High Performance, Hall Effect-Based
Current Sensor IC with a Low-Resistance Conductor
5A/10A/20A/25A/30A/40A/50A series

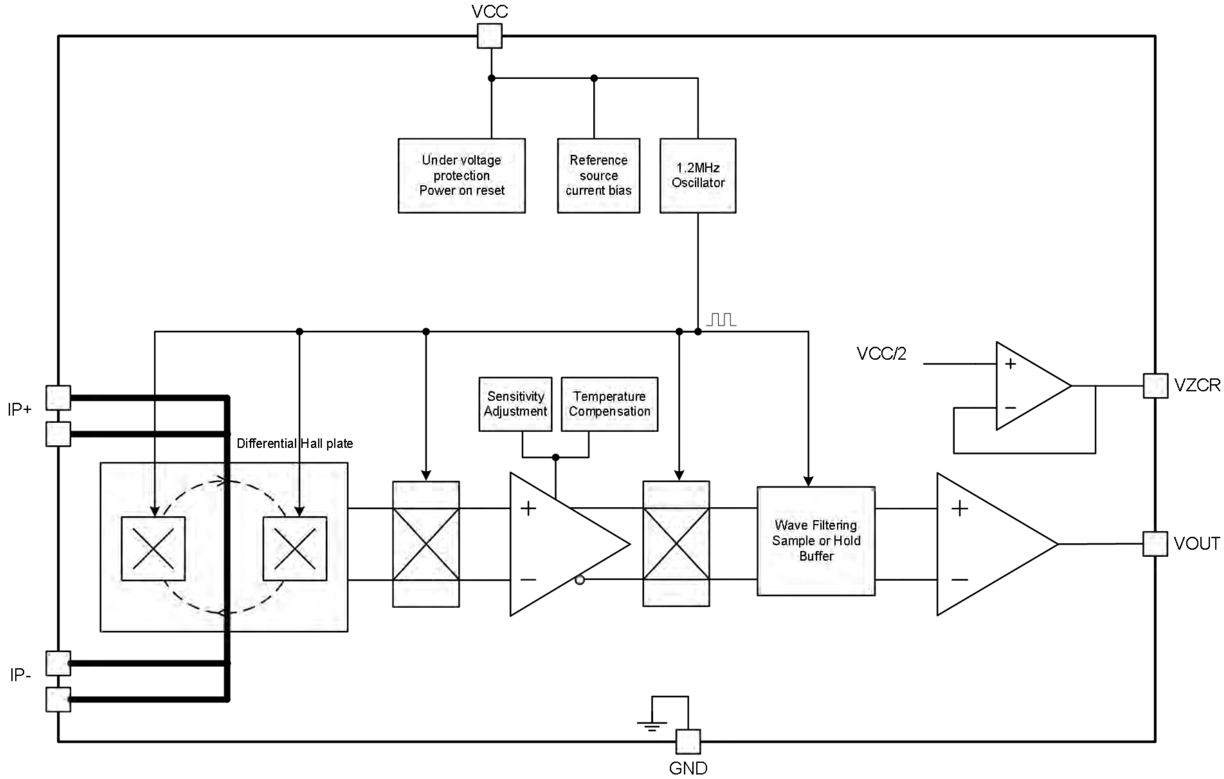
FEATURES

- Zero current output voltage is 50%VCC
- Current sensing range available: 5A/10A/20A/25A/30A/40A/50A
- High isolation and withstand voltage (3500V_{RMS} isolation voltage between pins 1-4 and 5-8)
- Less power loss, internal conductor's resistance is 0.9mΩ
- High bandwidth, up to 250KHz
- 1.2μs output rise time in response to step input current
- Total output error ±0.5% at T_a=25°C and ±3% at T_a=-40~125°C
- Tokmas ® patented temperature compensation
- Outputs desensitized to mechanical stress
- Differential Hall structure, strong resistance to external magnetic interference
- ESD (HBM) 4000V
- Operating ambient temperature: -40~125°C

APPLICATIONS

- Motor controller
- Load detection and management
- Switch-mode power supplies
- Over-current fault protection
- Other applications requiring current detection

FUNCTION BLOCK DIAGRAM

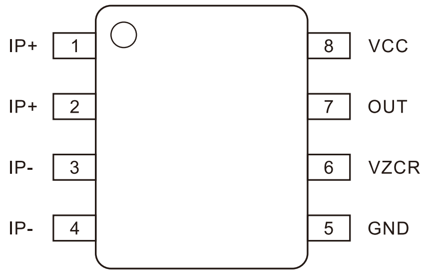


ORDERING INFORMATION

Part No.	SENS. (mV/A)	Package	Packing Form
CI5930-5A	400	SOP8	tape reel, 2000 pcs/reel
CI5930-10A	200	SOP8	tape reel, 2000 pcs/reel
CI5930-20A	100	SOP8	tape reel, 2000 pcs/reel
CI5930-25A	80	SOP8	tape reel, 2000 pcs/reel
CI5930-30A	67	SOP8	tape reel, 2000 pcs/reel
CI5930-40A	50	SOP8	tape reel, 2000 pcs/reel
CI5930-50A	40	SOP8	tape reel, 2000 pcs/reel
CI5930-XXA(Note1)	-	SOP8	tape reel, 2000 pcs/reel

Note 1: When XXA is within the range of 50A, customers can customize the range according to their needs.

PINOUT DIAGRAM



SOP8 Package

Name	Number	Description	Name	Number	Description
IP+	1	Current Sampled +	GND	5	Ground
IP+	2	Current Sampled +	VZCR	6	Zero Current Reference Signal Output
IP-	3	Current Sampled -	OUT	7	Analog Voltage Output
IP-	4	Current Sampled -	VCC	8	Power Supply

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
Power Supply	V_{CC}	7	V
Output Voltage	V_{OUT}	-0.3~VCC+0.3	V
Output Source Current	$I_{OUT(SOURCE)}$	6	mA
Output Sink Current	$I_{OUT(SINK)}$	30	mA
Input current peak current (3 s)	I_{PEAK}	100	A
Input current continuous current	I_{CON}	40	A
Isolation Voltage	V_{ISO}	3500	VAC
Operating Ambient Temperature	T_a	-40~125	°C
Junction Temperature	T_J	165	°C
Storage Temperature	T_S	-55~150	°C
Magnetic Flux Density	B	Not Limited	mT
Electrostatic Discharge Voltage (HBM)	ESD(HBM)	4000	V

Note: Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

ISOLATION CHARACTERISTICS

Parameter	Symbol	Test Conditions	Value	Unit
Withstand isolation voltage	V_{ISO}	Test method: 50 / 60Hz, 1min	3500	V_{RMS}
	V_{TEST}	t = 1s (100% production)	3900	V_{RMS}
Working voltage of basic insulation	V_{WFSI}	Basic insulation UL standard 62368-1:2014	600	V_{PK}
			424	V_{RMS}
Clearance	D_{cl}	minimum distance through air from IP leads to signal leads	3.8	mm

Continued:

Parameter	Symbol	Test Conditions	Value	Unit
Maximum repetitive peak isolation voltage	V_{IORM}	AC voltage (bipolar)	600	V_{PK}
Maximum working isolation voltage	V_{IOWM}	AC voltage（sine wave）	424	V_{RMS}
		DC voltage	600	V_{DC}
Maximum transient isolation voltage	V_{IOTM}	Test method: t = 60s (qualification)	4949	V_{PK}
	V_{TEST}	t = 1s (100% production)	5515	
Maximum surge isolation voltage **(Note 1)**	V_{IOSM}	Tested 1.2us (rise) / 50us (width) One time	7000	V_{PK}
Surge Current **(Note 2)**	I_{SURGE}	Tested in compliance to IEC 61000-4-5 8μs (rise) / 20μs (width)	7.5	kA

Note1： Testing is carried out in air to determine the intrinsic surge immunity of the isolation barrier.

Note2: Certification pending.

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min.	Max.	Unit
Input voltage **(Note 1)**	VIN+, VIN- ***(Note 1)***	-600	600	V_{PK}
Input current (DC / AC RMS) **(Note 2)**	IP	-50	50	A
Power Supply	V_{CC}	4.5	5.5	V
Operation Temperature	T_A	-40	125	°C

Note 1: Vin +, VIN – refers to the voltage of current input pins IP + and IP -, relative to pin 5 (GND).

Note 2: Decrease due to higher ambient temperature.

ELECTRICAL PARAMETERS (T_a=25°C and VCC=5V, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power Supply	V_{CC}	-	4.5	-	5.5	V
Supply Current	I_{CC}	OUT pin floated	-	20	25	mA
Internal benchmark	VZCR		2.470	2.500	2.530	V
Zero Current Output Voltage	$V_{OUT(Q)}$	IP=0	2.490	2.500	2.510	V
Output Capacitance Load	C_L		-	-	1	nF
Output Resistive Load	R_L		1.5	-	-	kΩ
Res. of Primary Conductor	R_P	IP=2A	-	0.9	1.2	mΩ
Propagation Time	t_D			1	2	μs
Rise Time	tr		-	1	2.2	μs
Common Mode Rejection Ratio	CMRR		38	-	-	dB
Bandwidth	BW	-3dB	250	-	-	kHz
Reference Output Source Current	$I_{ZCR(SOURCE)}$		-	-	400	μA
Reference Output Sink Current	$I_{ZCR(SINK)}$		-	-	3000	μA
Nonlinearity	Lin_{ERR}		-	0.1	0.5	%
Symmetry	Sym_{ERR}		-	0.5	1.5	%
Power-on Time	T_{POR}	Output rising from 0 to 90% of steady-state	-	10	-	μs

5A PERFORMANCE CHARACTERISTICS

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Current Accuracy Range	I_P	-	-5	-	5	A
Sensitivity	Sens	full range of I_P	388	400	412	mV/A
Zero Current Differential Output Error	V_{OE}		-45		45	mV
Noise	$V_{NOISE(P-P)}$		-	70	-	mV
Zero Current Output Slope	$\Delta V_{OUT(Q)}$		-	0.34	-	mV/℃
Sensitivity Slope	Δ_{SENS}		-	0.03	-	mV/A /℃
Total Output Error	E_{TOT}		-3.0	-	3.0	%

10A PERFORMANCE CHARACTERISTICS

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Current Accuracy Range	I_P	-	-10	-	10	A
Sensitivity	Sens	full range of I_P	194	200	206	mV/A
Zero Current Differential Output Error	V_{OE}		-40		40	mV
Noise	$V_{NOISE(P-P)}$		-	55	-	mV
Zero Current Output Slope	$\Delta V_{OUT(Q)}$		-	0.34	-	mV/℃
Sensitivity Slope	Δ_{SENS}		-	0.03	-	mV/A /℃
Total Output Error	E_{TOT}		-3.0	-	3.0	%

20A PERFORMANCE CHARACTERISTICS

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Current Accuracy Range	I_P	-	-20	-	20	A
Sensitivity	Sens	full range of I_P	97	100	103	mV/A
Zero Current Differential Output Error	V_{OE}		-25		25	mV
Noise	$V_{NOISE(P-P)}$		-	35	-	mV
Zero Current Output Slope	$\Delta V_{OUT(Q)}$		-	0.34	-	mV/℃
Sensitivity Slope	Δ_{SENS}		-	0.02	-	mV/A /℃
Total Output Error	E_{TOT}		-3.0	-	3.0	%

25A PERFORMANCE CHARACTERISTICS

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Current Accuracy Range	I_P	-	-25	-	25	A
Sensitivity	Sens	full range of I_P	77.6	80	82.4	mV/A
Zero Current Differential Output Error	V_{OE}		-20		20	mV
Noise	$V_{NOISE(P-P)}$		-	30	-	mV
Zero Current Output Slope	$\Delta V_{OUT(Q)}$		-	0.34	-	mV/℃
Sensitivity Slope	Δ_{SENS}		-	0.017	-	mV/A /℃
Total Output Error	E_{TOT}		-3.0	-	3.0	%

30A PERFORMANCE CHARACTERISTICS

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Current Accuracy Range	I_P	-	-30	-	30	A
Sensitivity	Sens	full range of I_P	65	67	69	mV/A
Zero Current Differential Output Error	V_{OE}		-15		15	mV
Noise	$V_{NOISE(P-P)}$		-	30	-	mV
Zero Current Output Slope	$\Delta V_{OUT(Q)}$		-	0.28	-	mV/℃
Sensitivity Slope	Δ_{SENS}		-	0.015	-	mV/A /℃
Total Output Error	E_{TOT}		-3.0	-	3.0	%

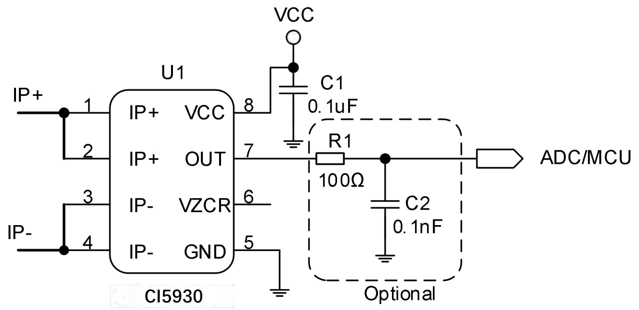
40A PERFORMANCE CHARACTERISTICS

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Current Accuracy Range	I_P	-	-40	-	40	A
Sensitivity	Sens	full range of I_P	48.5	50	51.5	mV/A
Zero Current Differential Output Error	V_{OE}		-10		10	mV
Noise	$V_{NOISE(P-P)}$		-	25	-	mV
Zero Current Output Slope	$\Delta V_{OUT(Q)}$		-	0.21	-	mV/℃
Sensitivity Slope	Δ_{SENS}		-	0.01	-	mV/A /℃
Total Output Error	E_{TOT}		-3.0	-	3.0	%

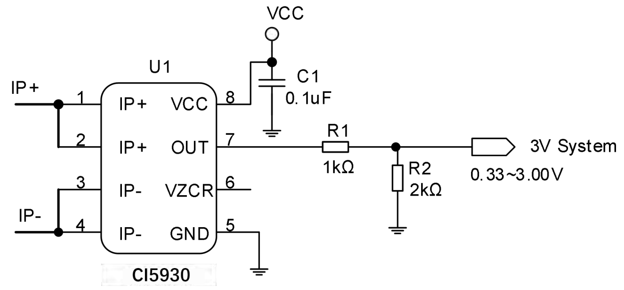
50A PERFORMANCE CHARACTERISTICS

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Current Accuracy Range	I_P	-	-50	-	50	A
Sensitivity	Sens	full range of I_P	38.8	40	41.2	mV/A
Zero Current Differential Output Error	V_{OE}		-10		10	mV
Noise	$V_{NOISE(P-P)}$		-	25	-	mV
Zero Current Output Slope	$\Delta V_{OUT(Q)}$		-	0.17	-	mV/℃
Sensitivity Slope	Δ_{SENS}		-	0.01	-	mV/A /℃
Total Output Error	E_{TOT}		-3.0	-	3.0	%

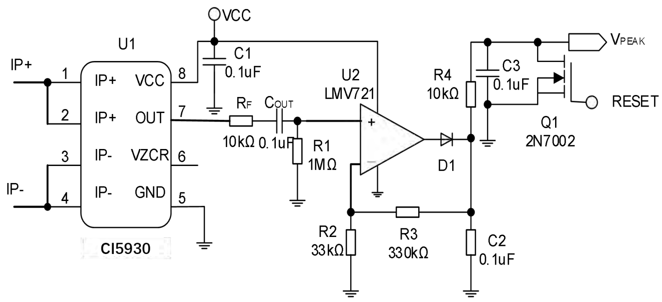
TYPICAL APPLICATION CIRCUITS



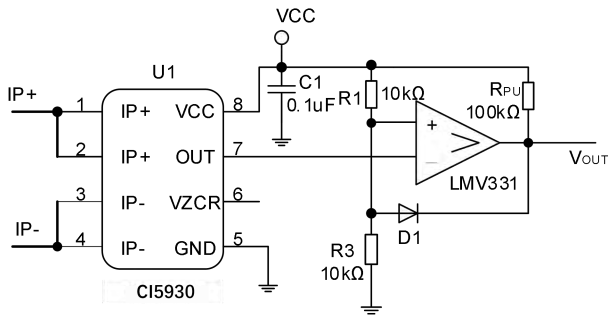
Typical Output Application



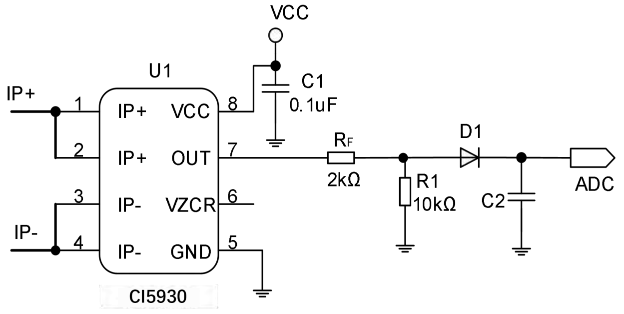
Signal Attenuation Circuit



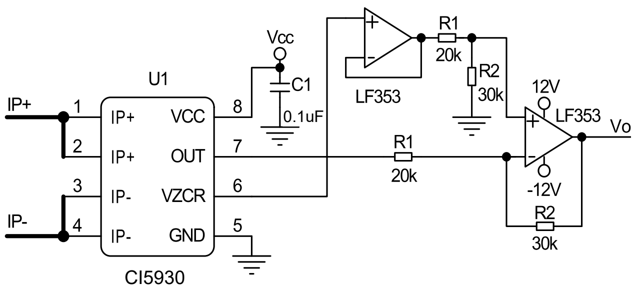
Peak Current Detection



Over Current Fault Latch

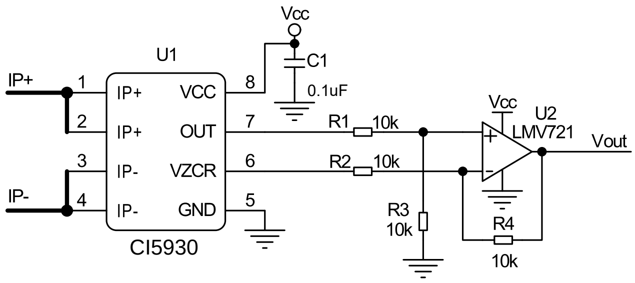


Rectifier output, instead of current transformer application



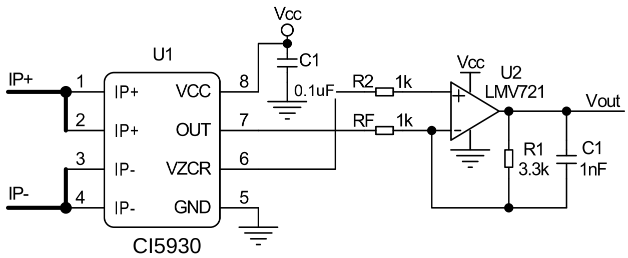
Zero Migration Application

TYPICAL APPLICATION CIRCUITS



Application of single source zero shift with unidirectional current

Note: the output current of IZCR is < 0.4mA. It is suggested that 0.3mA should be reserved in design



Gain amplifier application

Note: output direction of VOUT

Function Description

The CI5930 device is a precision current sensor based on Hall sensor. It has 424V_{RMS} basic isolated working voltage, less than 3% full scale error and zero current reference signal output in the whole temperature range, which can realize unidirectional or bidirectional current detection. The input current flows through a wire between isolated input current pins, which has a resistance of 0.9 mΩ at room temperature to reduce insertion loss. The magnetic field generated by the input current is sensed by Hall sensor and amplified by precise signal chain. It can be used for AC and DC current measurement with a bandwidth of 250kHz. The measuring current is 5-50A. There are 7 kinds of Current sensing range to choose. It can work under single power supply of 4.5V to 5.5V. CI5930 is optimized for high accuracy and temperature stability, compensating for misalignment and sensitivity over the entire range.

The input current of CI5930 flows through the primary side of the package through IP + and IP – pins, the current flowing through the chip generates a magnetic field proportional to the input current and is measured by an isolated Precision Hall sensor IC. Compared with other current measurement methods, the low impedance lead frame path reduces power consumption and does not require any external devices on the primary side. In addition, the internal integrated differential common mode suppression circuit can make the chip output not affected by external interference magnetic signal, and only measure the magnetic field generated by the input current, so as to suppress the interference of external magnetic field.

The typical resistance of the primary current input conductor at 25 ° C is 0.9 mΩ. The lead frame is made of copper. The temperature coefficient of the input wire is positive, and the wire resistance increases with the increase of temperature. The typical temperature coefficient is 3300 ppm/° C. For every 100 ° C increase in temperature, the primary side resistance will increase by 33%.

Input Current

In use, the primary side of the chip (package pins 1-4) is connected in series at any position in the whole circuit. The input current flowing from IP + (package pins 1-2) to IP - (package pins 3-4) is positive, otherwise it is negative. Do not shunt resistors between IP + and IP -, unless there are very special reasons - such as minimizing insertion loss - which will reduce the current flowing through the chip, and the wire resistance will also be affected by temperature drift, which requires external temperature and precision correction of the whole system.

Output Characteristic

The static output point (IP = 0A) of CI5930 is VCC / 2.

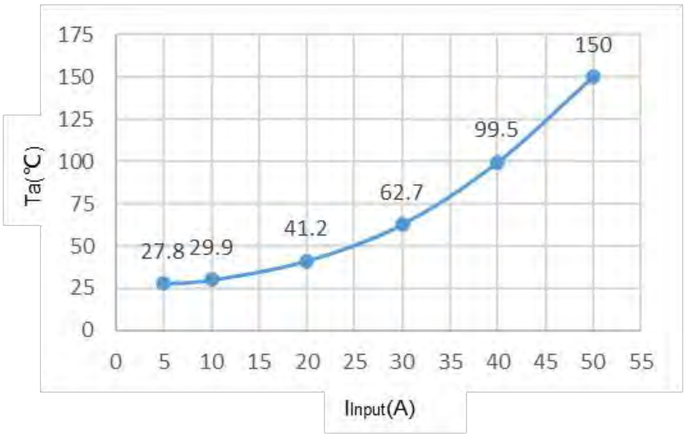
When the current increases, the V_{OUT} increases until the saturation voltage of the output operational amplifier (VCC – rail voltage); when the current decreases, the V_{OUT} decreases until the saturation voltage (GND + rail voltage) of the Output Op Amp. Crosschip ensures the accuracy and linearity of V_{OUT} in the range of 0.5 ~ 4.5V. In order to ensure the consistency of mass manufacturing, there is a certain margin in this range, but it is not recommended for customers to use this margin.

When the input current exceeds the range, the output of V_{OUT} is close to the rail voltage of the power supply. When the input current does not exceed the tolerance limit of the chip, the voltage will always be maintained. After the input current returns to the range, the output of V_{OUT} will return to normal without any damage to the chip.

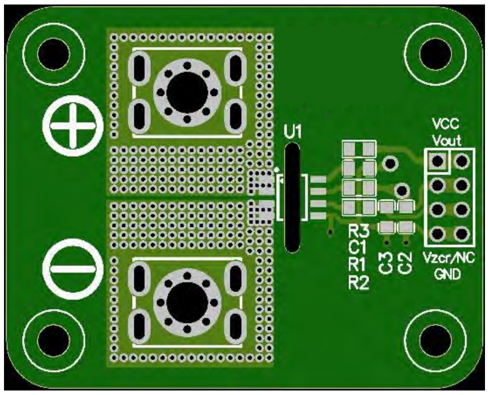
Product Name	Input Current	Sensitivity (mV/A)	Calculation Formula *(Note 1)*
CI5930-5A	-5A ~ +5A	400	V_{OUT} = VCC / 2 + 0.400 × I_P(A)……(V)
CI5930-10A	-10A ~ +10A	200	V_{OUT} = VCC / 2 + 0.200 × I_P(A)……(V)
CI5930-20A	-20A ~ +20A	100	V_{OUT} = VCC / 2 + 0.100 × I_P(A)……(V)
CI5930-25A	-25A ~ +25A	80	V_{OUT} = VCC / 2 + 0.080 × I_P(A)……(V)
CI5930-30A	-30A ~ +30A	67	V_{OUT} = VCC / 2 + 0.067 × I_P(A)……(V)
CI5930-40A	-40A ~ +40A	50	V_{OUT} = VCC / 2 + 0.050 × I_P(A)……(V)
CI5930-50A	-50A ~ +50A	40	V_{OUT} = VCC / 2 + 0.040 × I_P(A)……(V)

Note: the formula is only applicable to DC current calculation. When AC current is applied, pay attention to I_{PEAK} = 1.414 × I_{RMS} and the positive & negative current direction.

Relationship between Package Temperature & Input Current



Input Current (IP) vs. Package temperature

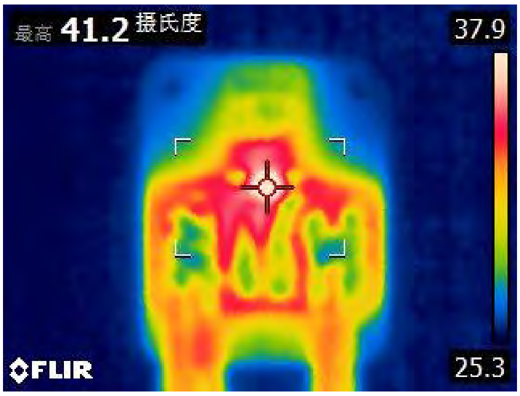


Thickness: 1.6mm, FR-4 double-sided plate, 2oz copper foil total 1200m2

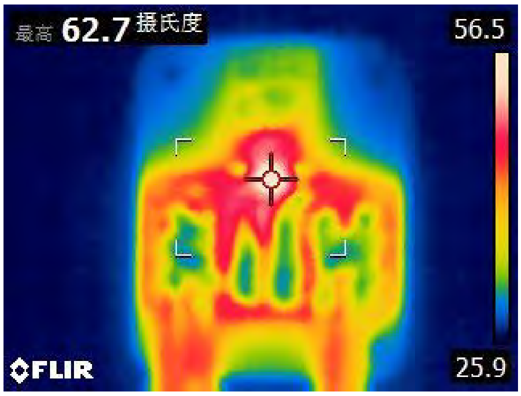
Test environment: open environment, stagnant air

Note: Based on the demo board test, for specific applications, it is necessary to strengthen the heat dissipation according to the actual application scenario or select the board with high Tg.

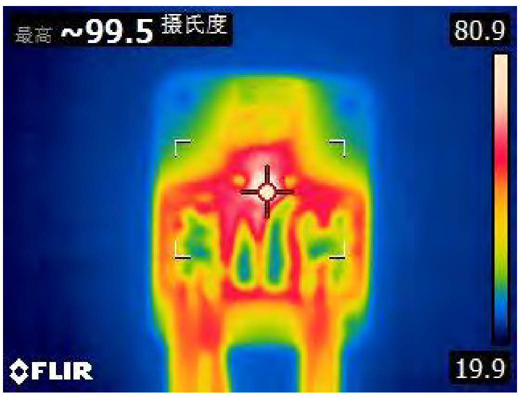
For example: Temperature tests shall be considered for the specific installation conditions in end system which needs a cooling system that can provide wind speeds of at least 10.8 m/s.



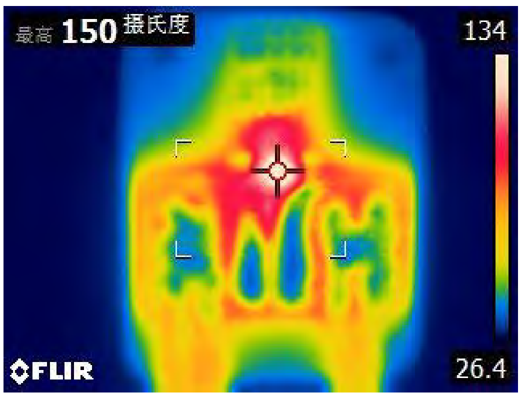
Package Thermography (Input Current 20A)



Package Thermography (Input Current 30A)

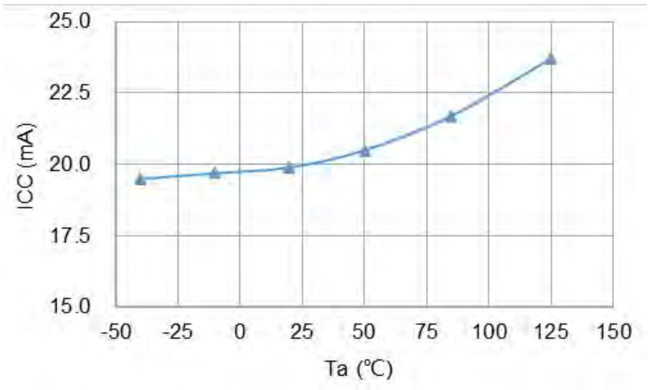


Package Thermography (Input Current 40A)

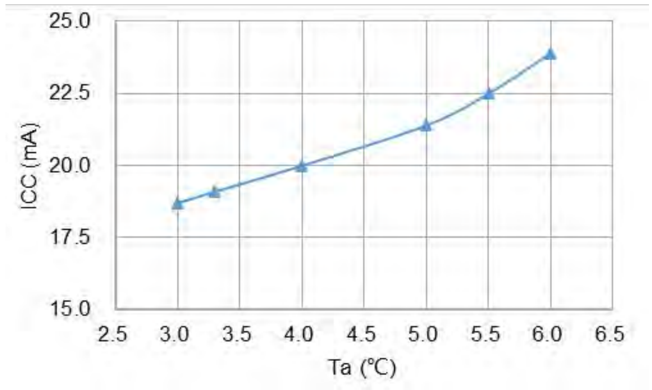


Package Thermography (Input Current 50A)

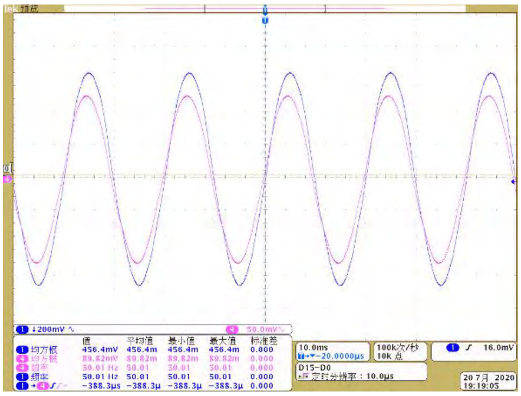
OUTPUT WAVEFORMS AND CURVES



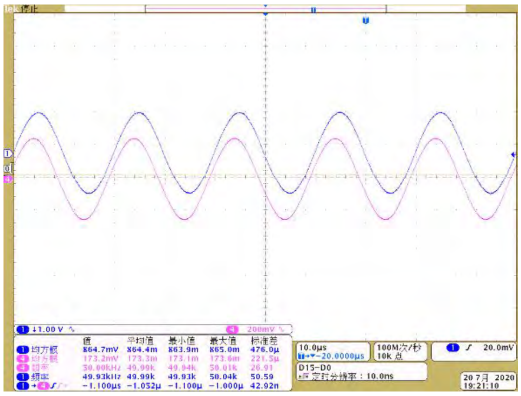
I_{CC} vs. Ta



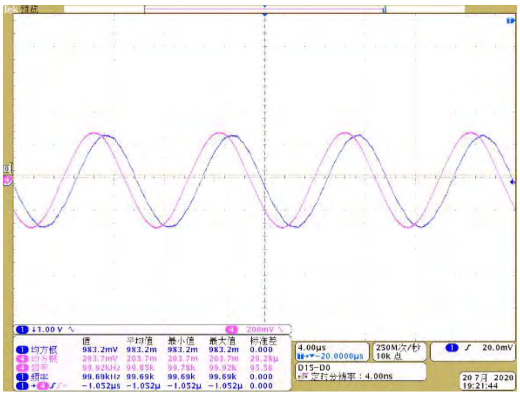
I_{CC} vs. V_{CC}



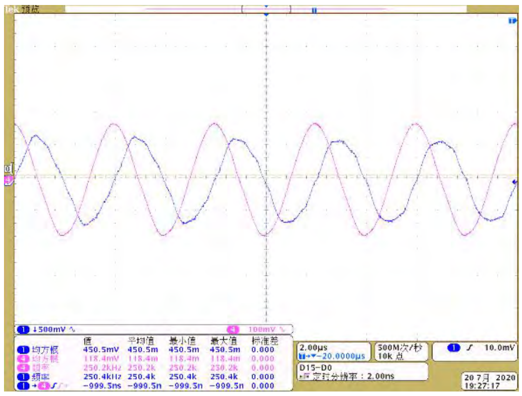
AC output voltage waveform (50Hz)



AC output voltage waveform (50kHz)

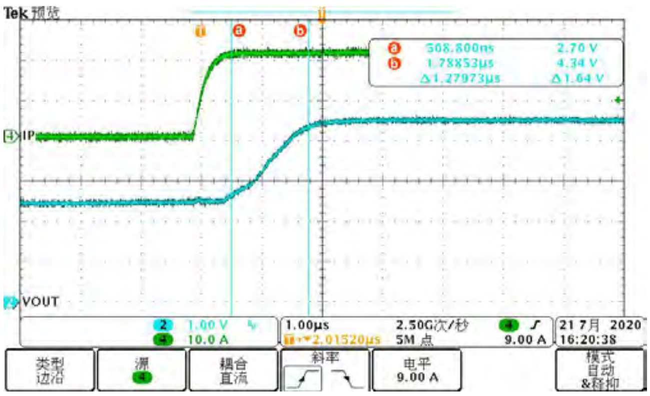


AC output voltage waveform (100kHz)



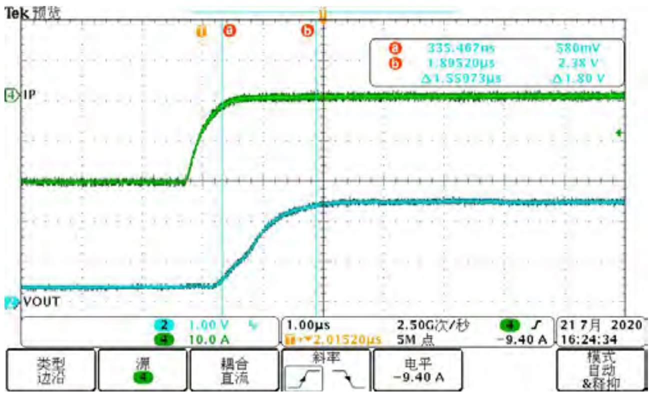
AC output voltage waveform (250kHz)

OUTPUT WAVEFORMS AND CURVES



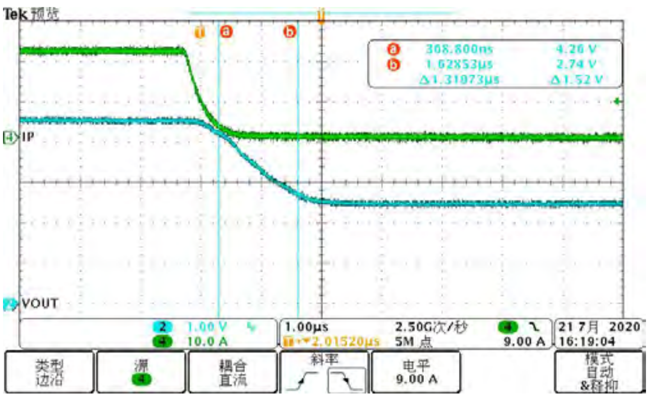
V_{OUT} vs IP (20A)

(Positive Current Rising Edge Response)



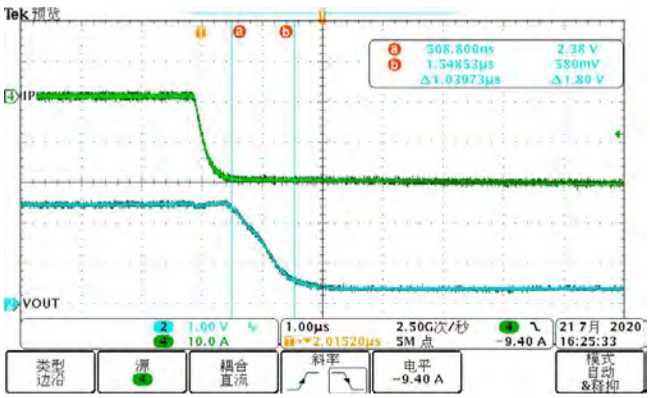
V_{OUT} vs IP (20A)

(Negative Current Rising Edge Response)



V_{OUT} vs IP (20A)

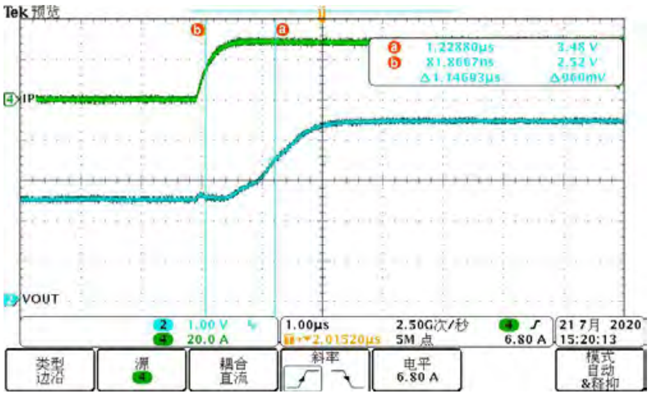
(Positive Current Falling Edge Response)



V_{OUT} vs IP (20A)

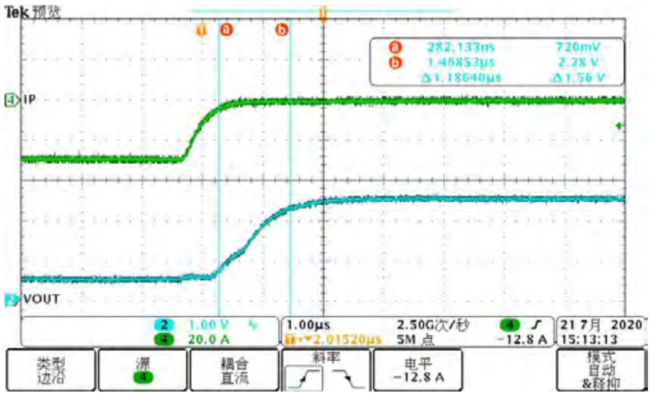
(Negative Current Falling Edge Response)

OUTPUT WAVEFORMS AND CURVES



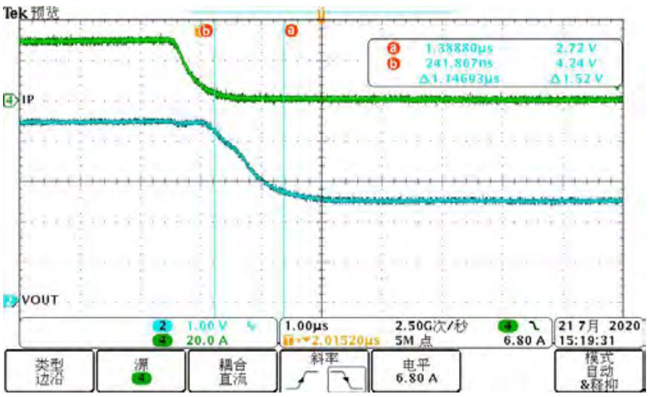
V_{OUT} vs IP (30A)

(Positive Current Rising Edge Response)



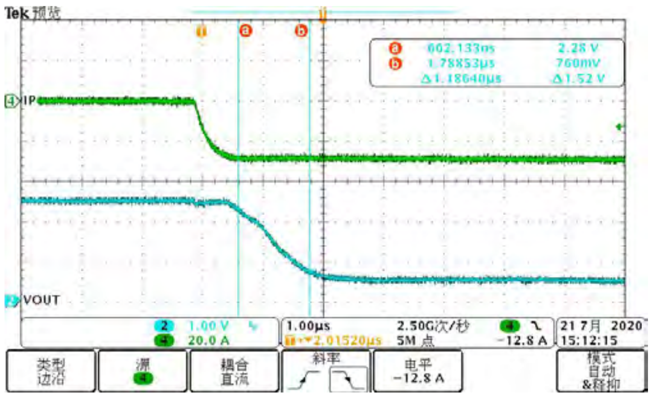
V_{OUT} vs IP (30A)

(Negative Current Rising Edge Response)



V_{OUT} vs IP (30A)

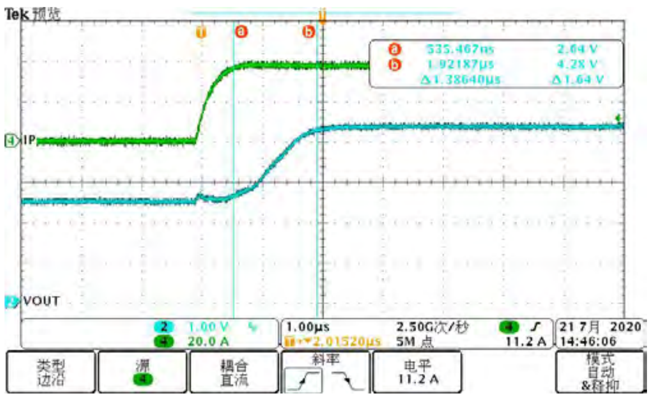
(Positive Current Falling Edge Response)



V_{OUT} vs IP (30A)

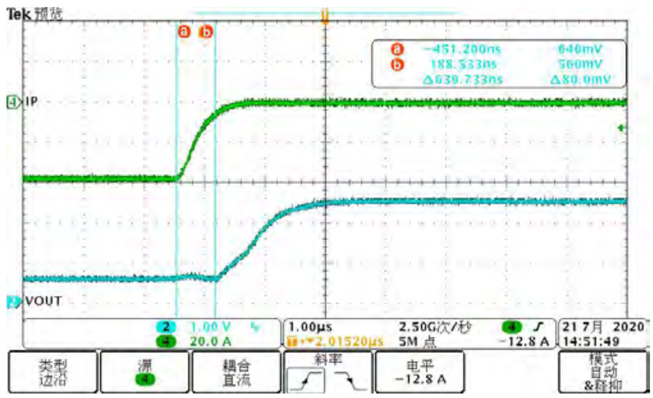
(Negative Current Falling Edge Response)

OUTPUT WAVEFORMS AND CURVES



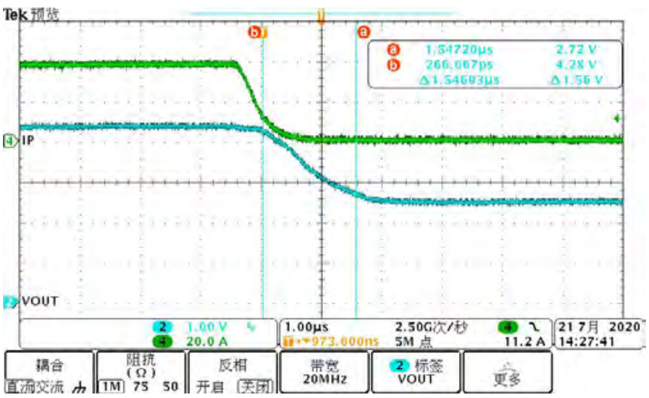
V_{OUT} vs IP (40A)

(Positive Current Rising Edge Response)



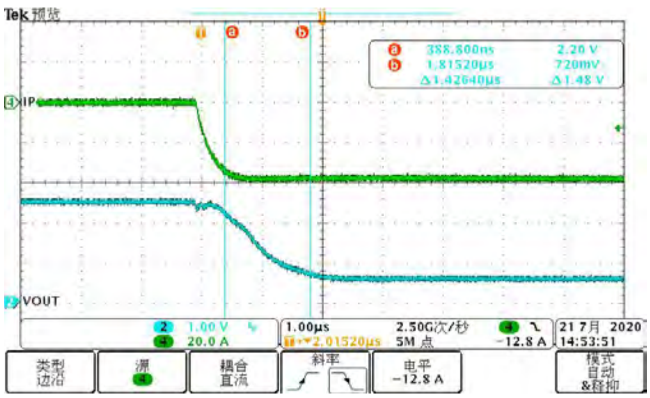
V_{OUT} vs IP (40A)

(Negative Current Rising Edge Response)



V_{OUT} vs IP (40A)

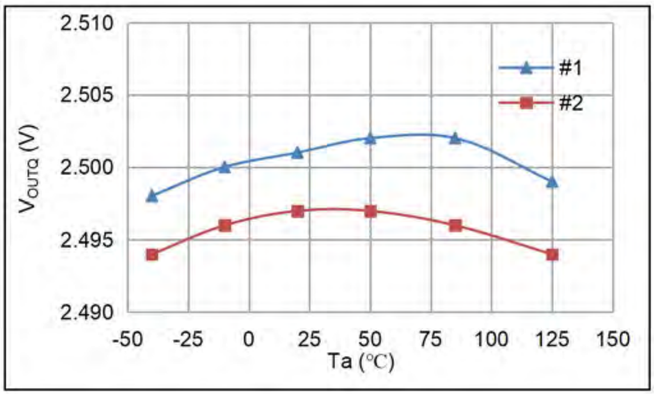
(Positive Current Falling Edge Response)



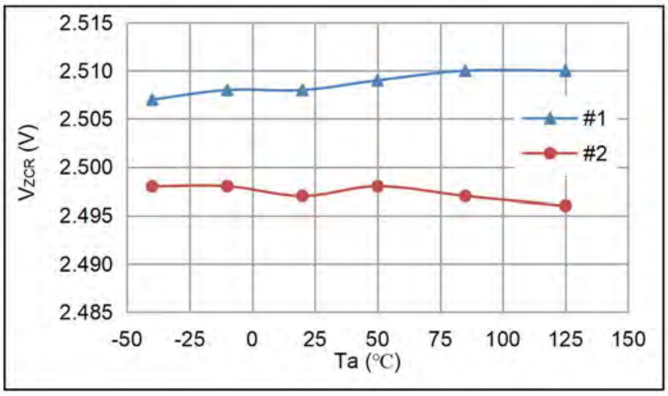
V_{OUT} vs IP (40A)

(Negative Current Falling Edge Response)

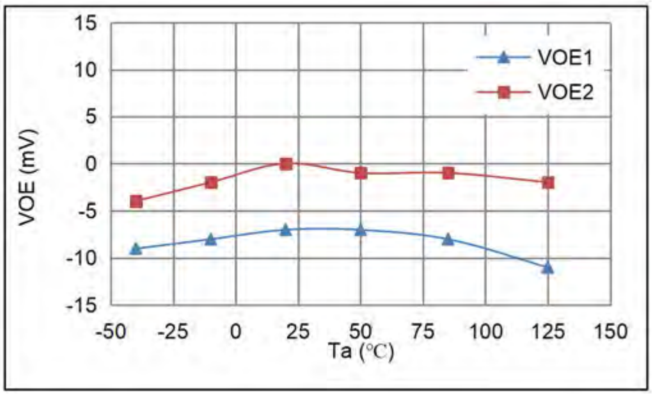
20A



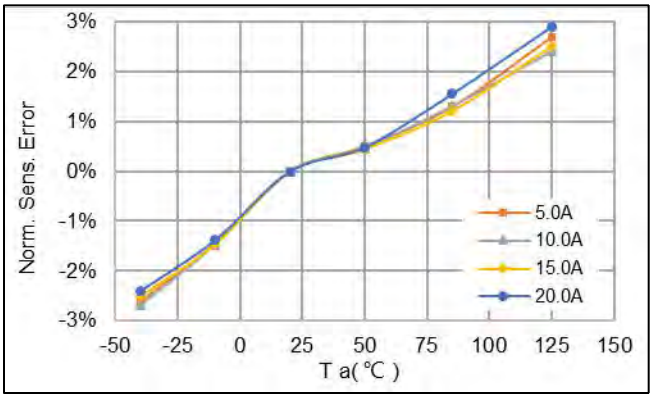
V_{OUTQ} vs. Ta



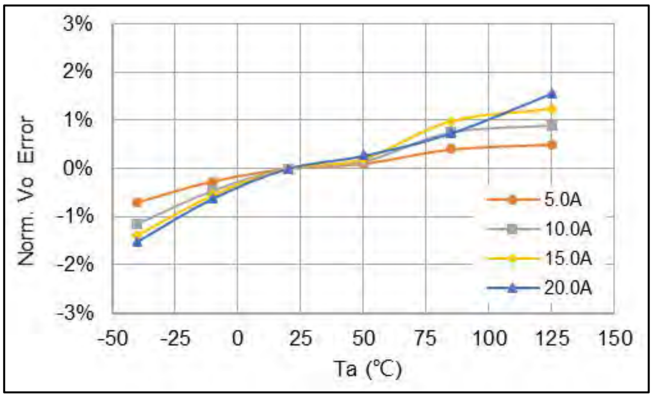
V_{ZCR} vs. Ta



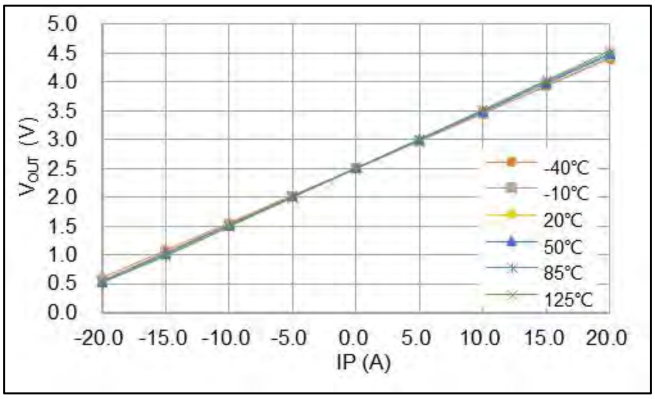
V_{OE} vs. Ta



Sens error vs. Ta

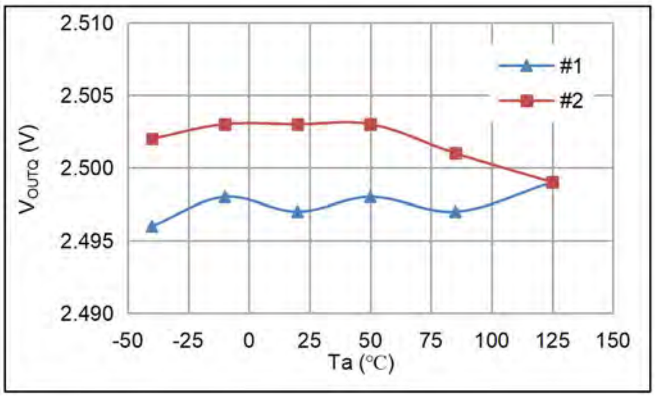


V_{OUT} error vs. Ta

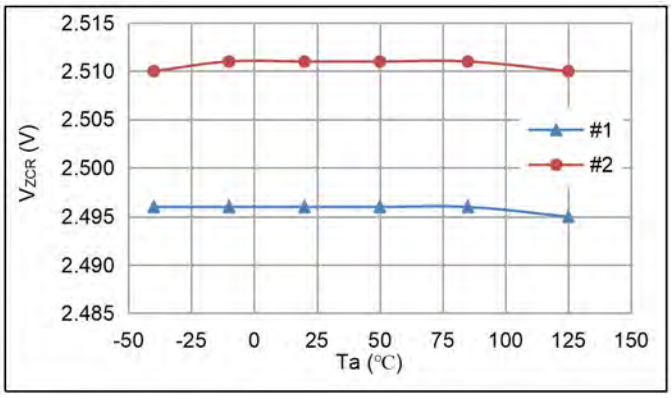


V_{OUT} vs. IP

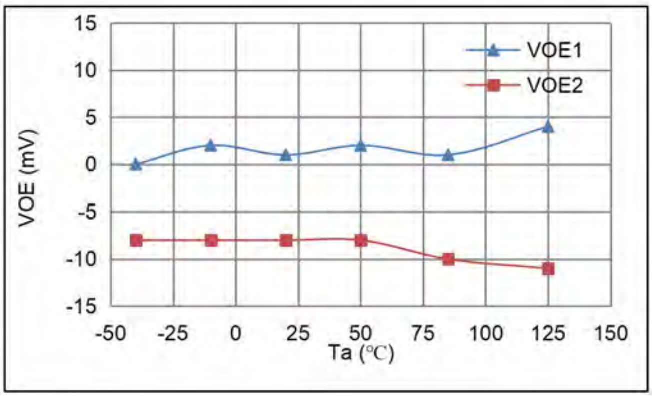
30A



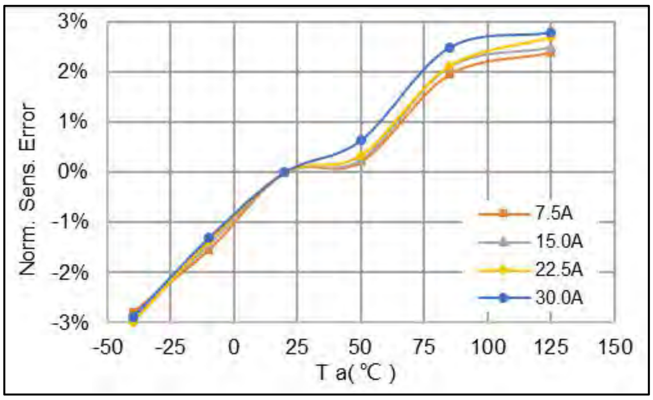
V_{OUTQ} vs. Ta



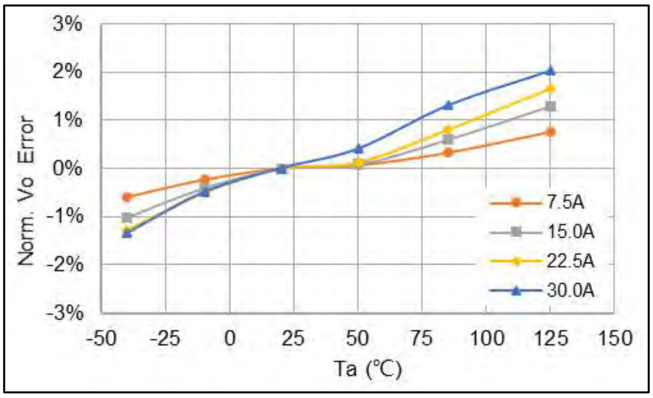
V_{ZCR} vs. Ta



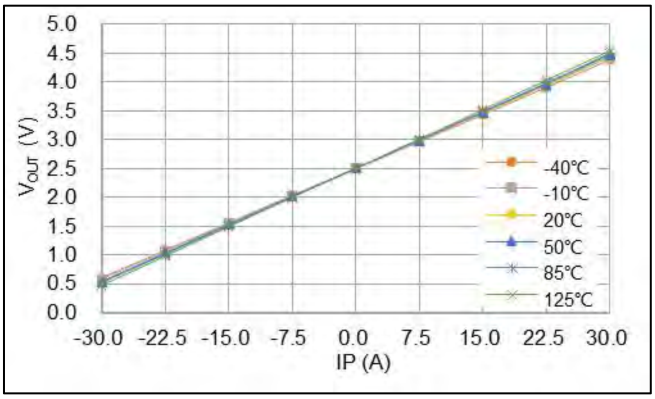
V_{OE} vs. Ta



Sens error vs. Ta

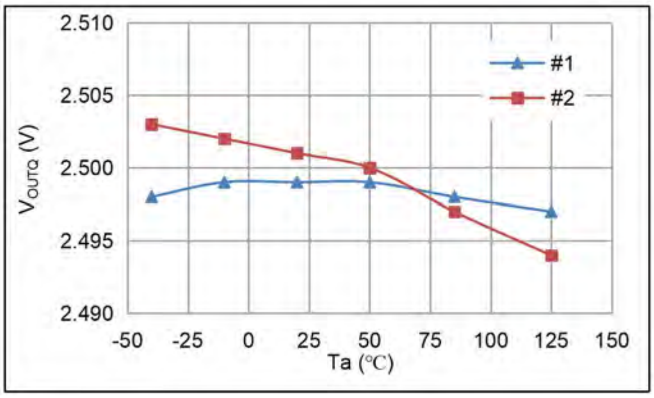


V_{OUT} error vs. Ta

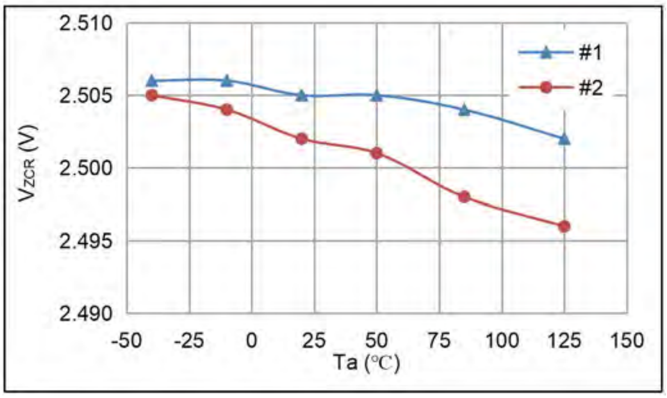


V_{OUT} vs. IP

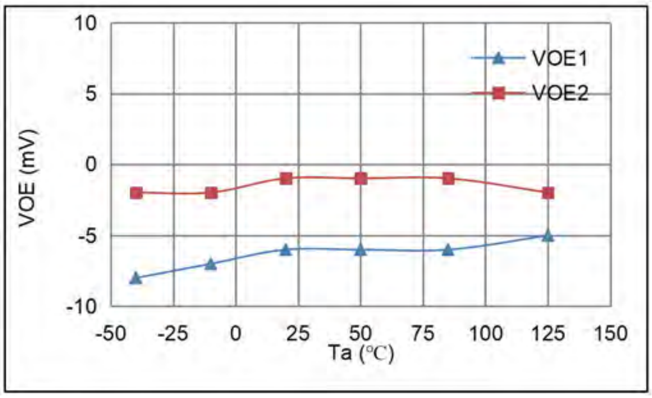
40A



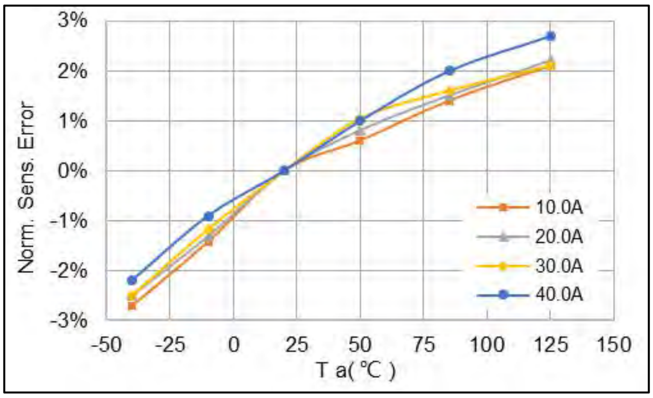
V_{OUTQ} vs. Ta



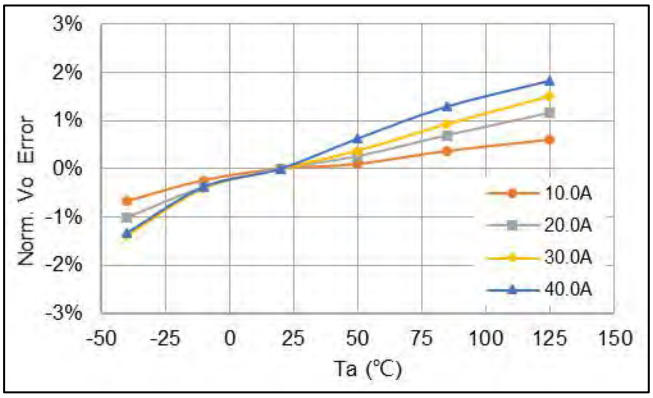
V_{ZCR} vs. Ta



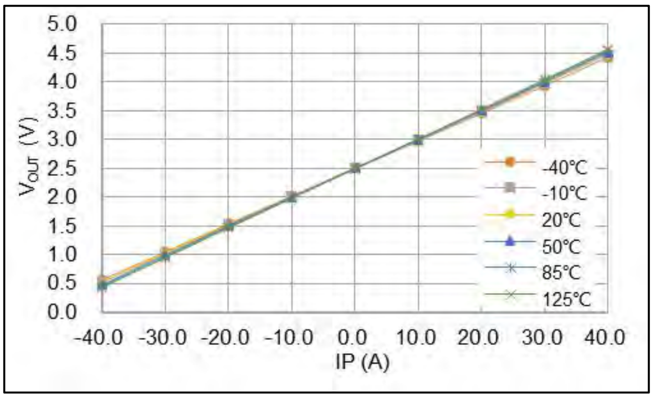
V_{OE} vs. Ta



Sens error vs. Ta



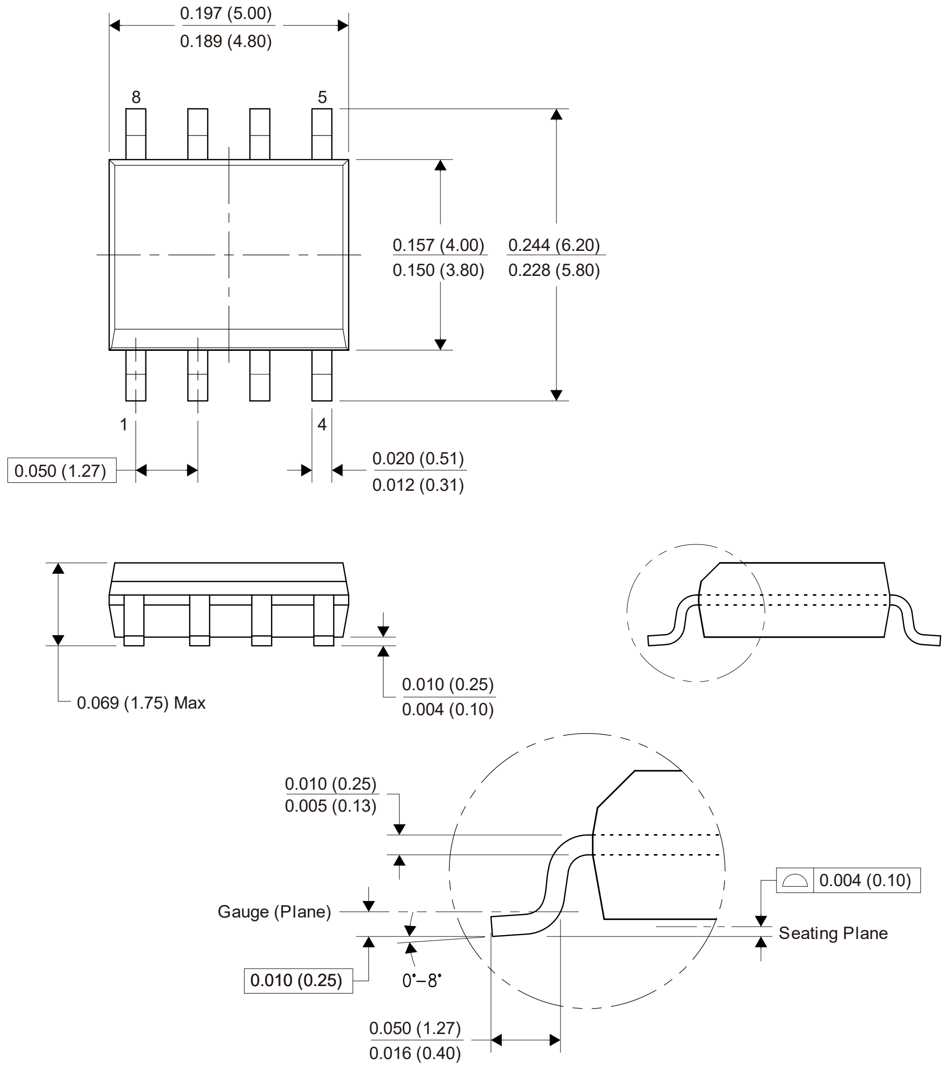
V_{OUT} error vs. Ta



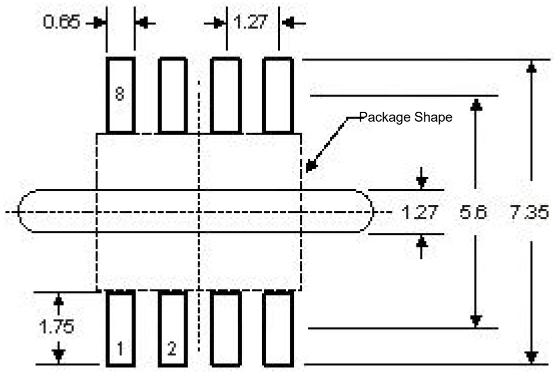
V_{OUT} vs. IP

PACKAGE INFORMATION

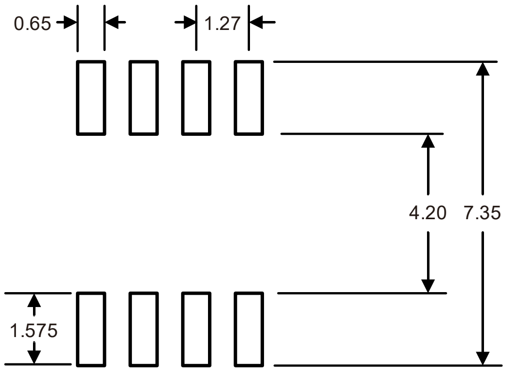
SOP8 PACKAGE



Package Reference

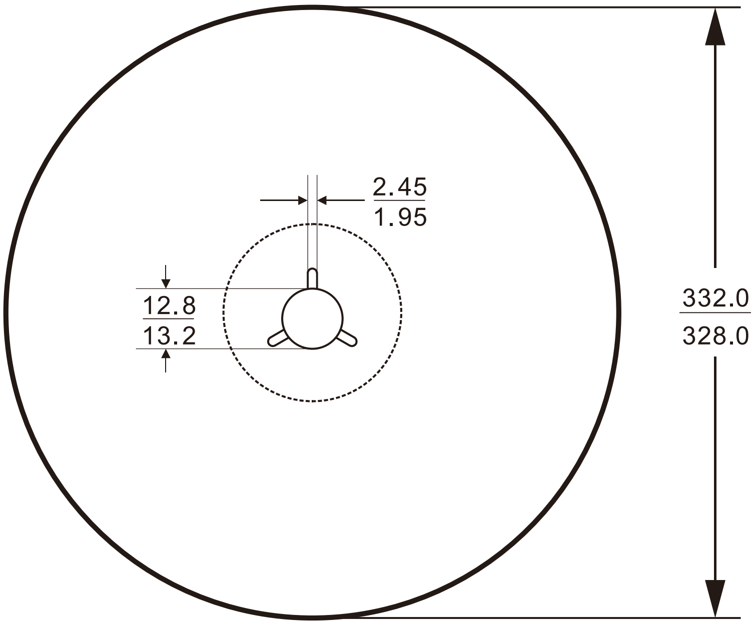


Reference 1: PCB slotting increases creepage distance

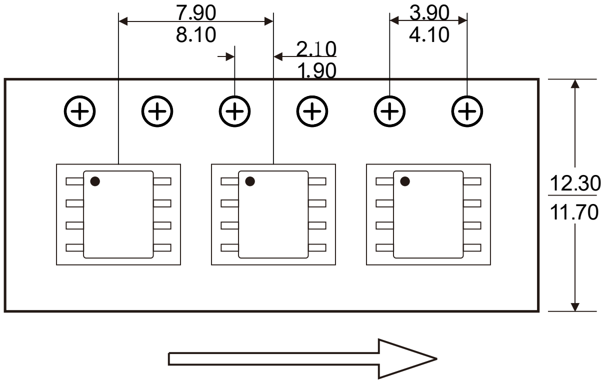


Reference 2: shorten pad length and increase creepage distance

Packaging & Taping



Information of Reel size



User Direction of Feed

Note: The space between the front and back of each tape is 50 ± 2 grids