



## High Performance, Hall Effect-Based Current Sensor IC with a Low-Resistance Conductor 10A/20A/30A/40A/50A/65A series

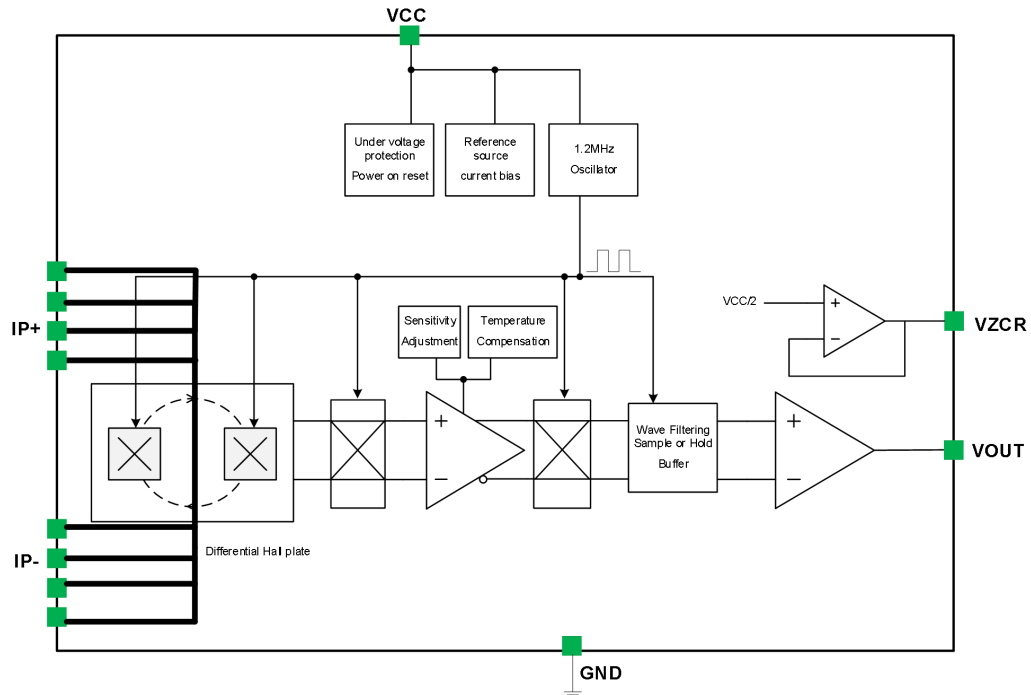
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### FEATURES

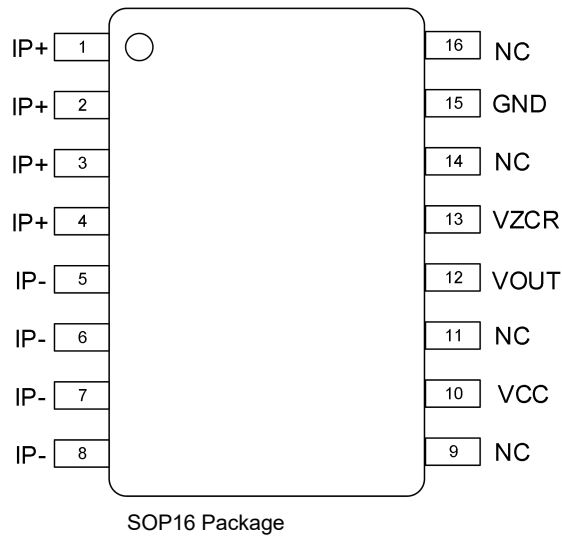
- ◆ Zero current output voltage is 50%VCC
- ◆ Current sensing range available: 10A/20A/30A/40A/50A/65A
- ◆ 1.2MHz chopper frequency, high bandwidth, low noise, single ended analog output
- ◆ High isolation and withstand voltage (3750V(AC) isolation voltage between pins 1-8 and 9-16)
- ◆ Less power loss, internal conductor's resistance is 0.6mΩ
- ◆ High bandwidth, up to 250KHz, 1.2μs output rise time in response to step input current
- ◆ Total output error  $\pm 1\%$  at  $T_a=25^\circ\text{C}$  and  $\pm 3\%$  at  $T_a=-40\sim 125^\circ\text{C}$
- ◆ CrossChip® patented temperature compensation
- ◆ Outputs desensitized to mechanical stress
- ◆ Differential Hall structure, strong resistance to external magnetic interference
- ◆ ESD (HBM) 4000V
- ◆ Operating ambient temperature:  $-40\sim 125^\circ\text{C}$

### APPLICATIONS

- ◆ Motor controller
- ◆ Load detection and management
- ◆ Switch-mode power supplies
- ◆ Over-current fault protection

**FUNCTION BLOCK DIAGRAM**

**ORDERING INFORMATION**

Part No.	SENS. (mV/A)	Package	Packing Form
CI5931-10A	200	SOP16	tape reel, 1000 pcs/reel
CI5931-20A	100	SOP16	tape reel, 1000 pcs/reel
CI5931-30A	67	SOP16	tape reel, 1000 pcs/reel
CI5931-40A	50	SOP16	tape reel, 1000 pcs/reel
CI5931-50A	40	SOP16	tape reel, 1000 pcs/reel
CI5931-65A	30.75	SOP16	tape reel, 1000 pcs/reel

**PINOUT DIAGRAM**


Name	Number	Description	Name	Number	Description
IP+	1	Current Sampled +	NC	9	NC
IP+	2	Current Sampled +	VCC	10	Power Supply
IP+	3	Current Sampled +	NC	11	NC
IP+	4	Current Sampled +	VOUT	12	Analog Voltage Output
IP-	5	Current Sampled -	VZCR	13	Zero Current Reference
IP-	6	Current Sampled -	NC	14	NC
IP-	7	Current Sampled -	GND	15	Ground
IP-	8	Current Sampled -	NC	16	NC

**ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Value	Unit
Power Supply	$V_{CC}$	7	V
Output Voltage	$V_{OUT}$	-0.3~ $V_{CC}+0.3$	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	$I_{CON}$	60	A
Isolation Voltage	$V_{ISO}$	3750	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 <sub>ISO</sub>	Test method: 50 / 60Hz, 1min	3750	V <sub>RMS</sub>
	V <sub>TEST</sub>	t = 1s (100% production)	4500	V <sub>RMS</sub>
Working Voltage for Basic Insulation	V <sub>WVBI</sub>	Basic insulation	1131	V <sub>PK</sub> or VDC
		UL standard 62368-1:2014	800	V <sub>RMS</sub>
Working Voltage for Reinforced Isolation	V <sub>WVRI</sub>	Reinforced Isolation	565	V <sub>PK</sub> or VDC
		UL standard 62368-1:2014	400	V <sub>RMS</sub>
Clearance	D <sub>cl</sub>	minimum distance through air from IP leads to signal leads	7.8	mm
Maximum surge isolation voltage ( <b>Note 1</b> )	V <sub>IOSM</sub>	Test method per IEC 62368-1, 1.2/50μs waveform, V <sub>TEST</sub> = 1.3×V <sub>IOSM</sub> (qualification)	8000	V <sub>PK</sub>

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

**RECOMMENDED OPERATING CONDITIONS**

Parameter	Symbol	Min.	Max.	Unit
Input voltage ( <b>Note 1</b> )	VIN+, VIN- ( <b>Note 1</b> )	-1131	1131	V <sub>PK</sub>
Input voltage ( <b>Note 2</b> )	VIN+, VIN- ( <b>Note 2</b> )	-565	565	V <sub>PK</sub>
Input current (DC / AC RMS) ( <b>Note 3</b> )	IP	-50	50	A
Power Supply	V <sub>CC</sub>	4.5	5.5	V
Operation Temperature	T <sub>A</sub>	-40	125	°C

**Note 1:** Vin +, VIN – refers to the voltage of current input pins IP + and IP -, relative to pin 15 (GND), Basic Insulation.

**Note 2:** Vin +, VIN – refers to the voltage of current input pins IP + and IP -, relative to pin 15 (GND), Reinforced Isolation.

**Note 3:** Decrease due to higher ambient temperature.

**ELECTRICAL PARAMETERS** (T<sub>a</sub>=25°C and V<sub>CC</sub>=5V, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power Supply	V <sub>CC</sub>	-	4.5	5	5.5	V
Supply Current	I <sub>CC</sub>	OUT pin floated	-	20	25	mA
Internal benchmark	V <sub>ZCR</sub>		2.470	2.500	2.530	V
Zero Current Output Voltage	V <sub>OUT(O)</sub>	IP=0	2.490	2.500	2.510	V
Output Capacitance Load	C <sub>L</sub>		-	-	1	nF
Output Resistive Load	R <sub>L</sub>		1.5	-	-	kΩ
Res. of Primary Conductor	R <sub>P</sub>		-	0.6	1.5	mΩ
Propagation Time	t <sub>D</sub>			1	2	us
Rise Time	t <sub>r</sub>		-	1	2.2	us
Common Mode Rejection Ratio	CMRR		38	-	-	dB
Bandwidth	BW	-3dB	250	-	-	kHz
Reference Output Source Current	I <sub>ZCR(SOURCE)</sub>		-	-	400	uA
Reference Output Sink Current	I <sub>ZCR(SINK)</sub>		-	-	2000	uA
Nonlinearity	Lin <sub>ERR</sub>		-	0.2	0.5	%

**Continued:**

Symmetry	Sym <sub>ERR</sub>		-	0.8	1.5	%
Power-on Time	T <sub>POR</sub>	Output rising from 0 to 90% of steady-state	-	10	-	us

**20A PERFORMANCE CHARACTERISTICS**

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Current Accuracy Range	I <sub>P</sub>	-	-20	-	20	A
Sensitivity	Sens	full range of I <sub>P</sub>	97	100	103	mV/A
Zero Current Differential Output Error	V <sub>OE</sub>		-40		40	mV
Noise	V <sub>NOISE(P-P)</sub>		-	40	-	mV
Zero Current Output Slope	ΔV <sub>OUT(Q)</sub>		-	0.34	-	mV/°C
Sensitivity Slope	Δ <sub>SENS</sub>		-	0.017	-	mV/A/°C
Total Output Error	E <sub>TOT</sub>		-3.0	-	3.0	%

**30A PERFORMANCE CHARACTERISTICS**

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Current Accuracy Range	I <sub>P</sub>	-	-30	-	30	A
Sensitivity	Sens	full range of I <sub>P</sub>	65	67	69	mV/A
Zero Current Differential Output Error	V <sub>OE</sub>		-30		30	mV
Noise	V <sub>NOISE(P-P)</sub>		-	35	-	mV
Zero Current Output Slope	ΔV <sub>OUT(Q)</sub>		-	0.05	-	mV/°C
Sensitivity Slope	Δ <sub>SENS</sub>		-	0.01	-	mV/A/°C
Total Output Error	E <sub>TOT</sub>		-3.0	-	3.0	%

**40A PERFORMANCE CHARACTERISTICS**

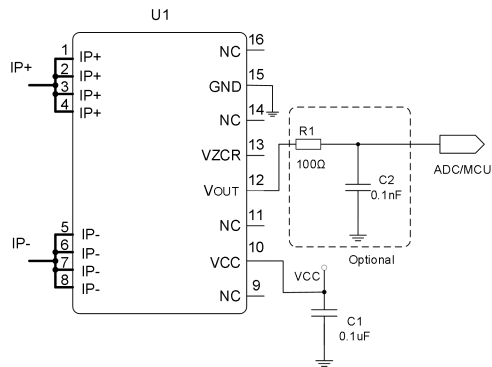
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Current Accuracy Range	I <sub>P</sub>	-	-40	-	40	A
Sensitivity	Sens	full range of I <sub>P</sub>	48.5	50	51.5	mV/A
Zero Current Differential Output Error	V <sub>OE</sub>		-25		25	mV
Noise	V <sub>NOISE(P-P)</sub>		-	25	-	mV
Zero Current Output Slope	ΔV <sub>OUT(Q)</sub>		-	0.05	-	mV/°C
Sensitivity Slope	Δ <sub>SENS</sub>		-	0.01	-	mV/A/°C
Total Output Error	E <sub>TOT</sub>		-3.0	-	3.0	%

**50A PERFORMANCE CHARACTERISTICS**

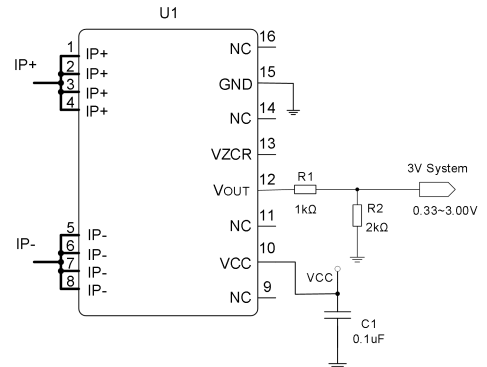
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Current Accuracy Range	$I_P$	-	-50	-	50	A
Sensitivity	Sens	full range of $I_P$	38.8	40	41.2	mV/A
Zero Current Differential Output Error	$V_{OE}$		-20		20	mV
Noise	$V_{NOISE(P-P)}$		-	25	-	mV
Zero Current Output Slope	$\Delta V_{OUT(Q)}$		-	0.05	-	mV/°C
Sensitivity Slope	$\Delta SENS$		-	0.01	-	mV/A/°C
Total Output Error	$E_{TOT}$		-3.0	-	3.0	%

**65A PERFORMANCE CHARACTERISTICS**

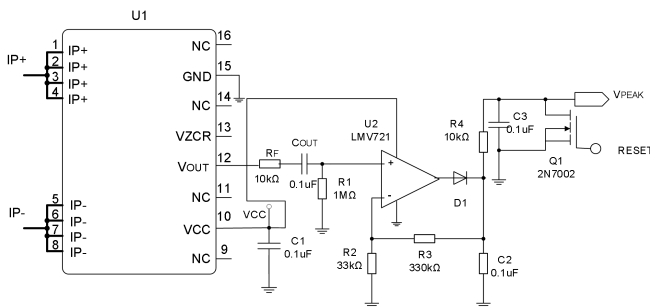
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Current Accuracy Range	$I_P$	-	-65	-	65	A
Sensitivity	Sens	full range of $I_P$	29.83	30.75	31.67	mV/A
Zero Current Differential Output Error	$V_{OE}$		-15		15	mV
Noise	$V_{NOISE(P-P)}$		-	20	-	mV
Zero Current Output Slope	$\Delta V_{OUT(Q)}$		-	0.05	-	mV/°C
Sensitivity Slope	$\Delta SENS$		-	0.01	-	mV/A/°C
Total Output Error	$E_{TOT}$		-3.0	-	3.0	%

**TYPICAL APPLICATION CIRCUITS**


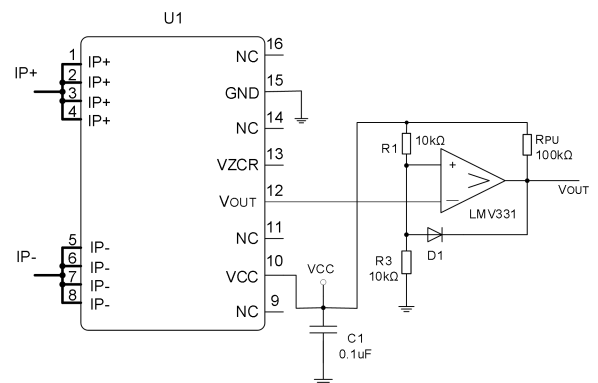
Typical Output Application



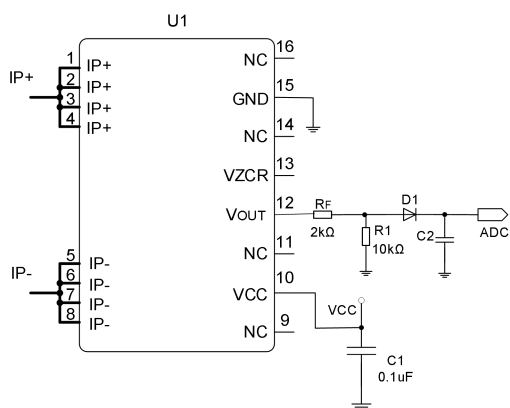
Signal Attenuation Circuit



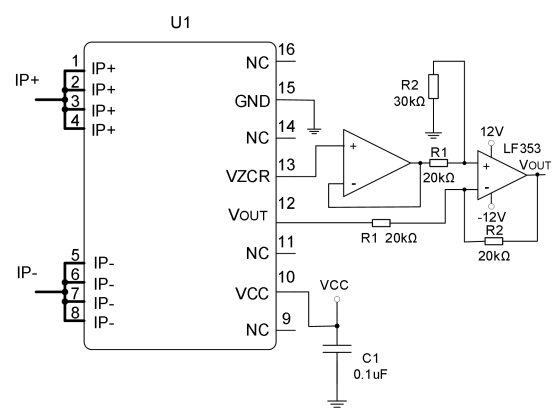
Peak Current Detection



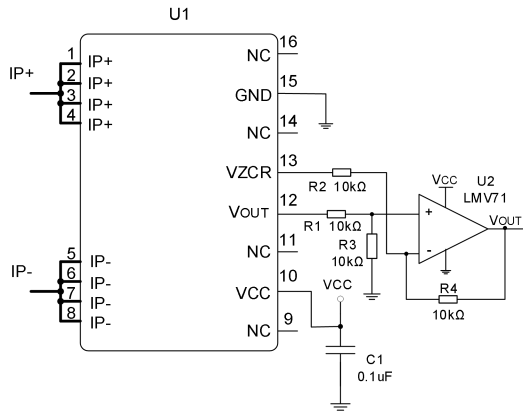
Over Current Fault Latch



Rectifier output, instead of current transformer application

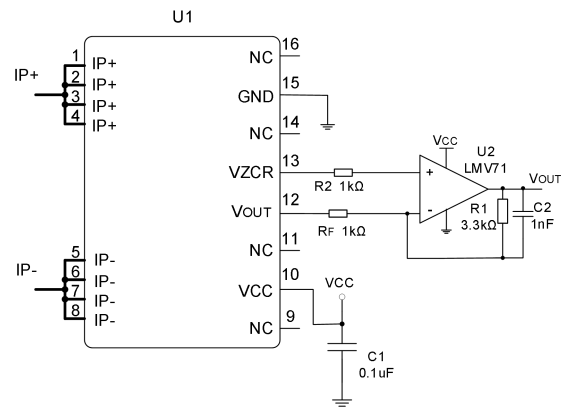


Zero Migration Application



Application of single source zero shift with unidirectional current

**Note: the output current of  $I_{zcr}$  is  $< 0.4\text{mA}$ . It is suggested that  $0.3\text{mA}$**

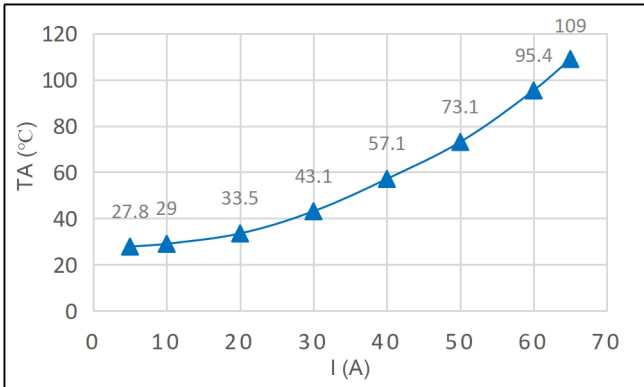


Gain amplifier application

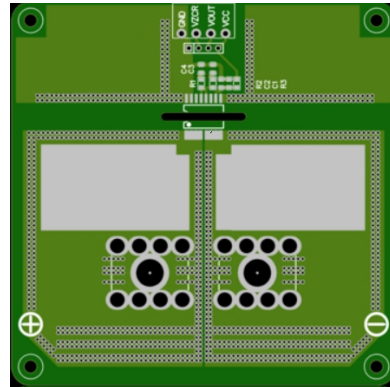
**Note: output direction of  $V_{out}$**



**Relationship between Package Temperature & Input Current**

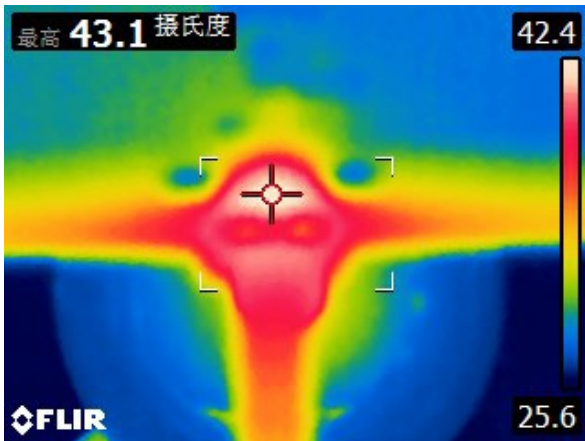


Input Current (IP) vs. Package temperature

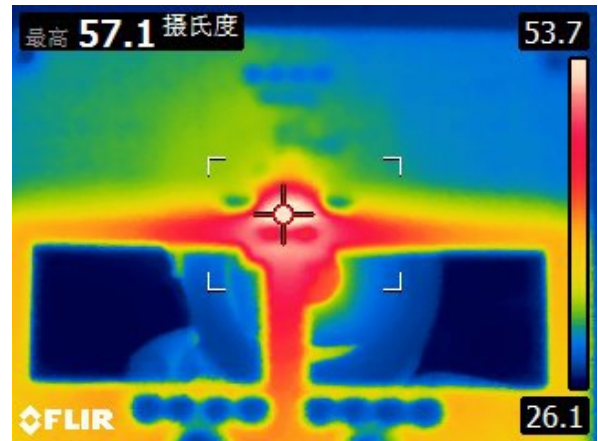


Thickness: 1.6mm, FR-4 double-sided plate, 4oz copper foil  
total 10000m2

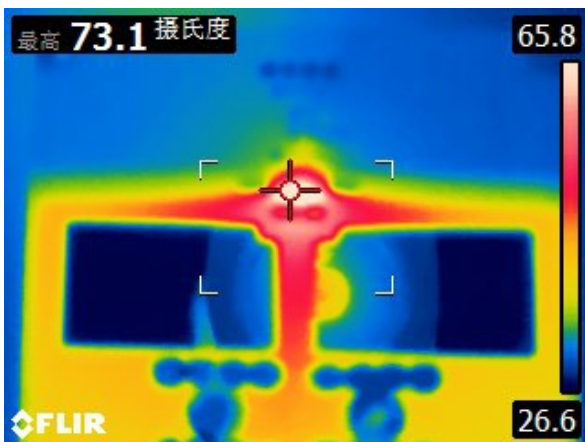
Test environment: open environment, stagnant air



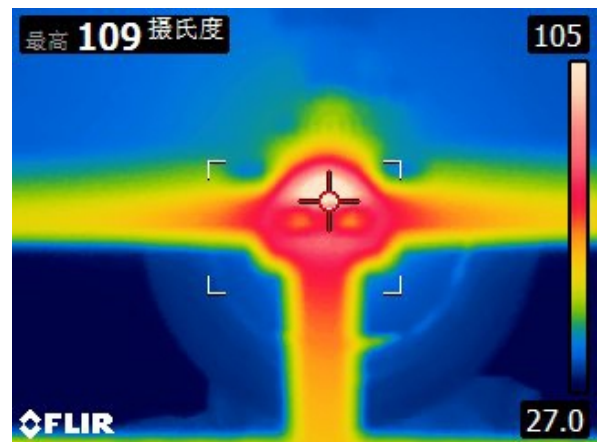
Package Thermography (Input Current 30A)



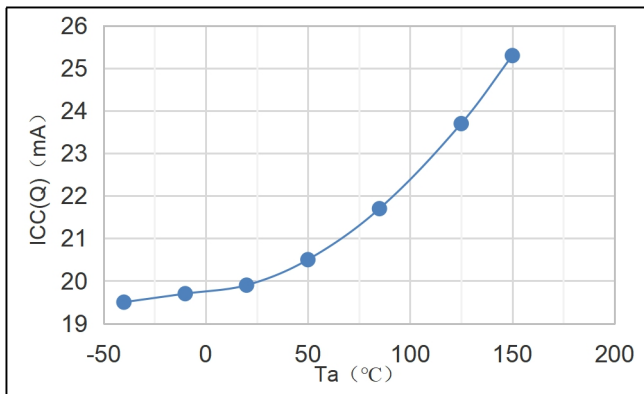
Package Thermography (Input Current 40A)



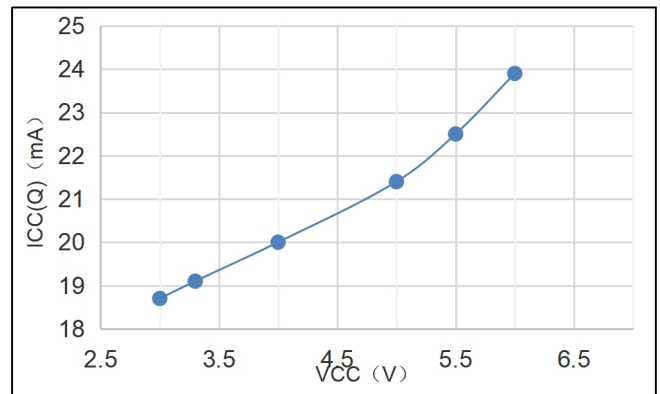
Package Thermography (Input Current 50A)



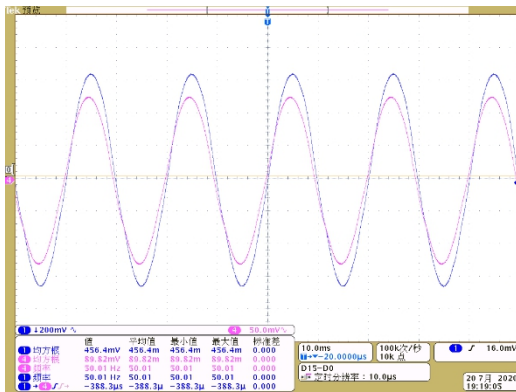
Package Thermography (Input Current 65A)

**OUTPUT WAVEFORMS AND CURVES**


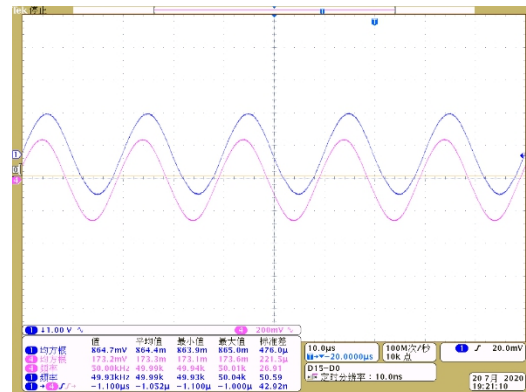
Icc vs. Ta



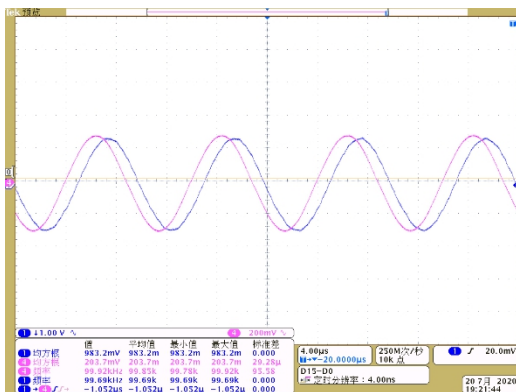
Icc vs. VCC



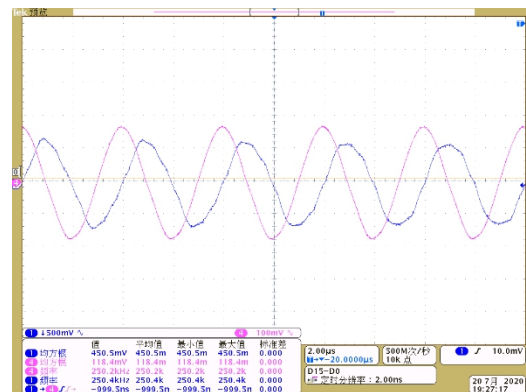
AC output voltage waveform (50Hz)



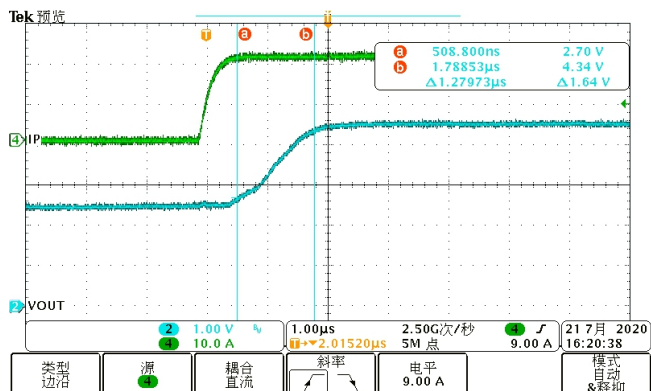
AC output voltage waveform (50kHz)



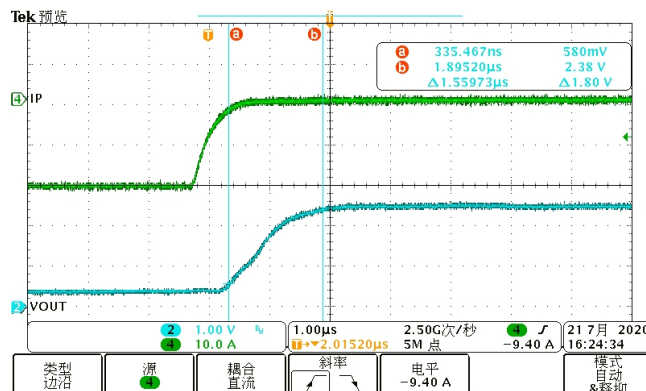
AC output voltage waveform (100kHz)



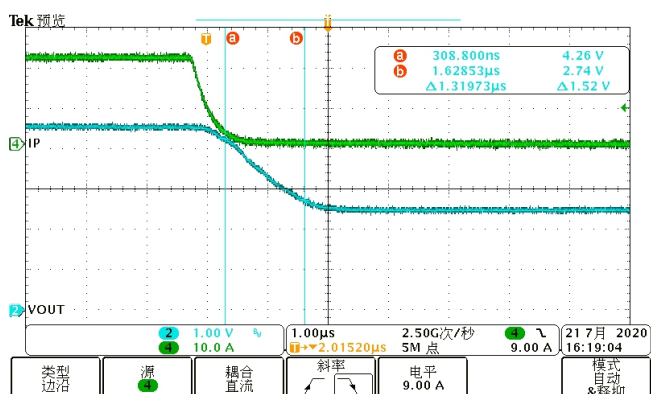
AC output voltage waveform (250kHz)


 V<sub>OUT</sub> vs IP (20A)

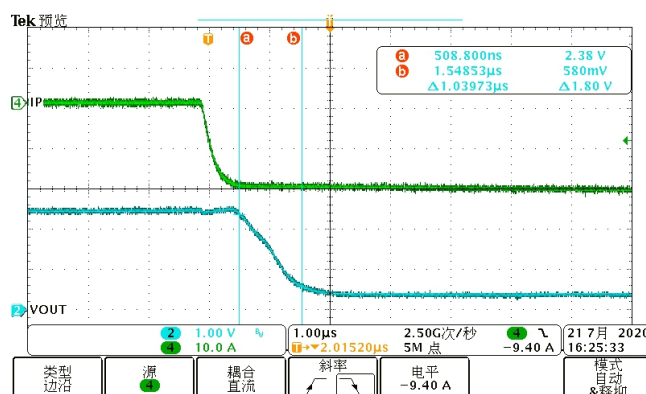
(Positive Current Rising Edge Response)


 V<sub>OUT</sub> vs IP (20A)

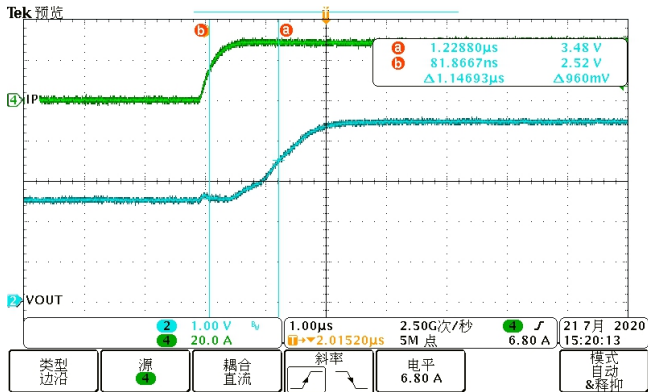
(Negative Current Rising Edge Response)


 V<sub>OUT</sub> vs IP (20A)

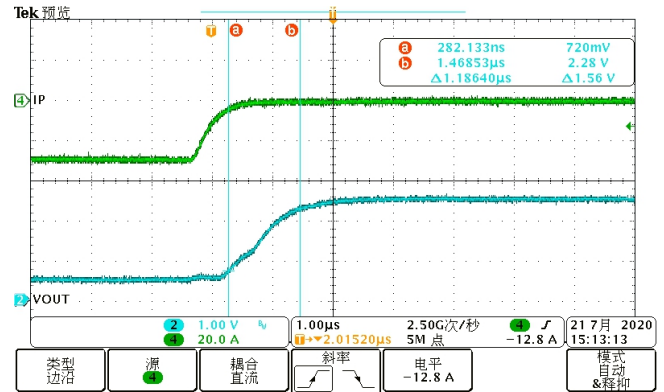
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 V<sub>OUT</sub> vs IP (20A)

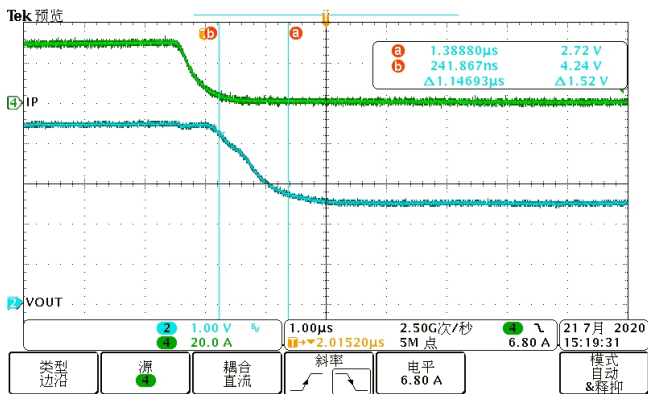
(Negative Current Falling Edge Response)


 V<sub>OUT</sub> vs IP (30A)

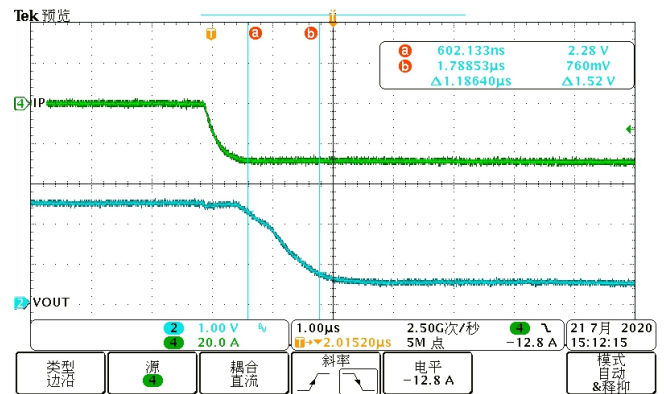
(Positive Current Rising Edge Response)


 V<sub>OUT</sub> vs IP (30A)

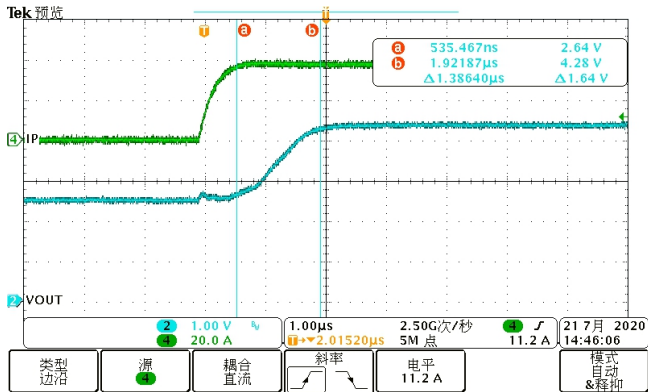
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 V<sub>OUT</sub> vs IP (30A)

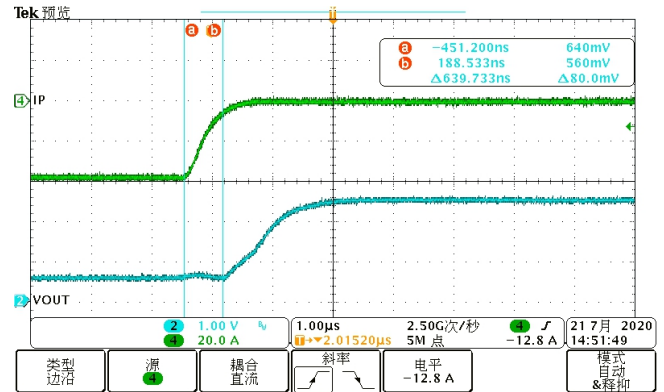
(Positive Current Falling Edge Response)


 V<sub>OUT</sub> vs IP (30A)

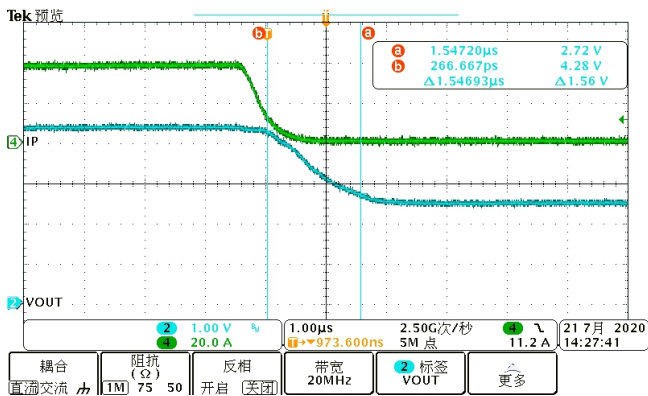
(Negative Current Falling Edge Response)


 V<sub>OUT</sub> vs IP (40A)

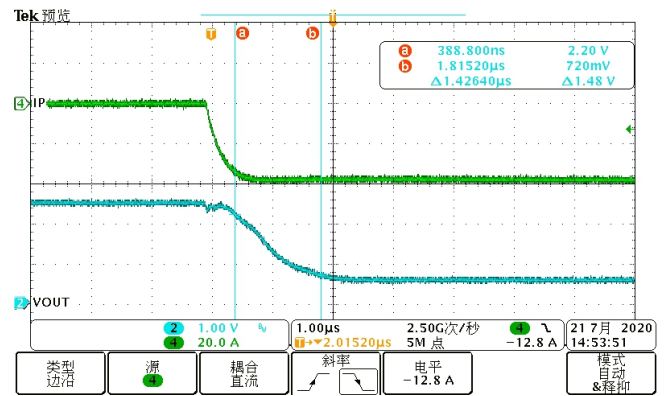
(Positive Current Rising Edge Response)


 V<sub>OUT</sub> vs IP (40A)

(Negative Current Rising Edge Response)

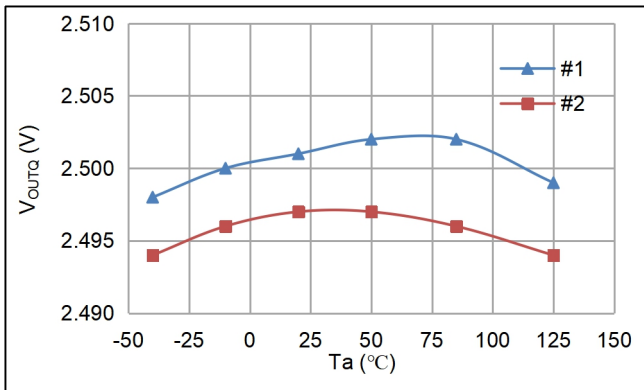
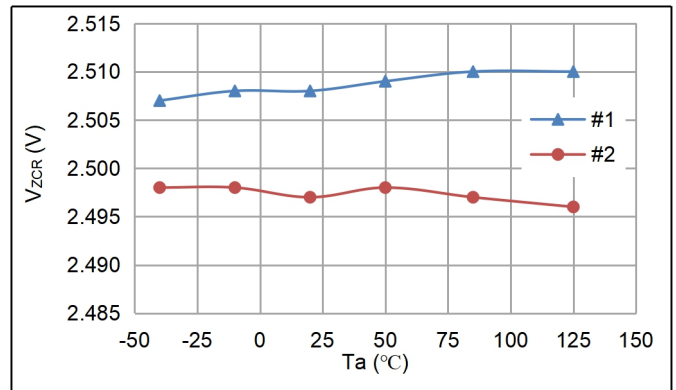
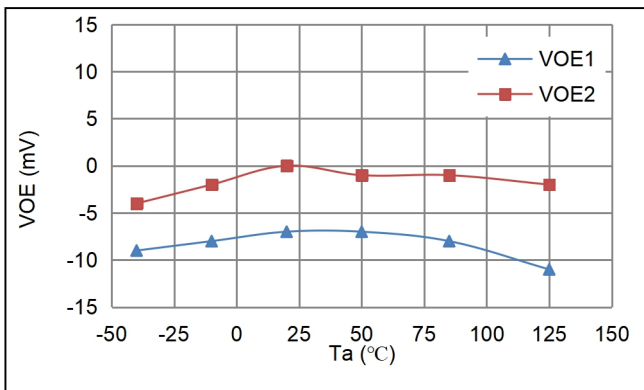
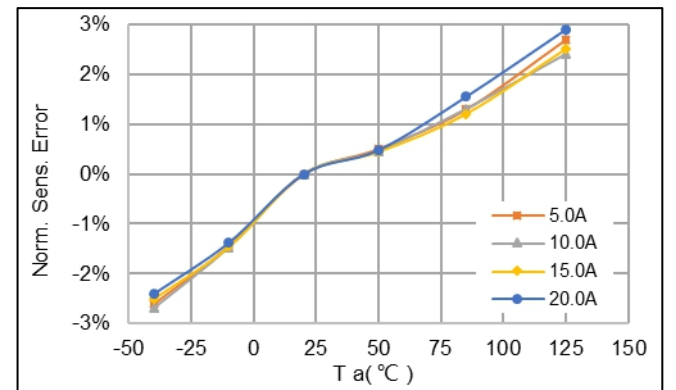
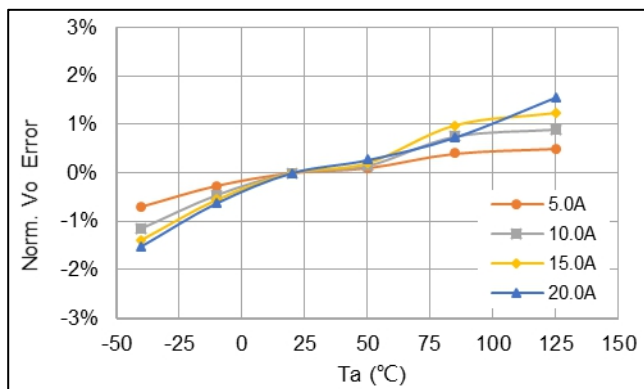
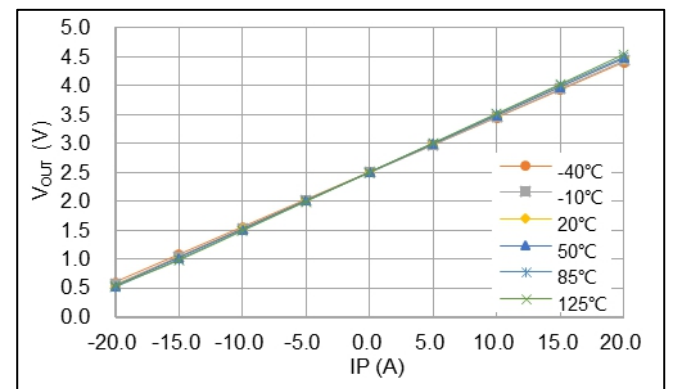

 V<sub>OUT</sub> vs IP (40A)

(Positive Current Falling Edge Response)

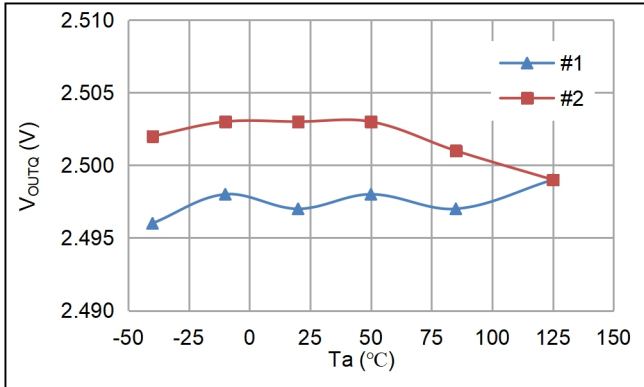
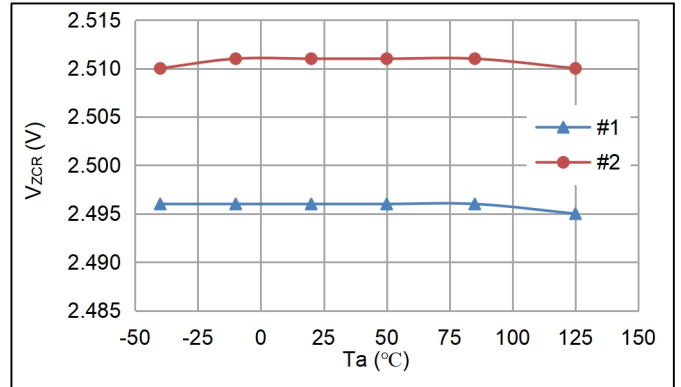
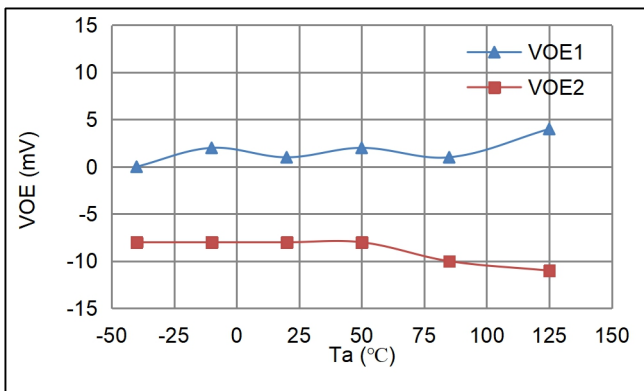
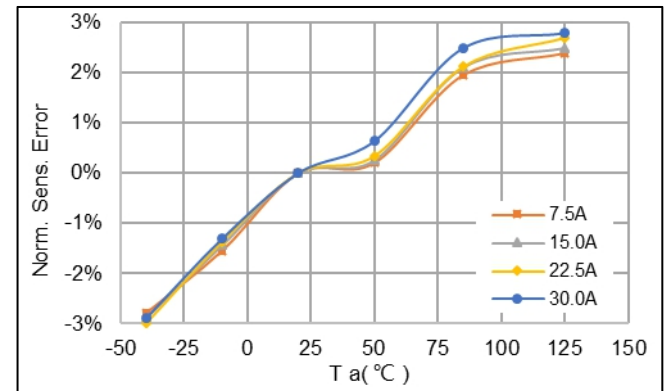
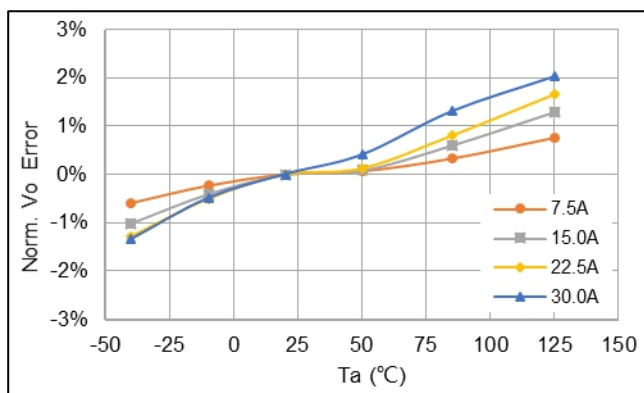
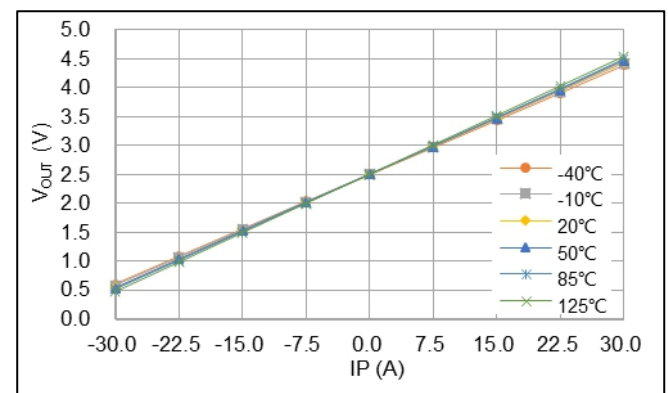

 V<sub>OUT</sub> vs IP (40A)

(Negative Current Falling Edge Response)

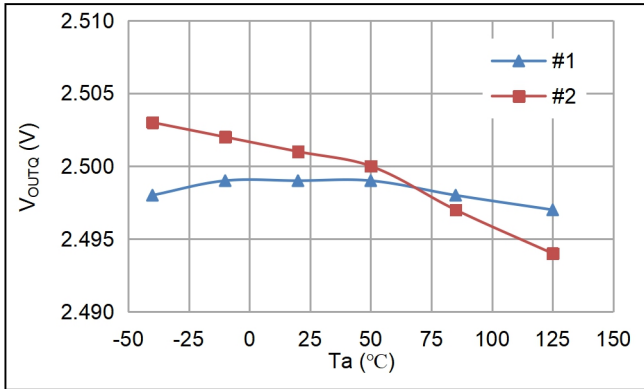
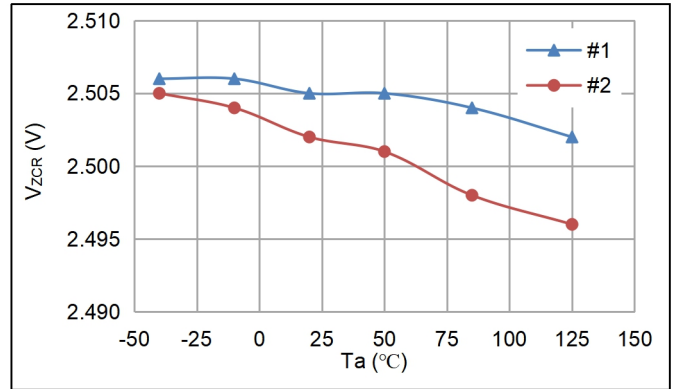
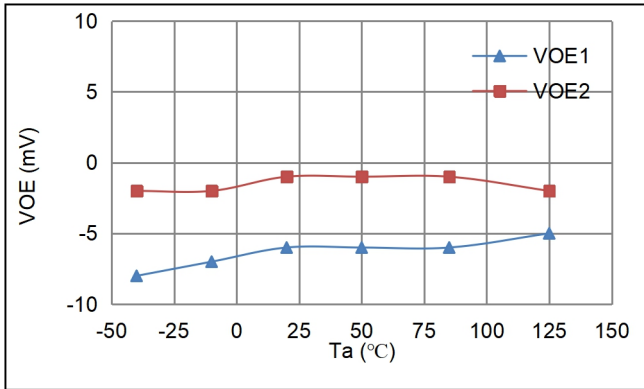
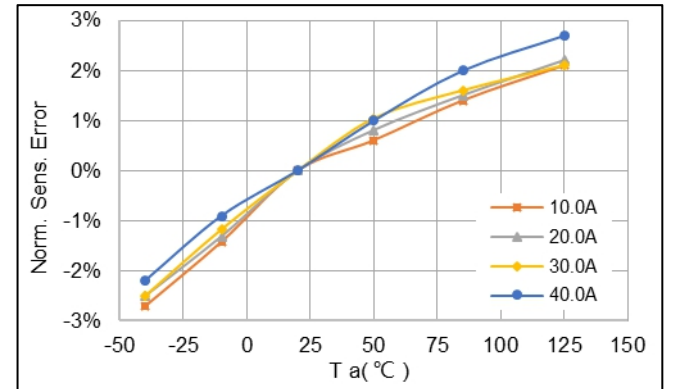
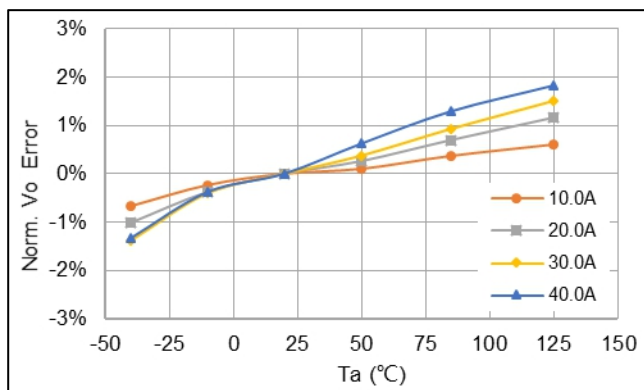
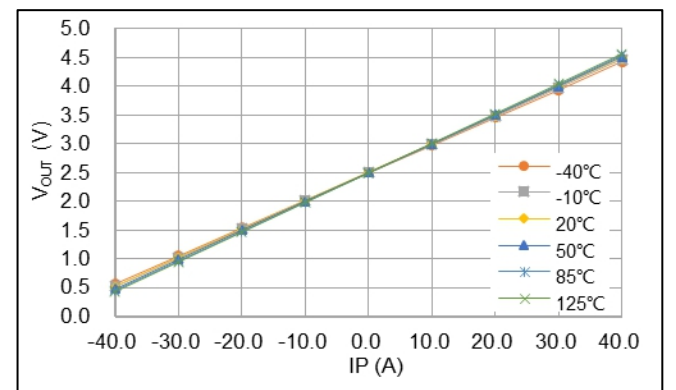
## 20A


 V<sub>OUTQ</sub> vs. T<sub>a</sub>

 V<sub>ZCR</sub> vs. T<sub>a</sub>

 V<sub>OE</sub> vs. T<sub>a</sub>

 Sens error vs. T<sub>a</sub>

 V<sub>OUT</sub> error vs. T<sub>a</sub>

 V<sub>OUT</sub> vs. I<sub>P</sub>

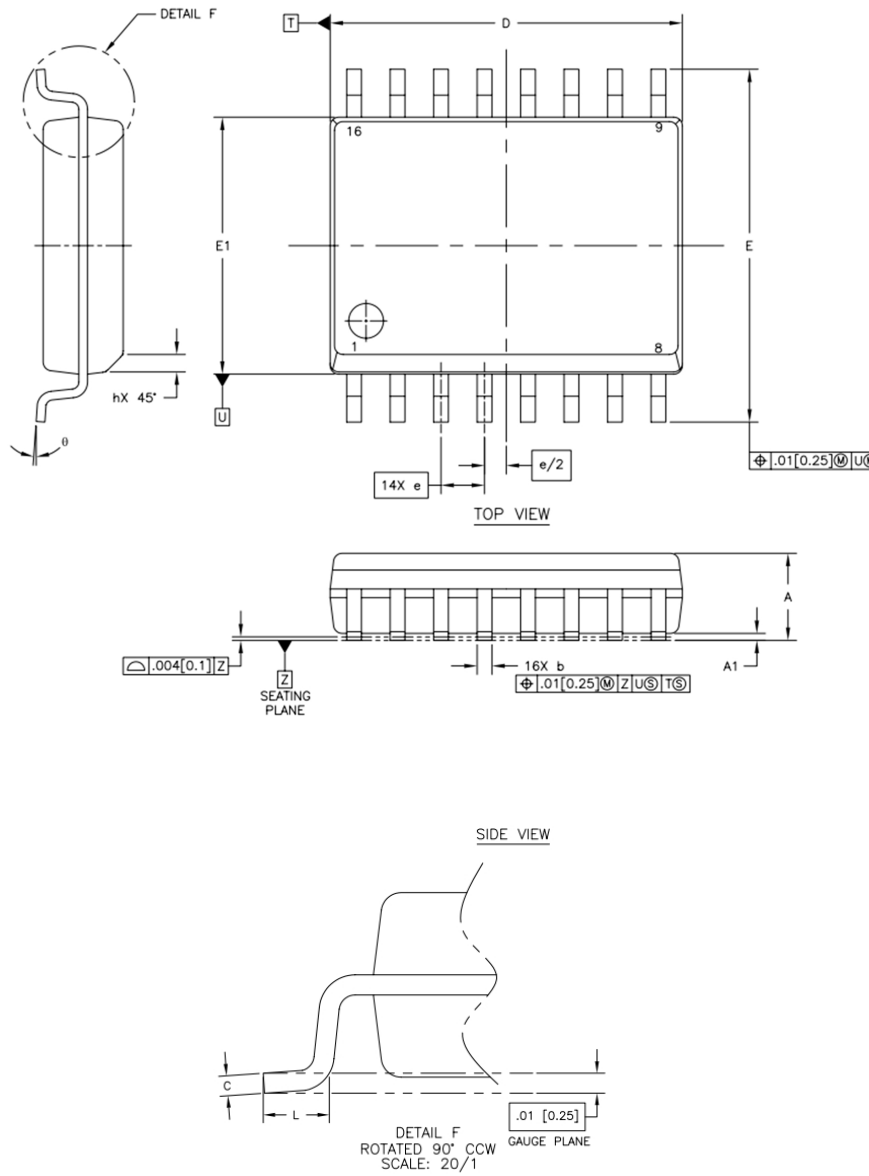
## 30A


 V<sub>outTa</sub> vs. T<sub>a</sub>

 V<sub>ZCR</sub> vs. T<sub>a</sub>

 V<sub>OE</sub> vs. T<sub>a</sub>

 Sens error vs. T<sub>a</sub>

 V<sub>OUT</sub> error vs. T<sub>a</sub>

 V<sub>OUT</sub> vs. I<sub>P</sub>

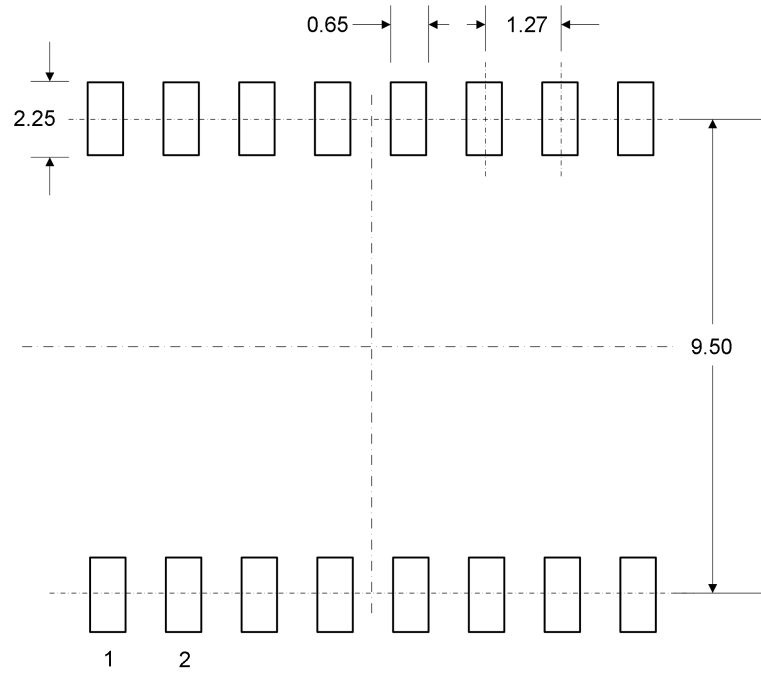
## 40A


 V<sub>outq</sub> vs. T<sub>a</sub>

 V<sub>zcr</sub> vs. T<sub>a</sub>

 V<sub>oe</sub> vs. T<sub>a</sub>

 Sens error vs. T<sub>a</sub>

 V<sub>out</sub> error vs. T<sub>a</sub>

 V<sub>out</sub> vs. I<sub>P</sub>



**PACKAGE INFORMATION**
**SOP16 PACKAGE**


Symbol	Millimeters		
	Min	TYP	Min
A	2.35		2.65
A1	0.10		0.30
b	0.33		0.51
c	0.23		0.32
D	10.10		10.50
E1	7.40		7.60
E	10.00		10.63
e	1.27 BSC		
L	0.40		1.27
h	0.25		0.75
$\theta$	0°		8°

**Package Reference**

Reference: shorten pad length and increase creepage distance