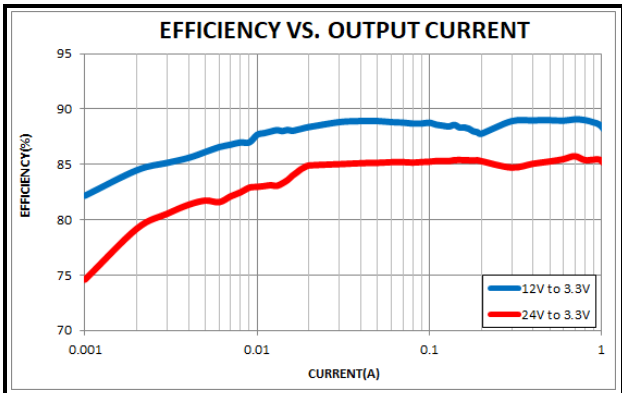


FIG.3 EFFICIENCY V.S. LOAD CURRENT

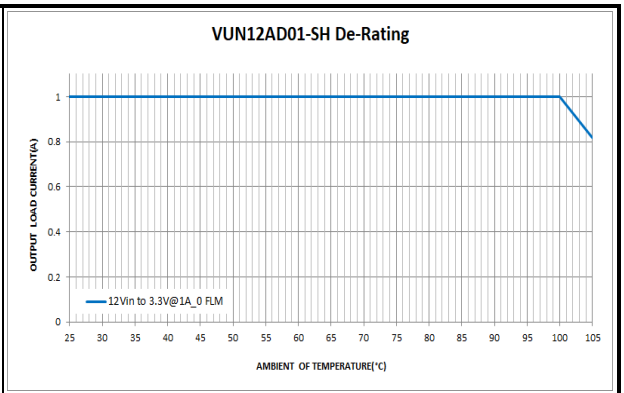


FIG.4 DE-RATING CURVE

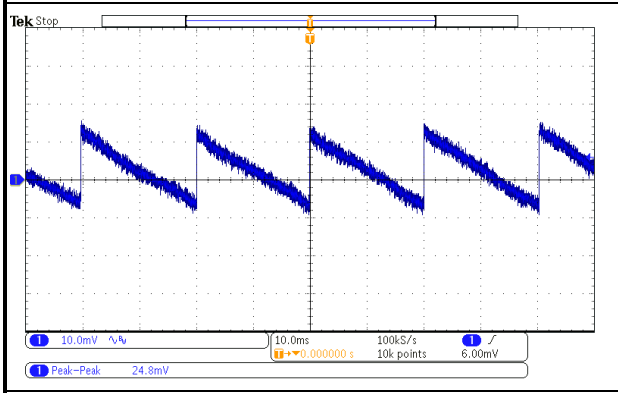


FIG.5 OUTPUT RIPPLE
(12VIN, 3.3VOUT, IOUT=0A)

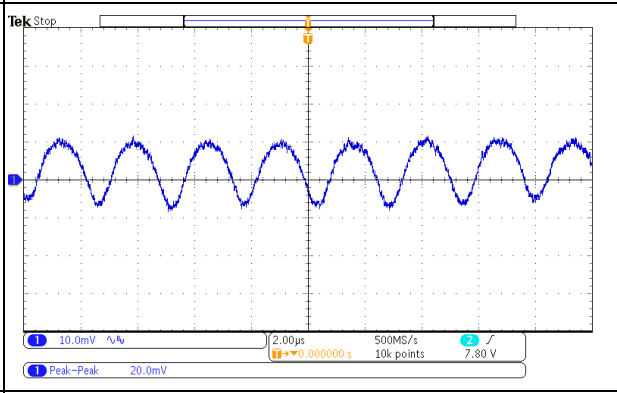


FIG.6 OUTPUT RIPPLE
(12VIN, 3.3VOUT, IOUT=1A)

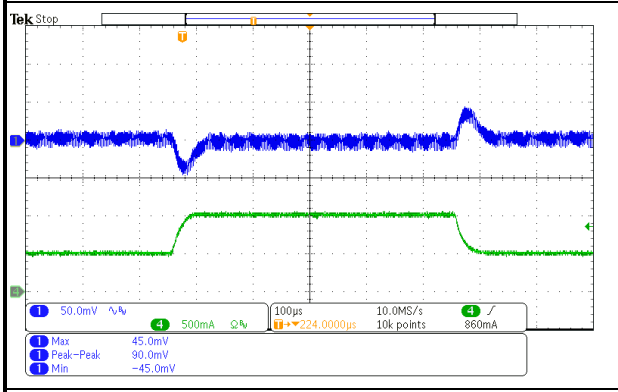


FIG.7 TRANSIENT RESPONSE
(12VIN, 50% to 100% Io LOAD STEP)

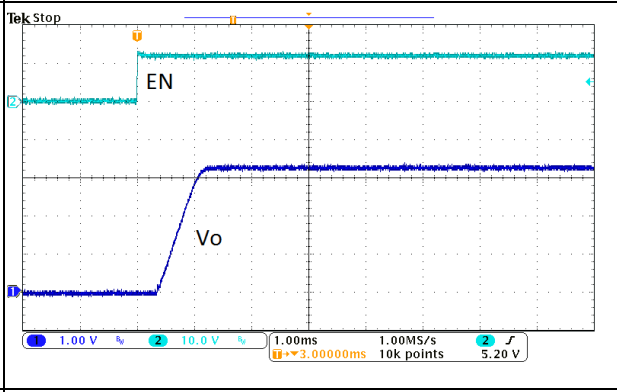


FIG.8 TURN-ON
(12VIN, IOUT=1A)

TYPICAL PERFORMANCE CHARACTERISTICS: 5.0 Vout

Conditions: T_A = 25 ºC, unless otherwise specified. Test Board Information: 30mm×30mm×1.6mm, 4 layers 1 oz.
The output ripple and transient response measurement is short loop probing and 20MegHz bandwidth limited.
Fsw=420KHz, Cin=10uF/50V/1210/X7R*2, Cout=22uF/16V/1210/X7R*2, Cfb=22pF / 50V / 0402 / X7R.
The following figures provide the typical characteristic curves at 5.0Vout.

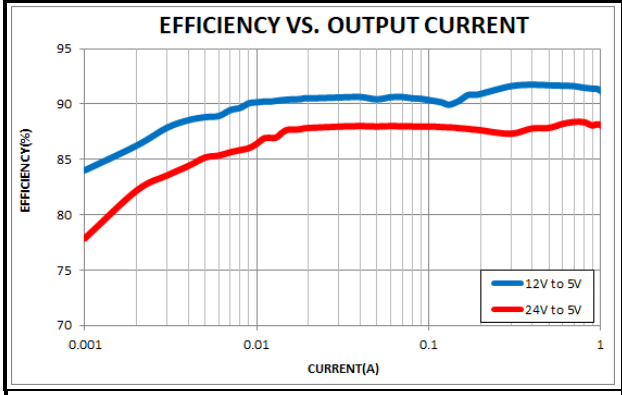


FIG.9 EFFICIENCY V.S. LOAD CURRENT

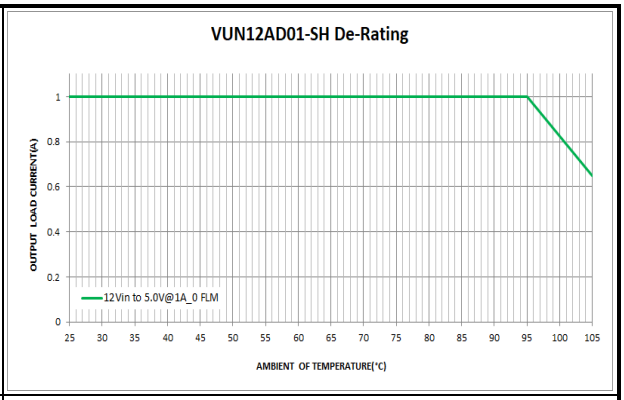


FIG.10 DE-RATING CURVE

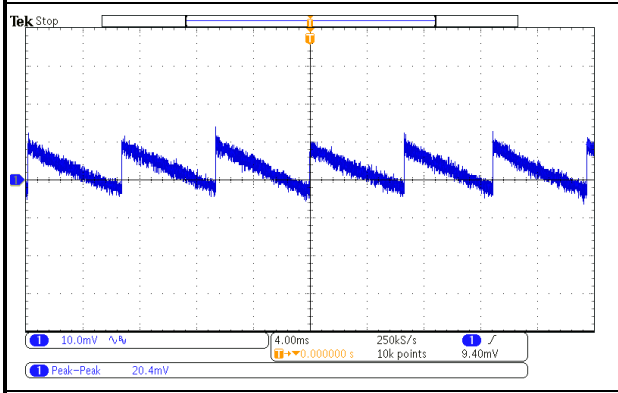


FIG.11 OUTPUT RIPPLE
(12VIN, 5VOUT, IOUT=0A)

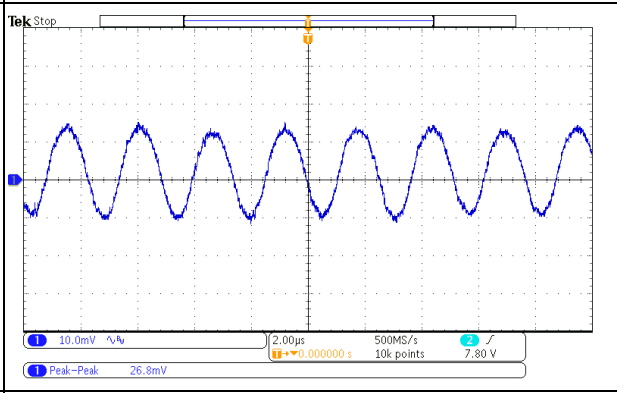


FIG.12 OUTPUT RIPPLE
(12VIN, 5VOUT, IOUT=1A)

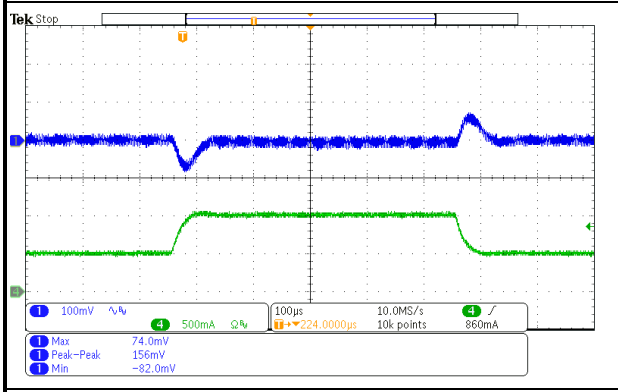


FIG.13 TRANSIENT RESPONSE
(12VIN, 50% to 100% Io LOAD STEP)

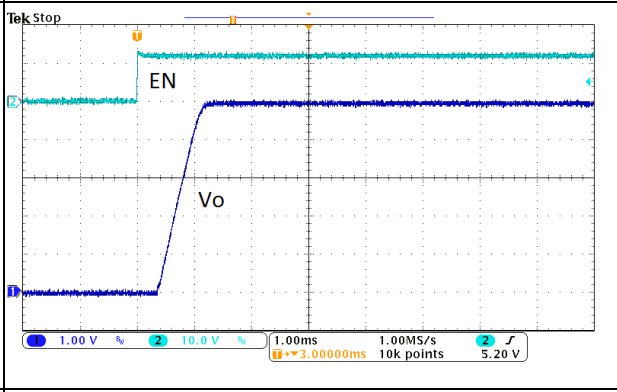


FIG.14 TURN-ON
(12VIN, IOUT=1A)

TYPICAL PERFORMANCE CHARACTERISTICS: 7.2 Vout

Conditions: T_A = 25 ºC, unless otherwise specified. Test Board Information: 30mm×30mm×1.6mm, 4 layers 1 oz.
The output ripple and transient response measurement is short loop probing and 20MegHz bandwidth limited.
Fsw=420KHz, Cin=10uF/50V/1210/X7R*2, Cout=22uF/16V/1210/X7R*2, Cfb=22pF / 50V / 0402 / X7R.
The following figures provide the typical characteristic curves at 7.2Vout.

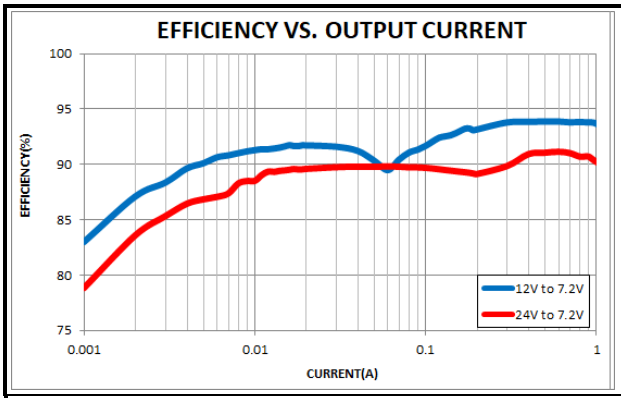


FIG.15 EFFICIENCY V.S. LOAD CURRENT

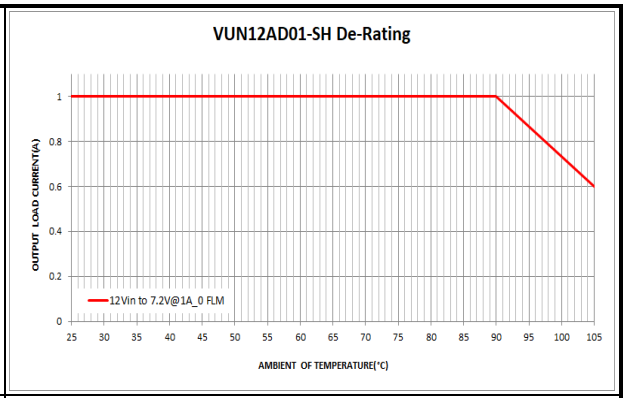


FIG.16 DE-RATING CURVE

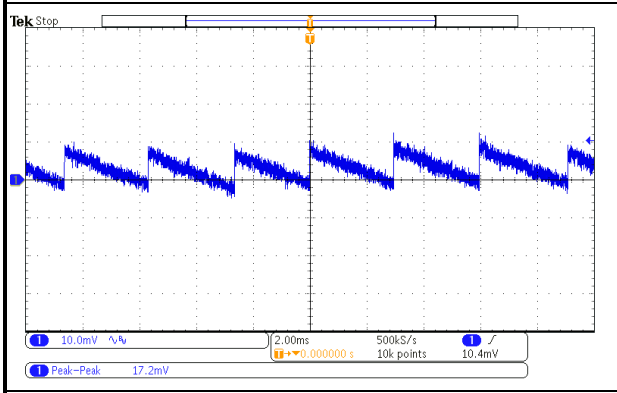


FIG.17 OUTPUT RIPPLE
(12VIN, 7.2VOUT, IOUT=0A)

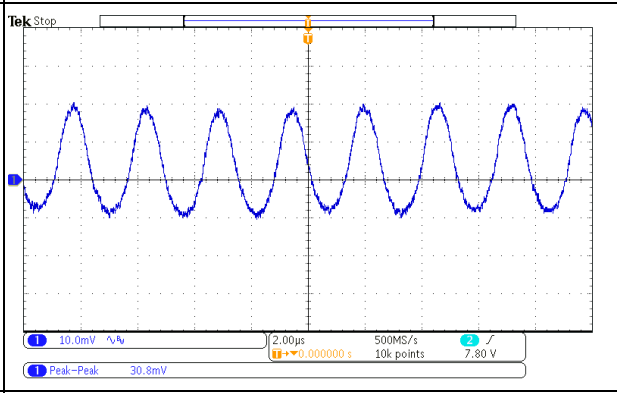


FIG.18 OUTPUT RIPPLE
(12VIN, 7.2VOUT, IOUT=1A)

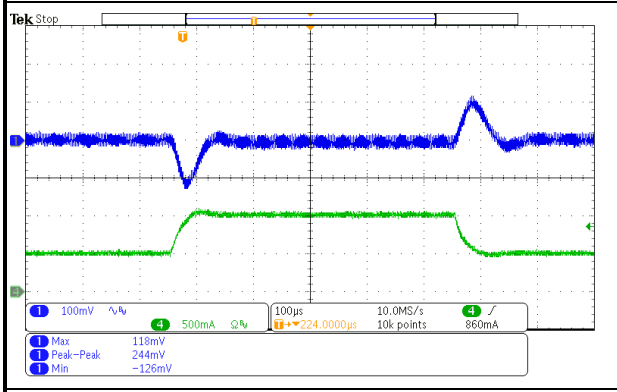


FIG.19 TRANSIENT RESPONSE
(12VIN, 50% to 100% Io LOAD STEP)

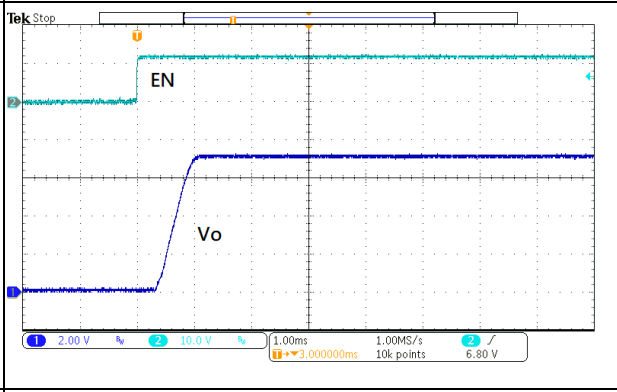


FIG.20 TURN-ON
(12VIN, IOUT=1A)

APPLICATIONS INFORMATION: (Cont.)

SAFETY CONSIDERATIONS:

Certain applications and/or safety agencies may require fuses at the inputs of power conversion components. Fuses should also be used when there is the possibility of sustained input voltage reversal which is not current limited. For greatest safety, we recommend a fast blow fuse installed in the ungrounded input supply line. The installer must observe all relevant safety standards and regulations. For safety agency approvals, install the converter in compliance with the end-user safety standard.

INPUT FILTERING:

The module should be connected to as low AC impedance source supply and a highly inductive source or line inductance can affect the stability of the module. Input capacitors must be placed directly to the input pin of the module, to minimize input ripple voltage and ensure module stability.

OUTPUT FILTERING:

To reduce output ripple and improve the dynamic response to as step load change, the additional capacitors at the output must be used. Low ESR ceramic capacitors are recommended to improve the output ripple and dynamic response of the module.

PROGRAMMING OUTPUT VOLTAGE:

The output voltage can be programmed by the dividing resistor R_{FB1} and R_{FB2} (R_{FB1} connected from FB to Vout; R_{FB2} connected from FB to GND). Assume R_{FB1} set 100 Kohm, the output voltage can be calculated as shown in Equation 1 and the resistance according to typical output voltage is shown in TABLE 1.

$$VOUT\,(V) = 0.6 \times \left(1 + \frac{R_{FB1}}{R_{FB2}}\right) \qquad \text{(EQ.1)}$$

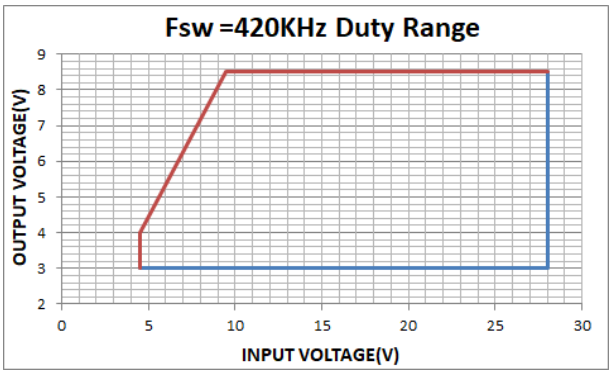
Vout	3.3V	5V	7.2V
RFB2 (Ohm)	22.222k	13.636k	9.09k

TABLE 1: OUTPUT VOLTAGE SETTING

Note. R_{FB1} maximum 200 Kohm, minimum 10 Kohm.

APPLICATIONS INFORMATION: (Cont.)

DUTY CYCLE RANGE OF APPLICATION :



At 105℃, application limited as below :

(1) 8.1V input voltage to 7.2V output voltage, absolute Output current maximum 700mA

(2) 8.2V input voltage to 7.2V output voltage, absolute Output current maximum 850mA

LOAD TRANSIENT CONSIDERATIONS :

The VUN12AD01-SH module integrates the compensation components to achieve good stability and transient responses. In some applications, adding a 22pF ceramic cap in parallel with R_{FB1}.

THERMAL CONSIDERATIONS:

All of thermal testing condition is complied with JEDEC EIJ/JESD 51 Standards. Therefore, the test board size is 30mm×30mm×1.6mm with 4 layers. The case temperature of module sensing point is shown as FIG.21 then $Rth(j_{choke}\text{-}a)$ is measured with the component mounted on an effective thermal conductivity test board on 0 LFM condition. The VUN12AD01-SH module is designed for using when the case temperature is below 117°C regardless the change of output current, input/output voltage or ambient temperature.

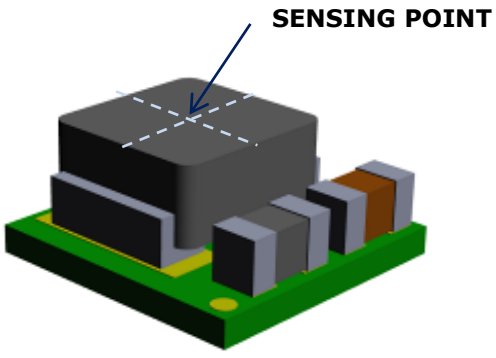
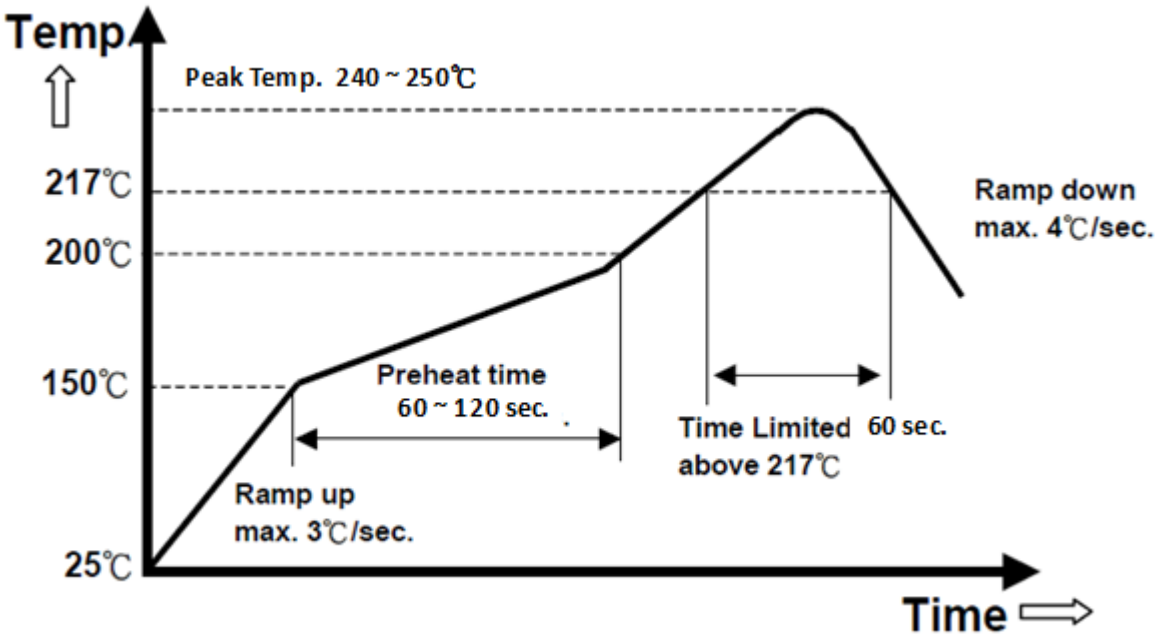


FIG.21 CASE TEMPERATURE SENSING POINT

APPLICATIONS INFORMATION: (Cont.)

REFLOW PARAMETERS:

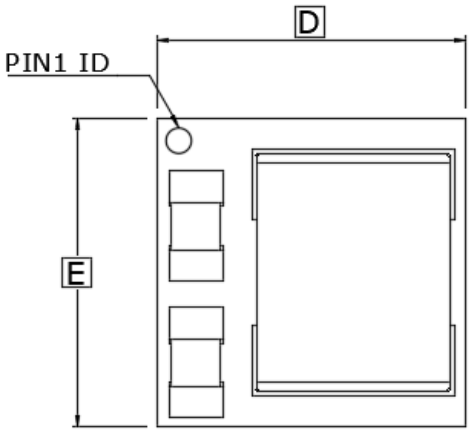
Lead-free soldering process is a standard of electronic products production. Solder alloys like Sn/Ag, Sn/Ag/Cu and Sn/Ag/Bi are used extensively to replace the traditional Sn/Pb alloy. Sn/Ag/Cu alloy (SAC) is recommended for this power module process. In the SAC alloy series, SAC305 is a very popular solder alloy containing 3% Ag and 0.5% Cu and easy to obtain. Figure 22 shows an example of the reflow profile diagram. Typically, the profile has three stages. During the initial stage from room temperature to 150°C, the ramp rate of temperature should not be more than 3°C/sec. The soak zone then occurs from 150°C to 200°C and should last for 60 to 120 seconds. Finally, keep at over 217°C for 60 seconds limit to melt the solder and make the peak temperature at the range from 240°C to 250°C. It is noted that the time of peak temperature should depend on the mass of the PCB board. The reflow profile is usually supported by the solder vendor and one should adopt it for optimization according to various solder type and various manufacturers' formulae.



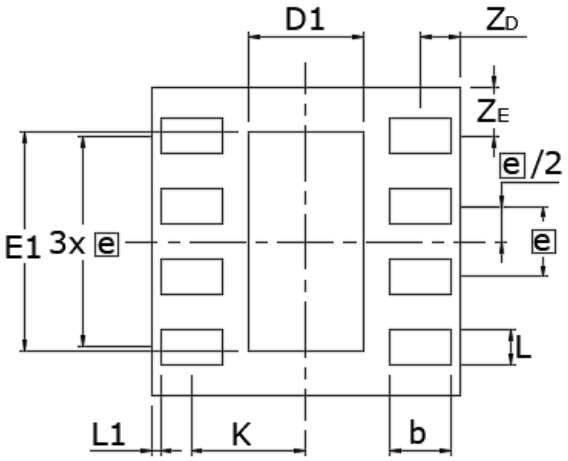
PACKAGE OUTLINE DRAWING:

Unit:mm

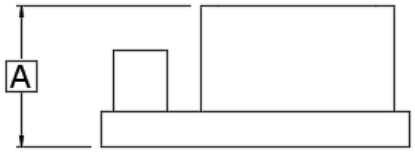
General Tolerance:0.1mm



TOP VIEW



BOTTOM VIEW

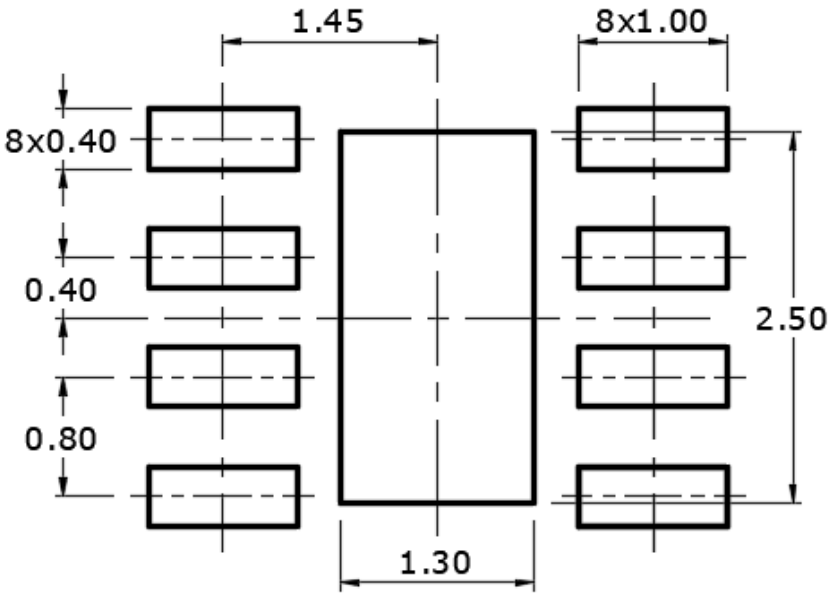


SIDE VIEW

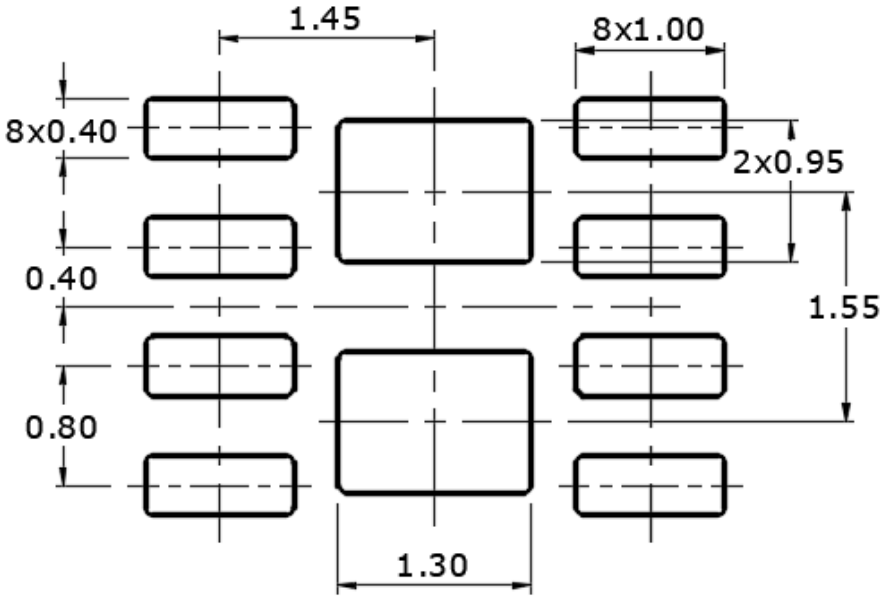
DIM	MILLIMETERS		
	MIN	NOM	MAX
A	1.40	1.55	1.70
D	3.40	3.50	3.60
D1	1.20	1.30	1.40
E	3.40	3.50	3.60
E1	2.40	2.50	2.60
K	1.20	1.30	1.40
e	0.70	0.80	0.90
b	0.60	0.70	0.80
L	0.30	0.40	0.50
L1	0.00	0.10	0.20
ZD	0.30	0.45	0.60
ZE	0.40	0.55	0.70

LAND PATTERN REFERENCE:

Unit: mm



RECOMMENDED LAND PATTERN

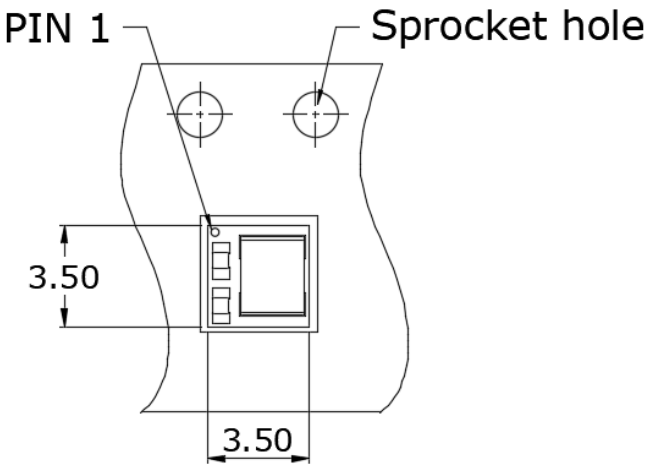


RECOMMENDED STENCIL PATTERN
BASED ON 0.1mm THICKNESS STENCIL

PACKING REFERENCE:

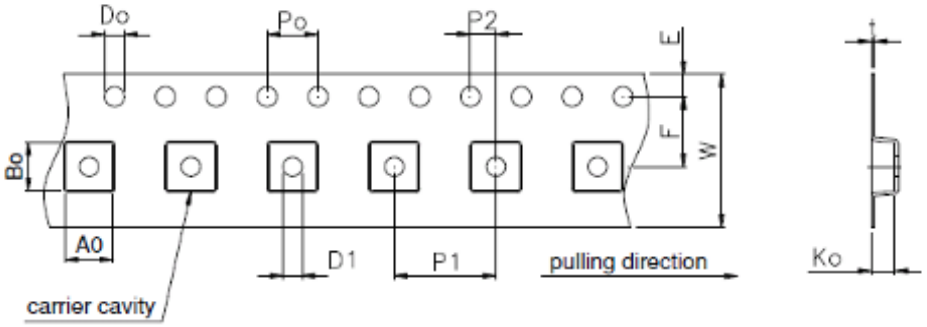
Unit: mm

Package In Tape Loading Orientation



Tape Dimension

Unit:mm

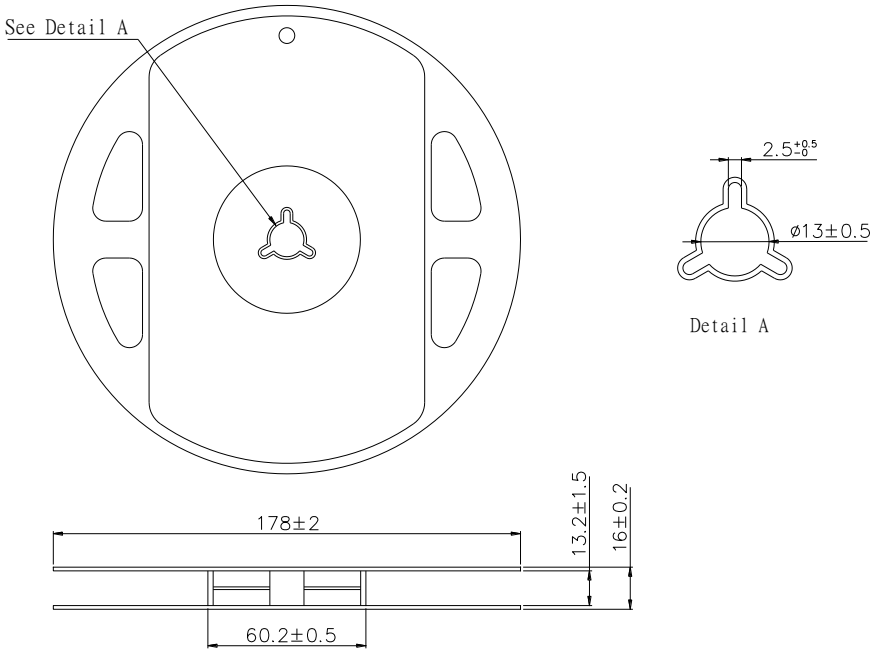


A0	3.80 ± 0.10	E	1.75 ± 0.10
B0	3.80 ± 0.10	K0	1.88 ± 0.10
F	5.50 ± 0.05	P0	4.00 ± 0.10
W	12.0 ± 0.30	P1	8.00 ± 0.10
D0	φ1.5 +0.10/-0.00	P2	2.00 ± 0.05
D1	φ1.5± 0.10	t	0.25 ± 0.1

PACKING REFERENCE: (Cont.)

Unit: mm

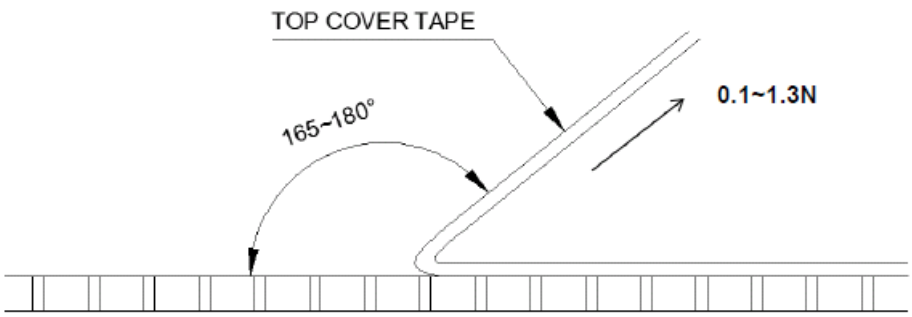
Reel Dimension



Peel Strength of Top Cover Tape

The peel speed shall be about 300mm/min.

The peel force of top cover tape shall be between 0.1N to 1.3N



REVISION HISTORY:

Date	Revision	Changes
2016.11.02	00	Issue initial preliminary datasheet
2017.01.04	01	1、 Change minimum output voltage from 1.2V to 2V 2、 Switching frequency fixed 420KHz 3、 Change page 4 I_{IN}、Ripple、Dynamic testing value 4、 Change page 5、6 efficiency and ripple figure 5、 Change page 8 Duty cycle range only 420KHz
2017.12.29	02	1、 Change maximum output voltage from 6V to 8.5V 2、 Change EN low threshold from max. 0.8V to min. 0.4V
2018.06.20	03	1、 Add page 3 FS and FB to GND maximum ratings 2、 Add page 8 about 105℃ application limited
2019.03.06	04	1、 Change minimum output voltage from 2V to 3V 2、 Update page 4~7 electrical specification and performance characteristic 3、 Update page 9 duty cycle range of application