MCS1812

Isolated, Coreless 5A to 100A, Hall-Effect Current Sensor with Fast OCD

PRELIMINARY SPECIFICATION SUBJECT TO CHANGE

DESCRIPTION

The MCS1812 is a Hall effect-based linear current sensor IC for AC or DC current sensing. The Hall array is differential to cancel out any stray magnetic field.

The low primary conductor resistance (0.45mΩ) allows large current flow in close proximity of an integrated circuit containing high accuracy Hall sensors. This current generates a magnetic field sensed at two different points by the integrated Hall transducers. The magnetic field difference between these two points is then converted into a voltage proportional to the applied current. 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 allows the MCS1812 to replace opto-isolators or other expensive isolation devices.

The MCS1812 integrates user configurable Over Current Detection with 1µs fast response time, making it an ideal solution for monitoring system over current events.

The MCS1812 is available in an SOIC16 WB package.

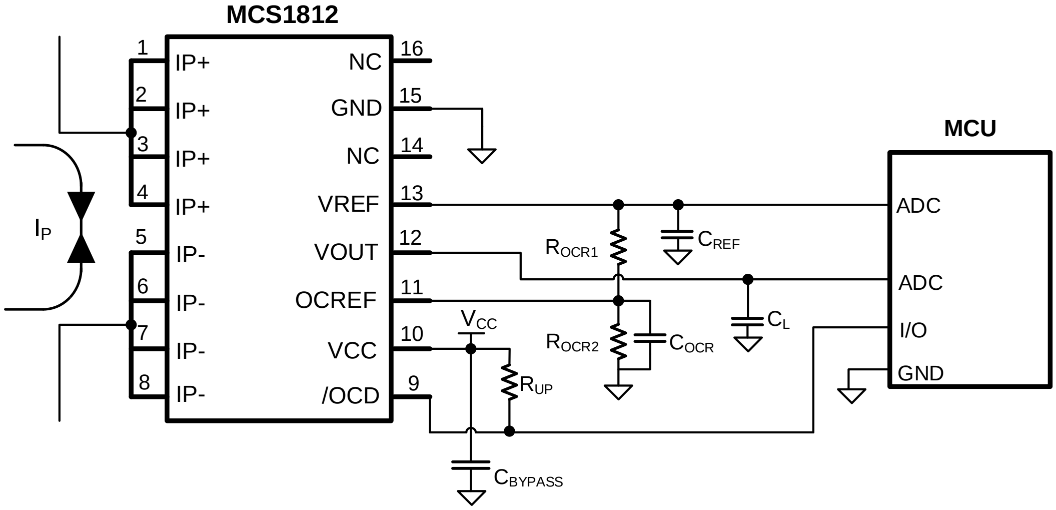
FEATURES

- 3.3V or 5V Single Supply Options
- Immune to External Magnetic Fields by Differential Sensing
- 0.45mΩ Internal Conductor Resistance
- 5kV$_{RMS}$ Minimum Isolation Voltage
- 1118V$_{IOWM_RMS}$ for basic isolation, 559V$_{IOWM_RMS}$ for reinforce isolation
- ±2% Total Error
- 5A to 100A Bidirectional or Unidirectional Range
- 350kHz Bandwidth
- Configurable Over Current Detection (OCD), 1µs Response Time
- Zero-current Reference Output VREF
- Ratiometric or Absolute Output from Supply Voltage
- Output Proportional to AC or DC Currents
- Factory-trimmed for Accuracy
- SOIC16 WB Package

APPLICATIONS

- Multi-Phase Inverters
- Motor Control
- Load Detection & Management
- Switched-Mode Power Supplies
- Over-Current Fault Protection

TYPICAL APPLICATION



ORDERING INFORMATION

Part Number*	Supply Voltage(V)	Rated Current Range (A)	Sensitivity (mV/A)	Top Marking	MSL Rating
MCS1812GY-3-005-BA	3.3	±5	264	*See Below*	1
MCS1812GY-3-010-BA	3.3	±10	132		
MCS1812GY-3-020-BA	3.3	±20	66		
MCS1812GY-3-030-BA	3.3	±30	44		
MCS1812GY-3-040-BA	3.3	±40	33		
MCS1812GY-3-050-BA	3.3	±50	26.4		
MCS1812GY-3-065-BA	3.3	±65	20.3		
MCS1812GY-3-080-BA	3.3	±80	16.5		
MCS1812GY-3-100-BA	3.3	±100	13.2		
MCS1812GY-5-005-BA	5	±5	400		
MCS1812GY-5-010-BA	5	±10	200		
MCS1812GY-5-020-BA	5	±20	100		
MCS1812GY-5-030-BA	5	±30	66		
MCS1812GY-5-040-BA	5	±40	50		
MCS1812GY-5-050-BA	5	±50	40		
MCS1812GY-5-065-BA	5	±65	30.7		
MCS1812GY-5-080-BA	5	±80	25		
MCS1812GY-5-100-BA	5	±100	20		
More variants please contact MPS factory					

* For Tape & Reel, add suffix -Z (e.g. MCS1812GY-3-005-BA-Z).

PART NUMBERING

MCS1812GY-A-BBB-CD

G	Operating Temperature T_J: -40°C to +125°C
Y	Package Code for SOIC16 WB
A	Supply Voltage 3 for 3.3V supply 5 for 5V supply
BBB	Rated Current Range
C	Current Polarity B = Bidirectional U = Unidirectional
D	Output (V_{OUT}) Mode R = Ratiometric A = Absolute

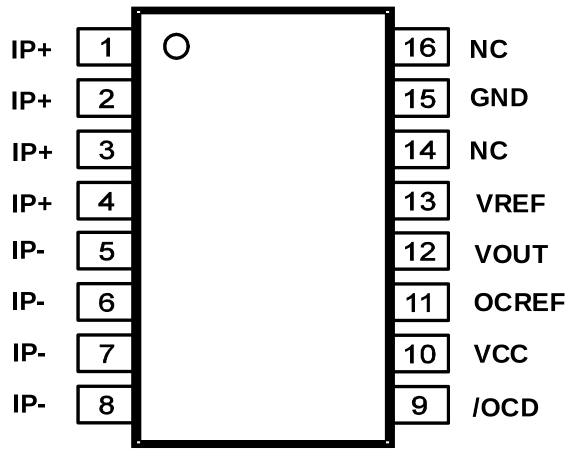
TOP MARKING (MCS1812GY-A-BBB-CD)

MPSYYWW
MCS1812
LLLLLLLLL

MPS: MPS prefix
YY: Year code
WW: Week code
MCS1812: Part number
LLLLLLLLL: Lot number

PACKAGE REFERENCE

TOP VIEW



Package Diagram

SOIC16 WB

PIN FUNCTIONS

Package Pin #	Name	Description
1,2,3,4	IP+	**Primary current +.** Terminals for current being sampled; fused internally.
5,6,7,8	IP-	**Primary current -.** Terminals for current being sampled; fused internally.
9	/OCD	**Over Current Detection.** Open drain, active low, connect a resistor (1kΩ to 100kΩ) from /OCD pin to VCC pin. Leave floating if not used.
10	VCC	**Voltage Supply.** Connect a 0.1µF to 1µF bypass capacitor from the VCC pin to GND.
11	OCREF	**Reference for Over Current Detection.** Connect to a resistive divider from VCC to GND. A 0.1µF bypass capacitor from the OCREF pin to GND is recommended. Leave floating if OCD function is not used.
12	VOUT	**Analog output.**
13	VREF	**Reference output voltage.** Connect a 0.1µF bypass capacitor 1,2,3,4the VREF pin to GND.
14	NC	**No connection.** Not internally connected.
15	GND	**Ground.** Signal ground terminal.
16	NC	**No connection.** Not internally connected.

ABSOLUTE MAXIMUM RATINGS (1)

Supply Voltage (V_{CC}).................... -0.3V to 6.5V
Output Voltage (V_{OUT}) .... -0.3V to 6.5V
Reference Voltage (V_{REF}).............. -0.3V to 6.5V
$V_{/OCD}$, V_{OCREF} .... -0.3V to 6.5V
Junction Temperature............................. 165°C
Lead Temperature .... 260°C
Storage Temperature............... -65°C to +165°C

ESD Rating

Human-body model (HBM) ....±4kV
Charge device model (CDM).....................±2kV

Recommended Operating Conditions (2)

Supply voltage (V_{CC}) 3.3V option.... 3.0V to 3.6V
Supply voltage (V_{CC}) 5V option.......4.5V to 5.5V
Operating junction temp. (T_J)....-40°C to +150°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
Surge voltage test	V_{SURGE}	Test ±5 pulses at 2/minute, 1.2µs (rise)/50µs (width) according to IEC61000-4-5	10	kV
Withstand isolation voltage	V_{ISO}	Agency type-tested for 60 seconds in accordance with IEC62368-1. 100% Tested in production in accordance with IEC 62368-1:2018.	5000	V_{RMS}
Maximum working voltage for basic isolation	V_{IOWM}	Maximum approved working voltage for basic isolation according to IEC62368-1:2018.	1580	V_{PK} or V_{DC}
			1118	V_{RMS}
Maximum working voltage for reinforce isolation	V_{IOWM}	Maximum approved working voltage for basic isolation according to IEC62368-1:2018.	790	V_{PK} or V_{DC}
			559	V_{RMS}
External clearance	CLR	Shortest distance through air from IP leads to signal leads	8	mm
External creepage	CPG	Shortest distance along package body from IP leads to signal leads	8	mm
Distance through insulation	DTI	Minimum distance through insulation	75	µm
Comparative tracking index	CTI	Material Group II	575	V
Common-mode transient immunity	CMTI	Applied standard: /OCD signal logic is not changed, VOUT ripple is <100mV after 1us.	>100	V/ns

WITHSTANDING CURRENT CAPABILITY

Parameters	Symbol	Conditions	Rating	Units
Surge current test	I_{SURGE}	Test ±1 pulses at 1/minute, 8µs (rise)/20µs (width) according to IEC61000-4-5	20	kA
Transient current test (3)	$I_{TRANSIENT}$	T_A=25°C. 100ms single peak, tested on MPS EVB	600	A

Note:

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

MCS1812 COMMON ELECTRICAL CHARACTERISTICS

V_{CC} = 3.3V for 3.3V option and V_{CC} = 5V for 5V option, C_{BYPASS}=0.1uF, C_{REF}=0.1uF, C_L=open, 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	3.3	3.6	V
		5V option		4.5	5	5.5	V
V_{CC} under-voltage lockout threshold	V_{CC_UVLO}	V_{CC} rising		2.3	2.7	3.1	V
V_{CC} under-voltage lockout hysteresis	$V_{CC\_UVLO\_HYS}$			110	400	650	mV
Operating supply current	I_{CC}	V_{CC}=3.3V for 3.3V option			20	25	mA
		V_{CC}=5V for 5V option			20	25	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			0.45		mΩ
Frequency bandwidth	f_{BW}				350		kHz
Power-On time	t_{PO}	I_P=I_{PMAX}			120		µs
Rise time	t_R	I_P=I_{PMAX}			0.9		µs
Propagation delay	t_{PD}	I_P=I_{PMAX}			1		µs
Response time	$t_{RESPONSE}$	I_P=I_{PMAX}			1.6		µs
Noise density	I_{ND}	Input referred noise density for 3.3V option,			350		µA(rms) /√Hz
		Input referred noise density for 5V option,			300		µA(rms) /√Hz
Noise	I_N	Input referred noise for 3.3V option, 350kHz			210		$mA_{(rms)}$
		Input referred noise for 5V option, 350kHz			190		$mA_{(rms)}$
Nonlinearity	E_{LIN}	Over full range of I_P			±0.5		%
Ratiometry(6) (for ratiometric option)	K_{SENS}	V_{CC} from 95% V_{CC} to 105% V_{CC}		98	100	102	%
	K_{VO}	V_{CC} from 95% V_{CC} to 105% V_{CC}		99	100	101	%
Power supply sensitivity error(6) (for absolute option)	$E_{SENS(PS)}$	V_{CC} from 95% V_{CC} to 105% V_{CC}		-1	±0.5	1	%
Power supply offset error	$V_{OE(PS)}$	V_{CC} from 95% V_{CC} to 105% V_{CC}		-10	±5	10	mV
Power supply rejection ratio	PSRR	DC to 1kHz, 100mV pk-pk ripple around V_{CC}=$V_{CC(typ)}$, I_P=0A			-40		dB
Zero current output voltage of bidirectional option	$V_{OUT(Q)}$ (I_P=0A)	Ratiometric option			V_{CC}/2		V
		Absolute option	5V option		2.5		V
			3.3V option		1.65		V

MCS1812 COMMON ELECTRICAL CHARACTERISTICS *(continued)*

V_{CC} = 3.3V for 3.3V option and V_{CC} = 5V for 5V option, C_{BYPASS}=0.1uF, C_{REF}=0.1uF, C_L=open, T_J = -40°C to +125°C, typical values at T_J = 25°C, unless otherwise noted.

Parameters	Symbol	Condition		Min	Typ	Max	Units
Zero current output voltage of unidirectional option	$V_{OUT(Q)}$ (I_P=0A)	Ratiometric option			0.1*V_{CC}		V
		Absolute option	5V option,		0.5		V
			3.3V option		0.33		V
Reference output of bidirectional option	V_{REF}	Ratiometric option			V_{CC}/2		V
		Absolute option	5V option		2.5		V
			3.3V option		1.65		V
Reference output of unidirectional options	V_{REF}	Ratiometric option			0.1*V_{CC}		V
		Absolute option	5V option		0.5		V
			3.3V option		0.33		V
Reference output error voltage	V_{REF_E}			-10		10	mV
Reference output capacitance load (6)	$C_{L\_REFERENCE}$	From V_{OUT} to GND				4.7	nF
Reference output resistive load (6)	$R_{L\_REFERENCE}$	From V_{OUT} to GND		4.7			kΩ
Common-Mode field rejection	CMFR	Input-referred error due to common-mode field			2		mA/G
Saturation Voltage (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
OCREF input linear range (6)	V_{OCREF}	5V option		0.1		2	V
		3.3V option		0.1		1.32	V
/OCD threshold range (6)	$I_{/OCD}$	Bidirectional option, relative to primary rated current I_{PMAX}		0.5*I_{PMAX}		2*I_{PMAX}	A
		Unidirectional option, relative to primary rated current I_{PMAX}		0.25*I_{PMAX}		1*I_{PMAX}	A
/OCD low voltage (6)	$V_{/OCD\_L}$	OCD triggered				0.3	V
/OCD external pull-up resistance (6)	R_{PULLUP}	Connect from /OCD to VCC		1		100	kΩ
/OCD hysteresis	$I_{/OCD\_HYST}$	Percentage of $I_{/OCD}$		3	15		%
/OCD error	$E_{/OCD}$	V_{OCREF} from V_{OCREF_MIN} to V_{OCREF_MAX}		±10	±5	±10	%

MCS1812 COMMON ELECTRICAL CHARACTERISTICS *(continued)*

V_{CC} = 3.3V for 3.3V option and V_{CC} = 5V for 5V option, C_{BYPASS}=0.1uF, C_{REF}=0.1uF, C_L=open, 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 response time	$t_{RESPONSE\_/OCD}$	Time from I_P > $I_{/OCD}$ to $V_{/OCD}$ below $V_{/OCD\_L}$, apply a 1.2*$I_{/OCD}$		1	1.5	µs

MCS1812GY-3-005-BA PERFORMANCE CHARACTERISTICS

VCC=3.3V, T_J=-40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (4)	Max	Units
Rated Current Range (5)	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		±2		%
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		±15		mV
Total Output Error	E_{TOT}	I_P=5A, T_J=25°C to 125°C	-2		2	%
		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		%

MCS1812GY-3-010-BA PERFORMANCE CHARACTERISTICS

VCC=3.3V, T_J=-40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (4)	Max	Units
Rated Current Range (5)	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		±2		%
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		±10		mV
Total Output Error	E_{TOT}	I_P=10A, T_J=25°C to 125°C	-2		2	%
		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		%

MCS1812GY-3-020-BA PERFORMANCE CHARACTERISTICS

VCC=3.3V, T_J=-40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (4)	Max	Units
Rated Current Range (5)	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		±2		%
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		±10		mV
Total Output Error	E_{TOT}	I_P=20A, T_J=25°C to 125°C	-2		2	%
		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		%

MCS1812GY-3-030-BA PERFORMANCE CHARACTERISTICS

VCC=3.3V, T_J=-40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (4)	Max	Units
Rated Current Range (5)	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		±2		%
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		±10		mV
Total Output Error	E_{TOT}	I_P=30A, T_J=25°C to 125°C	-2		2	%
		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		%

MCS1812GY-3-040-BA PERFORMANCE CHARACTERISTICS

VCC=3.3V, T_J=-40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (4)	Max	Units
Rated Current Range (5)	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		±2		%
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		±10		mV
Total Output Error	E_{TOT}	I_P=40A, T_J=25°C to 125°C	-2		2	%
		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		%

MCS1812GY-3-050-BA PERFORMANCE CHARACTERISTICS

VCC=3.3V, T_J=-40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (4)	Max	Units
Rated Current Range (5)	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		±2		%
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		±10		mV
Total Output Error	E_{TOT}	I_P=50A, T_J=25°C to 125°C	-2		2	%
		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		%

MCS1812GY-3-065-BA PERFORMANCE CHARACTERISTICS

VCC=3.3V, T_J=-40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (4)	Max	Units
Rated Current Range (5)	I_P		-65		65	A
Sensitivity	SENS	-65A≤I_P≤65A, T_J=25°C		20.3		mV/A
Sensitivity Error	E_{SENS}	I_P=65A, T_J=25°C to 125°C	-2		2	%
		I_P=65A, T_J=-40°C to 25°C		±2		%
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		±10		mV
Total Output Error	E_{TOT}	I_P=65A, T_J=25°C to 125°C	-2		2	%
		I_P=65A, 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		%

MCS1812GY-3-080-BA PERFORMANCE CHARACTERISTICS

VCC=3.3V, T_J=-40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (4)	Max	Units
Current Sensing Range (5)	I_P		-80		80	A
Sensitivity	SENS	-80A≤I_P≤80A, T_J=25°C		16.5		mV/A
Sensitivity Error	E_{Sens}	I_P=80A, T_J=25°C to 125°C	-2		2	%
		I_P=80A, T_J=-40°C to 25°C		±2		%
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		±10		mV
Total Output Error	E_{TOT}	I_P=80A, T_J=25°C to 125°C	-2		2	%
		I_P=80A, 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		%

MCS1812GY-3-100-BA PERFORMANCE CHARACTERISTICS

VCC=3.3V, T_J=-40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (4)	Max	Units
Rated Current Range (5)	I_P		-100		100	A
Sensitivity	SENS	-100A≤I_P≤100A, T_J=25°C		13.2		mV/A
Sensitivity Error	E_{SENS}	I_P=100A, T_J=25°C to 125°C	-2		2	%
		I_P=100A, T_J=-40°C to 25°C		±2		%
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		±10		mV
Total Output Error	E_{TOT}	I_P=100A, T_J=25°C to 125°C	-2		2	%
		I_P=100A, 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		%

MCS1812GY-5-005-BA PERFORMANCE CHARACTERISTICS

VCC=5V, T_J=-40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (4)	Max	Units
Rated Current Range (5)	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		±2		%
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		±15		mV
Total Output Error	E_{TOT}	I_P=5A, T_J=25°C to 125°C	-2		2	%
		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		%

MCS1812GY-5-010-BA PERFORMANCE CHARACTERISTICS

VCC=5V, T_J=-40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (4)	Max	Units
Rated Current Range (5)	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		±2		%
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		±10		mV
Total Output Error	E_{TOT}	I_P=10A, T_J=25°C to 125°C	-2		2	%
		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		%

MCS1812GY-5-020-BA PERFORMANCE CHARACTERISTICS

VCC=5V, T_J=-40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (4)	Max	Units
Rated Current Range (5)	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		±2		%
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		±10		mV
Total Output Error	E_{TOT}	I_P=20A, T_J=25°C to 125°C	-2		2	%
		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		%

MCS1812GY-5-030-BA PERFORMANCE CHARACTERISTICS

VCC=5V, T_J=-40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (4)	Max	Units
Rated Current Range (5)	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		±2		%
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		±10		mV
Total Output Error	E_{TOT}	I_P=30A, T_J=25°C to 125°C	-2		2	%
		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		%

MCS1812GY-5-040-BA PERFORMANCE CHARACTERISTICS

VCC=5V, T_J=-40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (4)	Max	Units
Rated Current Range (5)	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		±2		%
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		±10		mV
Total Output Error	E_{TOT}	I_P=40A, T_J=25°C to 125°C	-2		2	%
		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		%

MCS1812GY-5-050-BA PERFORMANCE CHARACTERISTICS

VCC=5V, T_J=-40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (4)	Max	Units
Rated Current Range (5)	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		±2		%
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		±10		mV
Total Output Error	E_{TOT}	I_P=50A, T_J=25°C to 125°C	-2		2	%
		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		%

MCS1812GY-5-065-BA PERFORMANCE CHARACTERISTICS

VCC=5V, T_J=-40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (4)	Max	Units
Rated Current Range (5)	I_P		-65		65	A
Sensitivity	SENS	-65A≤I_P≤65A, T_J=25°C		30.7		mV/A
Sensitivity Error	E_{SENS}	I_P=65A, T_J=25°C to 125°C	-2		2	%
		I_P=65A, T_J=-40°C to 25°C		±2		%
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		±10		mV
Total Output Error	E_{TOT}	I_P=65A, T_J=25°C to 125°C	-2		2	%
		I_P=65A, 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		%

MCS1812GY-5-080-BA PERFORMANCE CHARACTERISTICS

VCC=5V, T_J=-40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ (4)	Max	Units
Rated Current Range (5)	I_P		-80		80	A
Sensitivity	SENS	-80A≤I_P≤80A, T_J=25°C		25		mV/A
Sensitivity Error	E_{SENS}	I_P=80A, T_J=25°C to 125°C	-2		2	%
		I_P=80A, T_J=-40°C to 25°C		±2		%
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		±10		mV
Total Output Error	E_{TOT}	I_P=80A, T_J=25°C to 125°C	-2		2	%
		I_P=80A, 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		%

MCS1812GY-5-100-BA PERFORMANCE CHARACTERISTICS

VCC=5V, T_J=-40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ [4]	Max	Units
Rated Current Range [5]	I_P		-100		100	A
Sensitivity	SENS	-100A≤I_P≤100A, T_J=25°C		20		mV/A
Sensitivity Error	E_{SENS}	I_P=100A, T_J=25°C to 125°C	-2		2	%
		I_P=100A, T_J=-40°C to 25°C		±2		%
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		±10		mV
Total Output Error	E_{TOT}	I_P=100A, T_J=25°C to 125°C	-2		2	%
		I_P=100A, 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) Typical values denoted with the "±" sign signify ±3 sigma values.
5) The device can operate at higher primary current levels (I_P) if the maximum junction temperature (T_J (MAX)) is not exceeded. Beyond the rated current range, the current sensor continues to provide an analog output voltage proportional to the primary current until the device reaches the high or low saturation voltage. However, the nonlinearity increases beyond the rated current range.
6) Guaranteed by design and characterization.

FUNCTIONAL BLOCK DIAGRAM

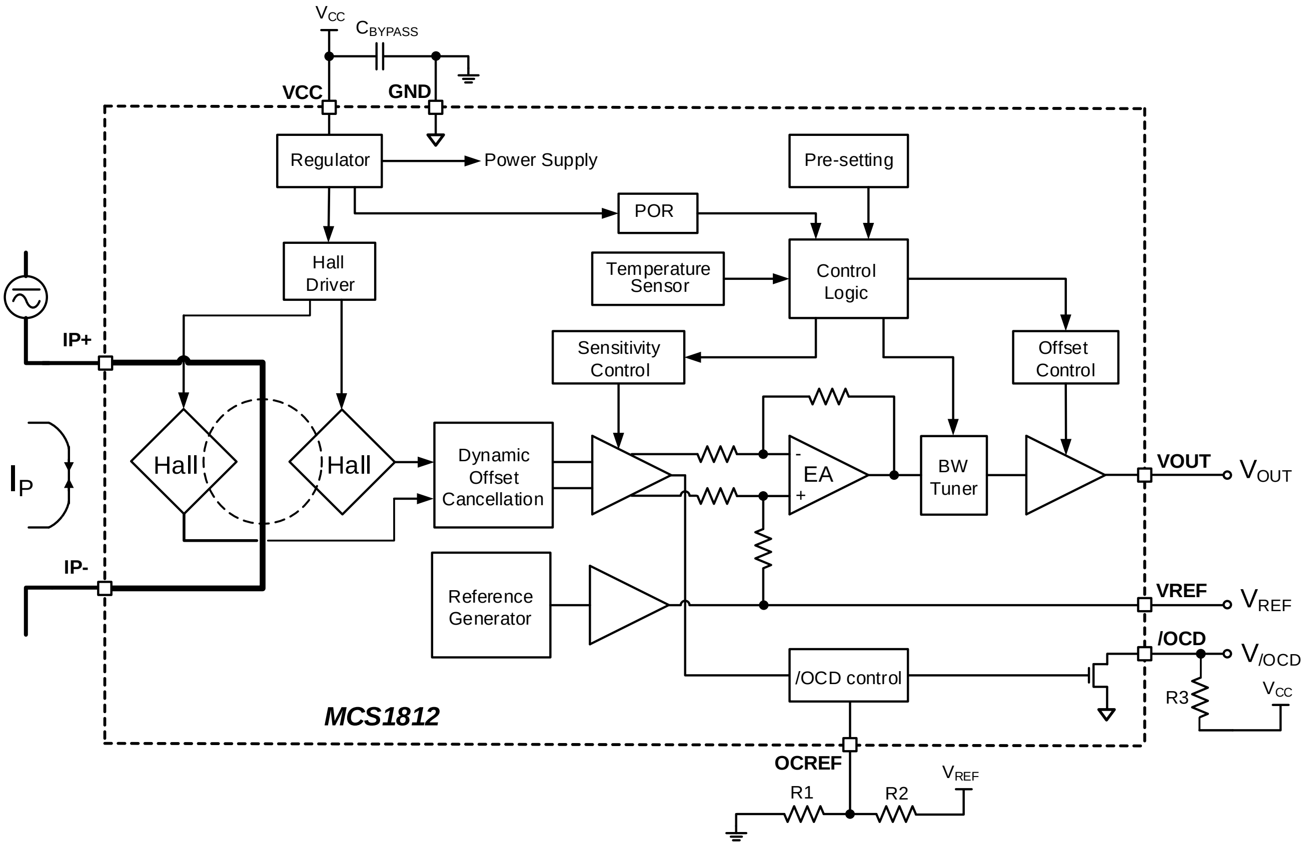


Figure 1: Functional Block Diagram

OPERATION

Rated Current

I_{PMAX} is the rated current. The sensor output is linear and is a function of the primary current (I_P). I_P follows the specified performances when I_P is operating in the rated current range (see Figure 2). The ideal sensor output voltage is given in 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, $SENS_{\_TYP}$ is the typical sensitivity. Beyond the rated current range, the sensor continues to provide an analog output voltage proportional to the primary current until the device reaches the high or low saturation voltage. However, the nonlinearity increases much beyond the rated current range.

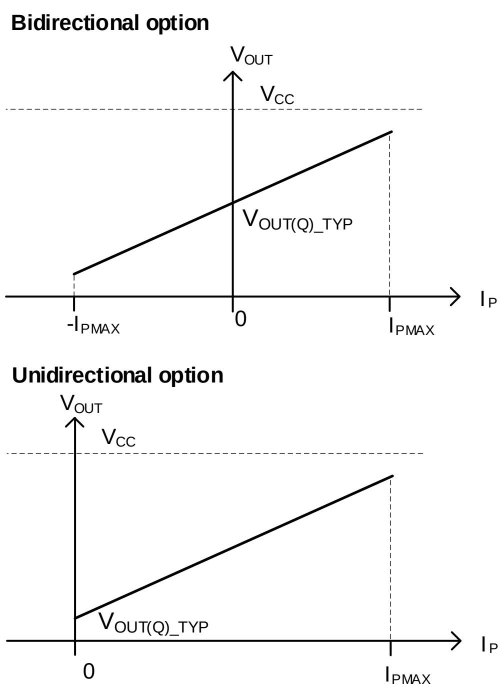


Figure 2: Sensor Output Function

Sensitivity (SENS)

The sensitivity (SENS, in mV/A) indicates how the output changes when the primary current changes. SENS is the product of the average between the two coupling constants (in mT/A) and the transducer gain (in mV/mT). The gain is factory-trimmed to the sensor's target sensitivity.

Differential Sensing

Figure 3 shows a cross-section of the sensor.

There are two Hall devices located at either side of the conductor. The magnetic field generated by the input current is opposite in the two sensing points 1 and 2 (B_1 and B_2, respectively). The difference (B_1 – B_2) of the two magnetic fields is then converted to a voltage through the transducer. Thus, if it has an external common-mode stray field across the two sensing points, the affect will be eliminated.

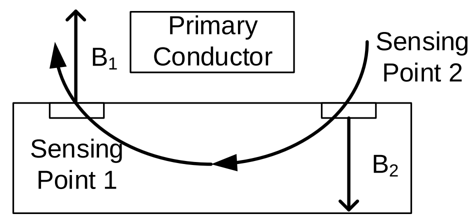


Figure 3: Cross-Section of the Sensor

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 the sensitivity (SENS, in mV/A). I_N represents the smallest current the device is able to resolve without any external signal treatment.

Reference Output Voltage (V_{REF})

The internal reference voltage output for the VREF pin is the zero-current output voltage. The typical value is referenced in the EC table. The V_{REF} combined with V_{OUT} can be configured as a differential measurement. In addition, V_{REF} can be used as a reference supply for OCREF pin or external ADC.

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

$V_{OUT(Q)}$ is the output voltage when the primary current is 0A and the values are listed in the EC table.

Offset Voltage (V_{OE})

The offset voltage (V_{OE}) is the difference between the typical zero current output voltage 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 the sensitivity.

Nonlinearity (E_{LIN})

The primary current and sensor output has a linear relationship. In other words, sensitivity should be a constant value in the full scale I_P. However, sensitivity changes slightly with I_P, and nonlinearity is to identify this change.

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

$$E_{LIN(\pm)} = (1 - \frac{SENS(I_P = \pm I_{PMAX})}{SENS(I_P = \pm 1/2\, I_{PMAX})}) \times 100 \quad (2)$$

And E_{LIN}=max($E_{LIN(+)}$, $E_{LIN(-)}$).

Total Output Error (E_{TOT})

The total output error (E_{TOT}, in %) is the relative difference between the sensor output and the ideal output at a given primary current. E_{TOT} can be estimated 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, $V_{OUT\_IDEAL}(I_P)$ is ideal output given by Equation (1).

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

Power Supply Offset Error ($V_{OE(PS)}$)

Power supply offset error is defined as how much the offset error varies when V_{CC} varies from 95% V_{CC} to 105% V_{CC}.

Power Supply Sensitivity Error ($E_{SENS(PS)}$)

For options selected for an absolute output, the sensitivity is ideally constant while V_{CC} is changing. Power supply sensitivity error indicates the percentage error of sensitivity from 95% V_{CC} to 105% V_{CC}. $E_{SENS(PS)}$ can be calculated with Equation (4):

$$E_{SENS(PS)}(V_{CC}) = (1 - \frac{SENS(V_{CC})}{SENS(V_{CC\_TYP})}) * 100\% \quad (4)$$

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

Ratiometry Coefficients

For ratiometric option parts, the sensor output is ratiometric. This means the sensitivity and the zero-current output scales with V_{CC}. The ratiometry coefficients (K_{SENS} and K_{VO}) measure whether the sensitivity and zero-current output are proportional.

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

$$K_{SENS}(V_{CC}) = \frac{SENS(V_{CC}) / SENS(V_{CC\_TYP})}{V_{CC} / V_{CC\_TYP}} \quad (5)$$

K_{VO} can be calculated with Equation (6):

$$K_{VO}(V_{CC}) = \frac{V_{OUT}(I_P = 0, V_{CC}) / V_{OUT}(I_P = 0, V_{CC\_TYP})}{V_{CC} / V_{CC\_TYP}} \quad (6)$$

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 1.

Common-Mode Field Rejection (CMFR)

In real application, the external common-mode stray field will influence the sensing accuracy. The Common-mode field rejection is the suppressing capacity to an external common-mode stray field. It is defined as the input referred current (in mA) induced by the stray filed (in Gauss).

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 primary current. 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 primary current (see Figure 4).

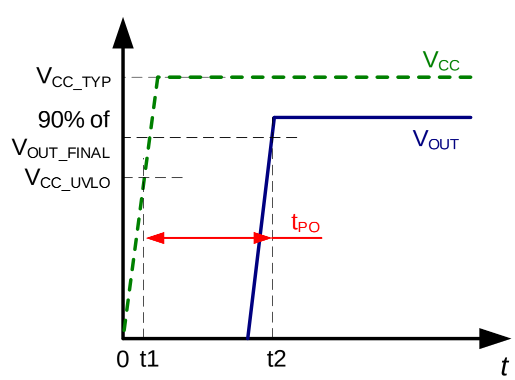


Figure 4: Power-On Time (t_{PO})

Propagation Delay (t_{PD})

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

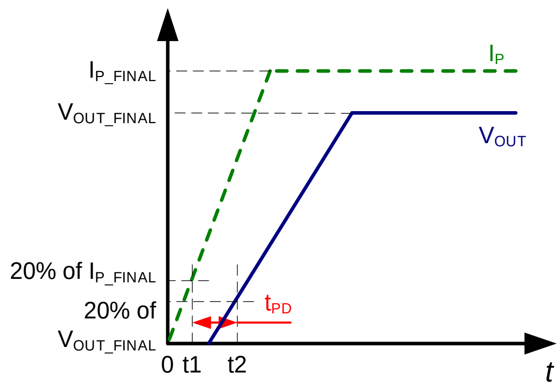


Figure 5: Propagation Delay (t_{PD})

Rise Time (t_R)

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

1. t1: The sensor's V_{OUT} reaches 10% of its rated value.
2. t2: The sensor's V_{OUT} reaches 90% of its rated value (see Figure 6).

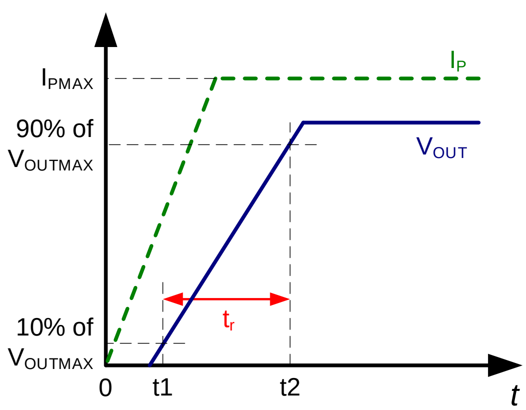


Figure 6: Rising Time (t_R)

The sensor bandwidth (f_{BW}) is defined as the 3dB cutoff frequency. Using the rising time, f_{BW} can be estimated with Equation (7):

$$f_{BW} = 0.35 / t_R \quad (7)$$

Response Time ($t_{RESPONSE}$)

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 primary current (see Figure 7).

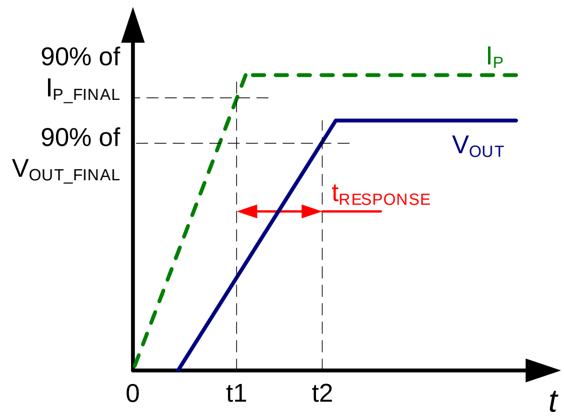


Figure 7: Response Time ($t_{RESPONSE}$)

APPLICATION INFORMATION

Over Current Detection (OCD)

The MCS1812 integrates fast over current detection. When the primary current (I_P) exceeds the OCD threshold ($I_{/OCD}$), a high-speed detection circuit will pull down the /OCD pin to logic low within an OCD response time ($T_{/OCD\_RESPONSE}$).

The OCD threshold ($I_{/OCD}$) can be set by the voltage of OCREF pin. The relationship between OCD threshold and V_{OCREF} is shown in table 1, figure 8 and figure 9, where I_{PMAX} is the rated primary current.

Table 1: OCD Threshold vs. V_{OCREF}

V_{OCREF} (V) (3.3V)	V_{OCREF} (V) (5V)	Percentage of I_{PMAX}	
		Bidirectional	Unidirectional
<0.1		100% (factory default)	50%(factory default)
0.33	0.5	50%	25%
0.495	0.75	75%	37.5%
0.66	1	100%	50%
0.825	1.25	125%	62.5%
0.99	1.5	150%	75%
1.155	1.75	175%	87.5%
1.32	2	200%	100%

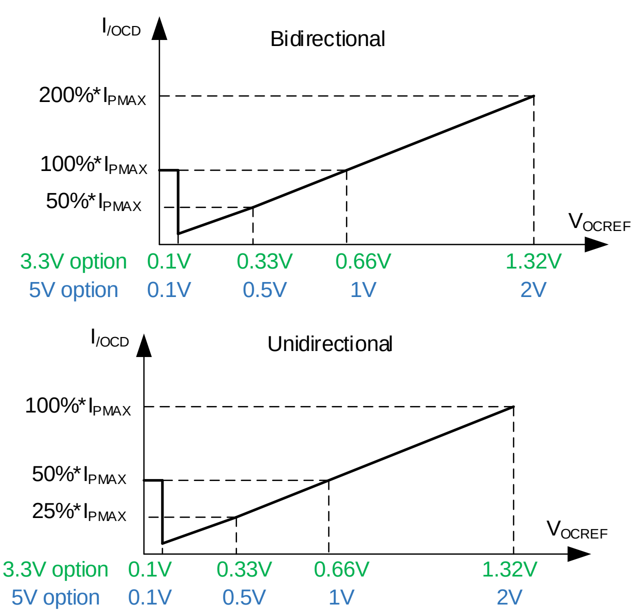


Figure 8: OCD Threshold vs. V_{OCREF}

The equation to set the OCREF voltage (V_{OCREF}) to a desired OCD threshold ($I_{/OCD}$) is:

$$\text{5V, Bidirectional: } V_{OCREF} = \frac{I_{/OCD}}{I_{PMAX}} \quad (8)$$

$$\text{5V, unidirectional: } V_{OCREF} = 2 * \frac{I_{/OCD}}{I_{PMAX}} \quad (9)$$

$$\text{3.3V, bidirectional: } V_{OCREF} = 0.66 * \frac{I_{/OCD}}{I_{PMAX}} \quad (10)$$

$$\text{3.3V, unidirectional: } V_{OCREF} = 1.32 * \frac{I_{/OCD}}{I_{PMAX}} \quad (11)$$

The OCREF pin can be connected to a resistive divider from V_{REF} for bidirectional options, or from V_{CC} for unidirectional options. If the application only requires 100%*I_{PMAX} threshold of factory default set, the OCREF can be connected to GND through a resistor.

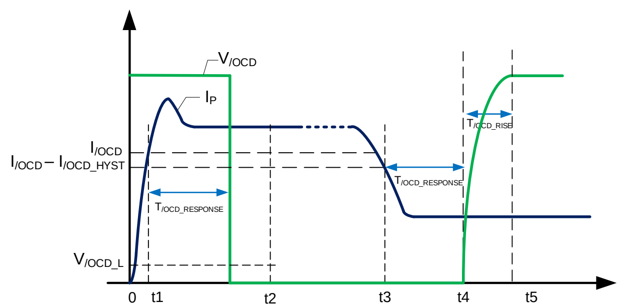


Figure 9: /OCD Timing

Figure 9 shows the /OCD Timing. When primary current I_P reaches the OCD threshold $I_{/OCD}$ and remains longer than the OCD response time $T_{/OCD\_RESPONSE}$, the /OCD pin voltage $V_{/OCD}$ will be pulled down below $V_{/OCD\_L}$. When the primary current I_P goes below $I_{/OCD}$-$I_{/OCD\_HYST}$ over another $T_{/OCD\_RESPONSE}$, the $V_{/OCD}$ starts to rise. The rise time $T_{/OCD\_RISE}$ is determined by the pull-up resistor (R_{PULLUP}) value and the capacitance from /OCD pin to GND. Note, a small RC will produce a fast rise time.

Self-heating Performance

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

The thermal behavior strongly depends on thermal environment and its cooling capacity, in particular the PCB copper area and thickness.

The thermal response is also related to the current (e.g. the amplitude and frequency of an AC current, or the peaks and duty cycle of a pulsed DC current).

The plot in Figure 10 shows the self-heating performance with DC current input. The data is collected with the part mounted on the MCS1812 demo board (see figure 11) at 25°C T_A after 10 minutes of continuous current.

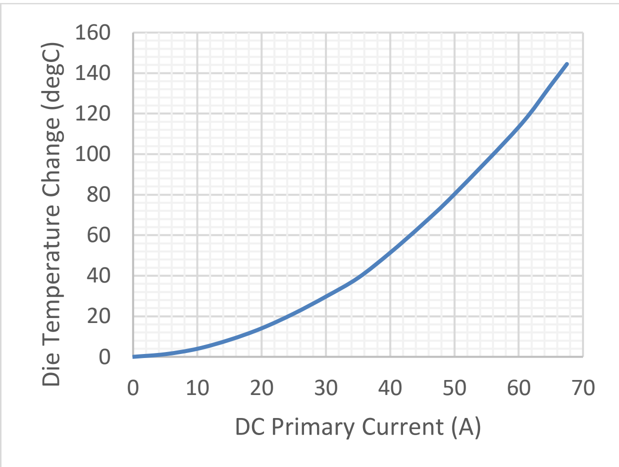
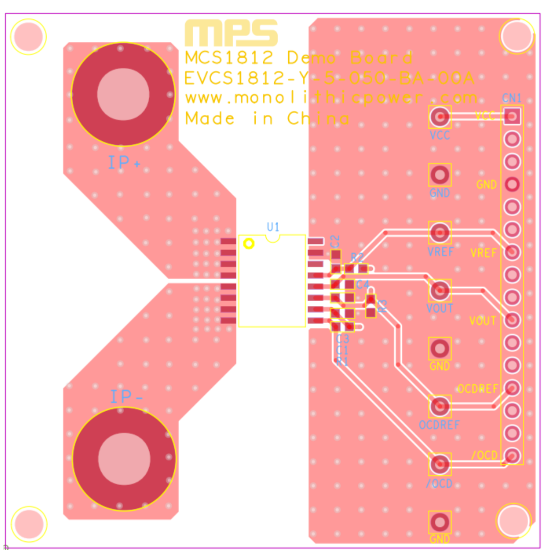


Figure 10: Self-heating Performance with DC Current Input

Layout Guide

Figure 11 shows the top and bottom layers of the MCS1812's evaluation board. The board includes in total 705mm^2, 4oz (140µm) copper connected to the primary conductor by the IP+ and IP- pins. The copper covers both the top and bottom sides with thermal vias connecting the two layers.



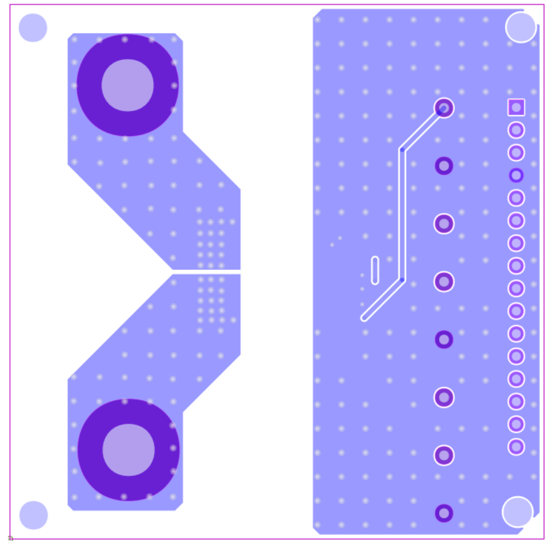


Figure 11: Top and Bottom Layers of MCS1812 Demo Board

It is recommended to place the primary current path as shown in Figure 12. The shape of the current path can be different but should not exceed the footprint of primary side.

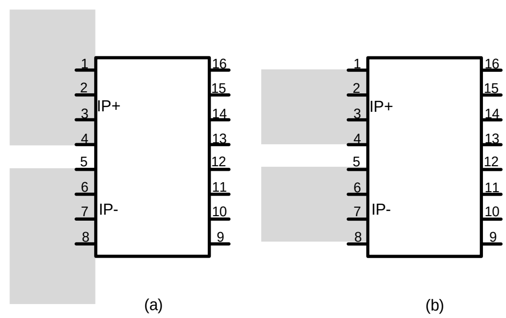


Figure 12: Example of Recommended Current Path (Gray Area)

It is not recommended to place the current path around or beneath the current sensor, as shown in Figure 13, which may reduce the withstand voltage and affect the accuracy of the sensor.

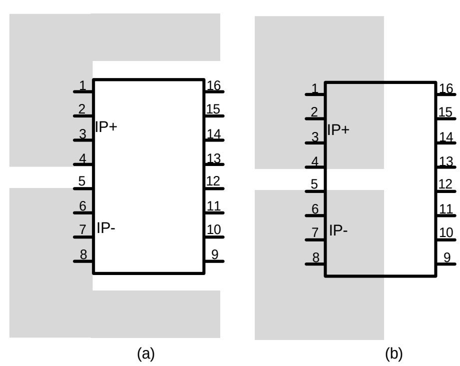


Figure 13: Example of Not Recommended Current Path (Gray Area)

TYPICAL APPLICATION CIRCUITS

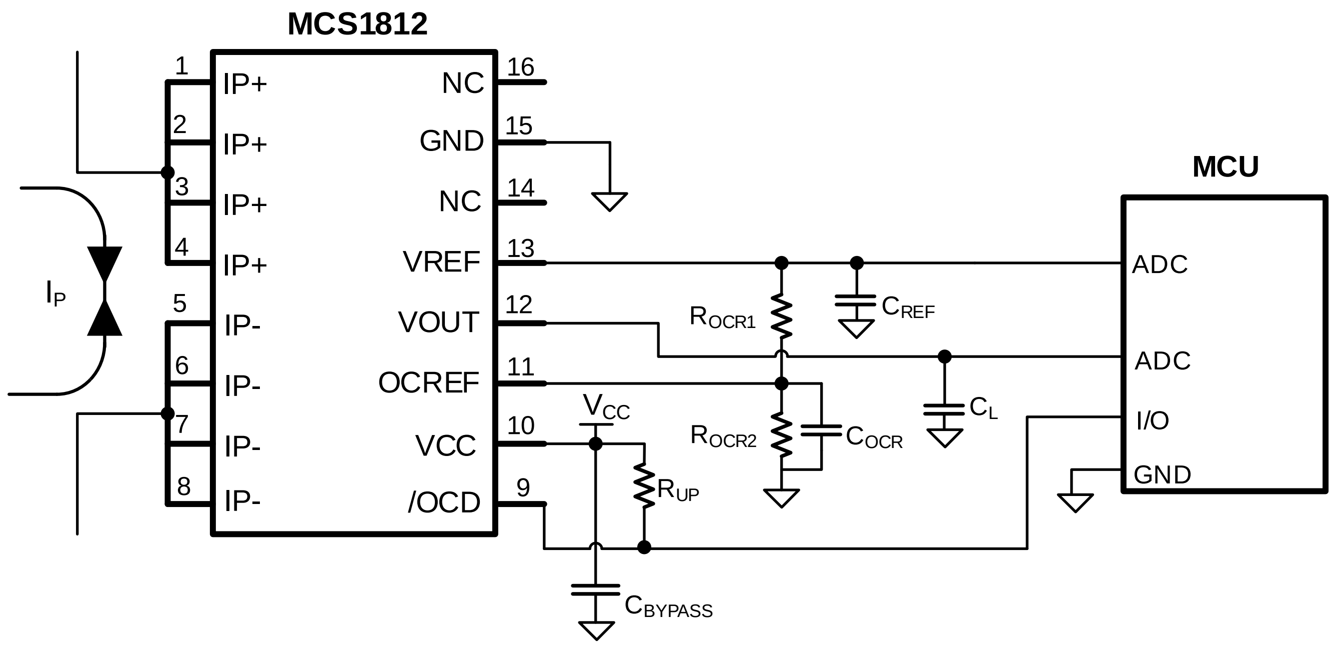


Figure 14: General Application Circuit for Bidirectional Options

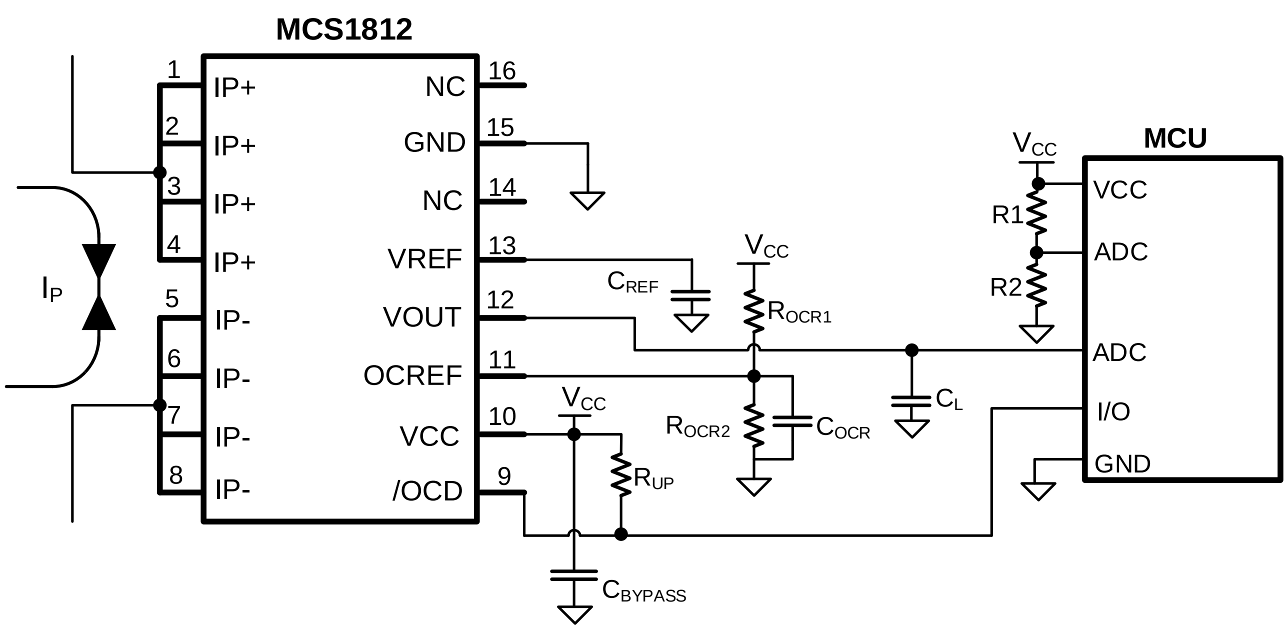


Figure 15: General Application Circuit for Unidirectional Options

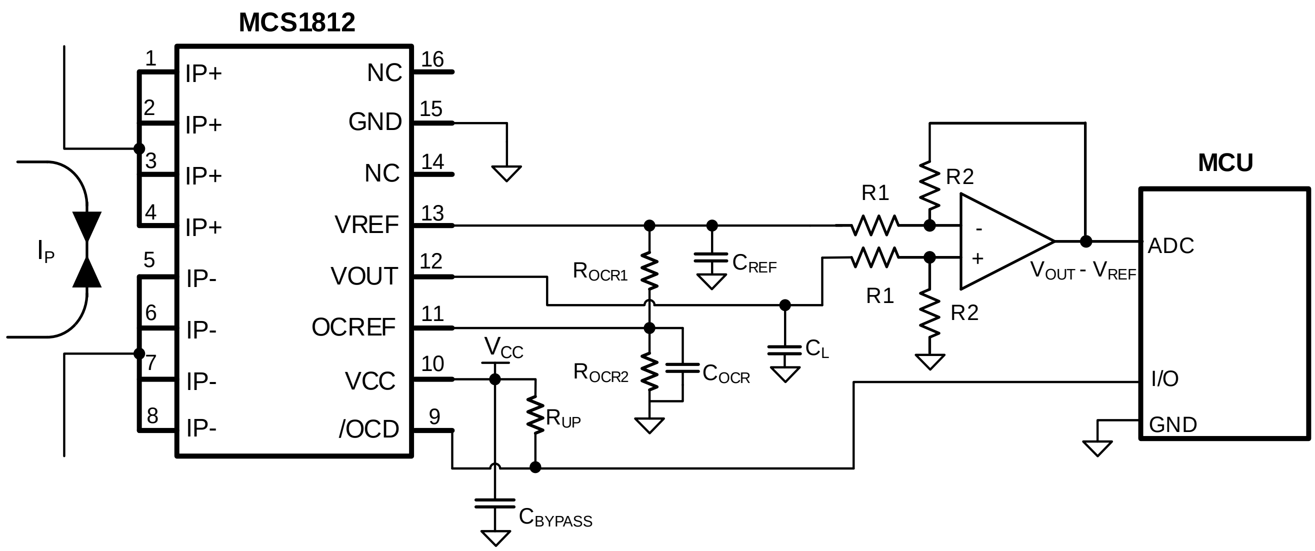
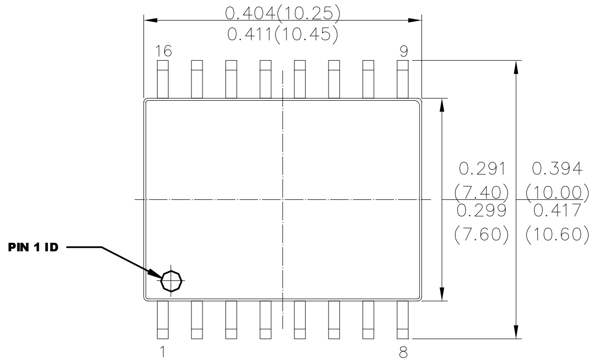


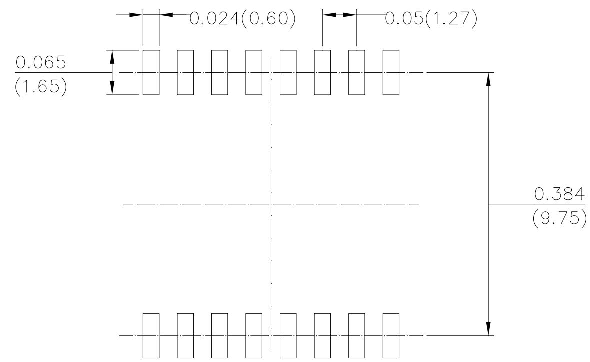
Figure 16: Application Circuit for Differential Sensing

PACKAGE INFORMATION

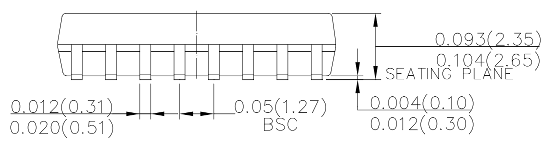
SOIC16 WB (HV ISOLATION)



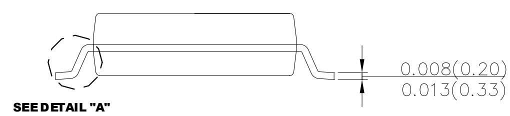
TOP VIEW



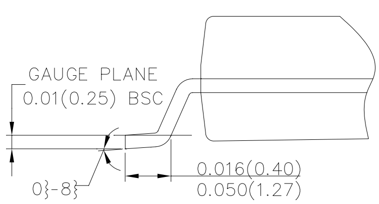
RECOMMENDED LAND PATTERN



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, PROTRUSIONS 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-013, VARIATION AA.
6) DRAWING IS NOT TO SCALE.