PWM control DC-DC Synchronous Step-Down Converter

General Description

The XT3417 is a current mode monolithic buck switching regulator. Operating with an input range of 2.5V-6.2V, the XT3417 delivers 1.5A of continuous output current with integrated P-Channel and N-Channel MOSFETs. The internal synchronous power switches provide high efficiency. Current mode control provides tight load transient response and cycle-by-cycle current limit.

The XT3417 guarantees robustness with hiccup output short-circuit protection, FB short-circuit protection, start-up current run-away protection, input under voltage lockout protection, hot-plug in protection, and thermal protection. The XT3417 provides output power good indication which is only available in SOT-23-5L package.

Package

- SOT-23-5L

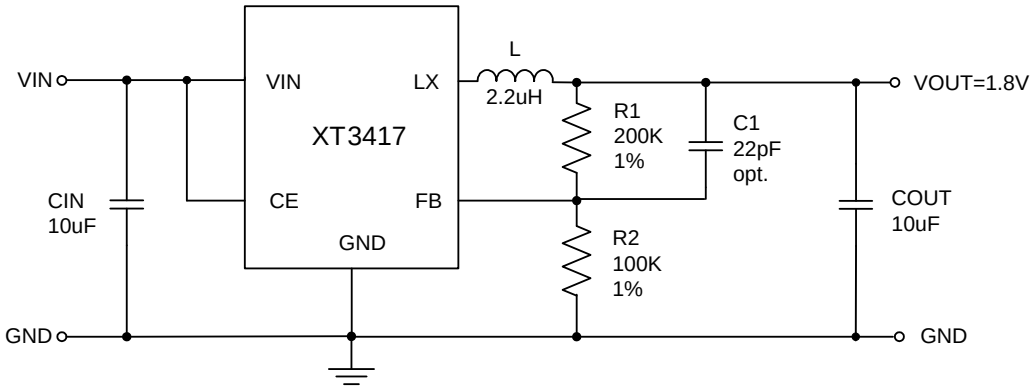
Applications

- Set Top Boxes
- Telecom/Networking Systems
- cameras, video equipment, communications equipment, regulated power supply
- GPU/DDR Power Supply

Features

- 1.5MHz switching frequency
- Up to 1.5A output current
- Up to 95% peak efficiency
- 2.5V to 6.2V operating input range
- can reach 100% duty cycle
- pure PWM mode
- Short circuit protection

Typical Application Circuit

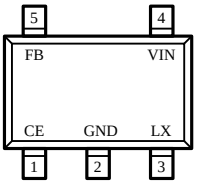


Ordering Information

XT3417A①②③

Item	Symbol	Description
①	W	Pure PWM mode
②	M	Package type : SOT-23-5L
③	R	Embossed Tape: Standard Feed
	L	Embossed Tape: Reverse Feed

■ Pin Configuration



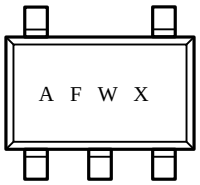
SOT-23-5L
(TOP VIEW)

■ Pin Assignment

Pin Number	Pin Name	Function Description
1	CE	Drive EN pin , high to turn on the regulator
2	GND	Ground
3	LX	internal power switch output port
4	VIN	Power Input
5	FB	Output feedback

■ Marking Rule

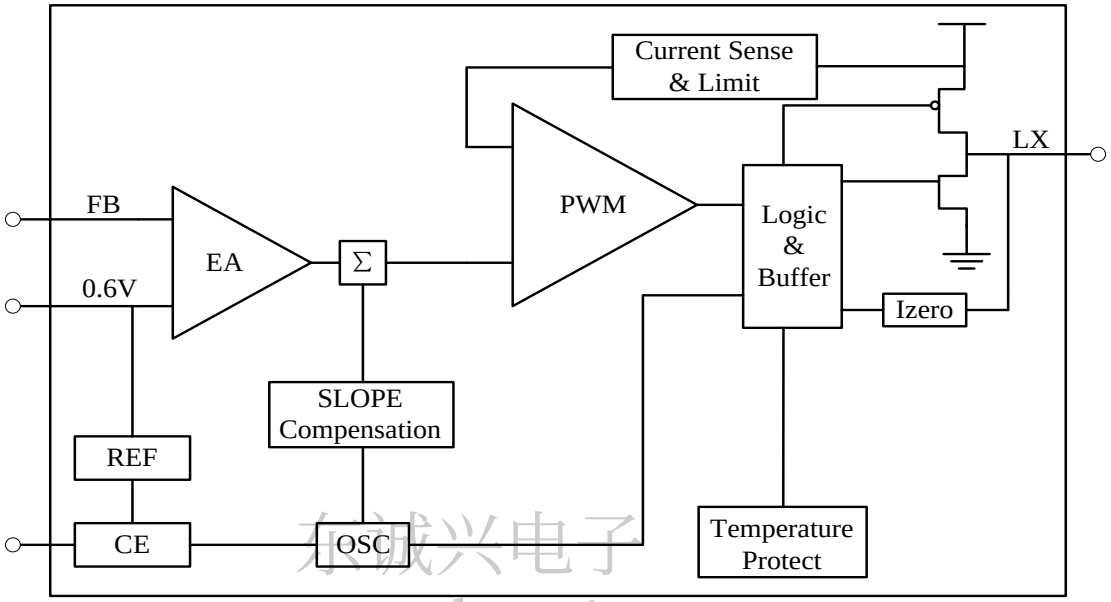
- SOT-23-5L



SOT-23-5L
(TOP VIEW)

符号	说明
A	外置反馈
F	频率1.5MHz
W	纯PWM模式
X	生产信息

■ Function Block Diagram



■ Absolute Maximum Ratings

Parameter		Symbol	Maximum Rating	Unit
Input Voltage		VIN	-0.3～6.5	V
Output Voltage		VFB	-0.3～6.5	
		VLX	-0.3～VIN + 0.3	
Voltage of the CE		VCE	-0.3～VIN + 0.3	V
LX side current		ILX	±2	A
Power Dissipation	SOT-23-5L	Pd	250	mW
Operating Ambient Temperature		Topr	-40～＋85	℃
Storage Temperature		Tstg	-55～＋125	

■ Electrical Characteristics

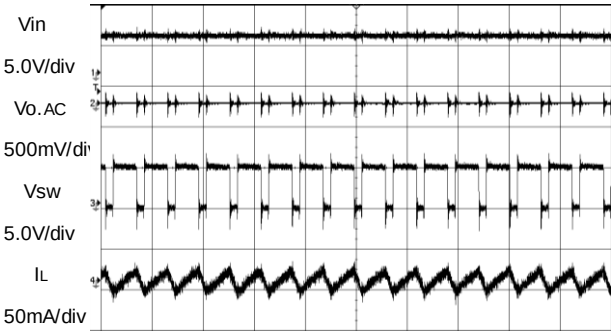
CIN=10uF, COUT=10uF, L=2.2uH (Ta=25℃Unless specified by a special)

项目	符号	条件	最小值	典型值	最大值	单位
Input Voltage	VIN	-	2.5	-	6.2	V
VIN Under Voltage Lockout Threshold	UVLO	-	-	2.4	-	V
VIN Under Voltage Lockout Threshold Delay	UVLO_HYS	-	-	500	-	mV
OVP	OVP	-	-	6.2	-	V
OVP Delay	OVP _HYS	-	-	300	-	mV
Regulated Feedback Voltage	VFB	Ta=25℃	0.588	0.6	0.612	V
Standby current	ISTB	VCE=0V, VIN=5V	0	-	1	uA
Supply Current	IACT	VFB=90%, ILOAD=0	-	300	500	uA
Peak Current Limit	ILIM	VFB=90%, VIN=5V	2.3	-	-	A
Load Regulation	ΔVOUT	ILOAD=10mA to 1.0A	-	0.5	-	%
Line Regulations	$\frac{\Delta VOUT}{\Delta VIN \times VOUT}$	VIN=2.5V to 6V	-	0.04	0.4	%
Switch Frequency	FOSC	VOUT=100%	-	1.5	-	MHz
Maximum Duty Cycle	DMAX	-	100	-	-	%
PFET On Resistance	RDSON_P	ISW=100mA	-	0.15	-	Ω
NFET On Resistance	RDSON_N	ISW= 100mA	-	0.1	-	Ω
SW side leakage current	ILEAK_SW	VCE=0V, VIN=5V	-	±0.01	±1	uA
CE “High” Voltage	VCEH	VIN=5V	1.2	-	-	V
CE “Low” Voltage	VCEL	VIN=5V	-	-	0.7	V
Output short	I_OS	FB<0.2V	-	0.2	-	A
Thermal Shutdown	TSHD	-	-	165	-	℃
Thermal Shutdown Delay	T_HYS	-	-	25	-	℃

■ Typical Performance Characteristics

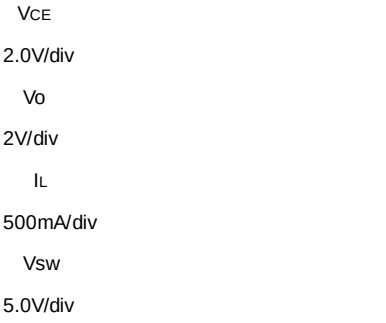
1、 Steady State Test

VIN=5.0V, VOUT=3.3V, IL=1.5A



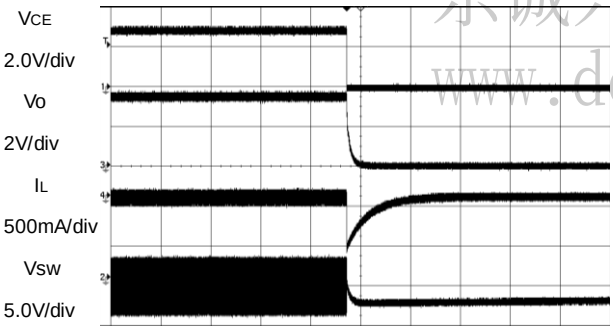
2、CE Open

VIN=5.0V, VOUT=3.3V, IL=1.5A



3、CE Shut Off

VIN=5.0V, VOUT=3.3V, IL=1.5A

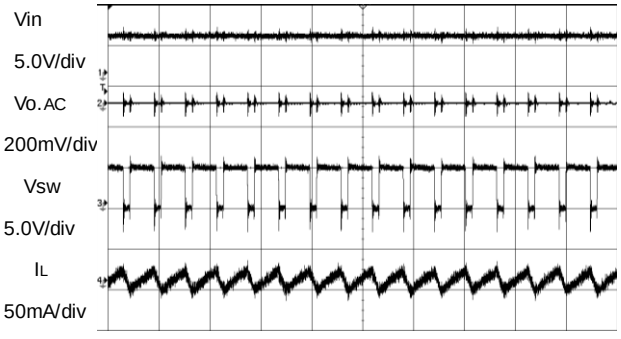


4、Medium Load Operation

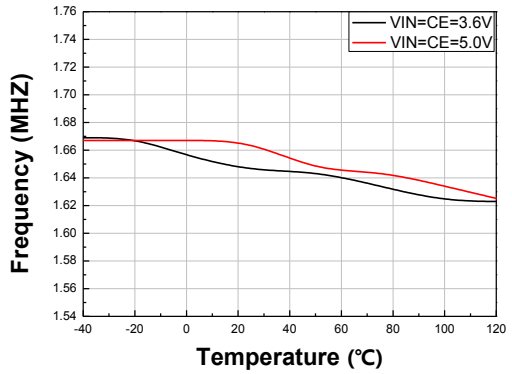
VIN=5.0V, VOUT=3.3V, IL=0.6A

5、Heavy Load Operation

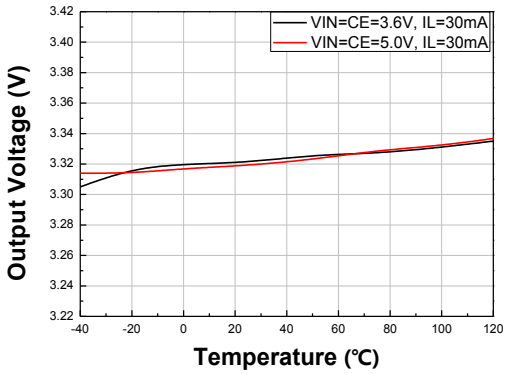
VIN=5.0V, VOUT=3.3V, IL=1.5A



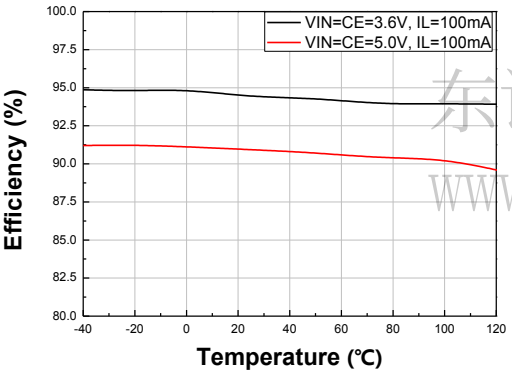
6、频率温度曲线



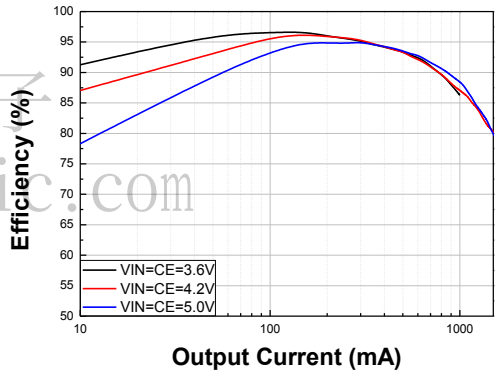
7、输出电压温度曲线



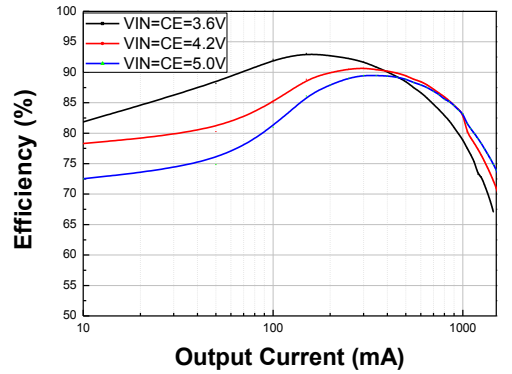
8、效率温度曲线



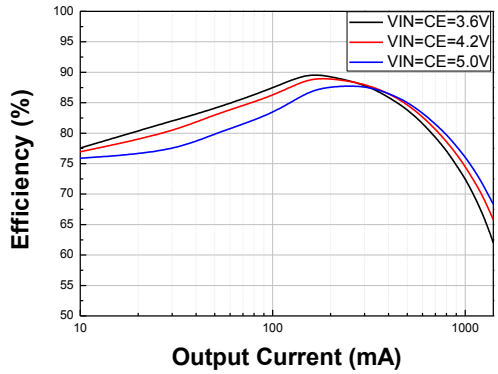
9、效率 @ VOUT=3.3V



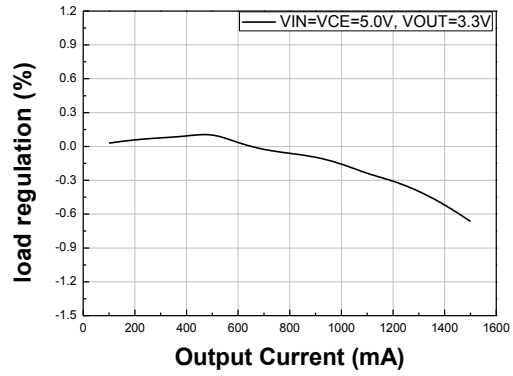
10、效率 @ VOUT=1.8V



11、效率 @ VOUT=1.2V



12、负载调整率@ VOUT=3.3V



■ FUNCTIONAL DESCRIPTION

The XT3417 is a synchronous, current-mode step-down regulator. It regulates input voltages from 2.5V~6.2V down to an output voltage as low as 0.6V, and is capable of supplying up to 1.5A of load current.

The XT3417 uses a constant frequency, current mode step-down architecture. Both the main (P-channel MOSFET) and synchronous (N-channel MOSFET) switches are internal. During normal operation, the internal top power MOSFET is turned on each cycle when the oscillator sets the RS latch, and turned off when the current comparator, ICOMP, resets the RS latch. The peak inductor current at which ICOMP resets the RS latch, is controlled by the output of error amplifier EA.

When the load current increases, it causes a slight decrease in the feedback voltage, FB, relative to the 0.6V reference, which in turn, causes the EA amplifier' s output voltage to increase until the average inductor current matches the new load current. While the top MOSFET is off, the bottom MOSFET is turned on until either the inductor current starts to reverse, as indicated by the current reversal comparator IRCMP, or the beginning of the next clock cycle.

- **Shut-Down Mode**

The XT3417 operates in shut-down mode when voltage at CE pin is driven below 0.7V. In shut-down mode, the entire regulator is off and the supply current consumed by theXT3417 drops below 1uA.

- **Hot-Plug In Protection**

If the Vin voltage exceeds 6.2V, IC will turn off power switch, entering over-voltage protection. It will remain in this state until Vin voltage is less than 6V.

- **Short Circuit Protection**

When output is shorted to ground, the switching frequency is reduced to prevent the inductor current from increasing beyond PFET current limit.

- **Thermal Protection**

When the temperature of the XT3417 rises above 165°C, it is forced into thermal shut-down.

Only when core temperature drops below 140°C can the regulator becomes active again.

■ APPLICATION INFORMATION

- **Output Voltage Set**

The output voltage is determined by the resistor divider connected at the FB pin, and the voltage can be calculated by:

$$VOUT = 0.6 \times (1 + \frac{R1}{R2})$$

The recommended value of R2 is KΩ.

- **Input Capacitor**

The input capacitor is used to supply the AC input current to the step-down converter and maintaining the DC input voltage. The input capacitor can be calculated by the following equation when the input ripple voltage is determined.

$$CIN = \frac{ILOAD}{\mathrm{fs} \times \Delta VIN} \times \frac{VOUT}{VIN} \times \left(1 - \frac{VOUT}{VIN}\right)$$

where fs is the switching frequency, ΔVIN is the input ripple current.

The input capacitor can be electrolytic, tantalum or ceramic. To minimizing the potential noise, a small X5R or X7R ceramic capacitor, i.e. 0.1uF, should be placed as close to the IC as possible when using electrolytic capacitors.

A 10uF ceramic capacitor is recommended in typical application.

- **Output Capacitor**

The output capacitor is required to maintain the DC output voltage, and the capacitance value determines the output ripple voltage. The output voltage ripple can be calculated by:

$$\Delta VOUT = \frac{VOUT}{\mathrm{fs} \times L} \times \left(1 - \frac{VOUT}{VIN}\right) \times \left(RESR + \frac{1}{8 \times \mathrm{fs} \times COUT}\right)$$

where COUT is the output capacitance value and RESR is the equivalent series resistance value of the output capacitor.

The output capacitor can be low ESR electrolytic, tantalum or ceramic, which lower ESR capacitors get lower output ripple voltage.

The output capacitors also affect the system stability and transient response, and a 10uF ceramic capacitor is recommended in typical application.

- **Inductor**

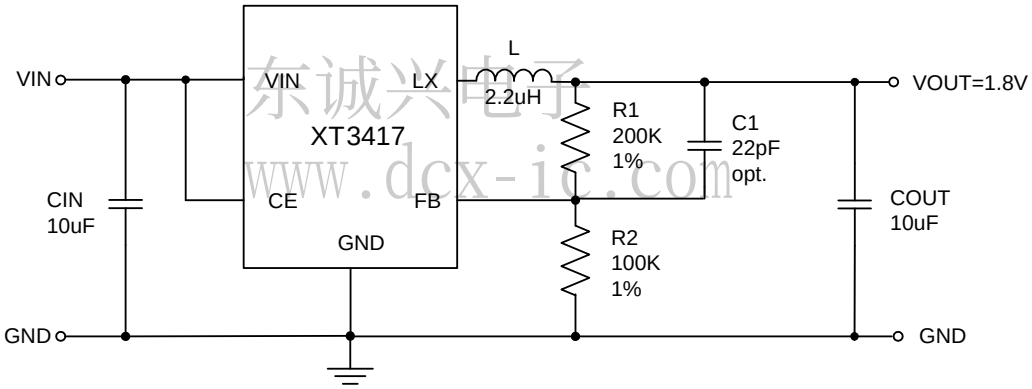
The inductor is used to supply constant current to the output load, and the value determines the ripple current which affect the efficiency and the output voltage ripple. The ripple current is typically allowed to be 40% of the maximum switch current limit, thus the inductance value can be calculated by:

$$L = \frac{VOUT}{\text{fs} \times \Delta IL} \times \left(1 - \frac{VOUT}{VIN}\right)$$

where VIN is the input voltage, VOUT is the output voltage, fs is the switching frequency, and ▵ IL is the peak-to-peak inductor ripple current.

A 2.2uH inductor is recommended in typical application.

■ REFERENCE DESIGN



Notes: C1 is optional.

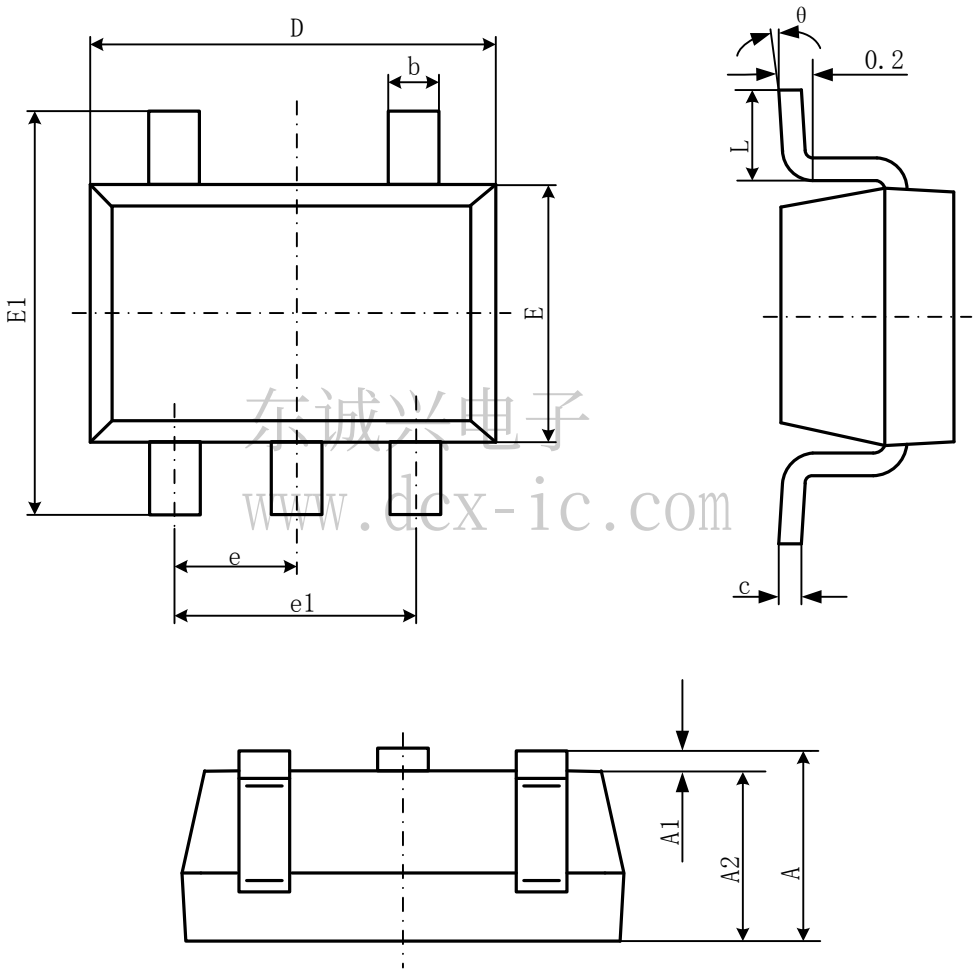
■ PCB Layout Note

For minimum noise problem and best operating performance, the PCB is preferred to following the guidelines as reference.

1. Place the input decoupling capacitor as close to XT3417 (VIN pin and PGND) as possible to eliminate noise at the input pin.
2. The loop area formed by input capacitor and GND must be minimized.
3. Put the feedback trace as far away from the inductor and noisy power traces as possible.
4. The ground plane on the PCB should be as large as possible for better heat dissipation.

■ Package Information

- **SOT-23-5L**



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

■ Version History

Version history	Number	modification date	Modifies the content	Modifier	Approver
01	01	2018.08.13			