MCS1805

Linear Hall-Effect Current Sensor with OCD, 3kV$_{RMS}$ Isolation, 580V$_{RMS}$ Working Voltage

DESCRIPTION

The MCS1805 is a linear Hall-effect current sensor IC for AC or DC current sensing. The differential Hall array cancels out any stray magnetic field.

The primary conductor's low resistance allows large currents to flow within close proximity to the integrated circuit, which contains high-accuracy Hall sensors. This current generates a magnetic field, which is sensed at two different points by the integrated Hall transducers. The magnetic field difference between these two points is then converted into a voltage that is proportional to the applied current. A spinning current technique is used for a low, stable offset.

The galvanic isolation between the pins of the primary conductive path and the sensor leads allow the MCS1805 to replace optoisolators or other isolation devices.

The MCS1805 integrates fast over-current detection (OCD), which makes it simple to monitor the system for OC events.

The MCS1805 requires a minimal number of external components. The device's small footprint saves board area and makes it well-suited for space-constrained applications. It is available in a SOIC-8 package.

FEATURES

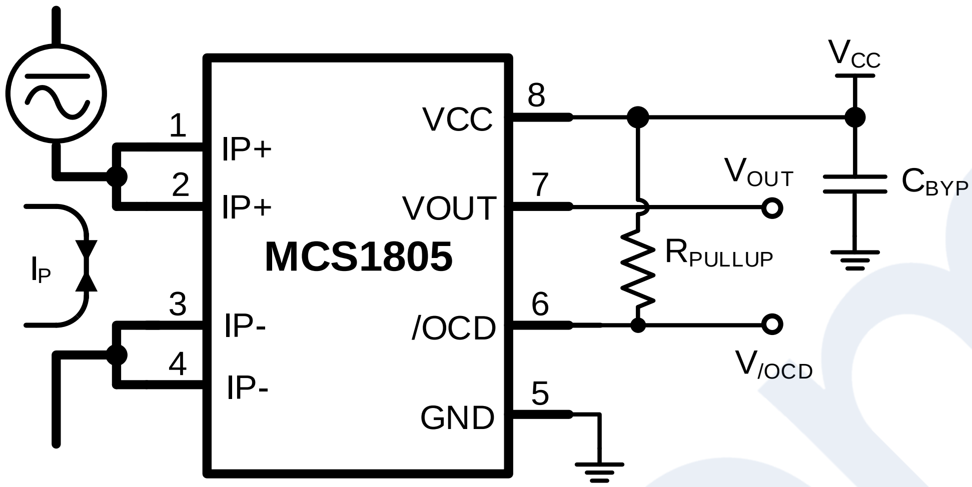
- 3.3V or 5V Single Supply Options
- Immune to External Gradient Magnetic Fields by Differential Sensing
- Extreme Low-Noise Density
- 3kV$_{RMS}$ Minimum Isolation Voltage
- 580V$_{RMS}$ Maximum Working Voltage
- ±2.5% Total Accuracy
- 5A to 50A Bidirectional or Unidirectional Range
- 120kHz Bandwidth
- Custom Over Current Detection (OCD) from 50% to 240% of I_{PMAX}
- Fast OCD with 1µs Response Time
- Output Voltage (VOUT) Proportional to AC or DC Currents
- Ratiometric V_{OUT} from Supply Voltage
- Factory-Trimmed for Accuracy
- Available in an SOIC-8 Package

Certificate Number:
B 113824 0012 Rev.00
CBS 113824 0013 Rev.00

APPLICATIONS

- Motor Control
- Automotive Systems
- Load Detection and Management
- Switch-Mode Power Supplies
- Over-Current Fault Protection

TYPICAL APPLICATION



ORDERING INFORMATION

Part Number *, **	Supply Voltage (V)	Rated Current Range (A)	Sensitivity (SENS) (mV/A)	OCD Threshold (A)	Top Marking	MSL Rating
MCS1805GS-305-B	3.3	±5	264	±5	*MCS1805*	*1*
MCS1805GS-310-B	3.3	±10	132	±10		
MCS1805GS-320-B	3.3	±20	66	±20		
MCS1805GS-330-B	3.3	±30	44	±30		
MCS1805GS-340-B	3.3	±40	33	±40		
MCS1805GS-350-B	3.3	±50	26.4	±50		
MCS1805GS-305-U	3.3	5	528	5		
MCS1805GS-310-U	3.3	10	264	10		
MCS1805GS-320-U	3.3	20	132	20		
MCS1805GS-330-U	3.3	30	88	30		
MCS1805GS-340-U	3.3	40	66	40		
MCS1805GS-350-U	3.3	50	52.8	50		
MCS1805GS-505-B	5	±5	400	±5		
MCS1805GS-510-B	5	±10	200	±10		
MCS1805GS-520-B	5	±20	100	±20		
MCS1805GS-530-B	5	±30	66	±30		
MCS1805GS-540-B	5	±40	50	±40		
MCS1805GS-550-B	5	±50	40	±50		
MCS1805GS-505-U	5	5	800	5		
MCS1805GS-510-U	5	10	400	10		
MCS1805GS-520-U	5	20	200	20		
MCS1805GS-530-U	5	30	132	30		
MCS1805GS-540-U	5	40	100	40		
MCS1805GS-550-U	5	50	80	50		

* For Tape & Reel, add suffix -Z (e.g. MCS1805GS-305-B-Z).

** Contact an MPS FAE for additional variants.

PART NUMBERING
(MCS1805GS-ABB-CDDD)

G	Operating Temperature (T_J): -40°C to +125°C	BB	Rated Current Range
S	Package Code for SOIC-8	C	Current Polarity: B = Bidirectional U = Unidirectional
A	Supply Voltage: 3 = 3.3V Supply 5 = 5V Supply	DDD	OCD Threshold: Blank = 100% I_{PMAX} (Default) 050 = 50% I_{PMAX} 150 =150% I_{PMAX} Contact the factory for other OCD level options.

TOP MARKING

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 MCS1805
LLLLLLLL
  MPSYWW
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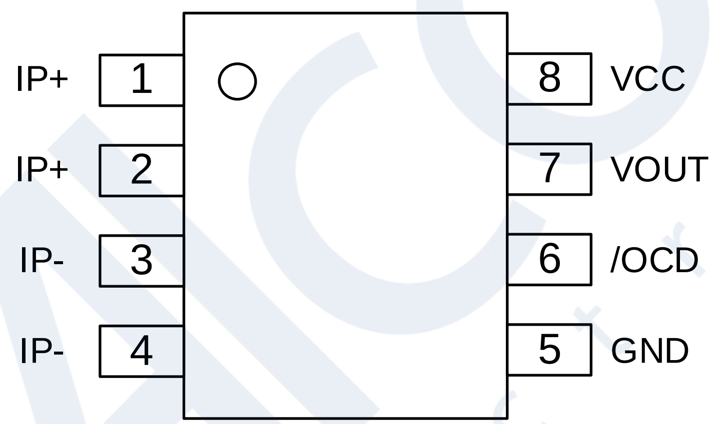
MCS1805: Part number
LLLLLLLL: Lot number
MPS: MPS prefix
Y: Year code
WW: Week code

PACKAGE REFERENCE

TOP VIEW



SOIC-8 (5mmx4mm)

PIN FUNCTIONS

Pin #	Name	Description
1, 2	IP+	**Primary current (+).** The IP+ pin is the positive terminal for the current being sampled. IP+ is fused internally.
3, 4	IP-	**Primary current (-).** The IP- pin is the negative terminal for the current being sampled. IP- is fused internally.
5	GND	**Ground.** The GND pin is the signal ground terminal.
6	/OCD	**Over-current detection.** The /OCD pin is an open drain, active low. Connect a 10kΩ to 500kΩ resistor from /OCD to VCC.
7	VOUT	**Analog output signal.**
8	VCC	**Voltage supply.** Connect a 0.1µF to 1µF bypass capacitor from the VCC pin to GND.

ABSOLUTE MAXIMUM RATINGS [1]

Supply voltage (V_{CC}) ....-0.3V to +6.5V
Output voltage (V_{OUT})...................-0.3V to +6.5V
$V_{/OCD}$...-0.3V to +6.5V
Junction temperature ....165°C
Lead temperature ....260°C
Storage temperature................ -65°C to +165°C

ESD Ratings

Human body model (HBM) .... ±2kV
Charged device model (CDM) .... ±2kV

Recommended Operating Conditions [2]

Supply voltage (V_{CC}) (3.3V option).....................
....3V to 3.6V
V_{CC} (5V option)...............................4.5V to 5.5V
Operating junction temp (T_J).... -40°C to +125°C

Notes:

1) Exceeding these ratings may damage the device.
2) The device is not guaranteed to function outside of its operating conditions.

ISOLATION CHARACTERISTICS

Parameters	Symbol	Condition	Rating	Units
Dielectric surge strength test voltage	V_{SURGE}	Test ±5 pulses at 2/minute, 1.2µs (rise) / 50µs (width) according to IEC 61000-4-5	6000	V
Withstand isolation voltage	V_{ISO}	Agency type-tested for 60 seconds in accordance with IEC62368-1:2018. 100% tested in production in accordance with IEC 62368-1:2018	3000	V_{RMS}
Maximum isolation working voltage	V_{IOWM}	Maximum approved working voltage for basic isolation, according to IEC 62368-1:2018	820	V_{PK} or V_{DC}
			580	V_{RMS}
External clearance	CLR	Shortest distance through the air from the IP leads to the signal leads	4.2	mm
External creepage	CPG	Shortest distance along the package body from the IP leads to the signal leads	4.2	mm

WITHSTANDING CURRENT CAPABILITY

Parameters	Symbol	Conditions	Rating	Units
Surge current test	I_{SURGE}	Test ±5 pulses at 2/minute, 8µs (rise) / 20µs (width) according to IEC61000-4-5	3000	A
Transient current test (3)	$I_{TRANSIENT}$	Single peak, 10ms	200	A

Note:

3) For the detailed transient current capability test, refer to MPS application note AN178, which is available on the MPS website.

MCS1805GS COMMON ELECTRICAL CHARACTERISTICS

V_{CC} = 3.3V for 3.3V option and V_{CC} = 5V for 5V option, T_J = -40°C to +125°C, typical values at T_J = 25°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ	Max	Units
Supply voltage	V_{CC}	3.3V option	3.0		3.6	V
		5V option	4.5		5.5	V
V_{CC} under-voltage lockout (UVLO) threshold	V_{CC_UVLO}	V_{CC} rising	2	2.5	3	V
V_{CC} UVLO hysteresis	$V_{CC\_UVLO\_HYS}$			400	500	mV
Operating supply current	I_{CC}	V_{CC} = 3.3V for 3.3V option		8	12	mA
		V_{CC} = 5V for 5V option		8	12	mA
Output capacitance load (6)	C_L	From VOUT to GND			4.7	nF
Output resistive load (6)	R_L	From VOUT to GND	4.7			kΩ
Primary conductor resistance	R_P	Effective		1.2		mΩ
Frequency bandwidth	f_{BW}			120		kHz
Power-on time	t_{PO}	$I_P = I_{PMAX}$		80		µs
Rise time	t_R	$I_P = I_{PMAX}$		3		µs
Propagation delay	t_{PD}	$I_P = I_{PMAX}$		2		µs
Response time	$t_{RESPONSE}$	$I_P = I_{PMAX}$		4		µs
Noise density	I_{ND}	Input referred noise density		100		µA(rms) / √Hz
Noise	I_N	Input referred noise, 120kHz BW		35		$mA_{(RMS)}$
Nonlinearity	E_{LIN}	Across the full I_P range		0.5		%
Ratiometry (6)	K_{SENS}	$V_{CC} = V_{CC\_MIN}$ to V_{CC_MAX}	98	100	102	%
	K_{VO}	$V_{CC} = V_{CC\_MIN}$ to V_{CC_MAX}, I_P = 0A	99	100	101	%
Zero-current output voltage	$V_{OUT(Q)}$ (I_P = 0A)	Bidirectional option		V_{CC} / 2		V
		Unidirectional option		0.1 x V_{CC}		V
First Hall magnetic coupling factor	P_{MCF1}			1.15		mT/A
Second Hall magnetic coupling factor	P_{MCF2}			0.25		mT/A
Hall plate matching	M_H			±1		%
Saturation voltage (4) (6)	$V_{OUT(H)}$	3.3V option, R_L = 4.7kΩ, T_J = 25°C	V_{CC} - 0.3			V
		5V option, R_L = 4.7kΩ, T_J = 25°C	V_{CC} - 0.5			V
	$V_{OUT(L)}$	3.3V option, R_L = 4.7kΩ, T_J = 25°C			0.3	V
		5V option, R_L = 4.7kΩ, T_J = 25°C			0.5	V

MCS1805GS COMMON ELECTRICAL CHARACTERISTICS *(continued)*

V_{CC} = 3.3V for 3.3V option and V_{CC} = 5V for 5V option, T_J = -40°C to +125°C, typical values at T_J = 25°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ	Max	Units
/OCD low voltage (6)	$V_{/OCD\_L}$	Over-current detection (OCD) triggered, R_{PULLUP} = 10kΩ			0.3	V
/OCD External Pull-up Resistance (6)	R_{PULLUP}	Connect from /OCD to VCC	10		500	kΩ
OCD current hysteresis	$I_{/OCD\_HYST}$	Percentage of $I_{/OCD}$	3	12		%
OCD error	$E_{/OCD}$		-10	±5	+10	%
OCD response time (6)	$t_{RESPONSE\_/OCD}$	Time from I_P > $I_{/OCD}$ to $V_{/OCD}$ falling below $V_{/OCD\_L}$		1	1.5	µs

MCS1805GS-305-B PERFORMANCE CHARACTERISTICS

V_{CC} = 3.3V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		-5		+5	A
Sensitivity	SENS	-5A ≤ I_P ≤ +5A, T_J = 25°C		264		mV/A
Sensitivity error	E_{SENS}	I_P = 5A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 5A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-15		+15	mV
		I_P = 0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 5A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 5A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-310-B PERFORMANCE CHARACTERISTICS

V_{CC} = 3.3V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		-10		+10	A
Sensitivity	SENS	-10A ≤ I_P ≤ +10A, T_J = 25°C		132		mV/A
Sensitivity error	E_{SENS}	I_P = 10A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 10A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-10		+10	mV
		I_P = 0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 10A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 10A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-320-B PERFORMANCE CHARACTERISTICS

V_{CC} = 3.3V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		-20		+20	A
Sensitivity	SENS	-20A ≤ I_P ≤ +20A, T_J = 25°C		66		mV/A
Sensitivity error	E_{SENS}	I_P = 20A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 20A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-10		+10	mV
		I_P = 0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 20A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 20A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-330-B PERFORMANCE CHARACTERISTICS

V_{CC} = 3.3V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		-30		+30	A
Sensitivity	SENS	-30A ≤ I_P ≤ +30A, T_J = 25°C		44		mV/A
Sensitivity error	E_{SENS}	I_P = 30A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 30A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-10		+10	mV
		I_P = 0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 30A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 30A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-340-B PERFORMANCE CHARACTERISTICS

V_{CC} = 3.3V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		-40		+40	A
Sensitivity	SENS	-40A ≤ I_P ≤ +40A, T_J = 25°C		33		mV/A
Sensitivity error	E_{Sens}	I_P = 40A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 40A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-10		+10	mV
		I_P = 0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 40A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 40A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-350-B PERFORMANCE CHARACTERISTICS

V_{CC} = 3.3V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		-50		+50	A
Sensitivity	SENS	-50A ≤ I_P ≤ +50A, T_J = 25°C		26.4		mV/A
Sensitivity error	E_{SENS}	I_P = 50A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 50A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-10		+10	mV
		I_P = 0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 50A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 50A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-305-U PERFORMANCE CHARACTERISTICS

V_{CC} = 3.3V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		0		5	A
Sensitivity	SENS	0A ≤ I_P ≤ 5A, T_J = 25°C		528		mV/A
Sensitivity error	E_{SENS}	I_P = 5A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 5A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-15		+15	mV
		I_P = 0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 5A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 5A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-310-U PERFORMANCE CHARACTERISTICS

V_{CC} = 3.3V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		0		10	A
Sensitivity	SENS	0A ≤ I_P ≤ 10A, T_J = 25°C		264		mV/A
Sensitivity error	E_{SENS}	I_P = 10A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 10A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-10		+10	mV
		I_P = 0A, T_J =- 40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 10A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 10A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-320-U PERFORMANCE CHARACTERISTICS

V_{CC} = 3.3V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		0		20	A
Sensitivity	SENS	0A ≤ I_P ≤ 20A, T_J = 25°C		132		mV/A
Sensitivity error	E_{SENS}	I_P= 20A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 20A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-10		+10	mV
		I_P = 0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 20A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 20A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-330-U PERFORMANCE CHARACTERISTICS

V_{CC} = 3.3V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		0		30	A
Sensitivity	SENS	0A ≤ I_P ≤ 30A, T_J = 25°C		88		mV/A
Sensitivity error	E_{SENS}	I_P = 30A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 30A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-10		+10	mV
		I_P = 0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 30A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 30A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-340-U PERFORMANCE CHARACTERISTICS

V_{CC} = 3.3V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		0		40	A
Sensitivity	SENS	0A ≤ I_P ≤ 40A, T_J = 25°C		66		mV/A
Sensitivity error	E_{SENS}	I_P = 40A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 40A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-10		+10	mV
		I_P = 0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 40A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 40A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-350-U PERFORMANCE CHARACTERISTICS

V_{CC} = 3.3V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		0		50	A
Sensitivity	SENS	0A ≤ I_P ≤ 50A, T_J = 25°C		52.8		mV/A
Sensitivity error	E_{SENS}	I_P = 50A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 50A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-10		+10	mV
		I_P = 0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 50A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 50A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-505-B PERFORMANCE CHARACTERISTICS

V_{CC} = 5V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		-5		+5	A
Sensitivity	SENS	-5A ≤ I_P ≤ +5A, T_J = 25°C		400		mV/A
Sensitivity error	E_{SENS}	I_P = 5A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 5A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-15		+15	mV
		I_P = 0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 5A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 5A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-510-B PERFORMANCE CHARACTERISTICS

V_{CC} = 5V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		-10		+10	A
Sensitivity	SENS	-10A ≤ I_P ≤ +10A, T_J = 25°C		200		mV/A
Sensitivity error	E_{SENS}	I_P = 10A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 10A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-15		+15	mV
		I_P = 0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 10A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 10A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-520-B PERFORMANCE CHARACTERISTICS

V_{CC} = 5V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		-20		+20	A
Sensitivity	SENS	-20A ≤ I_P ≤ +20A, T_J = 25°C		100		mV/A
Sensitivity error	E_{SENS}	I_P = 20A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 20A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-10		+10	mV
		I_P = 0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 20A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 20A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-530-B PERFORMANCE CHARACTERISTICS

V_{CC} = 5V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		-30		+30	A
Sensitivity	SENS	-30A ≤ I_P ≤ +30A, T_J = 25°C		66		mV/A
Sensitivity error	E_{SENS}	I_P = 30A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 30A, T_J = -40°C to +25°C		±1.5		%
Offset voltage (6)	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-10		+10	mV
		I_P = 0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 30A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 30A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-540-B PERFORMANCE CHARACTERISTICS

V_{CC} = 5V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		-40		+40	A
Sensitivity	SENS	-40A ≤ I_P ≤ +40A, T_J = 25°C		50		mV/A
Sensitivity error	E_{SENS}	I_P = 40A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 40A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-10		+10	mV
		I_P = 0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 40A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 40A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-550-B PERFORMANCE CHARACTERISTICS

V_{CC} = 5V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		-50		+50	A
Sensitivity	SENS	-50A ≤ I_P ≤ +50A, T_J = 25°C		40		mV/A
Sensitivity error	E_{SENS}	I_P = 50A, T_J= 25°C to 125°C	-2		+2	%
		I_P = 50A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-10		+10	mV
		I_P = 0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 50A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 50A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-505-U PERFORMANCE CHARACTERISTICS

V_{CC} = 5V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		0		5	A
Sensitivity	SENS	0A ≤ I_P ≤ 5A, T_J = 25°C		800		mV/A
Sensitivity error	E_{SENS}	I_P = 5A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 5A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-35		+35	mV
		I_P = 0A, T_J = -40°C to +25°C		±20		mV
Total output error	E_{TOT}	I_P = 5A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 5A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-510-U PERFORMANCE CHARACTERISTICS

V_{CC} = 5V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		0		10	A
Sensitivity	SENS	0A ≤ I_P ≤ 10A, T_J = 25°C		400		mV/A
Sensitivity error	E_{SENS}	I_P = 10A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 10A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-20		+20	mV
		I_P = 0A, T_J = -40°C to +25°C		±10		mV
Total output error	E_{TOT}	I_P = 10A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 10A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-520-U PERFORMANCE CHARACTERISTICS

V_{CC} = 5V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ [5]	Max	Units
Rated current range	I_P		0		20	A
Sensitivity	SENS	0A ≤ I_P ≤ 20A, T_J = 25°C		200		mV/A
Sensitivity error	E_{SENS}	I_P = 20A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 20A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-10		+10	mV
		I_P = 0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 20A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 20A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-530-U PERFORMANCE CHARACTERISTICS

V_{CC} = 5V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ [5]	Max	Units
Rated current range	I_P		0		30	A
Sensitivity	SENS	0A ≤ I_P ≤ 30A, T_J = 25°C		132		mV/A
Sensitivity error	E_{SENS}	I_P = 30A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 30A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-10		+10	mV
		I_P =0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 30A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 30A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-540-U PERFORMANCE CHARACTERISTICS

V_{CC} = 5V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ [5]	Max	Units
Rated current range	I_P		0		40	A
Sensitivity	SENS	0A ≤ I_P ≤ 40A, T_J = 25°C		100		mV/A
Sensitivity error	E_{SENS}	I_P = 40A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 40A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-10		+10	mV
		I_P = 0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 40A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 40A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

MCS1805GS-550-U PERFORMANCE CHARACTERISTICS

V_{CC} = 5V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (5)	Max	Units
Rated current range	I_P		0		50	A
Sensitivity	SENS	0 ≤ I_P ≤ 50A, T_J = 25°C		80		mV/A
Sensitivity error	E_{SENS}	I_P = 50A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 50A, T_J = -40°C to +25°C		±1.5		%
Offset voltage	V_{OE}	I_P = 0A, T_J = 25°C to 125°C	-10		+10	mV
		I_P = 0A, T_J = -40°C to +25°C		±5		mV
Total output error	E_{TOT}	I_P = 50A, T_J =25°C to 125°C	-2.5		+2.5	%
		I_P = 50A, T_J = -40°C to +25°C		±2		%
Sensitivity error lifetime drift	$E_{SENS(D)}$			±1		%
Total output error lifetime drift	$E_{TOT(D)}$			±1		%

Notes:

4) In addition to the rated current range (I_{PMAX}), the current sensor continues to provide an analog output voltage proportional to the primary current until the high or low saturation voltage. However, the nonlinearity increases beyond the rated current range (I_P).
5) Typical values with "±" are ±3σ values.
6) Guaranteed by design and characterization.

FUNCTIONAL BLOCK DIAGRAM

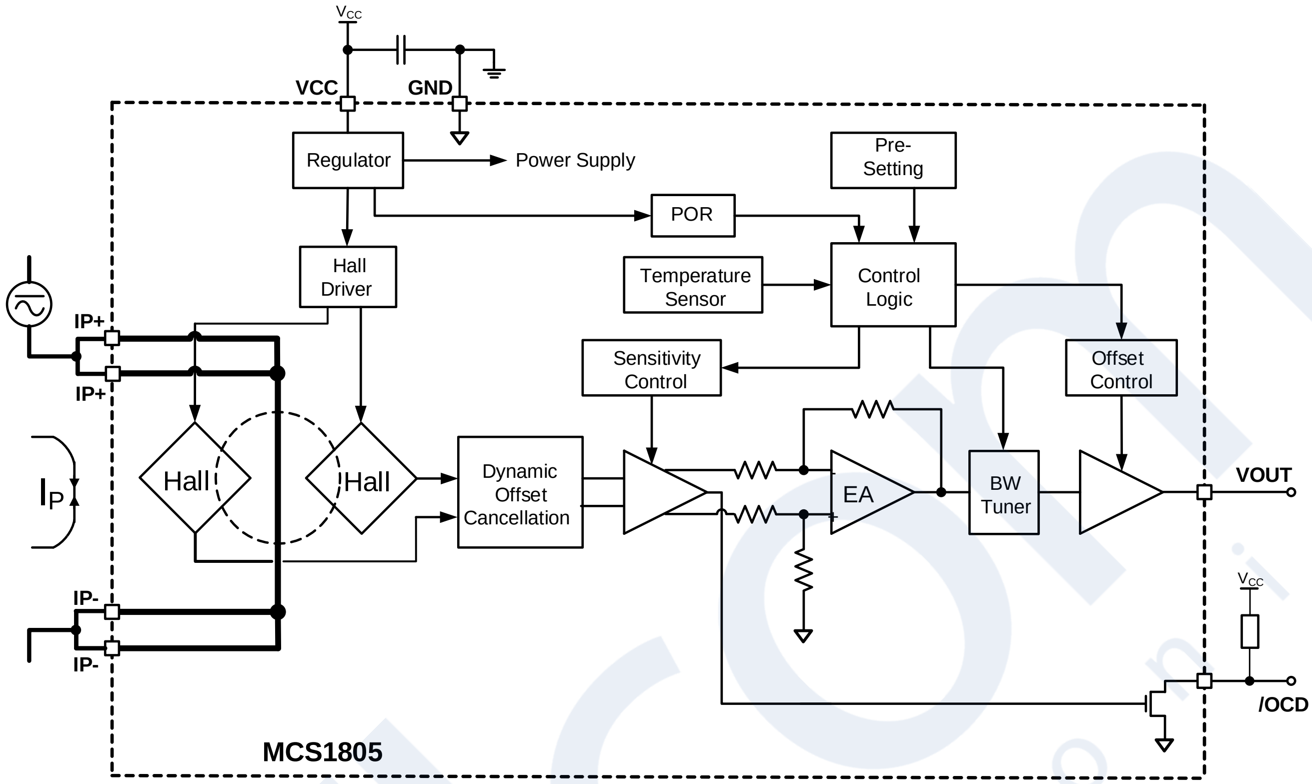


Figure 1: Functional Block Diagram

DEFINITIONS

Current Rating

I_{PMAX} is the rated current. The sensor's output is linear, as a function of the primary current (I_P), and the output voltage (V_{OUT}) follows the specified performance(s) when I_P is within the rated current range. The sensor's ideal output voltage can be calculated with Equation (1):

$$V_{OUT\_IDEAL}(I_P) = V_{OUT(Q)\_TYP} + SENS_{\_TYP} \times I_P \quad (1)$$

Where $V_{OUT(Q)\_TYP}$ is the typical zero-current output voltage, and $SENS_{\_TYP}$ is the typical sensitivity. Figure 2 shows the sensor's output function.

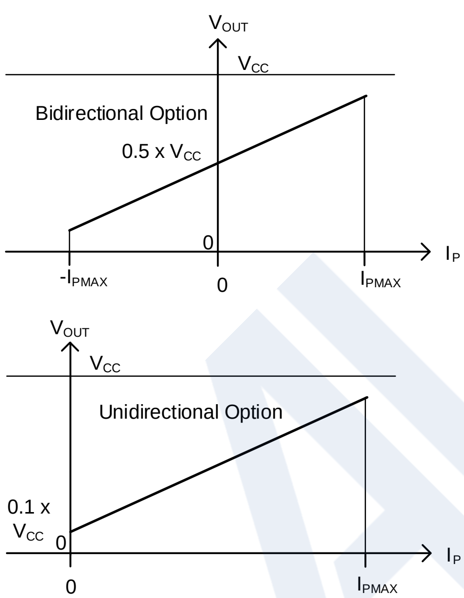


Figure 2: Sensor Output Function

Sensitivity (SENS)

The sensitivity (SENS, in mV/A) indicates how much V_{OUT} changes when I_P changes. It is the product of the average between the two coupling constants, P_{MCF1} and P_{MCF2} (in mT/A), and the transducer gain (in mV/mT). The gain is factory-trimmed to the sensor's target sensitivity.

Coupling Constants (P_{MCF1} and P_{MCF2})

Figure 3 shows a cross-section of the sensor. The first and second Hall magnetic coupling factors are defined as the amount of vertical magnetic field (denoted as the arrows B_1 and B_2 in Figure 3) produced at the sensing points 1 and 2, per unit of current injected in the primary conductor.

Due to the primary conductor's asymmetrical shape, the magnetic field generated in the two sensing points are different (see Figure 3).

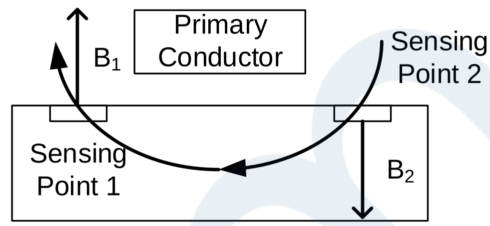


Figure 3: Sensor's Cross-Section

Noise (I_N)

The noise (I_N) is a random deviation that cannot be removed by calibrating the device. The input's referred noise is the root mean square (rms) of the sensor's output noise (in mV), divided by SENS (in mV/A). I_N represents the smallest current that the device can resolve without any external signal treatment.

Zero-Current Output Voltage ($V_{OUT(Q)}$)

$V_{OUT(Q)}$ is the output voltage when I_P is zero. For the typical value, see the Electrical Characteristics section on page 7.

Offset Voltage (V_{OE})

The offset voltage (V_{OE}) is the difference between the zero-current output's typical value and $V_{OUT(Q)}$. The variation is due to thermal drift, as well as the factory's resolution limits related to voltage offset trimming. To convert this voltage into amperes, divide V_{OE} by SENS.

Nonlinearity (E_{LIN})

I_P and the sensor's V_{OUT} should have a linear relationship, indicated by a straight line. A line that is not straight indicates nonlinearity, which is a deviation.

Nonlinearity (in %) can be estimated with Equation (2):

$$E_{LIN} = \frac{Max(V_{OUT}(I_P) - V_{LIN}(I_P))}{V_{OUT}(I_{PMAX}) - V_{OUT}(-I_{PMAX})} \times 100 \quad (2)$$

Where $V_{LIN}(I_P)$ is the approximate straight line calculated by the least square method.

Depending on the curvature of $V_{OUT}(I_P)$, E_{LIN} can be positive or negative.

Total Output Error (E_{TOT})

The total output error (E_{TOT}, in %) is the relative difference between the sensor's V_{OUT} and the ideal output at a given I_P. E_{TOT} can be calculated with Equation (3):

$$E_{TOT}(I_P) = \frac{V_{OUT}(I_P) - V_{OUT\_IDEAL}(I_P)}{SENS_{\_TYP} \times I_P} \times 100 \quad (3)$$

Where $SENS_{\_TYP}$ is the typical sensitivity, and $V_{OUT\_IDEAL}(I_P)$ is the ideal output voltage calculated with Equation (1) on page 18.

E_{TOT} incorporates all error sources and is a function of I_P. At currents close to I_{PMAX}, E_{TOT} is mainly caused by the sensitivity error. At currents close to 0A, E_{TOT} is mainly caused by V_{OE}. When I_P = 0A, E_{TOT} diverges to infinity due to the constant offset.

Ratiometry Coefficients

For ratiometric options, the sensor's V_{OUT} is ratiometric. This means that the sensitivity and the zero-current output scale with the supply voltage (V_{CC}). The ratiometry coefficients (K_{SENS} and K_{VO}) measure whether the sensitivity and zero-current output are proportional.

K_{SENS} can be estimated with Equation (4):

$$K_{SENS} = \frac{SENS(V_{CC}) / SENS(V_{CC\_TYP})}{V_{CC} / V_{CC\_TYP}} \quad (4)$$

K_{VO} can be calculated with Equation (5):

$$K_{VO} = \frac{V_{OUT}(I_P = 0, V_{CC}) / V_{OUT}(I_P = 0, V_{CC\_TYP})}{V_{CC} / V_{CC\_TYP}} \quad (5)$$

Where V_{CC_TYP} = 3.3V for the 3.3V option, and V_{CC_TYP} = 5V for the 5V option.

Ideally, both K_{SENS} and K_{VO} are equal to 1.

Power-On Time (t_{PO})

The power-on time (t_{PO}) is the time interval from when power is first applied to the device until the output can correctly indicate the applied I_P. t_{PO} is defined as the time between the following moments:

1. t1: The supply reaches the minimum operating voltage (V_{CC_UVLO}).
2. t2: V_{OUT} settles to 90% of its final value under an applied I_P (see Figure 4).

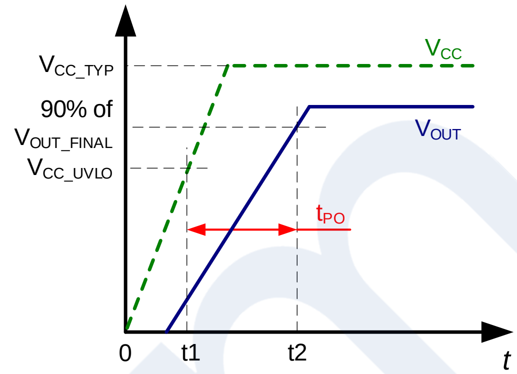


Figure 4: Power-On Time (t_{PO})

Propagation Delay (t_{PD})

The propagation delay (t_{PD}) represents the internal latency between an event that has been measured and the sensor's response. t_{PD} is defined as the time between the following moments:

1. t1: I_P reaches 20% of its final value.
2. t2: V_{OUT} reaches 20% of its final value, as it corresponds to the applied I_P (see Figure 5).

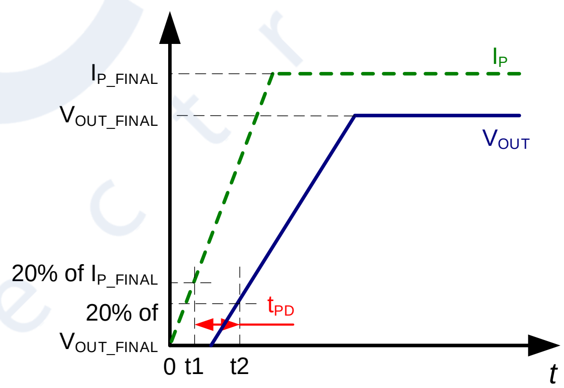


Figure 5: Propagation Delay (t_{PD})

Rise Time (t_R)

The rising time (t_R) is defined as the time between the following moments:

1. t1: The sensor's V_{OUT} reaches 10% of its full-scale value.
2. t2: The sensor's V_{OUT} reaches 90% of its full-scale value (see Figure 6 on page 20).

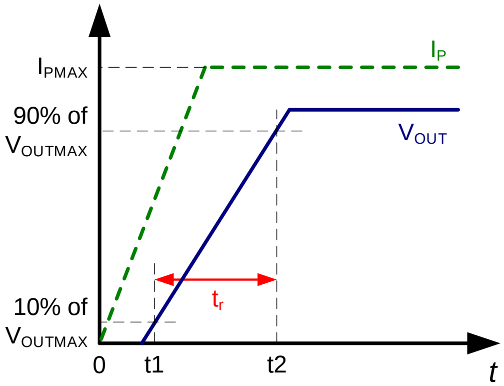


Figure 6: Rising Time (t_R)

The sensor bandwidth (f_{BW}) is defined as the 3dB cutoff frequency. Using the rising time, f_{BW} can be estimated with Equation (6):

$$f_{BW} = 0.35 / t_R \qquad (6)$$

Response Time ($t_{RESPONSE}$)

The response time ($t_{RESPONSE}$) is defined as the time between the following moments:

1. t1: The primary current signal reaches 90% of its final value.
2. t2: V_{OUT} reaches 90% of its final value, as it corresponds to the applied I_P (see Figure 7).

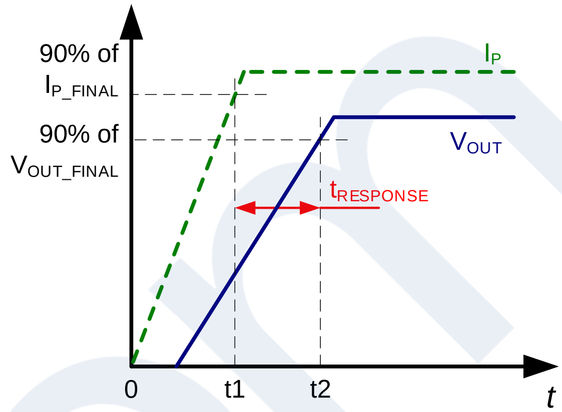


Figure 7: Response Time ($t_{RESPONSE}$)

APPLICATION INFORMATION

Over-Current Detection (OCD)

The MCS1805 integrates fast over-current detection (OCD) using the /OCD pin. When I_P exceeds the current limit ($I_{/OCD}$), a high-speed detection circuit triggers an OCD event within the OCD response time ($t_{RESPONSE\_/OCD}$). $I_{/OCD}$ can be preset between 50% and 240% of I_{PMAX} for different part numbers. Figure 8 shows the OCD timing.

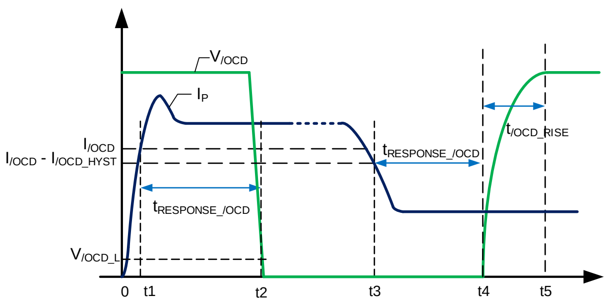


Figure 8: OCD Timing

If I_P reaches $I_{/OCD}$ and stays at this value for longer than $t_{RESPONSE\_/OCD}$, the /OCD pin's voltage ($V_{/OCD}$) pulls down to $V_{/OCD\_L}$.

If I_P falls below ($I_{/OCD}$ - $I_{/OCD\_HYST}$) during the next $t_{RESPONSE\_/OCD}$, $V_{/OCD}$ starts to rise. $t_{/OCD\_RISE}$ is the time it takes for $V_{/OCD}$ to rise from logic low to logic high. This time is dependent on the pull-up resistance (R_{PULLUP}) and the capacitance from the /OCD pin to GND. Small resistor and capacitor values result in a fast rising time.

Self-Heating Performance

Current flowing through the primary conductor can raise the conductor and the sensor IC temperature. Therefore, self-heating should be carefully verified to ensure that the MCS1805's junction temperature (T_J) does not exceed the maximum value (165°C).

The thermal behavior strongly depends on thermal environment of the MCS1805's components and its cooling capacity, such as the PCB copper area and thickness. The thermal response also depends on the profile of the current waveform (e.g. the amplitude and frequency for the AC current), as well as the peaks and duty cycle for a pulsed DC current.

Figure 9 shows the self-heating performance with the DC input current. The data is collected when the MCS1805 is mounted on its evaluation board after 10 minutes of continuous current at T_A = 25°C.

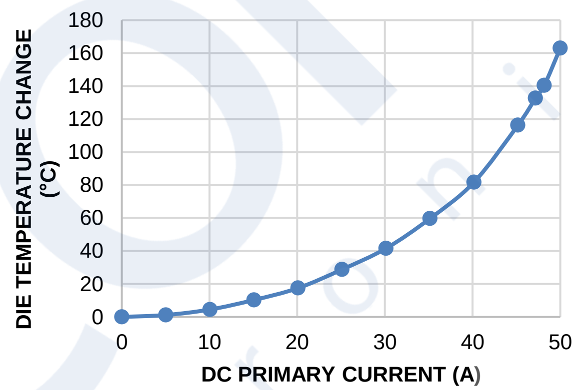
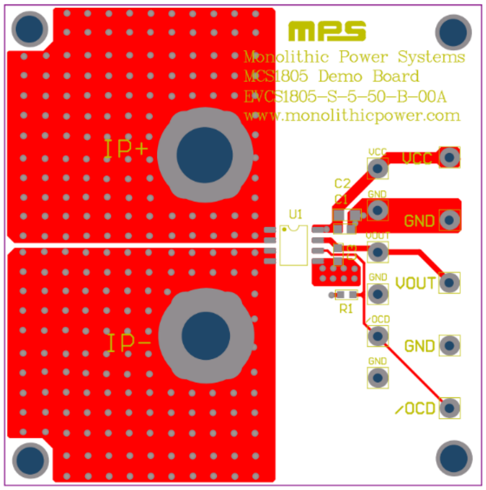
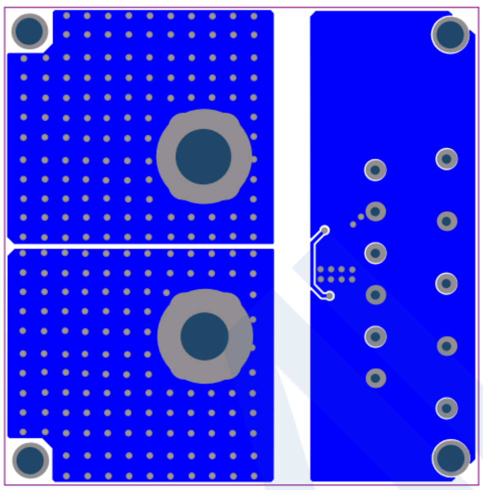


Figure 9: Self-Heating Performance with DC Current Input

Figure 10 on page 22 shows the top and bottom layers of the MCS1805's evaluation board. In total, the board includes is 37cm^2, with 4oz copper connected to the primary conductor by the IP+ and IP- pins. The copper covers both the top and bottom side with thermal vias connecting the two layers.



Top Layer



Bottom Layer

Figure 10: MCS1805 PCB

TYPICAL APPLICATION CIRCUIT

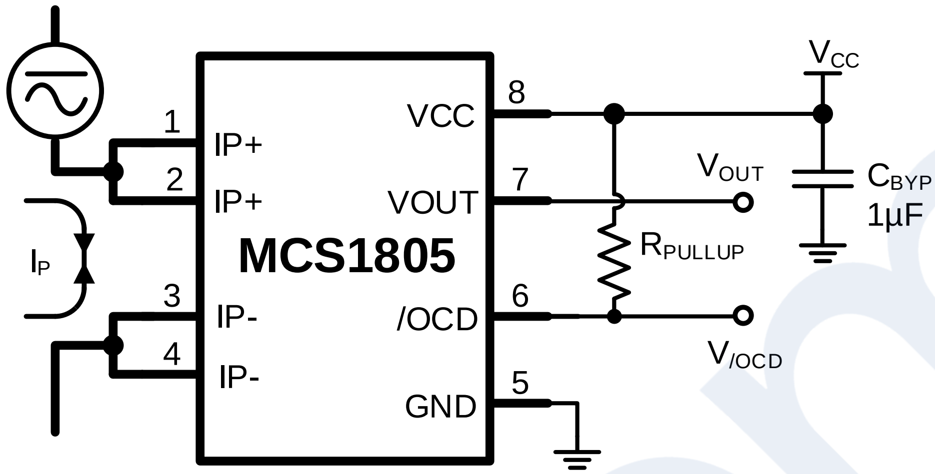
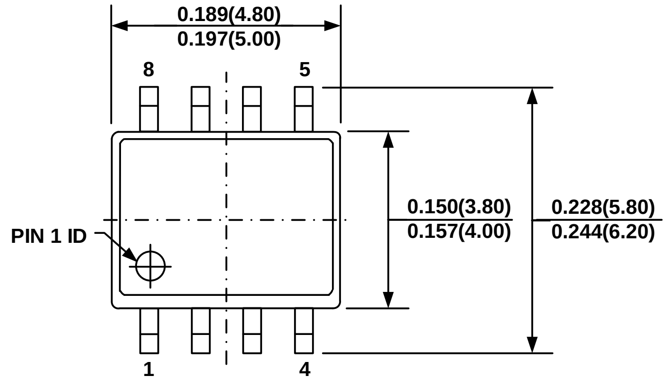


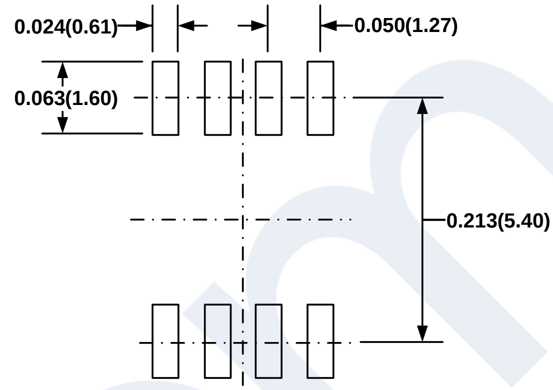
Figure 11: Typical Application Circuit

PACKAGE INFORMATION

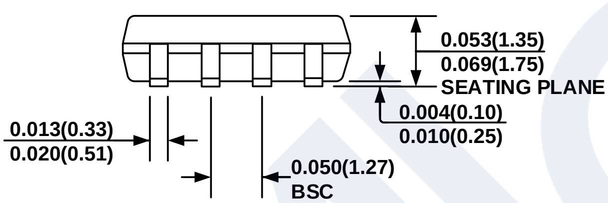
SOIC-8



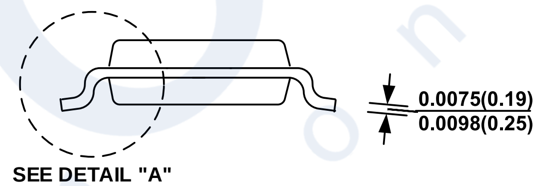
TOP VIEW



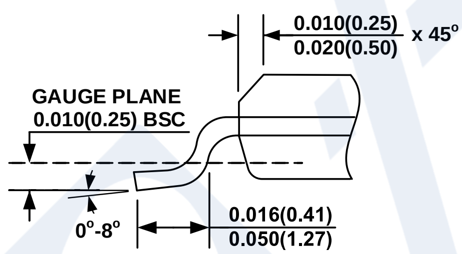
RECOMMENDED LAND PATTERN



FRONT VIEW



SIDE VIEW

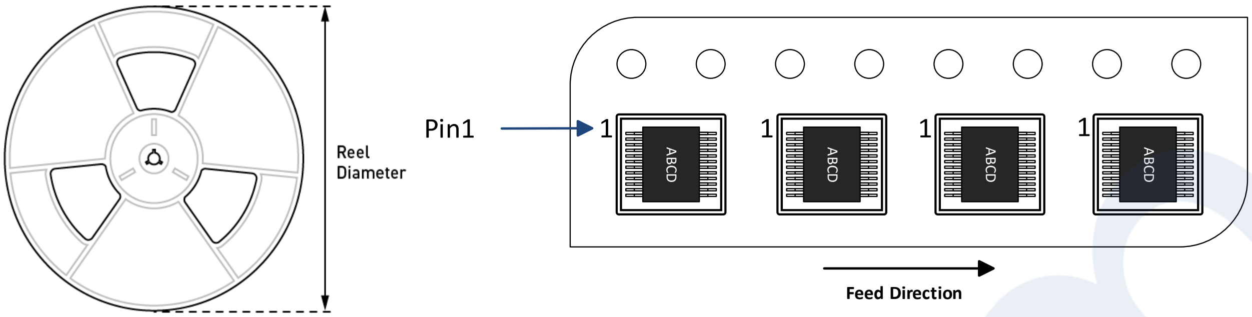


DETAIL "A"

NOTE:

1) CONTROL DIMENSION IS IN INCHES. DIMENSION IN BRACKET IS IN MILLIMETERS.
2) PACKAGE LENGTH DOES NOT INCLUDE MOLD FLASH, PROTRUSION, OR GATE BURRS.
3) PACKAGE WIDTH DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS.
4) LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.004" INCHES MAX.
5) DRAWING CONFORMS TO JEDEC MS-012, VARIATION AA.
6) DRAWING IS NOT TO SCALE.

CARRIER INFORMATION



Part Number	Package Description	Quantity/ Reel	Quantity/ Tube	Quantity/ Tray	Reel Diameter	Carrier Tape Width	Carrier Tape Pitch
MCS1805GS-ABB-CDDD-Z	SOIC-8	2500	N/A	N/A	13in	12mm	8mm

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	4/19/2023	Initial Release	-

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