0.8A , 4.5V-55V Input , Asynchronous Step Down Regulator

GENERAL DESCRIPTION

The PW2558 develops a high efficiency asynchronous step down DC/DC regulator capable of delivering 0.8A output current. The IC adopts current mode adaptive constant off time control. The PW2558 operates over a wide input voltage range from 4.5V to 55V and integrates main switch with very low $R_{DS(ON)}$ to minimize the conduction loss. Low output voltage ripple and small external inductor and capacitor sizes are achieved with 1.2MHz switching frequency.

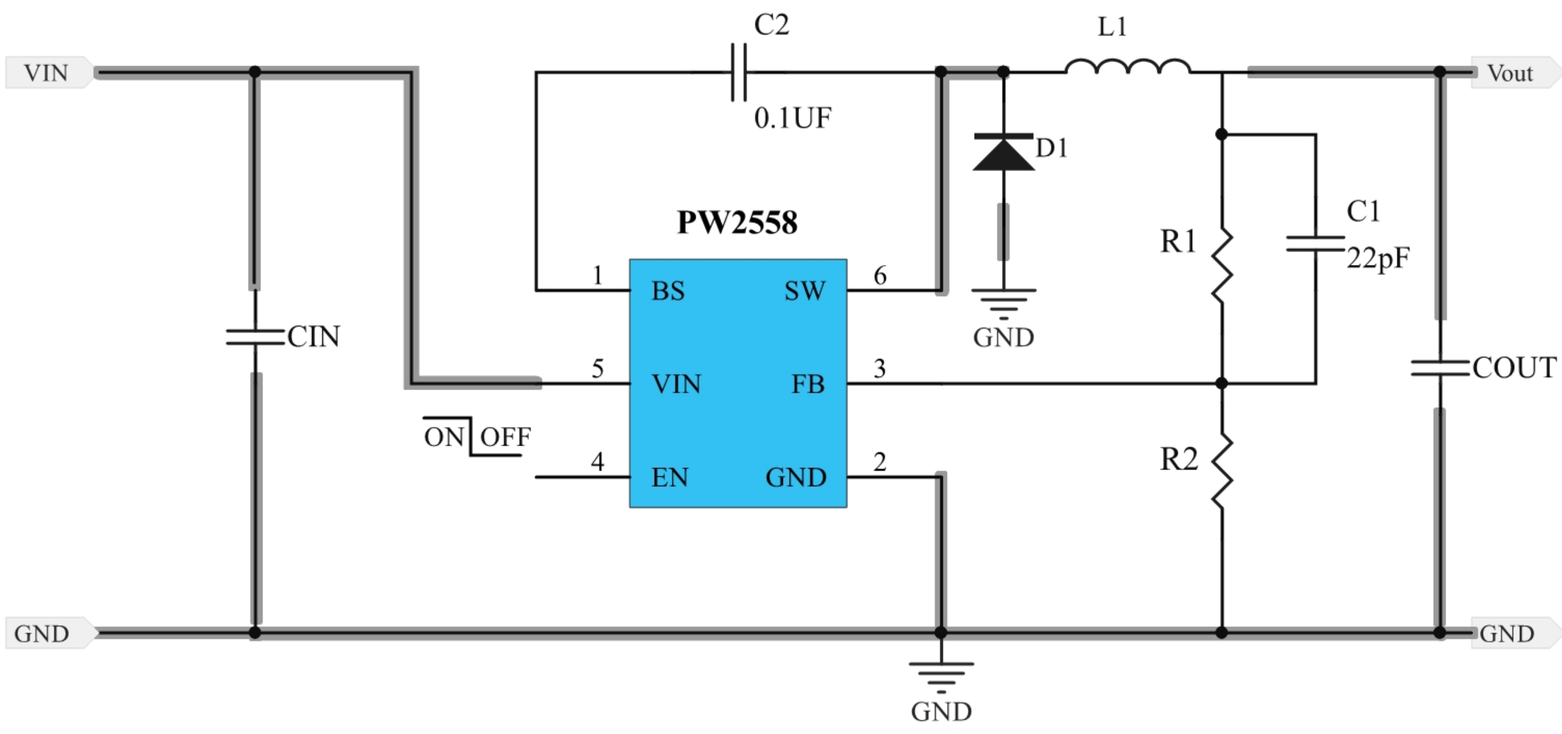
FEATURES

- Low $R_{DS(ON)}$ for Internal N-channel Power FET:700mΩ
- 4.5V-55V Input Voltage Range
- 0.8A Output Current Capability
- 1.2MHz Pseudo Constant Switching Frequency
- Internal Soft-start Limits the Inrush Current
- Hic-cup Mode Output Short Circuit Protection
- EN ON/OFF Control with Accurate Threshold
- Cycle by Cycle Peak Current Limit
- 0.6V±1 % Reference Voltage
- SOT23-6 Package

APPLICATIONS

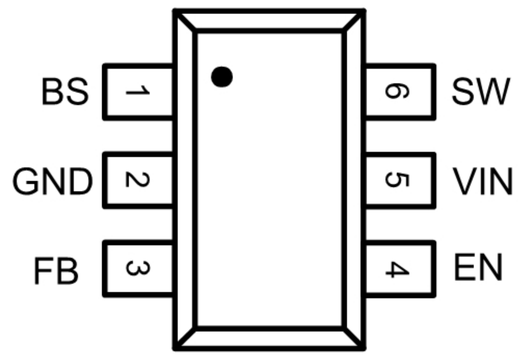
- Non-Isolated Telecommunication Buck Regulator
- Secondary High Voltage Post Regulator
- Automotive Systems

TYPICAL APPLICATION CIRCUIT



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PIN ASSIGNMENT/DESCRIPTION



Pin Number	Pin Name	Function
1	BS	Boot-strap pin. Supply high side gate driver. Decouple this pin to the SW pin with a 0.1μF ceramic capacitor.
2	GND	Ground pin.
3	FB	Output feedback pin. Connect this pin to the center point of the output resistor divider to program the output voltage: $VOUT = \left(1 + \frac{R1}{R2}\right) * 0.6$.
4	EN	Enable control. Pull high to turn on. Do not leave it floating.
5	VIN	Input pin. Decouple this pin to the GND pin with at least a 1μF ceramic capacitor.
6	SW	Inductor pin. Connect this pin to the switching node of the inductor.

Absolute Maximum Ratings (note1)

Parameter		VALUE	Unit
Supply Input Voltage		60	V
BS-SW		4	V
All other pins		VIN + 0.3V	V
Power Dissipation, PD @ TA = 25°C		1	W
Package Thermal Resistance (Note 2)	θJA	100	°C/W
	θJC	25	°C/W
Junction Temperature Range		150	°C
Lead Temperature (Soldering, 10 sec.)		260	°C
Storage Temperature Range		-65 to 125	°C

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RECOMMANDED OPERATING Conditions (note3)

Parameter	VALUE
Supply Input Voltage	4.5V to 55V
Junction Temperature Range	-40°C to 125°C
Ambient Temperature Range	-40°C to 85°C

Note 1: Stresses beyond the "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

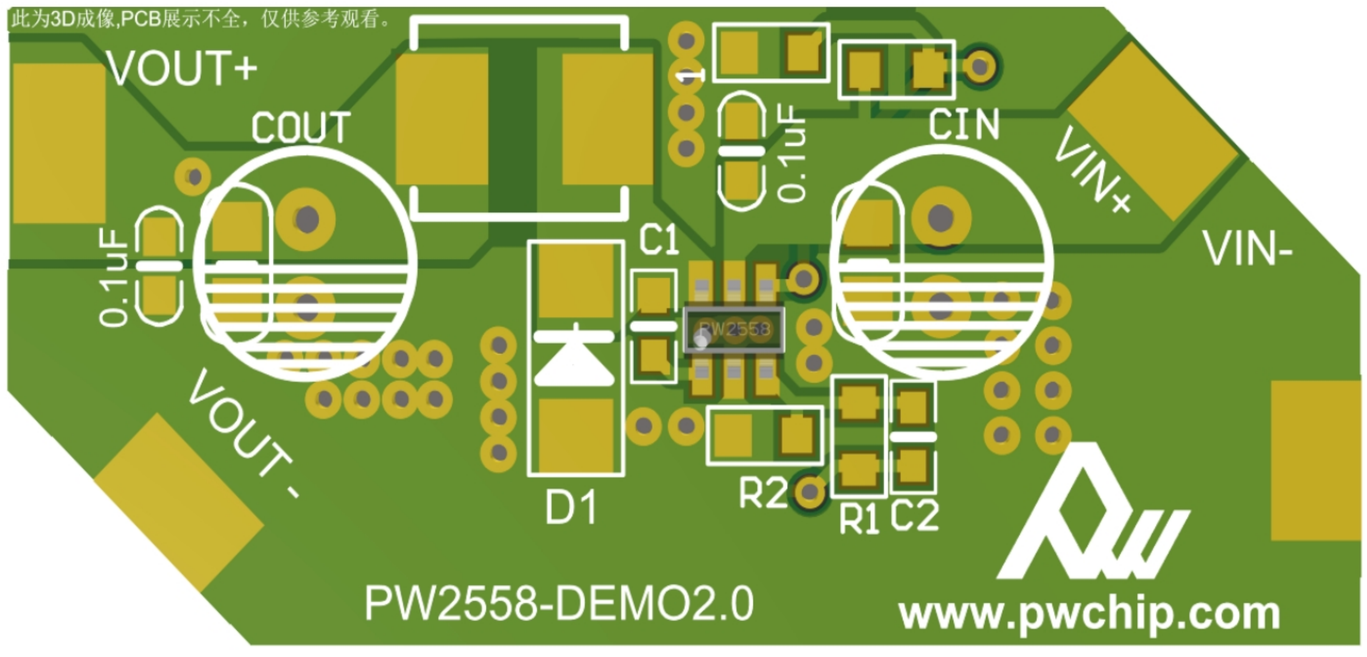
Note 2: θ_{JA} is measured in the natural convection at T_A = 25°C on a high effective thermal conductivity four-layer test board per. JESD51-7 . Pin 2 of SOT23-6 package is the case position for θ_{JC} measurement.

Note 3: The device is not guaranteed to function outside its operating conditions

Layout Considerations

The layout design of the PW2558 is relatively simple. For the best efficiency and minimum noise problem, the following components should be placed close to the IC: CIN, L1, D1, R1 and R2.

1. It is desirable to maximize the PCB copper area connecting to the GND pin to achieve the best thermal and noise performance. If the board space allows, a ground plane is highly desirable.
2. CIN must be close to the VIN and GND pins. The loop area formed by CIN and GND must be minimized.
3. The PCB copper area associated with the SW pin must be minimized to avoid the potential noise problem.
4. The components R1 and R2 and the trace connecting to the FB pin must NOT be adjacent to the SW node on the PCB layout to avoid the noise problem.
5. If the system chip interfacing with the EN pin has a high impedance state at shutdown mode and the VIN pin is connected directly to a power source such as a Li-Ion battery, it is desirable to add a pull down 1MΩ resistor between the EN and GND pins to prevent the noise from falsely turning on the regulator at shutdown mode.



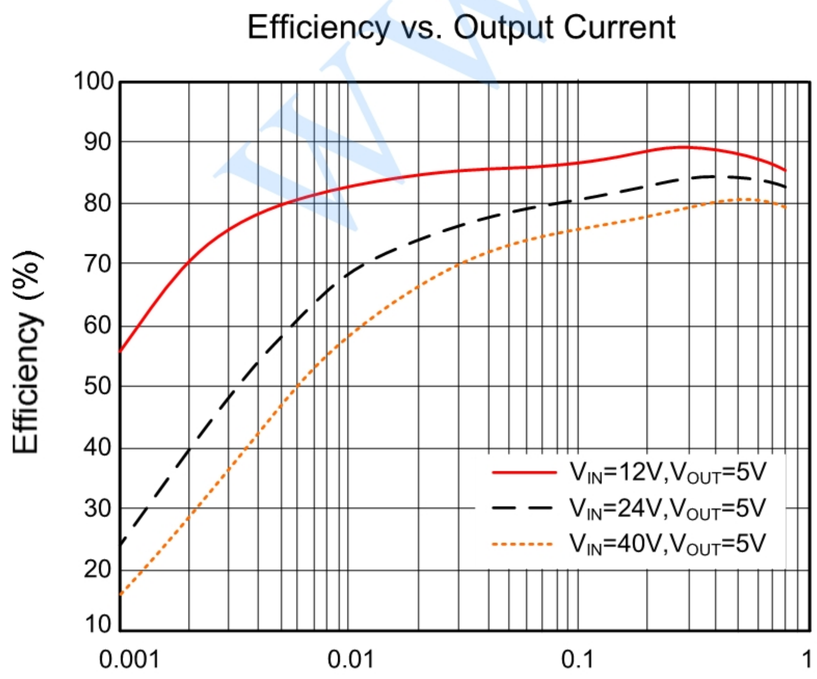
ELECTRICAL CHARACTERISTICS

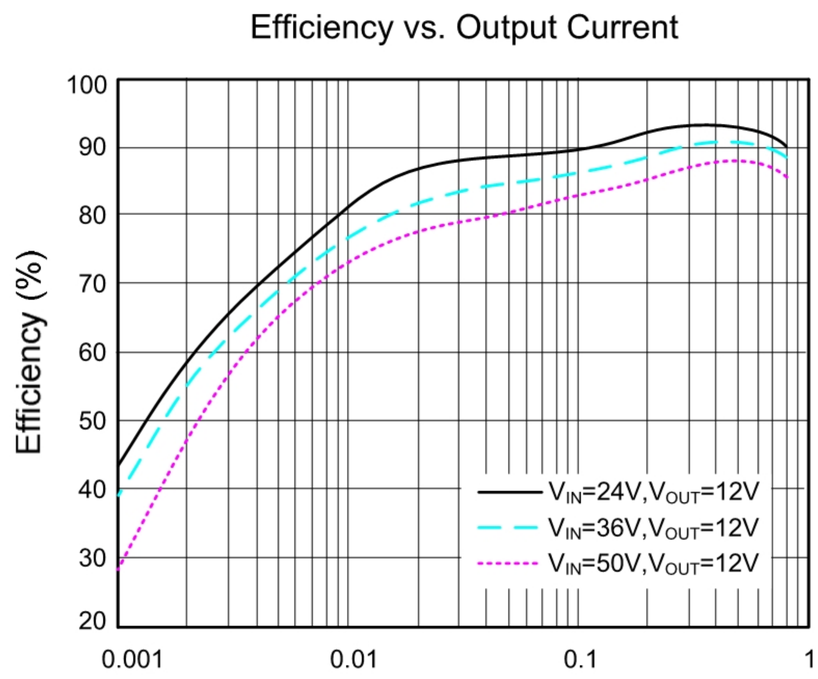
(VIN = 20V, VOUT = 12V, L = 6.8μH, COUT = 10uF, TA = 25°C, IOUT =0.1A unless otherwise specified.)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage Range	V_{IN}		4.5		55	V
Quiescent Current	I_Q	SW not switching		150		μA
Shutdown Current	I_{SHDN}	EN=0		5	10	μA
Feedback Reference Voltage	V_{REF}		0.594	0.6	0.606	V
FB Input Current	I_{FB}	$V_{FB}=V_{IN}$	-50		50	nA
Power FET RON	$R_{DS(ON)}$			700		mΩ
Power FET Peak Current Limit	$I_{LIM,TOP}$		1.05		1.65	A
EN Rising Threshold	V_{ENH}		1.18	1.23	1.28	V
EN Falling Threshold	V_{ENL}		0.94	1	1.06	V
Input UVLO Threshold	V_{UVLO}				4.5	V
Switching Frequency	F_{SW}			1.2		MHz
Switching Frequency Accuracy			-20		20	$\%F_{SW}$
Min ON Time	t_{ON}			100		ns
Min Off Time	t_{OFF}			80		ns
Soft-start Time	t_{SS}			1.4		ms
Thermal Shutdown Temperature	T_{SD}			150		°C
Thermal Shutdown Hysteresis	T_{HYS}			15		°C

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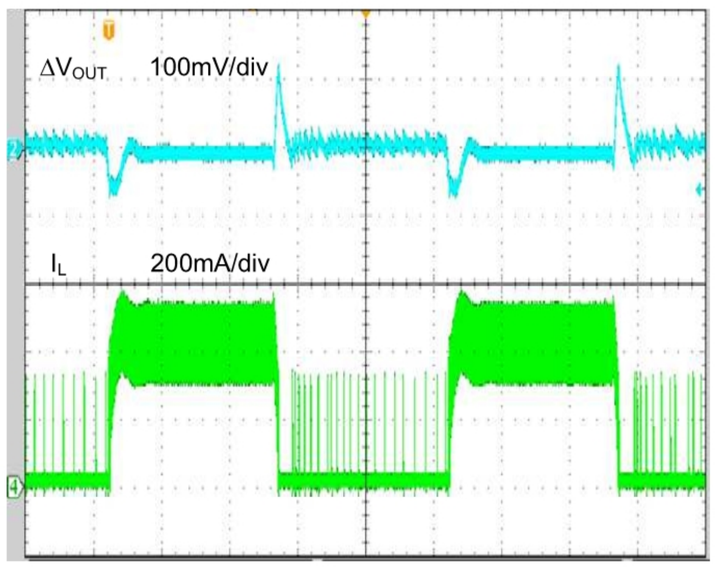
Typical Performance Characteristics





Load Transient

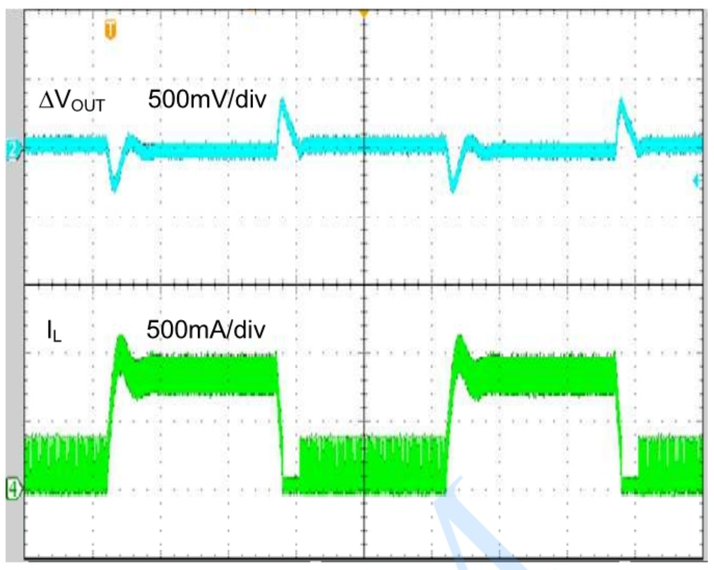
(V_{IN}=24V, V_{OUT}=12V, I_{OUT}=0A~0.4A)



Time (200μs/div)

Load Transient

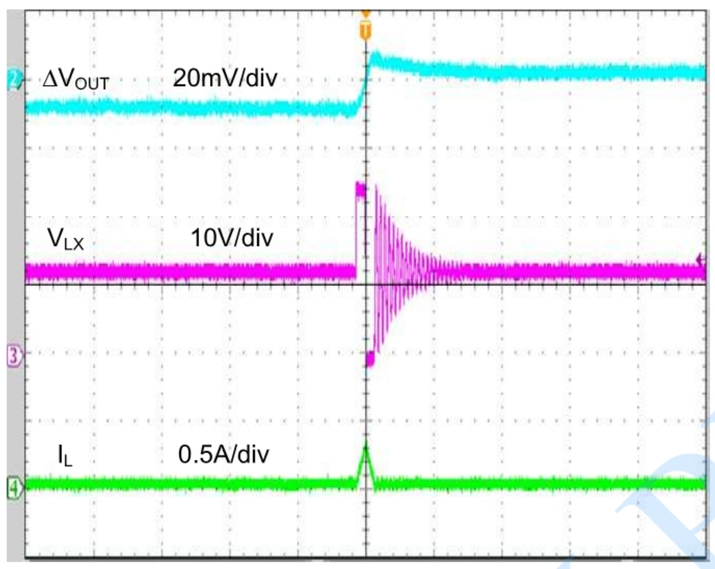
(V_{IN}=24V, V_{OUT}=12V, I_{OUT}=0.08A~0.8A)



Time (200μs/div)

Output Ripple

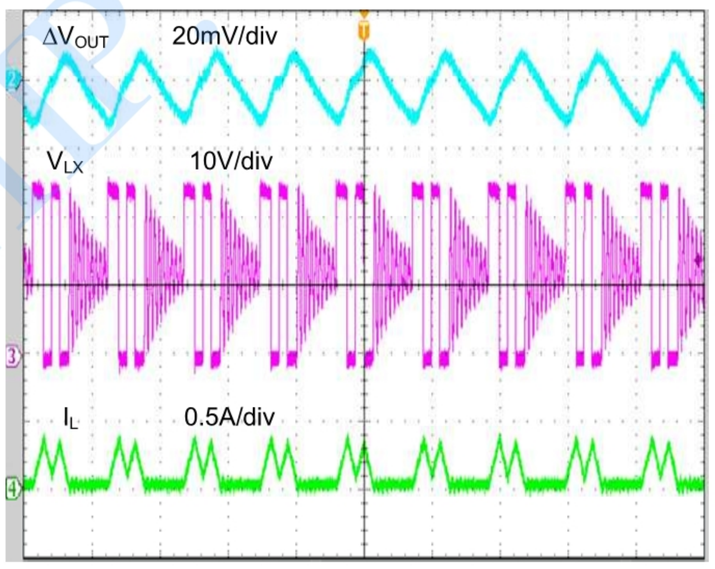
(V_{IN}=24V, V_{OUT}=12V, I_{OUT}=0A)



Time (4μs/div)

Output Ripple

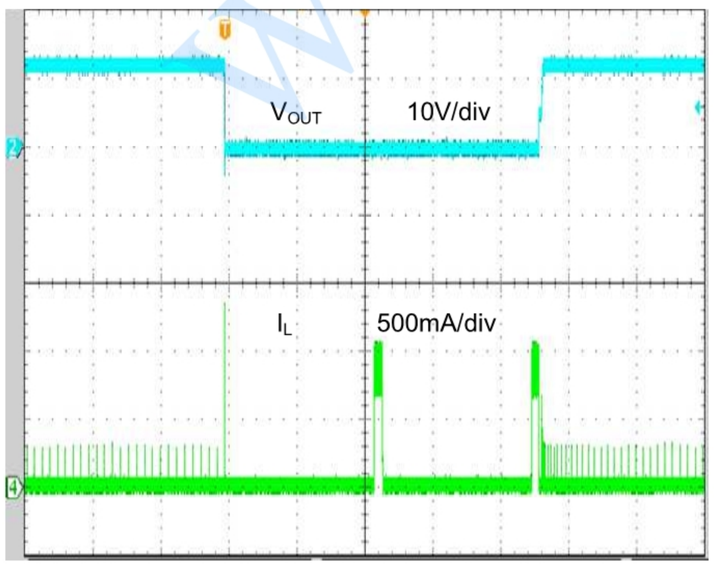
(V_{IN}=24V, V_{OUT}=12V, I_{OUT}=0.08A)



Time (4μs/div)

Short Circuit Protection

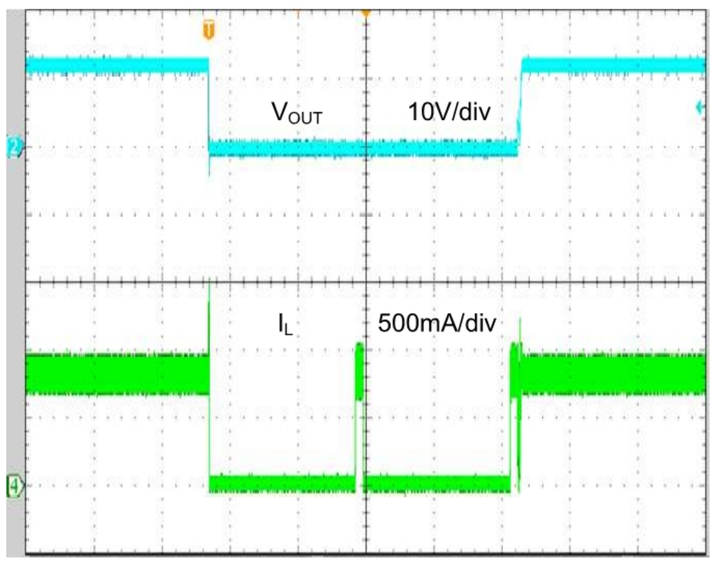
(V_{IN}=24V, V_{OUT}=12V, I_{OUT}=0A~Short)



Time (20ms/div)

Short Circuit Protection

(V_{IN}=24V, V_{OUT}=12V, I_{OUT}=0.8A~Short)

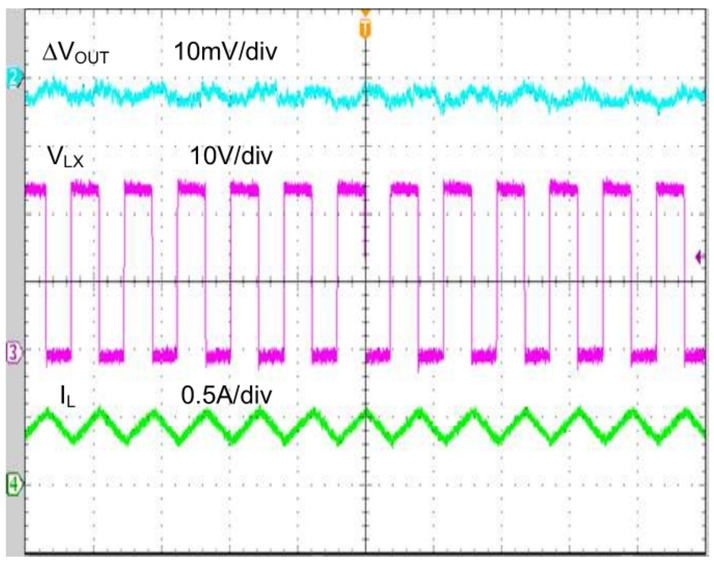


Time (20ms/div)

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Output Ripple

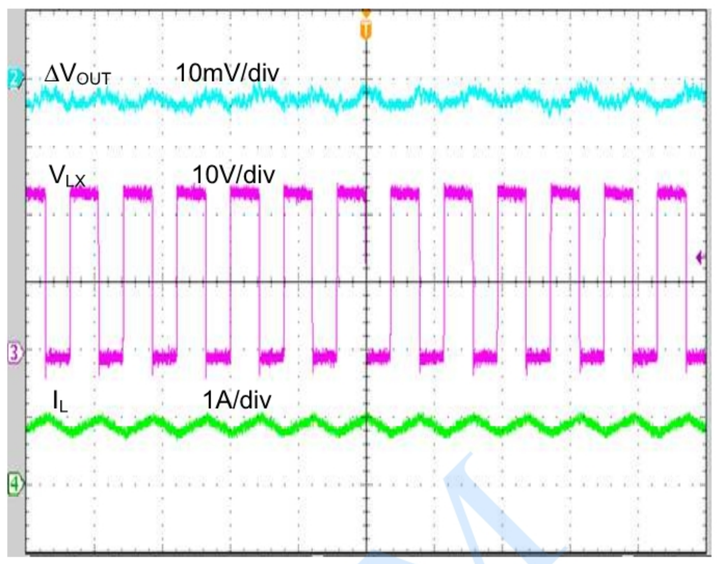
(V_{IN}=24V, V_{OUT}=12V, I_{OUT}=0.4A)



Time (1μs/div)

Output Ripple

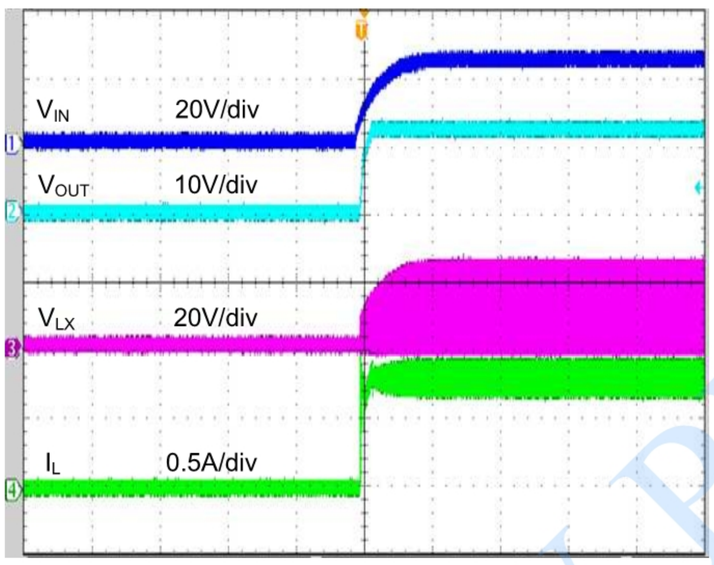
(V_{IN}=24V, V_{OUT}=12V, I_{OUT}=0.8A)



Time (1μs/div)

Startup from V_{IN}

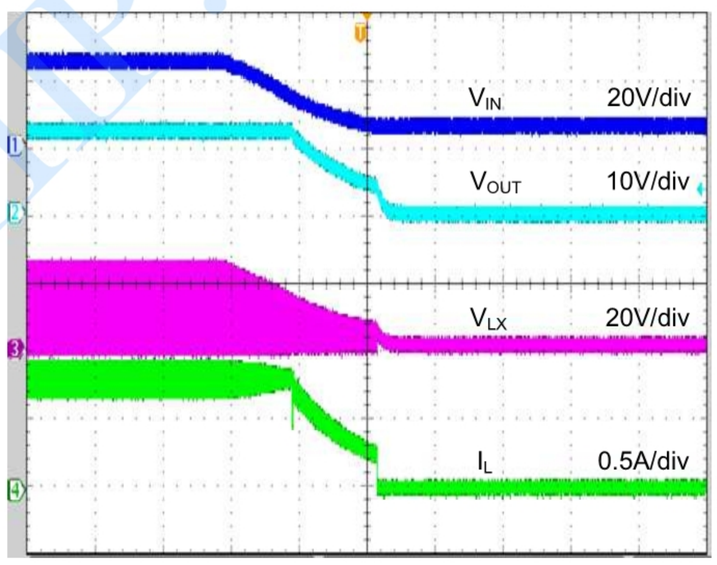
(V_{IN}=24V, V_{OUT}=12V, I_{OUT}=0.8A)



Time (10ms/div)

Shutdown from V_{IN}

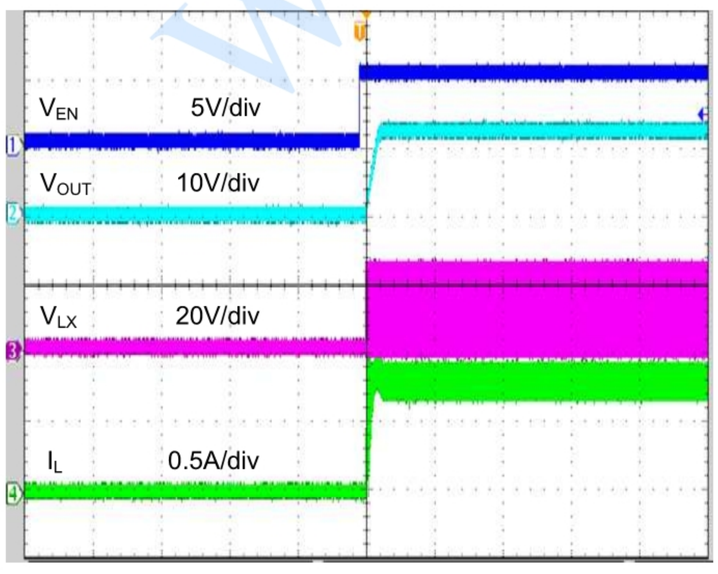
(V_{IN}=24V, V_{OUT}=12V, I_{OUT}=0.8A)



Time (4ms/div)

Startup from Enable

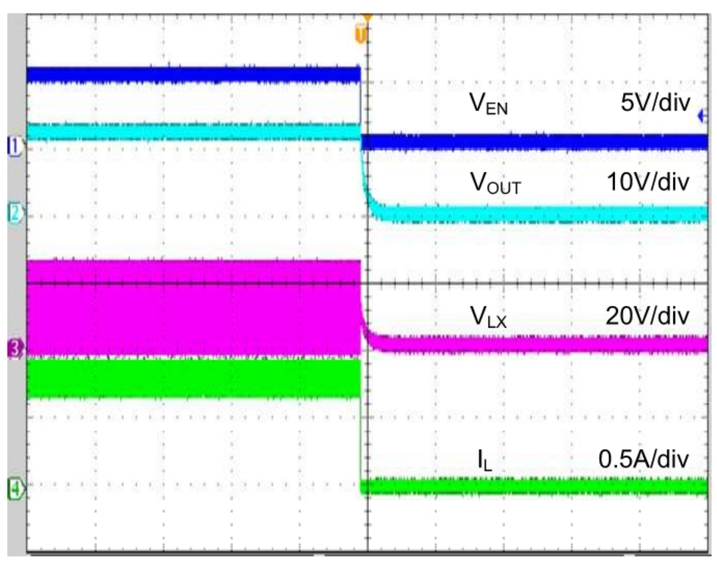
(V_{IN}=24V, V_{OUT}=12V, I_{OUT}=0.8A)



Time (4ms/div)

Shutdown from Enable

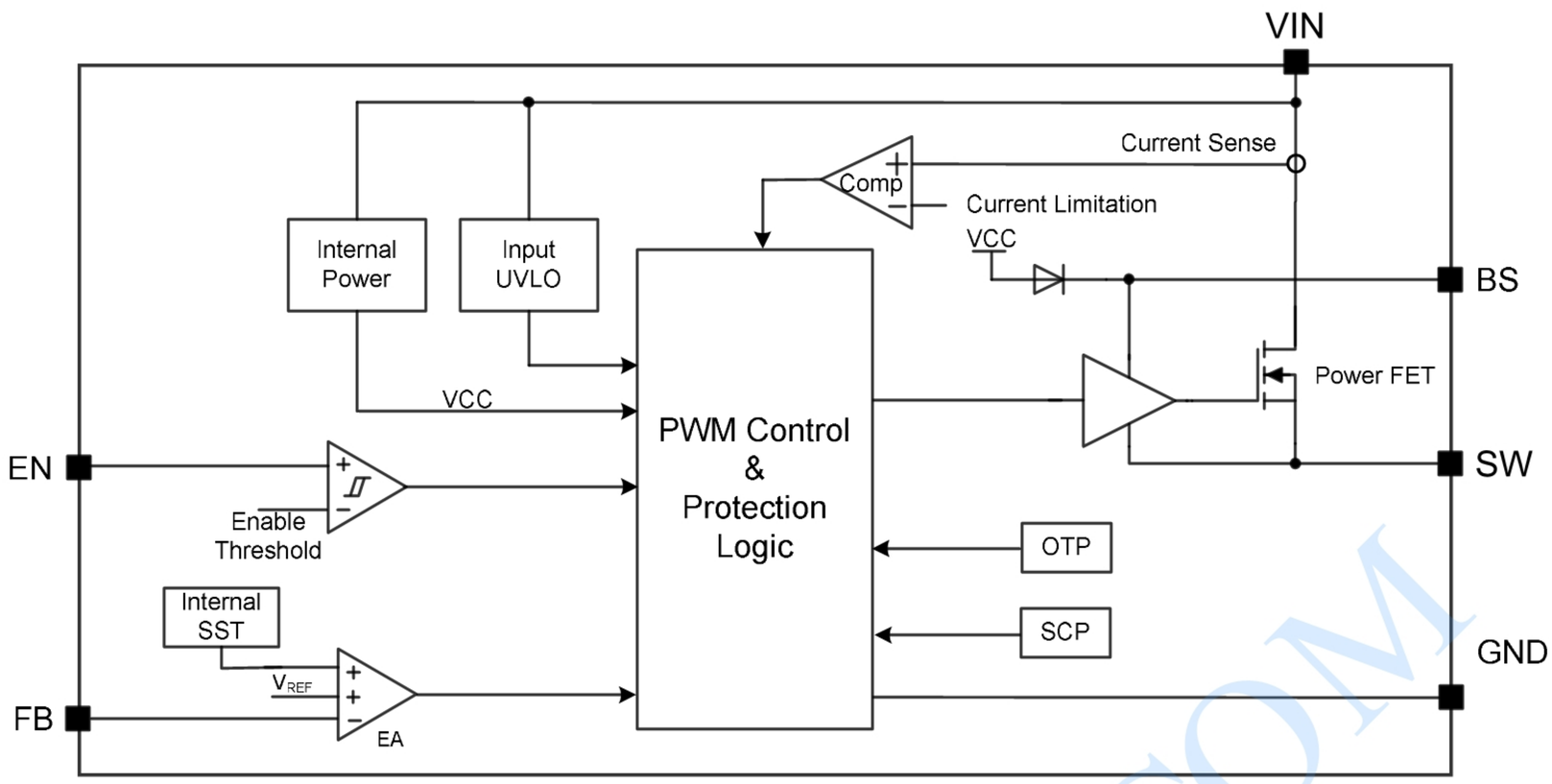
(V_{IN}=24V, V_{OUT}=12V, I_{OUT}=0.8A)



Time (4ms/div)

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Function Block



Operation

The PW2558 develops a high efficiency asynchronous step down DC/DC regulator capable of delivering 0.8A output current. The device adopts current mode adaptive constant off time control. The PW2558 operates over a wide input voltage range from 4.5V to 55V and integrates main switch with very low $R_{DS(ON)}$ to minimize the conduction loss. Low output voltage ripple and small external inductor and capacitor sizes are achieved with 1.2MHz switching frequency.

Application Information

Because of the high integration in the PW2558, the application circuit based on this IC is rather simple. Only the input capacitor CIN, the output capacitor COUT, the output inductor L1 and the feedback resistors (R1 and R2) need to be selected for the targeted applications.

Feedback Resistor Divider R1 and R2

Choose R1 and R2 to program the proper output voltage. To minimize the power consumption under light load, it is desirable to choose large resistance values for both R1 and R2. A value between 10kΩ and 1MΩ is highly recommended for both resistors. If VOUT is 1.2V, R1=100kΩ is chosen, then using the following equation, R2 can be calculated to be 100kΩ:

$$VOUT = \left(1 + \frac{R1}{R2}\right) * 0.6$$

Enable Operation

Pulling the EN pin low (<0.94V) will shutdown the device. During shutdown mode, the PW2558 shutdown current drops to lower than 10μA. Driving the EN pin high (>1.26V) will turn on the IC again.

External Bootstrap Capacitor

This capacitor provides the gate driver voltage for internal high side MOSEFET. A 100nF low ESR ceramic capacitor connected between the BS pin and the SW pin is recommended.

Load Transient Considerations

The PW2558 integrates the compensation components to achieve good stability and fast transient responses. In some application, adding a 22pF ceramic capacitor in parallel with R1 may further speed up the load transient responses and is thus recommended for applications with large load transient step requirements.

Input capacitor CIN:

The ripple current through the input capacitor is calculated as:

$$I_{CIN_RMS}=I_{OUT}\times\sqrt{D(1-D)}\,.$$

To minimize the potential noise problem, place a typical X5R or better grade ceramic capacitor really close to the VIN and GND pins. Care should be taken to minimize the loop area formed by CIN and VIN/GND pins. In this case, a 10μF low ESR ceramic capacitor is recommended.

Output capacitor COUT:

The output capacitor is selected to handle the output ripple noise requirements. Both steady state ripple and transient requirements must be taken into consideration when selecting this capacitor. For most applications, a X5R or better grade ceramic capacitor larger than 22μF capacitance can work well. The capacitance derating with DC voltage must be considered.

Output inductor L1:

There are several considerations in choosing this inductor.

1, Choose the inductance to provide the desired ripple current. It is suggested to choose the ripple current to be about 40% of the maximum output current. The inductance is calculated as:

$$L=\frac{V_{OUT}(1-V_{OUT}/V_{IN,MAX})}{F_{SW}\times I_{OUT,MAX}\times 40\%}$$

where Fsw is the switching frequency and IOUT,MAX is the maximum load current.

The PW2558 is quite tolerant of different ripple current amplitude. Consequently, the final choice of inductance can be slightly off the calculation value without significantly impacting the performance.

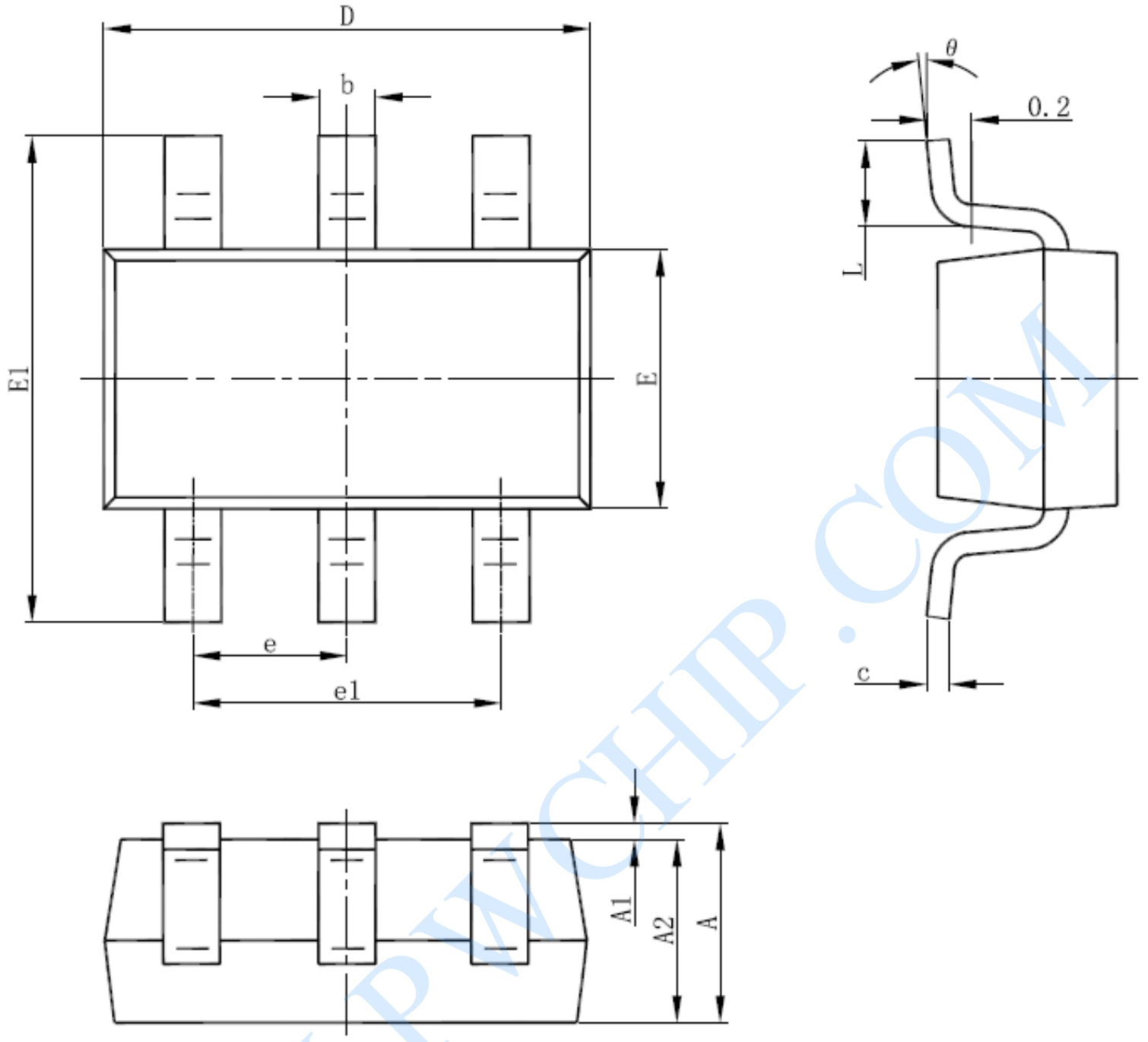
2, The saturation current rating of the inductor must be selected to be greater than the peak inductor current under full load conditions.

$$I_{SAT,MIN}>I_{OUT,MAX}+\frac{V_{OUT}(1-V_{OUT}/V_{IN,MAX})}{2\times F_{SW}\times L}$$

3, The DCR of the inductor and the core loss at the switching frequency must be low enough to achieve the desired efficiency requirement. It is desirable to choose an inductor with DCR<50mΩ to achieve a good overall efficiency.

PACKAGE DESCRIPTION

SOT23-6L



Symbol	Dimensions In Millimeters	
	Min	Max
A	0.900	1.450
A1	0.000	0.150
A2	0.900	1.300
b	0.300	0.500
c	0.100	0.200
D	2.800	3.000
E	1.500	1.700
E1	2.650	2.950
e	0.950(BSC)	
e1	1.800	2.000
L	0.300	0.600
θ	0°	8°

NOTE：

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