General Description

OCH19605 current sensor IC is an economical and precise solution for AC or DC current sensing in industrial, commercial, and communication systems. The small package is ideal for space-constrained applications while also saving costs due to reduced board area. Typical applications include motor control, load detection and management, switched-mode power supplies, and overcurrent fault protection. The device consists of a precise, low-offset, linear Hall sensor circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which is sensed by the integrated Hall IC and converted into a proportional voltage. The current is sensed differentially in order to reject common-mode fields, improving accuracy in magnetically noisy environments. The inherent device accuracy is optimized through the close proximity of the magnetic field to the Hall transducer. A precise, proportional voltage is provided by the low-offset, chopper-stabilized CMOS Hall IC, includes digital temperature compensation, resulting in extremely accurate performance over temperature. The output of the device has a positive slope when an increasing current flows through the primary copper conduction path (from pins 1 through 4, to pins 5 through 8), which is the path used for current sensing. The internal resistance of this conductive path is 0.85 mΩ typical, providing low power loss. The terminals of the conductive path are electrically isolated from the sensor leads (pins 9 through 16). This allows the OCH19605 current sensor IC to be used in high-side current sense applications without the use of high-side differential amplifiers or other costly isolation techniques.

The OCH19605 is provided in a low-profile surface-mount SOP-16L(W) package. The leadframe is plated with 100% matte tin, which is compatible with standard lead (Pb) free printed circuit board assembly processes. Internally, the device is Pb-free. The device is fully calibrated prior to shipment from the factory.

Features

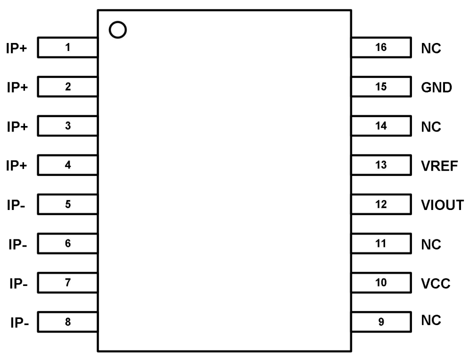
- Differential Hall sensing rejects common-mode fields
- Patented integrated digital temperature compensation circuitry allows for near closed loop accuracy over temperature in an open loop sensor
- Dielectric Strength Voltage =5.5 kVRMS
- 0.5VCC or 0.1VCC reference voltage output
- 250k bandwidth, step response time 1.6 us
- 0.85 mΩ primary conductor resistance for low power loss and high inrush current withstand capability
- Low-profile SOP-16L(W) package suitable for space-constrained applications
- 4.5 to 5.5 V single supply operation
- Output voltage proportional to AC or DC current
- Factory-trimmed sensitivity, quiescent output voltage and VREF voltage for improved accuracy
- Chopper stabilization results in extremely stable quiescent output voltage
- Nearly zero magnetic hysteresis
- Ratiometric output from supply voltage
- UL 62368-1 (ed.3) certification
- AEC-Q100 Grade 1, automotive qualified

Applications

- AC and DC Chargers
- Electric Drives
- DCDC converters
- Solar
- Power Supplies
- Demand/Load control

Certificate number:
UL-US-2410838-1

Pin Configuration



SOP-16L(W)
Figure 1, Pin Assignments of OCH19605

Number	Name	Description
1-4	IP+	Terminals for current being sensed; fused internally
5-8	IP-	Terminals for current being sensed; fused internally
9	NC	No internal connection
10	VCC	power supply terminal
11	NC	No internal connection
12	VIOUT	Analog output signal
13	VREF	Reference Voltage
14	NC	No internal connection
15	GND	Signal ground terminal
16	NC	No internal connection

Typical Application Circuit

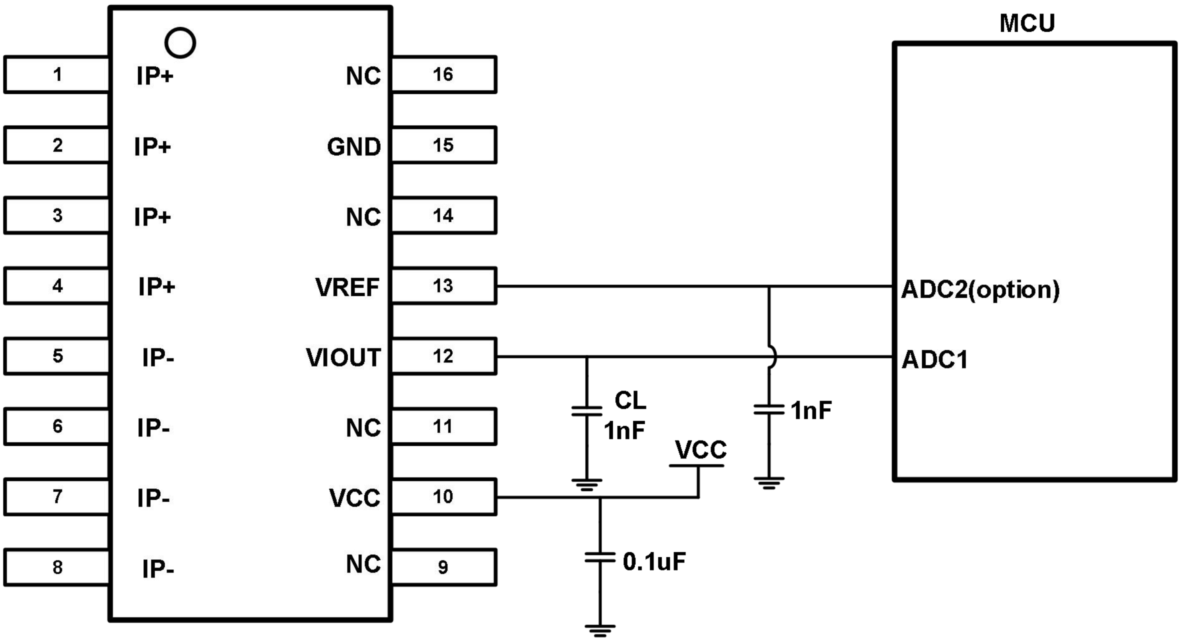


Figure 2, Typical Application of OCH19605

Ordering Information

Part Number	I_{PR}（A）	Sens(Typ)@VCC=5V（mV/A）	Temperature	Packing
OCH19605S16AE -20AB	±20A	100	-40～125°C	Tape and Reel，1500 pieces per reel
OCH19605S16AE -30AB	±30A	66	-40～125°C	
OCH19605S16AE -50AB	±50A	40	-40～125°C	
OCH19605S16AE -65AB	±65A	30.75	-40～125°C	

■ Block Diagram

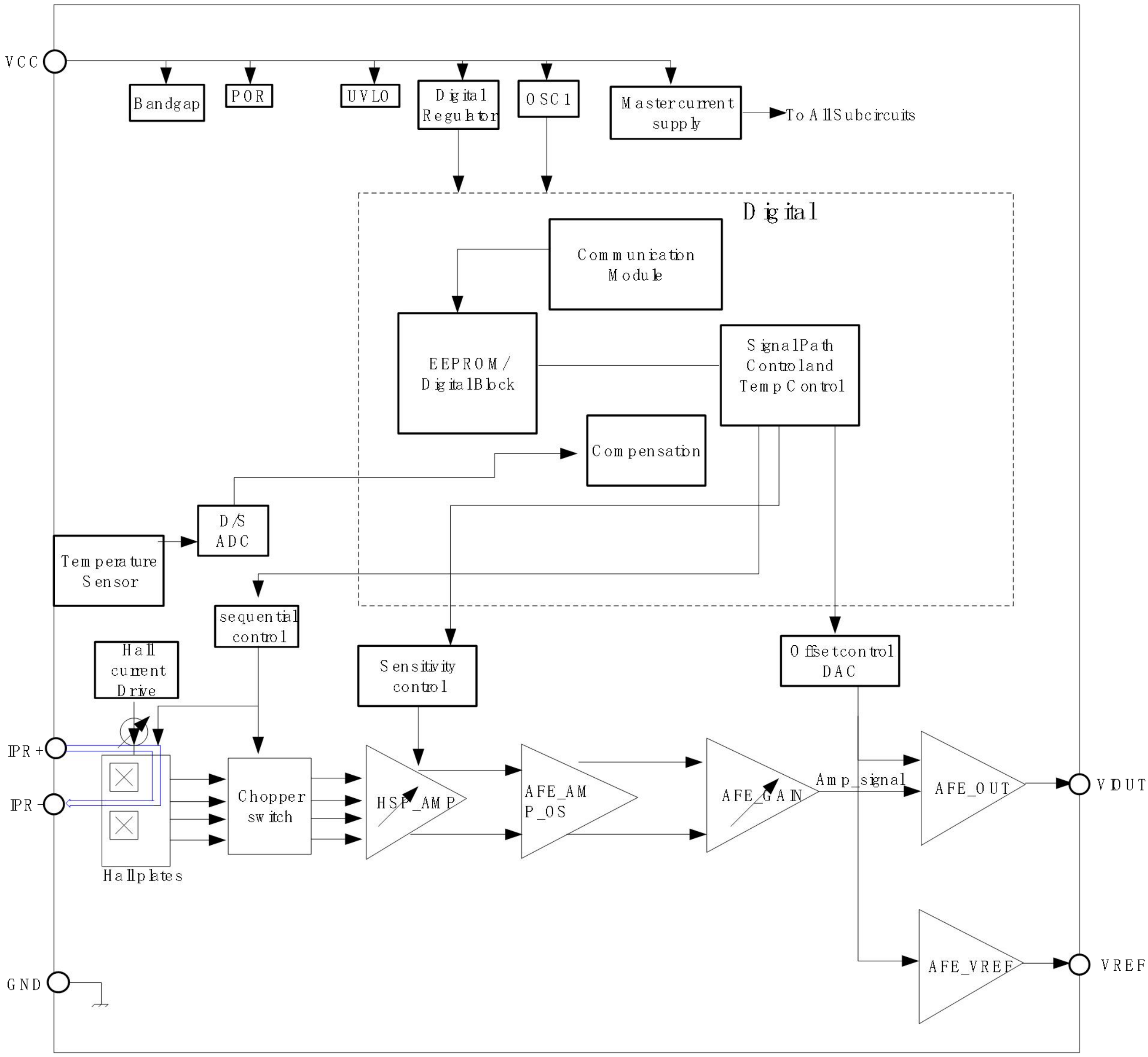


Figure 3, Block Diagram of OCH19605

■ Absolute Maximum Ratings

Characteristic	Symbol	Notes	Rating	Units
Supply Voltage	VCC		-0.3~6	V
Output Voltage	VIOUT		–0.3~VCC+0.3	V
Output source current	$IOUT\_{SOURCE}$		70	mA
Output sink current	$IOUT\_{SINK}$		3.5	mA
Maximum Continuous Current	IC_{MAX}	TA = 25°C	60	A
Operating Ambient Temperature	TA		–40 ~ 125	°C
Junction Temperature	T_J(max)		165	°C
Storage Temperature	Ts		–65 ~ 165	°C
ESD(HBM)	ESD	TA = 25°C	4K	V

■ ISOLATION CHARACTERISTICS

Characteristic	Symbol	Notes	Rating	Unit
Dielectric Strength Test Voltage	VISO	Agency type-tested for 60 seconds per UL 60950-1 (edition 2).	5500	VRMS
Working Voltage for Basic Isolation	VWVBI	Maximum approved working voltage for basic (single) isolation according to UL 60950-1 (edition 2). or	1550	VPK or VDC
			VDC 1097	VRMS
Working Voltage for Reinforced Isolation	VWVRI	Maximum approved working voltage for reinforced isolation according to UL 60950-1 (edition 2).	800	VPK or VDC
			565	VRMS
Clearance	Dcl	Minimum distance through air from IP leads to signal leads.	7.5	mm
Creepage	Dcr	Minimum distance along package body from IP leads to signal leads	8.2	mm

■ Electrical Characteristics

Valid through the full range of TA = –40°C to 125°C and VCC= 5 V, unless otherwise specified

Characteristic	Symbol	Notes	Rating			Unit
Supply Voltage	VCC	-	4.5	5	5.5	V
Undervoltage protection voltage	UVLO_H	VCC rise	2.85	3.0	3.15	V
	UVLO_L	VCC fall	-	2.55	2.8	V
	VHYS	UVLO_H- UVLO_L	0.05	0.45	-	V
Supply Current	ICC	VCC within VCC(min) and VCC(max)	-	16	20	mA
Output Capacitance Load	CL	VIOUT to GND Output	-	-	10	nF
Resistive Load	RL	VIOUT to GND	4.7	-	-	KΩ
Primary Conductor Resistance	RIP	TA = 25°C,IP=65A	-	0.85	-	mΩ
Primary Conductor Inductance	LIP	TA = 25°C	-	4	-	nH
Rise Time[1]	Tr	TA = 25°C, CL = 1 nF	-	1.8	-	us
Response Time[1]	$T_{RESPONSE}$	TA = 25°C, CL = 1 nF	-	1.6	-	us
Propagation Delay [1]	T_{PD}	TA = 25°C, CL = 1 nF	-	1.2	-	us
Output Slew Rate[1]	SR	TA = 25°C, CL = 1 nF	-	0.7	-	V/μs
Internal Bandwidth[1]	BW	Small signal –3 dB, CL = 1 nF	-	250	-	kHz
Noise	IN	Input-referenced noise density; TA = 25°C, CL = 1 nF	-	175	-	mA(RMS）
Nonlinearity Error	E_{LIN}	Through full range of IP – ±1 %	-1	0.2	1	%
Symmetry Error	E_{SYM}	IP=±IP_{MAX}	-1	0.2	1	%
Sensitivity Ratiometry Coefficient [2]	SENS_RAT_COEF	VCC = 4.5 to 5.5 V, TA = 25°C	-	1.25	-	-
Zero-Current Output Ratiometry Coefficient	QVO_RAT_COEF	VCC = 4.5 to 5.5 V, TA = 25°C	-	1	--	-
Saturation Voltage[3]	VOH	RL = 4.7 kΩ, TA = 25°C	VCC – 0.5	-	-	V
	VOL	RL = 4.7 kΩ, TA = 25°C	-	-	0.5	V
Power-On Time [4]	TPO		-	10	-	ms
Shorted Output to Ground Current	ISC_VIOUT(GND)	TA = 25°C	-	3	-	mA
Shorted Output to VCC Current	ISC_VIOUT(VCC)	TA = 25°C	-	70	-	mA
Shorted VREF to Ground Current	ISC_VREF(GND)	TA = 25°C	-	3	-	mA
Shorted VREF to VCC Current	ISC_VREF(VCC)	TA = 25°C	-	70	-	mA

Note1: According to definitions of dynamic response characteristics ,the parameters are guaranteed by design.

Note2: According to definitions of additional parameter characteristics ,

$$SENS_{RAT\_COEF} = [\frac{Sens(Vcc)}{Sens(5V)} - 1] * \frac{5V}{(Vcc - 5V)}$$

Note3: The sensor IC will continue to respond to current beyond the range of IP until the high or low saturation voltage; however, the nonlinearity in this region will be worse than through the rest of the measurement range..

Note4: When the supply is ramped to its operating voltage, OCH19605 requires a finite time to download the correct MTP before responding to an input magnetic field.

OCH19605-20AB PERFORMANCE CHARACTERISTICS: TA = –40°C to 125°C, VCC = 5 V, unless otherwise specified：

Characteristic	Symbol.	Test Conditions	Min.	Typ	Max	Units
NOMINAL PERFORMANCE						
Current Sensing Range	IPR	TA = 25°C, CL = 1 nF	-20	-	20	A
Sensitivity Sens	SENS	IPR(min)< IP < IPR(max)	-	100	-	mV/A
Zero Current Output Voltage	VOQ	Bidirectional; IP = 0 A	-	VCC × 0.5	-	V
Voltage Offset Error	VOE	IP = 0 A, TA = 25°C to 125°C	-15	±5	15	mV
		IP = 0 A, TA = –40°C to 25°C	-	±20	-	mV
Refence Voltage	VREF	TA = –40°C to 125°C	2.48	2.50	2.52	V
Sensitivity Error	ESENS	TA = 25°C to 125°C, measured at IP = IPR(max)	-2	±1	2	%
		TA = –40°C to 25°C measured at IP = IPR(max)	-	±1.5	-	%
Total Output Error	ETOT	IP = IPR(max), TA = 25°C to 125°C	-2.5	±1	2.5	%
		IP = IPR(max), TA = –40°C to 25°C	-	±2.5	-	%
Sensitivity Error Lifetime Drift	Esens_drift	-	-	±1	-	%
Total Output Error Lifetime Drift	Etot_drift	-	-	±1	-	%

OCH19605-30AB PERFORMANCE CHARACTERISTICS: TA = –40°C to 125°C, VCC = 5 V, unless otherwise specified：

Characteristic	Symbol.	Test Conditions	Min.	Typ	Max	Units
NOMINAL PERFORMANCE						
Current Sensing Range	IPR	TA = 25°C, CL = 1 nF	-30	-	30	A
Sensitivity Sens	SENS	IPR(min)< IP < IPR(max)	-	66	-	mV/A
Zero Current Output Voltage	VOQ	Bidirectional; IP = 0 A	-	VCC × 0.5	-	V
Voltage Offset Error	VOE	IP = 0 A, TA = 25°C to 125°C	-15	±5	15	mV
		IP = 0 A, TA = –40°C to 25°C	-	±20	-	mV
Refence Voltage	VREF	TA = –40°C to 125°C	2.48	2.50	2.52	V
Sensitivity Error	ESENS	TA = 25°C to 125°C, measured at IP = IPR(max)	-2	±1	2	%
		TA = –40°C to 25°C measured at IP = IPR(max)	-	±1.5	-	%
Total Output Error	ETOT	IP = IPR(max), TA = 25°C to 125°C	-2.5	±1	2.5	%
		IP = IPR(max), TA = –40°C to 25°C	-	±2.5	-	%
Sensitivity Error Lifetime Drift	Esens_drift	-	-	±1	-	%
Total Output Error Lifetime Drift	Etot_drift	-	-	±1	-	%

OCH19605-50AB PERFORMANCE CHARACTERISTICS: TA = –40°C to 125°C, VCC = 5 V, unless otherwise specified：

Characteristic	Symbol.	Test Conditions	Min.	Typ	Max	Units
NOMINAL PERFORMANCE						
Current Sensing Range	IPR	TA = 25°C, CL = 1 nF	-50	-	50	A
Sensitivity Sens	SENS	IPR(min)< IP < IPR(max)	-	40	-	mV/A
Zero Current Output Voltage	VOQ	Bidirectional; IP = 0 A	-	VCC × 0.5	-	V
Voltage Offset Error	VOE	IP = 0 A, TA = 25°C to 125°C	-15	±5	15	mV
		IP = 0 A, TA = –40°C to 25°C	-	±20	-	mV
Refence Voltage	VREF	TA = –40°C to 125°C	2.48	2.50	2.52	V
Sensitivity Error	ESENS	TA = 25°C to 125°C, measured at IP = IPR(max)	-2	±1	2	%
		TA = –40°C to 25°C measured at IP = IPR(max)	-	±1.5	-	%
Total Output Error	ETOT	IP = IPR(max), TA = 25°C to 125°C	-2.5	±1	2.5	%
		IP = IPR(max), TA = –40°C to 25°C	-	±2.5	-	%
Sensitivity Error Lifetime Drift	Esens_drift	-	-	±1	-	%
Total Output Error Lifetime Drift	Etot_drift	-	-	±1	-	%

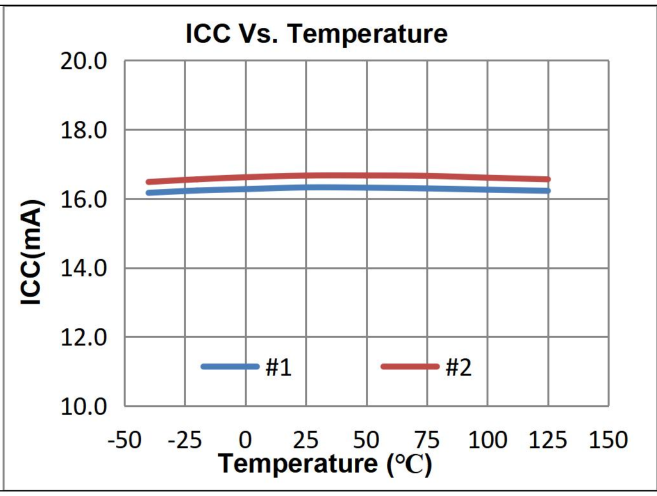
OCH19605-65AB PERFORMANCE CHARACTERISTICS: TA = –40°C to 125°C, VCC = 5 V, unless otherwise specified：

Characteristic	Symbol.	Test Conditions	Min.	Typ	Max	Units
NOMINAL PERFORMANCE						
Current Sensing Range	IPR	TA = 25°C, CL = 1 nF	-65	-	65	A
Sensitivity Sens	SENS	IPR(min)< IP < IPR(max)	29.83	30.75	31.67	mV/A
Zero Current Output Voltage	VOQ	Bidirectional; IP = 0 A	-	VCC × 0.5	-	V
Voltage Offset Error	VOE	IP = 0 A, TA = 25°C to 125°C	-15	±5	15	mV
		IP = 0 A, TA = –40°C to 25°C	-	±20	-	mV
Refence Voltage	VREF	TA = –40°C to 125°C	2.48	2.50	2.52	V
Sensitivity Error	ESENS	TA = 25°C to 125°C, measured at IP = IPR(max)	-2	±1	2	%
		TA = –40°C to 25°C measured at IP = IPR(max)	-	±1.5	-	%
Total Output Error	ETOT	IP = IPR(max), TA = 25°C to 125°C	-3	±1	3	%
		IP = IPR(max), TA = –40°C to 25°C	-	±2.5	-	%
Sensitivity Error Lifetime Drift	Esens_drift	-	-	±1	-	%
Total Output Error Lifetime Drift	Etot_drift	-	-	±1	-	%

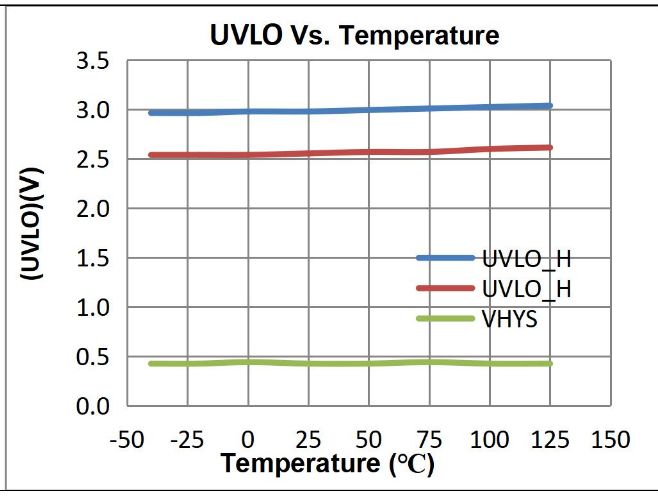
■ Typical Characteristics

OCH19605-typcal

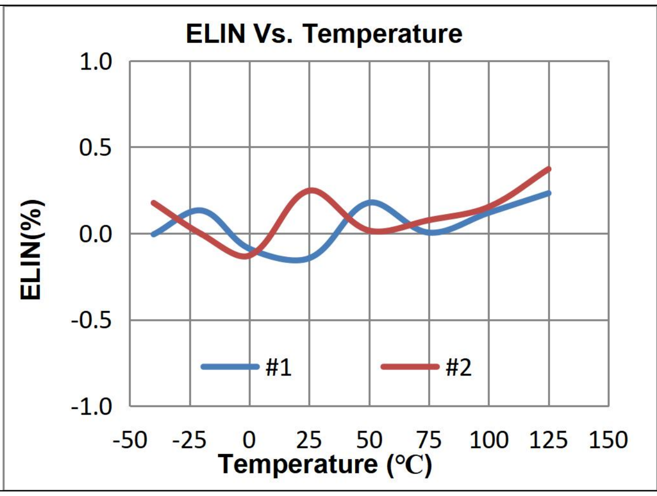
VCC Current vs. Temperature



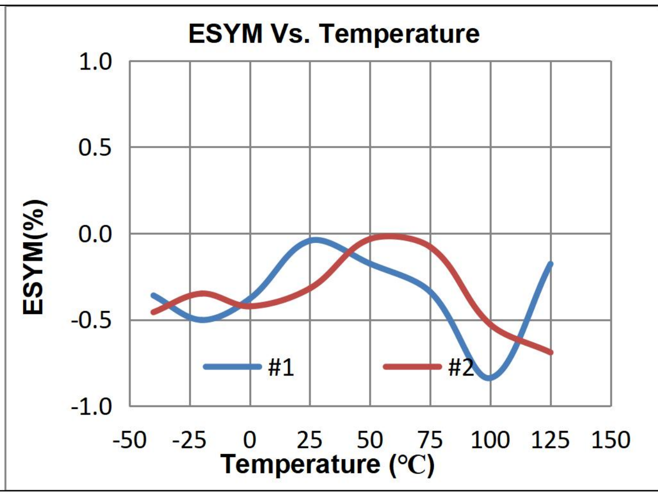
UVLO vs. Temperature



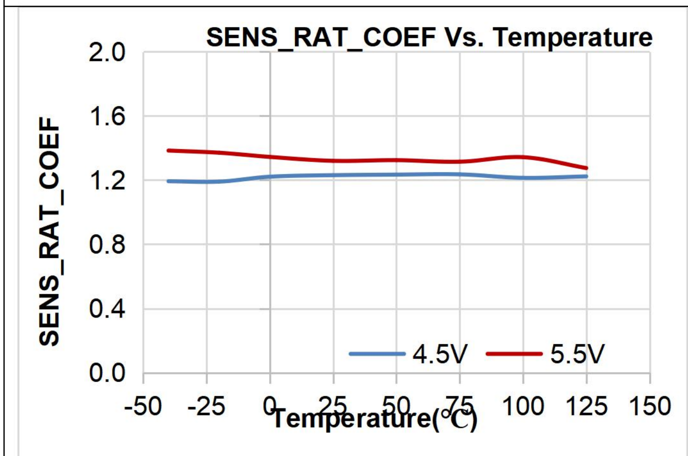
LIN vs. Temperature



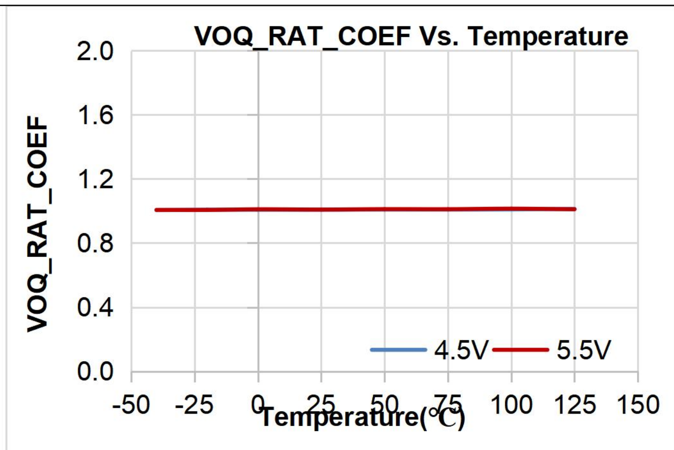
ESYM Error vs. Temperature



SENS_RAT_ COEF vs. Temperature

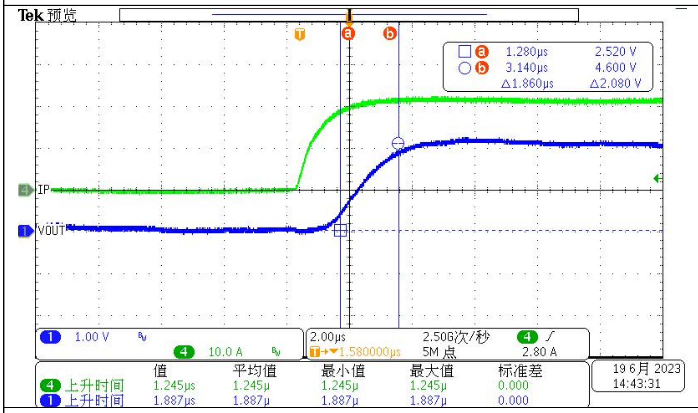


VOQ_RAT_ COEF vs. Temperature



OCH19605-typcal

Tr



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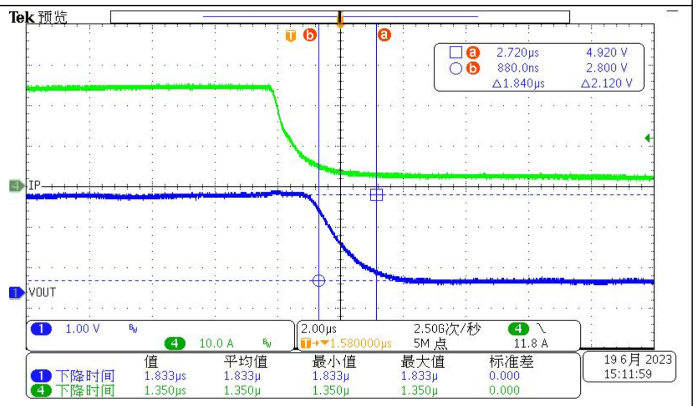
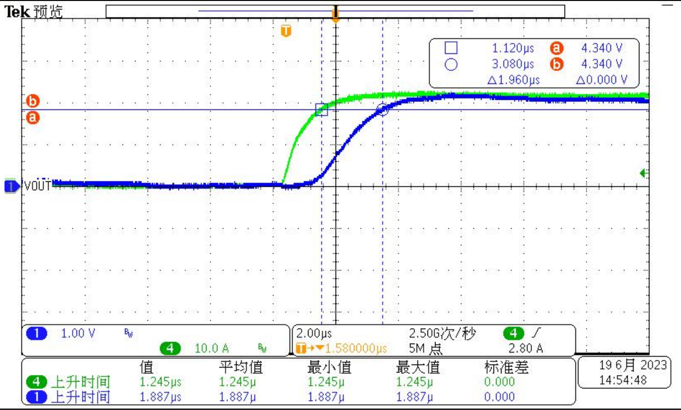
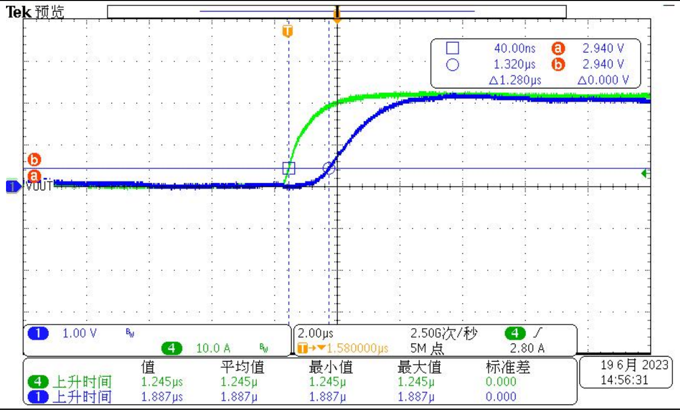


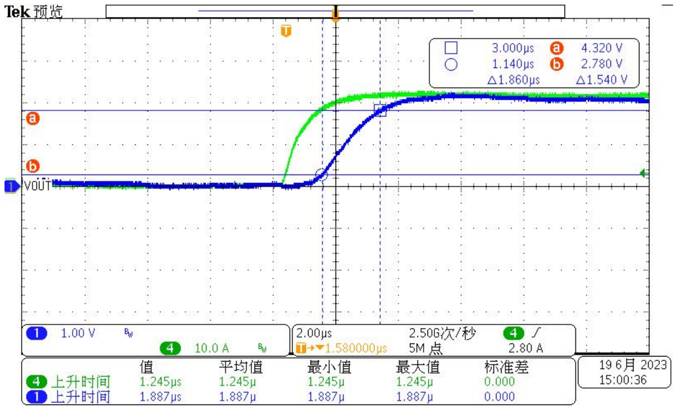
$T_{RESPONSE}$



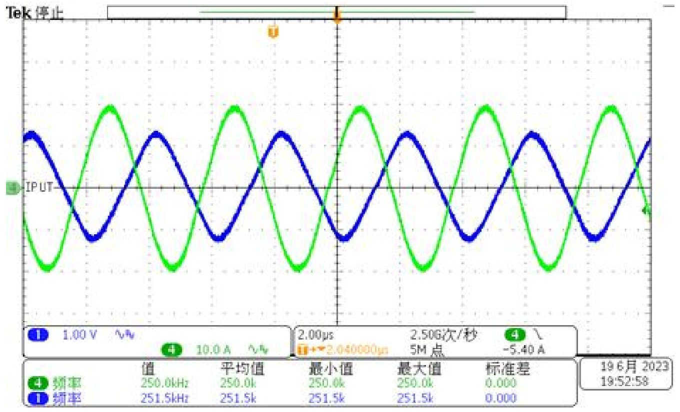
T_{PD}



SR

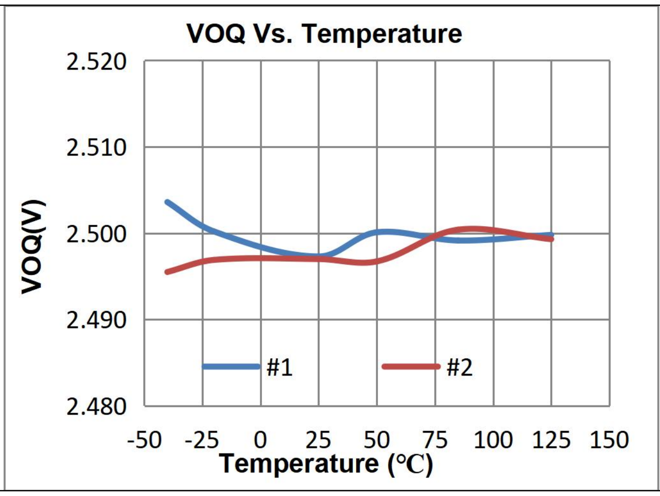


AC current vs VIOUT

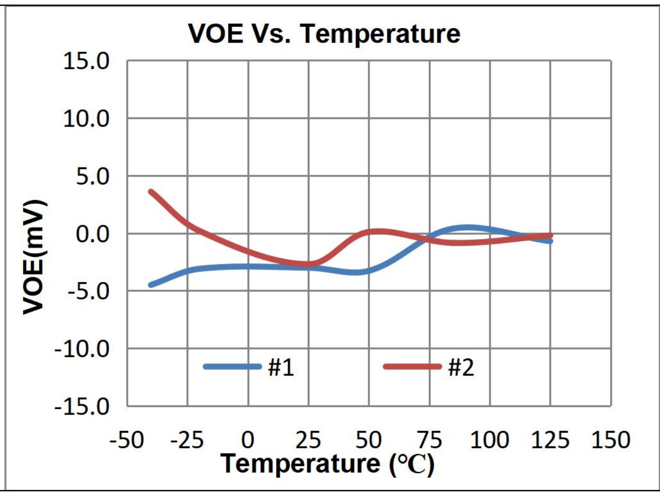


OCH19605-20AB

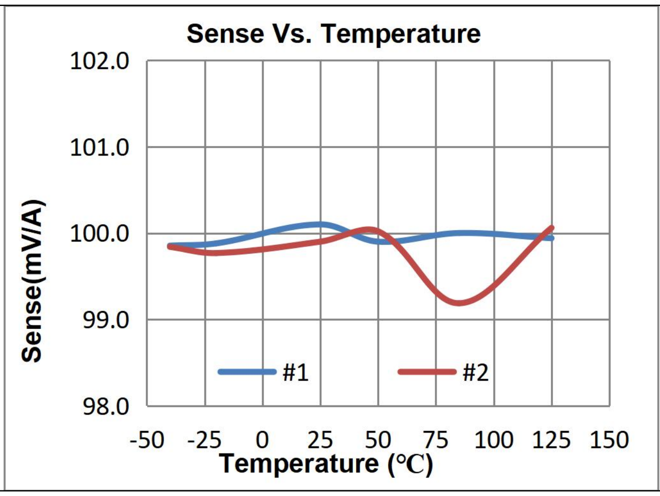
Zero Current Output Voltage vs. Temperature



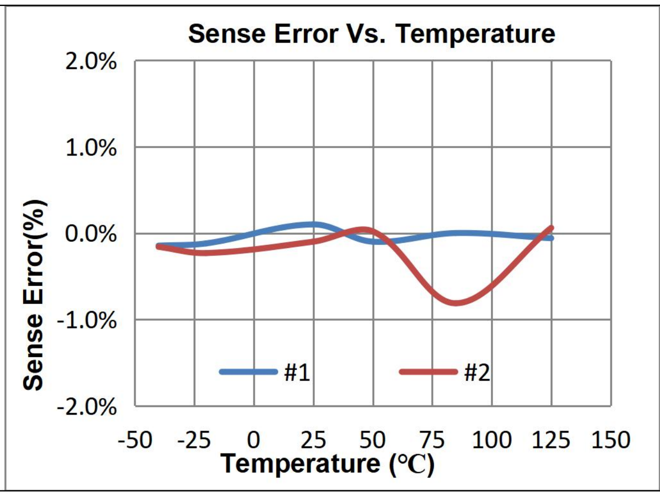
Offset Voltage vs. Temperature



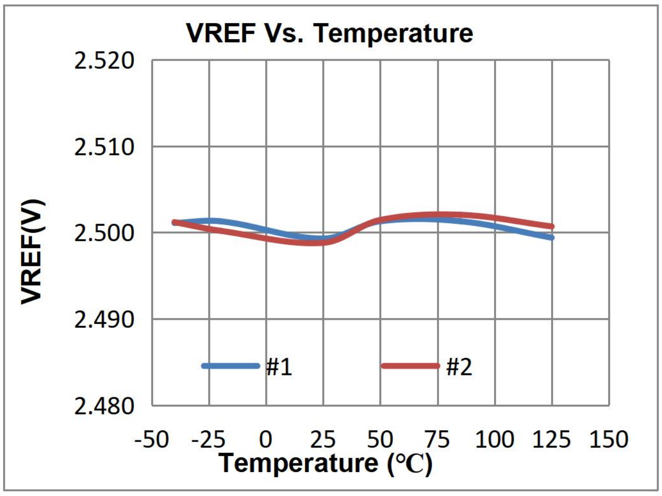
Sensitivity vs. Temperature



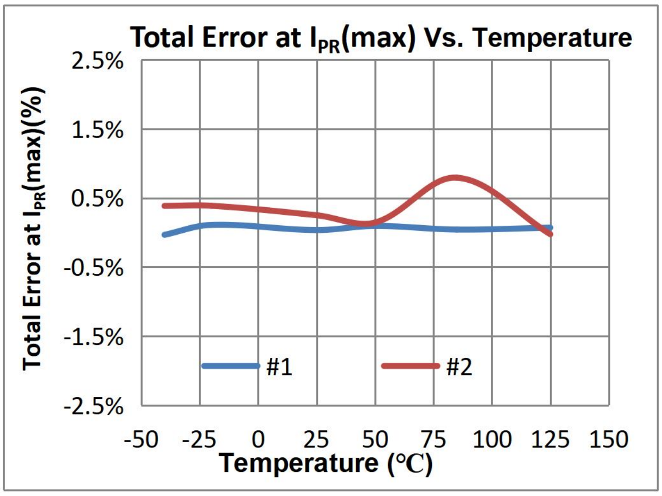
Sensitivity Error vs. Temperature



VREF vs. Temperature

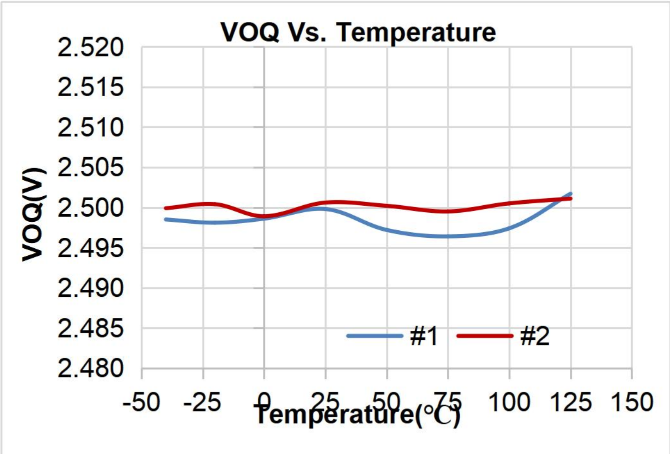


Total Error at I_{PR}(max) vs. Temperature

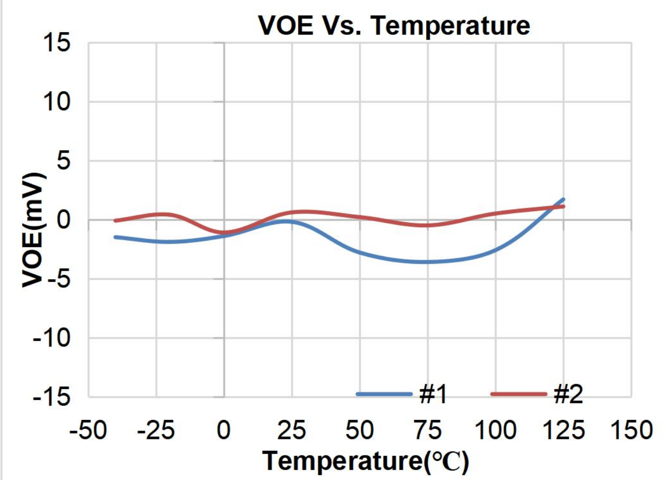


OCH19605-30AB

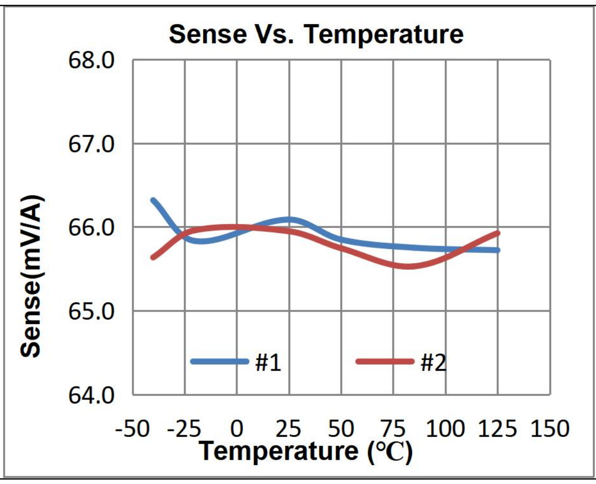
Zero Current Output Voltage vs. Temperature



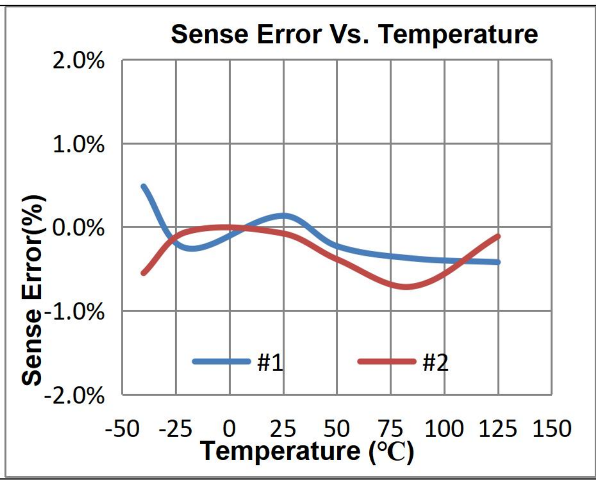
Offset Voltage vs. Temperature



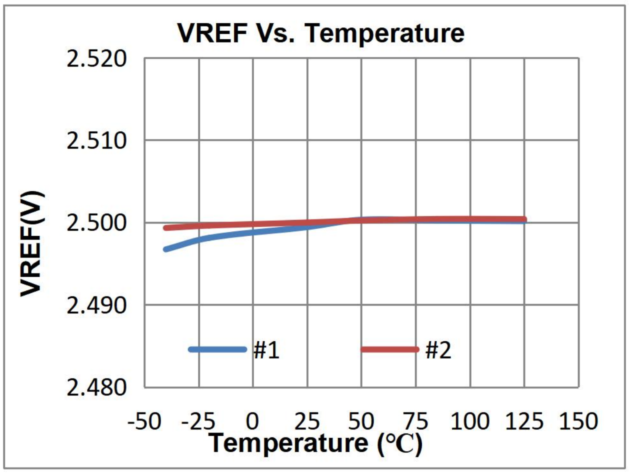
Sensitivity vs. Temperature



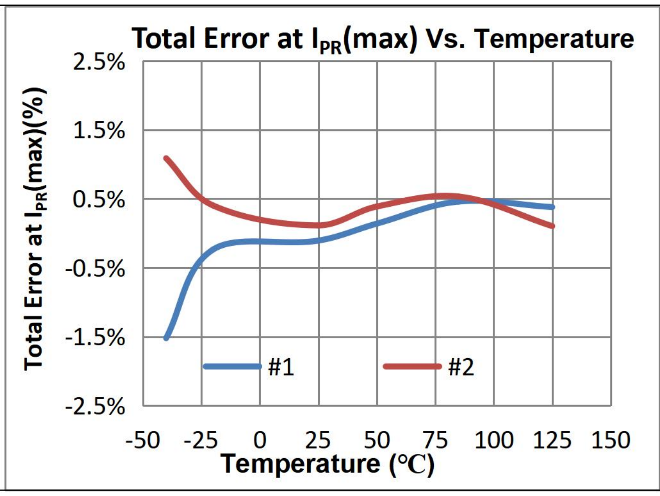
Sensitivity Error vs. Temperature



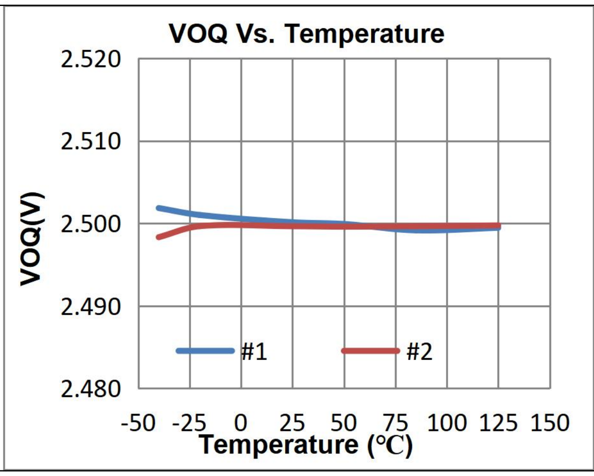
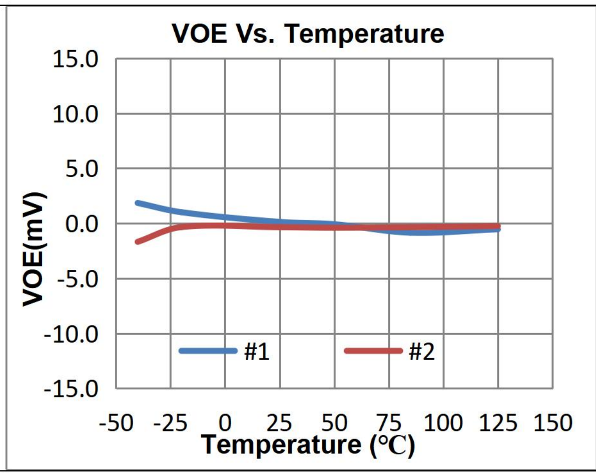
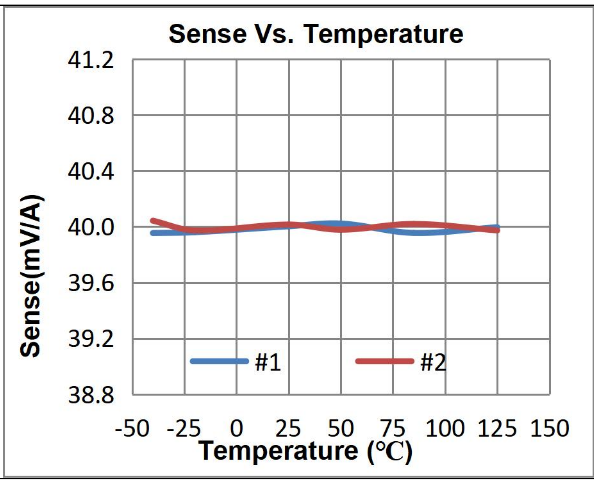
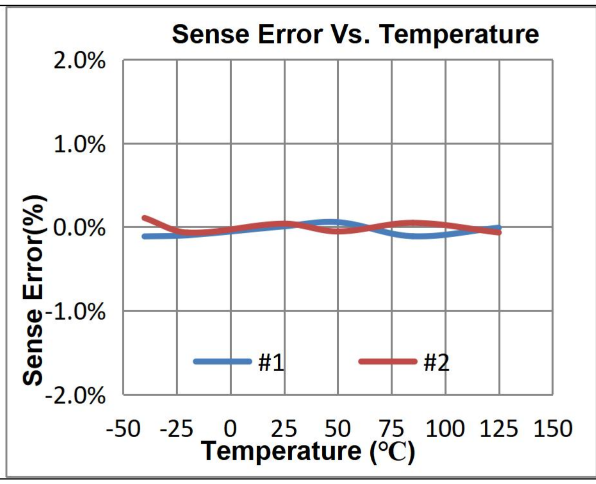
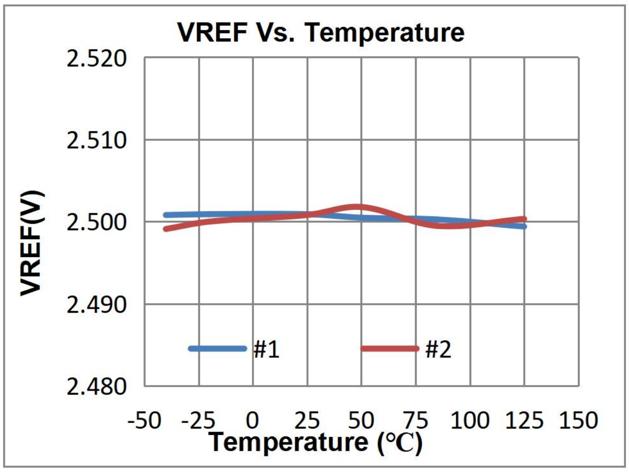
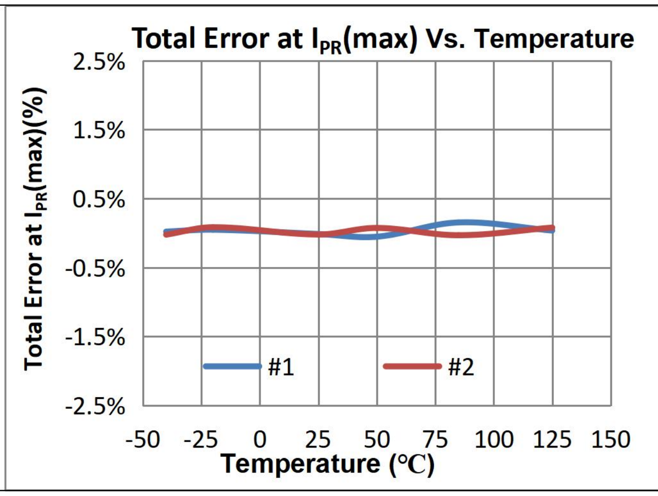
VREF vs. Temperature



Total Error at I_{PR}(max) vs. Temperature

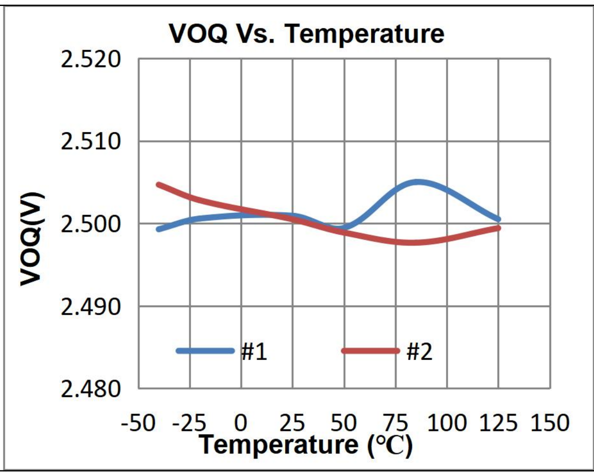


OCH19605-50AB

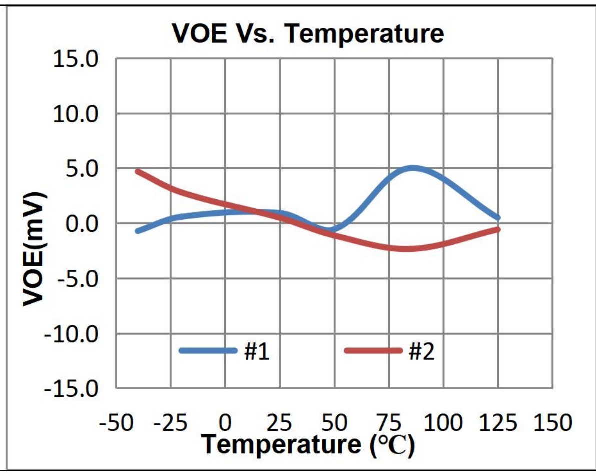
Zero Current Output Voltage vs. Temperature	Offset Voltage vs. Temperature
	
Sensitivity vs. Temperature	**Sensitivity Error vs. Temperature**
	
VREF vs. Temperature	**Total Error at I_{PR}(max) vs. Temperature**
	

OCH19605-65AB

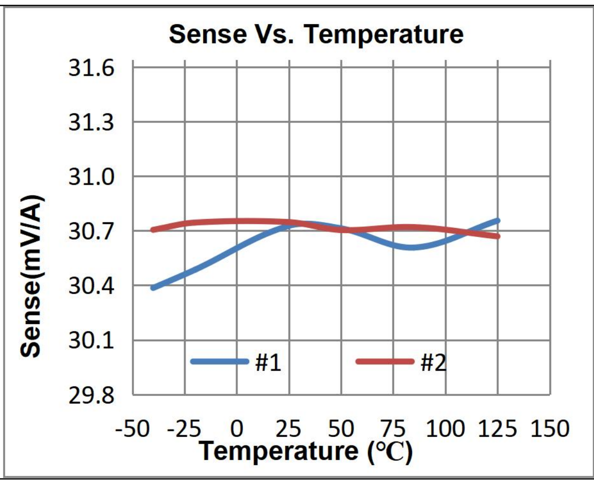
Zero Current Output Voltage vs. Temperature



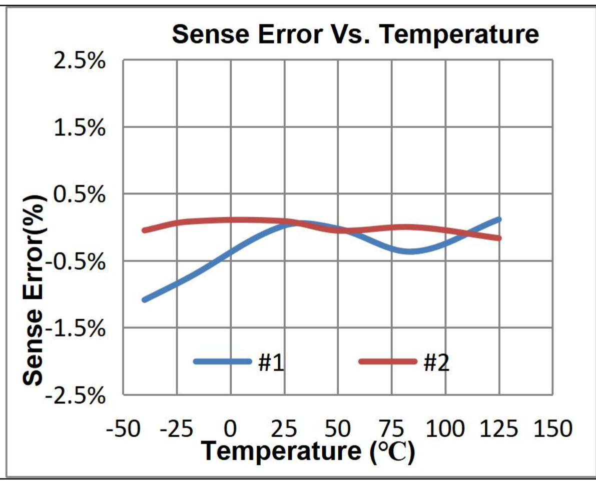
Offset Voltage vs. Temperature



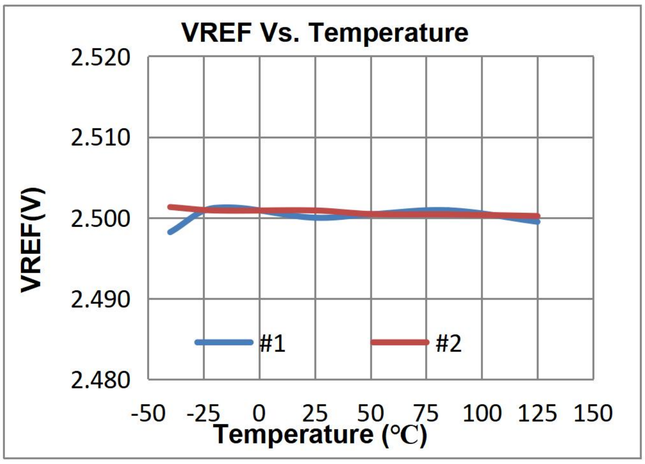
Sensitivity vs. Temperature



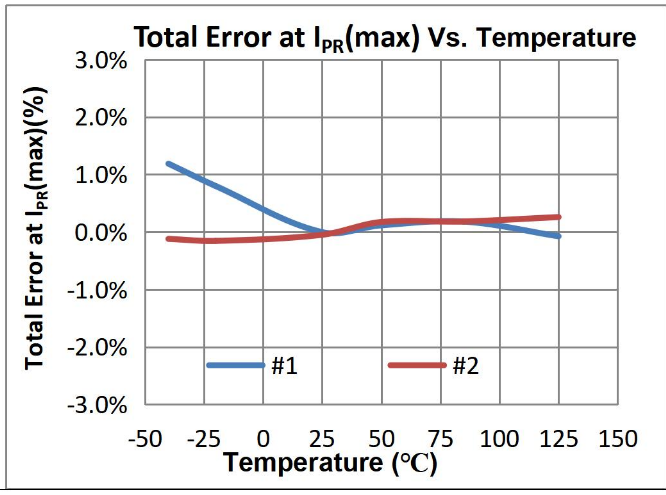
Sensitivity Error vs. Temperature



VREF vs. Temperature



Total Error at I_{PR}(max) vs. Temperature



■ DEFINITIONS OF ACCURACY CHARACTERISTICS

Sensitivity (Sens)

The change in sensor IC output in response to a IPR_MAX and IPR_1/2MAX change through the primary conductor. The sensitivity is the product of the magnetic coupling factor (G/A) (1 G = 0.1 mT) and the linear IC amplifier gain (mV/G). The linear IC amplifier gain is programmed at the factory to optimize the sensitivity (mV/A) for the full-scale current of the device.

$$Sens = \frac{V_{IOUT}(I_{PR(\max)}) - V_{IOUT}\left(I_{PR(\max)/2}\right)}{I_{PR(\max)} - I_{PR(\max)/2}}$$

Where VIOUT(IPR_MAX) is the output of the sensor IC with the maximum measurement current flowing through it and VIOUT(IPR_1/2MAX) is the output of the sensor IC with half of the maximum measurement current flowing through it.

Zero Current Output Voltage ($V_{IOUT(Q)}$)

The output of the sensor when the primary current is zero. For a unipolar supply voltage, it nominally remains at 0.5 × VCC for a bidirectional device and 0.1 × VCC for a unidirectional device. For example, in the case of a bidirectional output device, VCC = 5.0 V translates into $V_{IOUT(Q)}$ = 2.500 V.

Nonlinearity (E_{LIN})

The nonlinearity is a measure of how linear the output of the sensor IC is over the full current measurement range. The nonlinearity is calculated as:

$$E_{LIN} = \{1 - [\frac{V_{IOUT}(I_{PR(\max)}) - V_{IOUT(Q)}}{2 * V_{IOUT}\left(I_{PR(\max)/2}\right) - V_{IOUT(Q)}}]\} * 100(\%)$$

Offset Voltage (V_{OE})

The deviation of the device output from its ideal quiescent value of 0.5 × VCC (bidirectional) or 0.1 × VCC (unidirectional) due to nonmagnetic causes. To convert this voltage to amperes, divide by the device sensitivity, Sens.

$$V_{OE} = V_{IOUT(Q)} - V_{IOUT(Q)\_idel}$$

Total Output Error (E_{TOT})

The difference between the current measurement from the sensor IC and the actual current (I_P), relative to the actual current. This is equivalent to the difference between the ideal output voltage and the actual output voltage, divided by the ideal sensitivity, relative to the current flowing through the primary conduction path:

$$E_{TOT}(I_P) = \frac{V_{IOUT_{idel}}(I_P) - V_{IOUT}(I_P)}{Sens_{ideal}(I_P) * I_P} * 100(\%)$$

The Total Output Error incorporates all sources of error and is a function of IP. At relatively high currents, E_{TOT} will be mostly due to sensitivity error, and at relatively low currents, E_{TOT} will be mostly due to Offset Voltage (V_{OE}).

■ DEFINITIONS OF DYNAMIC RESPONSE CHARACTERISTICS

Power-On Time (T_{PO})

When the supply is ramped to its operating voltage, OCH19605 requires a finite time to download the correct MTP before responding to an input magnetic field. The typical MTP load time is10ms, after the power supply has reached its minimum specified operating voltage (VCC(min)). Power-On Time (T_{PO}) is defined as the time it takes for the output voltage to settle within ±10% of its steady-state value under an applied magnetic field, after the power supply has reached its minimum specified operating voltage (VCC(min)) as shown below in the chart.

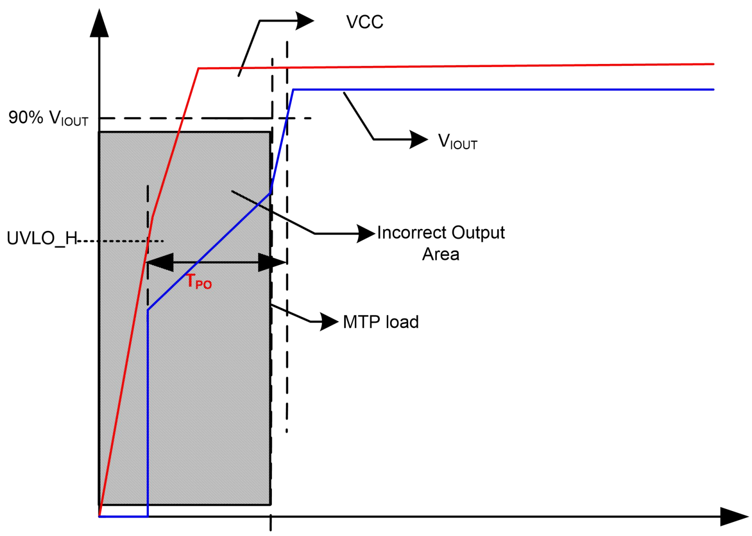


Figure 4, IC behavior when power on and the power-on time definition

Rise Time (Tr)

The time interval between the time of the sensor IC output reaches 10%~90% of its full-scale value (refer to Figure 5).

Output Slew Rate (SR)

The rate of change [V/μs] in the output voltage reaches 10%~90% of its full-scale value (refer to Figure 5).

Propagation Delay (T_{PD})

The time interval between the time of the primary current signal reaches 20% of its final value and the time of the sensor IC output reaches 20% of its corresponding to the applied current (refer to Figure 5).

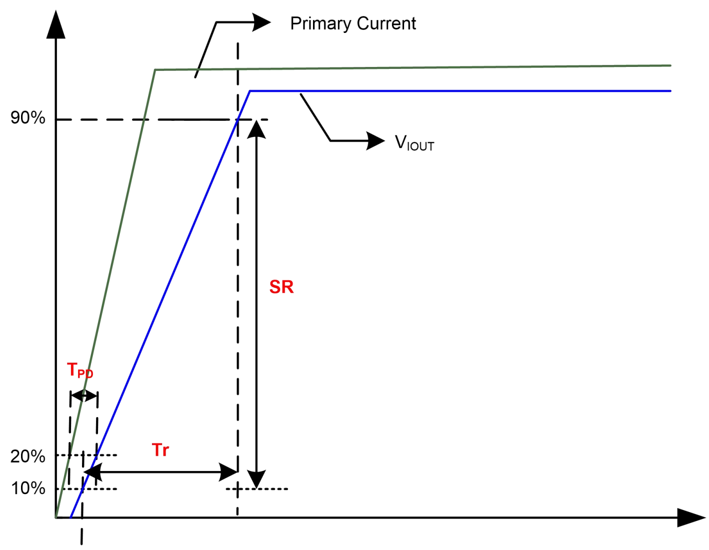


Figure 5, Tr time and T_{PD} time definition

Response Time ($T_{RESPONSE}$)
The time interval between the time of the primary current signal reaches 90% of its final value and the time of the sensor IC output reaches 90% of its corresponding to the applied current (refer to Figure 6).

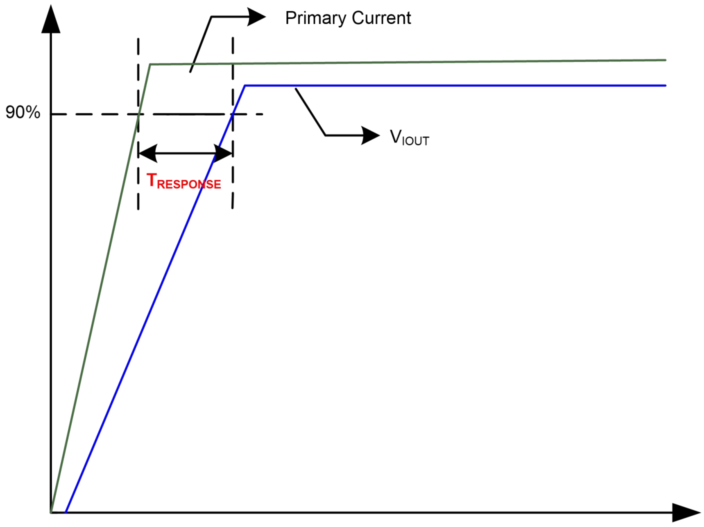


Figure 6, $T_{RESPONSE}$ time definition

■ DEFINITIONS OF ADDTIONAL PARAMETER CHARACTERISTICS

Sensitivity Ratiometry Coefficient
When the sensor IC operates within the operating voltage range 4.5~5.5V, the sensitivity is varying with the supply voltage. However, the output linear voltage range does not change with the supply voltage. So the sensitivity ratiometry coefficient characteristic of supply voltage is show below:

$$\mathrm{SENS_{RAT\_COEF}} = [\frac{Sens(Vcc)}{Sens(5V)} - 1] * \frac{5V}{(Vcc - 5V)}$$

VOQ Ratiometry Coefficient
When the sensor IC operates within the operating voltage range 4.5~5.5V, the VOQ is varying with the supply voltage. So the VOQ ratiometry coefficient characteristic of supply voltage is show below:

$$VOQ_{RAT\_COEF} = [\frac{VIOUTQ(V_{CC})}{VIOUTQ(5V)} - 1] * \frac{5V}{(Vcc - 5V)}$$

Thermal Rise vs. Primary Current

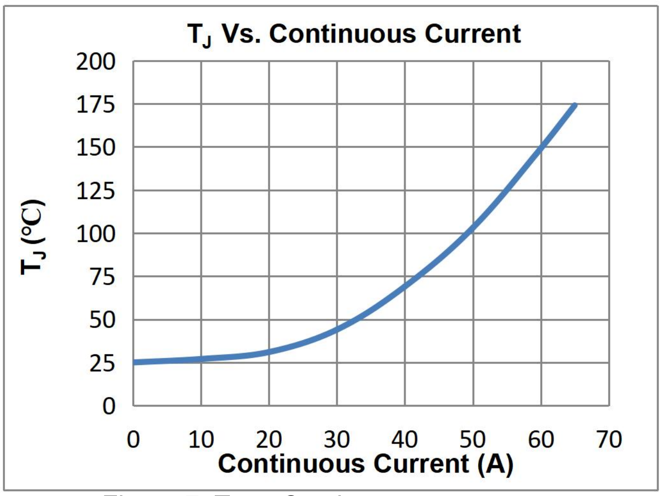
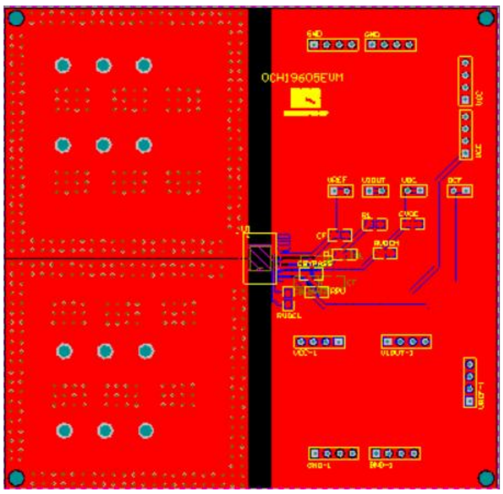


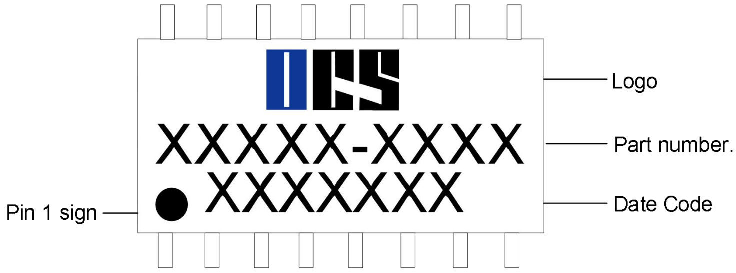
Figure 7, T_J vs Continuous current



Thickness 1.6mm, FR-4 double panel
2oz copper foil, total 8100mm^2
open environment, still air

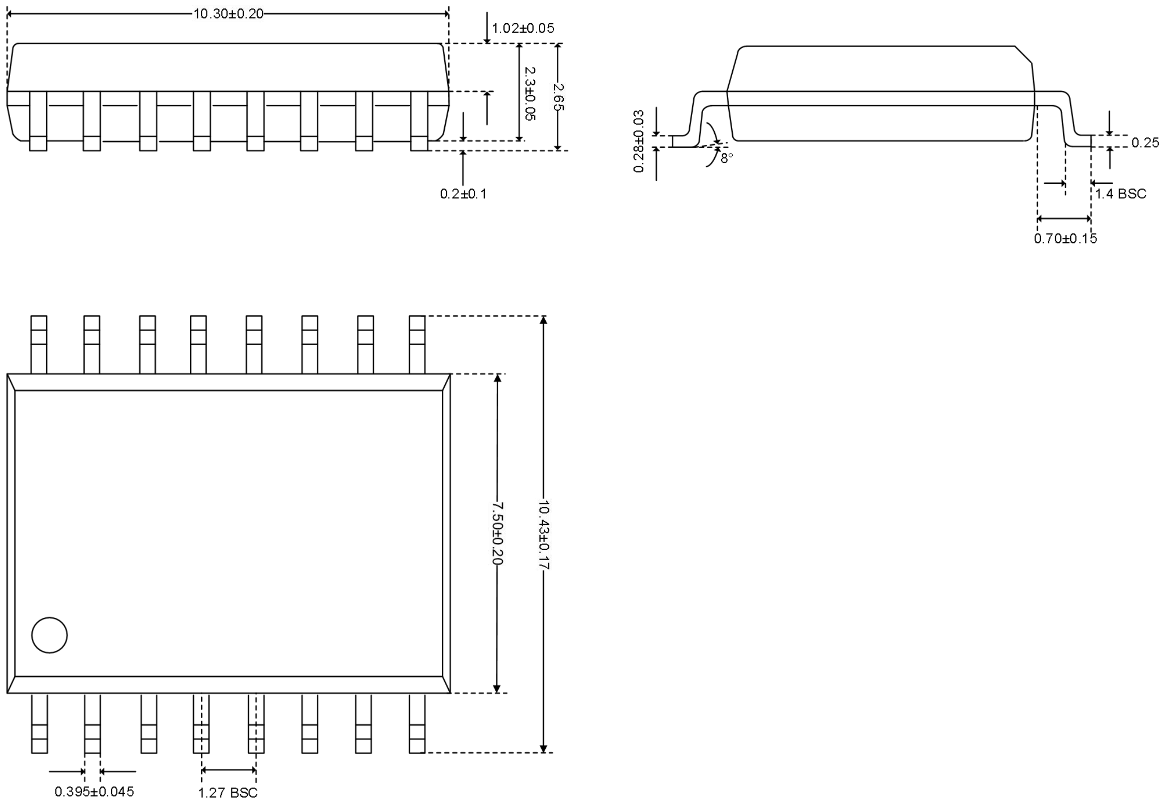
■ Marking Information

SOP-16L(W)



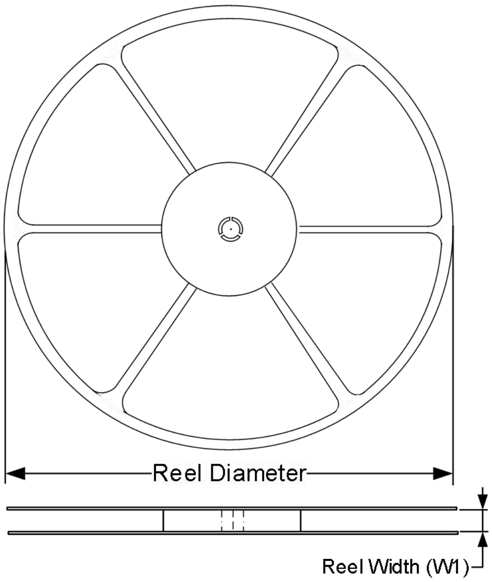
■ Package Information

SOP-16L(W)

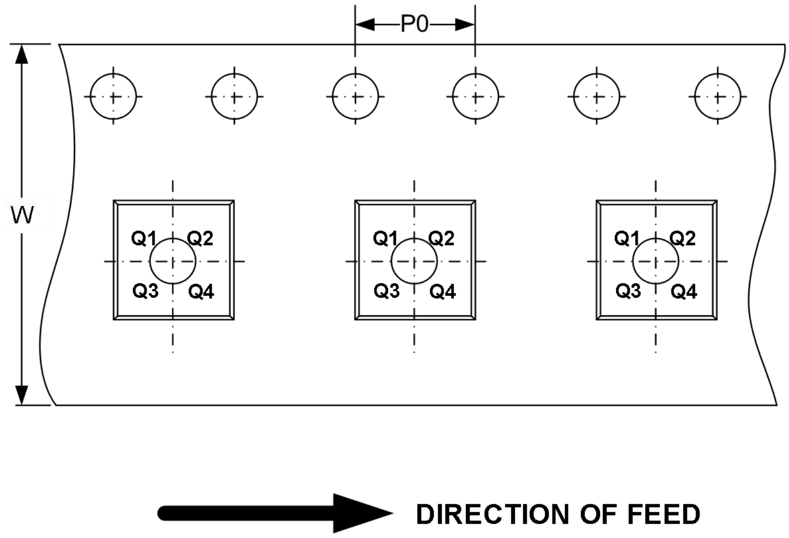


■ Packing Information

REEL DIMENSIONS



TAPE DIMENSIONS



Package type	SPQ (PCS)	Reel Diameter (mm)	Reel Width W1(mm)	W (mm)	P0 (mm)	MSL	Pin 1 Quadrant
SOP-16L(W)	1500	330	8.6	8.0	4.0	Level-3	Q1

Note: Carrier Tape Dimension, Reel Size and Packing Minimum.

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