MCS1823

Ultra-Small Package, Linear Hall-Effect Current Sensor with Over-Current Detection

DESCRIPTION

The MCS1823 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 (0.6mΩ) allows large currents to flow within close proximity to the integrated circuit that 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 MCS1823 integrates fast over-current detection (OCD), which makes it simple to monitor the system for OC events.

The MCS1823's small footprint reduces board area and makes this device well-suited for space-constrained applications. The MCS1823 is available in an ultra-small TQFN-12 (3mmx3mm) package.

FEATURES

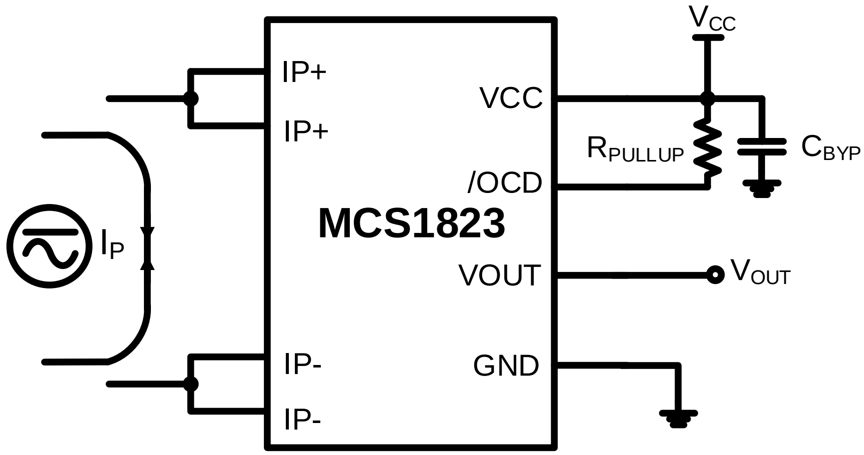
- 3.3V or 5V Single Supply Options
- Immune to All External Gradient Magnetic Fields by Differential Sensing
- 0.6mΩ Internal Conductor Resistance
- ±2.5% Total Accuracy
- 5A to 50A Bidirectional or Unidirectional Range
- 120kHz Bandwidth
- Custom Over-Current Detection (OCD) from 50% to 240% of I_{PMAX}
- Fast OCD with 1µs Response Time
- Output Voltage (V_{OUT}) Proportional to AC or DC Currents
- Ratiometric or Absolute V_{OUT} Options
- Factory-Trimmed for Accuracy
- No Magnetic Hysteresis
- Available in a TQFN-12 (3mmx3mm) Package

CB Certificate Number:
CA-11398-UL

APPLICATIONS

- Motor Control
- Audio Driver Current 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 (mV/A)	OCD Threshold (A)	Top Marking	MSL Rating
MCS1823GQTE-305BRN96	3.3	±5	264	±4.8	*BXPY*	*1*
MCS1823GQTE-305BRN23	3.3	±5	264	±11.5		
MCS1823GQTE-310BRN	3.3	±10	132	±10		
MCS1823GQTE-320BRN	3.3	±20	66	±20		
MCS1823GQTE-330BRN	3.3	±30	44	±30		
MCS1823GQTE-330BAL	3.3	±30	44	±30		
MCS1823GQTE-330BAN	3.3	±30	44	±30		
MCS1823GQTE-335URN	3.3	35	75.4	35		
MCS1823GQTE-340BRN	3.3	±40	33	±40		
MCS1823GQTE-350BRN	3.3	±50	26.4	±50		
MCS1823GQTE-505BRN	5	±5	400	±5		
MCS1823GQTE-510BRN	5	±10	200	±10		
MCS1823GQTE-520BRN	5	±20	100	±20		
MCS1823GQTE-530BRN	5	±30	66	±30		
MCS1823GQTE-540BRN	5	±40	50	±40		
MCS1823GQTE-550BRN	5	±50	40	±50		

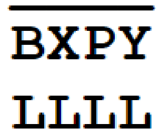
* For Tape & Reel, add suffix -Z (e.g. MCS1823GQTE-305BRN96-Z).

** Contact an MPS FAE for additional variants.

PART NUMBERING (MCS1823GQTE-ABBCDEFF)

G	Operating Temperature (T_J): -40°C to +125°C	C	Current Polarity: B = Bidirectional U = Unidirectional
QTE	Package Code for TQFN-12	D	Output (V_{OUT}) Mode: R = Ratiometric A = Absolute
A	Supply Voltage: 3 = 3.3V Supply 5 = 5V Supply	E	OCD Output Mode: N = Non-Latch Output L = Latched/OCD Output
BB	Rated Current Range	FF	Custom OCD Threshold: Blank = 100% of I_{PMAX} If FF≥50: 90 = 90% of I_{PMAX} If FF<50: 15 = 150% of I_{PMAX}

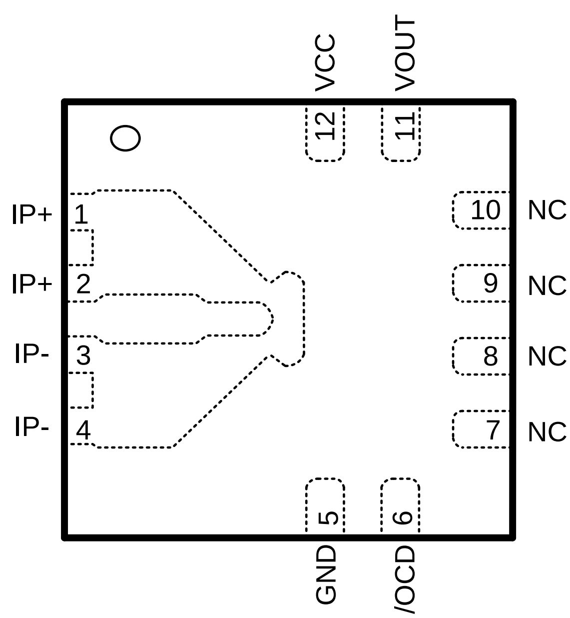
TOP MARKING



BXP: Product code of MCS1823GQTE
Y: Year code
LLLL: Lot number

PACKAGE REFERENCE

TOP VIEW



TQFN-12 (3mmx3mm)

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 to set a custom OCD threshold between 50% and 240% of I_{PMAX}
7, 8, 9, 10	NC	**No connection.**
11	VOUT	**Analog output signal.**
12	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) .... ±4kV
Charge 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
Maximum isolation working voltage	V_{IOWM}	Maximum approved working voltage for basic isolation, according to IEC62368-1	100	V_{PK} or V_{DC}

MCS1823GQTE 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		3.6	V
		5V option	4.5		5.5	V
VCC under-voltage lockout (UVLO) threshold	V_{CC_UVLO}	V_{CC} rising	2	2.5	3	V
VCC UVLO hysteresis	$V_{CC\_UVLO\_HYS}$			400	500	mV
Operating supply current	I_{CC}	V_{CC} = 3.3V for 3.3V option		9	12	mA
		V_{CC} = 5V for 5V option		9	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		0.6		mΩ
Frequency bandwidth	f_{BW}			120		kHz
Power-on time	t_{PO}	$I_P = I_{PMAX}$		60		µs
Rising 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 bandwidth (BW)		35		$mA_{(rms)}$
Nonlinearity	E_{LIN}	Over full range of I_P		0.5		%
Ratiometry (4) (6) (for ratiometric option)	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 for bidirectional options	$V_{OUT(Q)}$ (I_P = 0A)	Ratiometric option		V_{CC} / 2		V
		Absolute option: 5V option		2.5		V
		Absolute option: 3.3V option		1.65		V
Zero-current output voltage for unidirectional options	$V_{OUT(Q)}$ (I_P = 0A)	Ratiometric option		0.1 x V_{CC}		V
		Absolute option: 5V option		0.5		V
		Absolute option: 3.3V option		0.33		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		%

MCS1823GQTE 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
Saturation voltage (3) (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
/OCD Low voltage (6)	$V_{/OCD\_L}$	/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	$I_{/OCD\_HYST}$	As a 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 $V_{/OCD}$ below $V_{/OCD\_L}$		1	1.5	µs

MCS1823GQTE-305BRN96 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		%
/OCD threshold	$I_{/OCD}$			±96% x I_{PMAX}		A

MCS1823GQTE-305BRN23 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		%
/OCD threshold	$I_{/OCD}$			±230% x I_{PMAX}		A

MCS1823GQTE-310BRN 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		%
/OCD threshold	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-320BRN 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		%
/OCD threshold	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-330BRN 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		%
/OCD threshold	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-330BAL 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		%
/OCD threshold	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-330BAN 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		%
/OCD threshold	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-335URN 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		35	A
Sensitivity	SENS	0A ≤ I_P ≤ 35A, T_J = 25°C		75.4		mV/A
Sensitivity error	E_{SENS}	I_P = 35A, T_J = 25°C to 125°C	-2		+2	%
		I_P = 35A, 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 = 35A, T_J = 25°C to 125°C	-2.5		+2.5	%
		I_P = 35A, 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		%
/OCD threshold	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-340BRN 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		%
/OCD threshold	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-350BRN 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		%
/OCD threshold	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-505BRN 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		±10		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		%
/OCD threshold	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-510BRN 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		±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		%
/OCD threshold	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-520BRN 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		%
/OCD threshold	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-530BRN 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	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		%
/OCD threshold	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-540BRN 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		%
/OCD threshold	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-550BRN 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		%
/OCD threshold	$I_{/OCD}$			$\pm I_{PMAX}$		A

Notes:

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

FUNCTIONAL BLOCK DIAGRAM

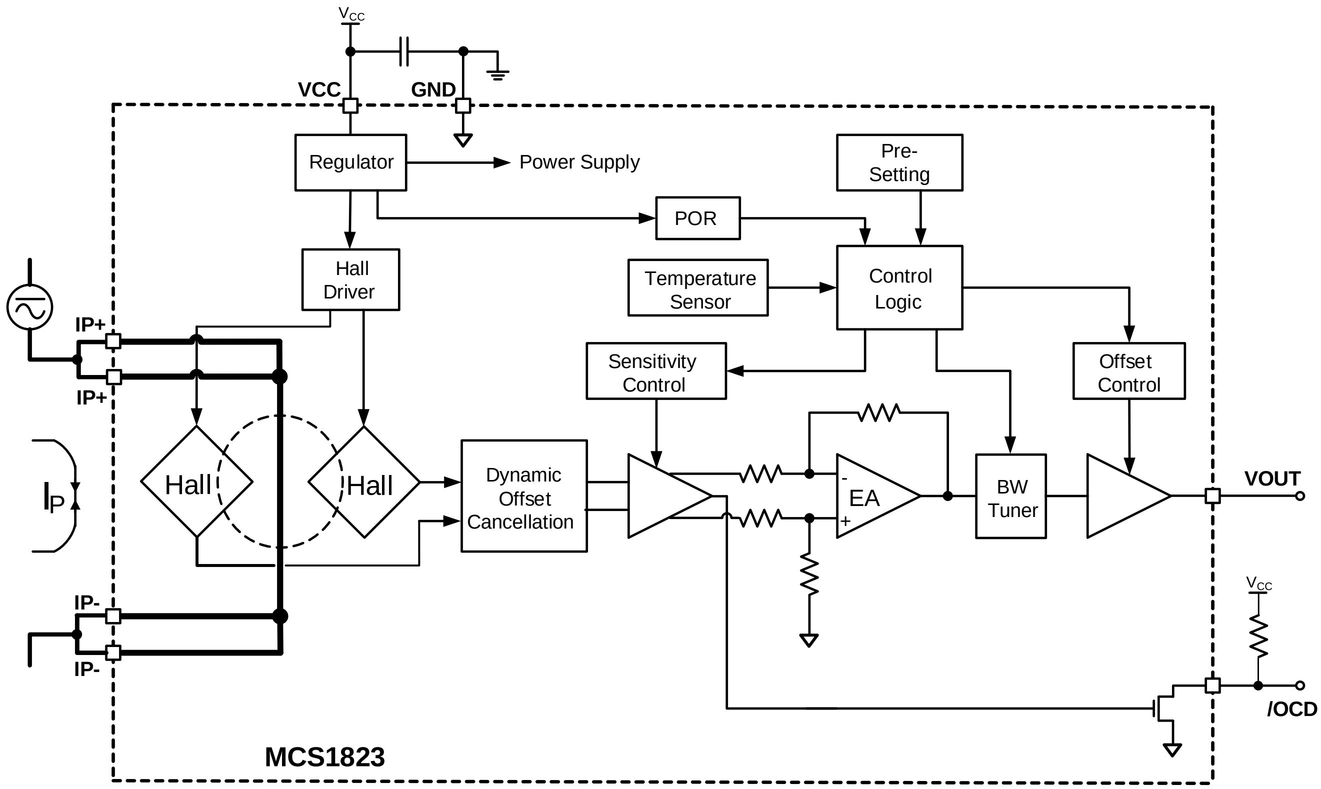


Figure 1: Functional Block Diagram

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.

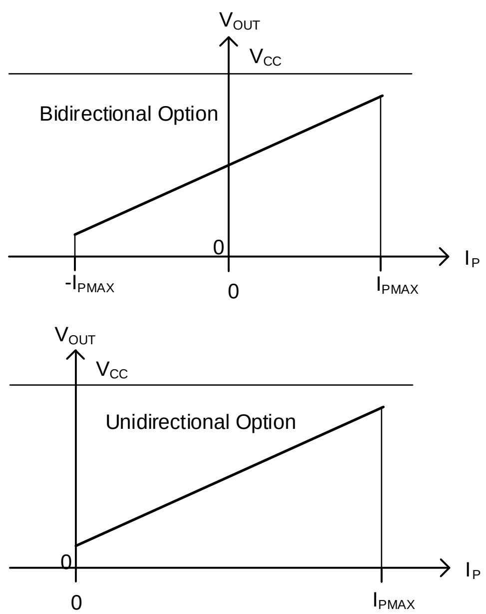


Figure 2: Sensor Output Function

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).

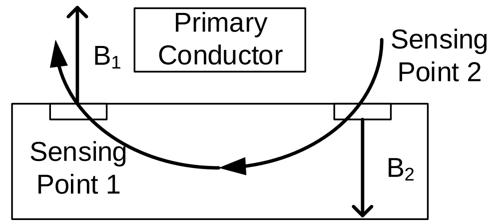


Figure 3: Sensor's Cross-Section

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.

Note that 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 output and the ideal output at a given I_P. 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, 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 affected mainly by the sensitivity error. At currents close to 0A, E_{TOT} is mainly caused by V_{OE}. Note that when I_P = 0A, E_{TOT} diverges to infinity due to the constant offset.

Ratiometry Coefficients

For ratiometric options, the sensor's output 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).

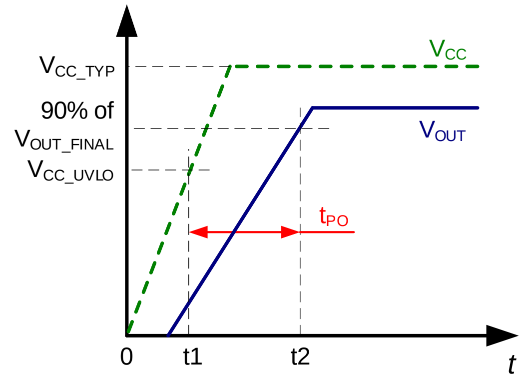


Figure 4: Power-On Time (t_{PO})

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).

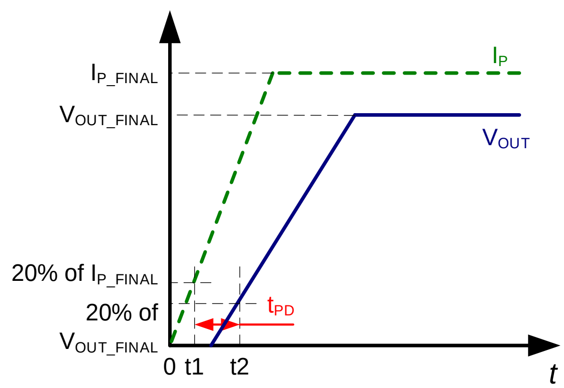


Figure 5: Propagation Delay (t_{PD})

Rising 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).

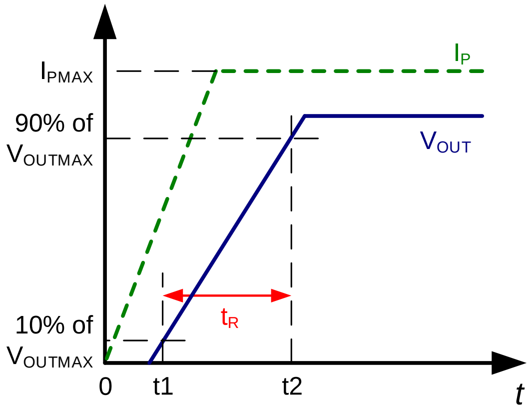


Figure 6: Rising Time (t_R)

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

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

Response Time ($t_{RESPONSE}$)

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

1. t1: I_P 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).

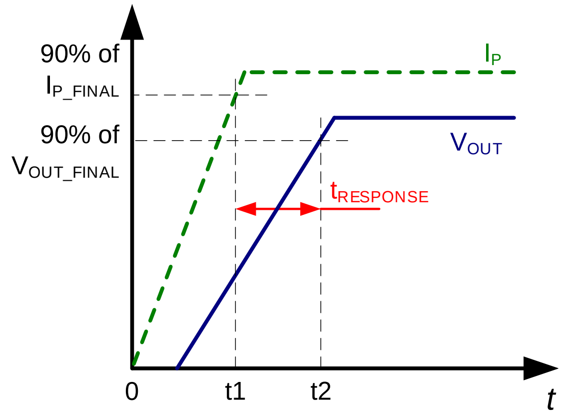


Figure 7: Response Time ($t_{RESPONSE}$)

APPLICATION INFORMATION

Over-Current Detection (OCD)

The MCS1823 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 ($t_{RESPONSE\_/OCD}$). $I_{/OCD}$ is preset for different part numbers. If an OCD event is triggered, the MCS1823 implements latch-off and non-latch /OCD pin output modes.

Figure 8 shows the non-latch OCD timing. When 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.

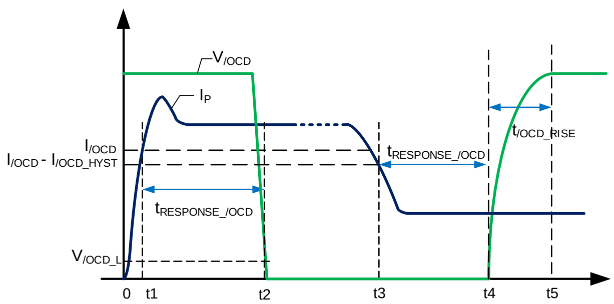


Figure 8: Non-Latch OCD Timing

In OCD latch mode, when an OCD event occurs, the /OCD pin remains latched low, even the OCD event has been removed (see Figure 9). The latched status is reset after the power is cycled on VCC.

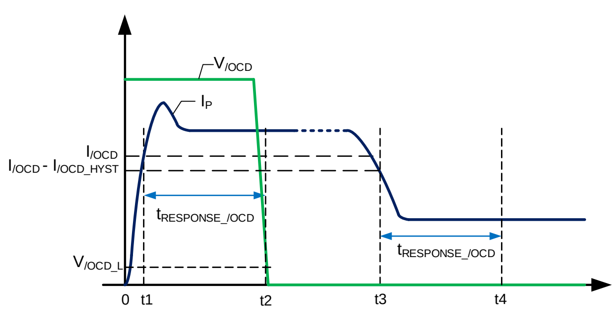


Figure 9: Latched OCD Timing

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 MCS1823's junction temperature (T_J) does not exceed the maximum value (165°C).

The thermal behavior strongly depends on thermal environment of the MCS1823'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 10 shows the self-heating performance with DC input current. The data is collected with the part mounted on the MCS1823 evaluation board after 10 minutes of continuous current at T_A = 25°C.

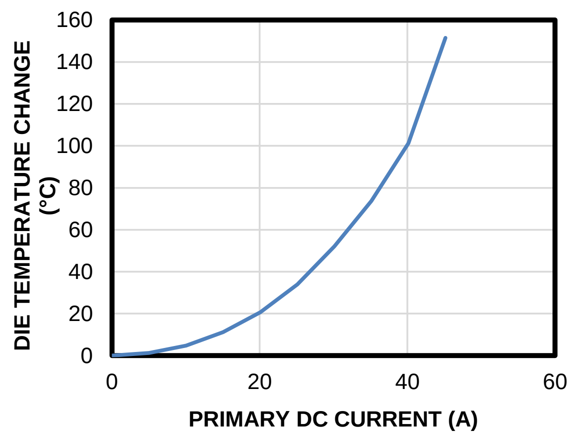
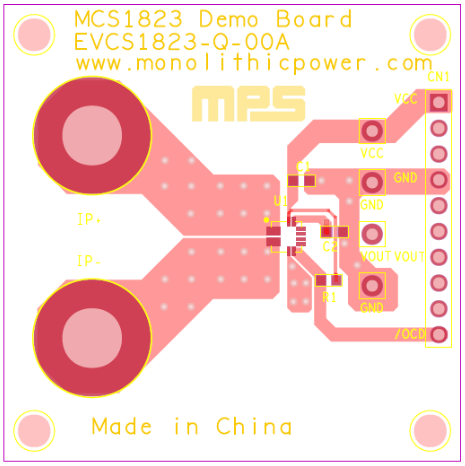
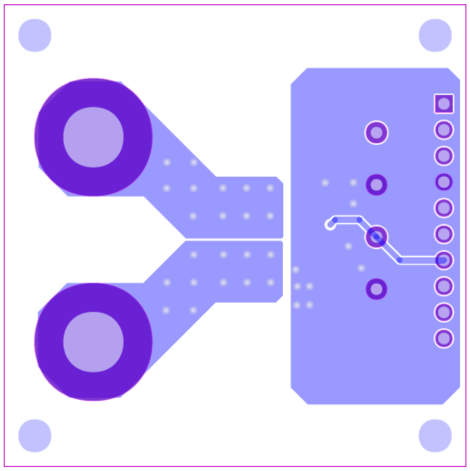


Figure 10: Self-Heating Performance with DC Input Current

Figure 11 on page 22 shows the top and bottom layers of the MCS1823's evaluation board. The board includes in total 570mm², 2.5oz (87µm) 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.



Top Layer



Bottom Layer

Figure 11: MCS1823 Demo Board

TYPICAL APPLICATION CIRCUIT

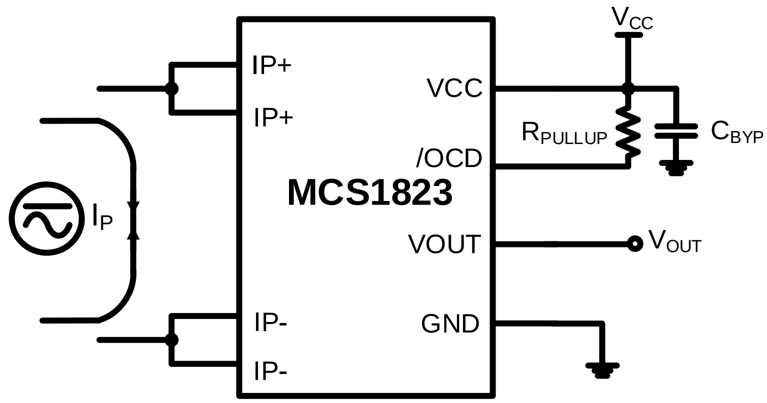
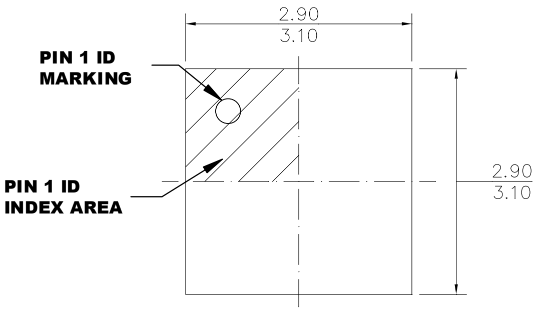


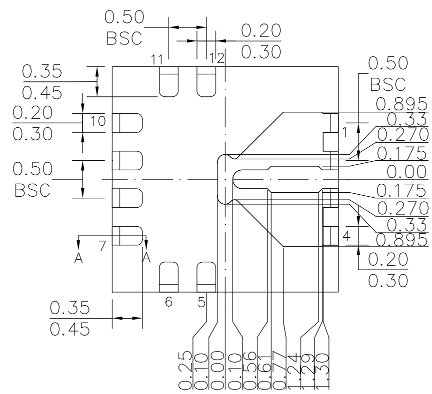
Figure 12: Typical Application Circuit

PACKAGE INFORMATION

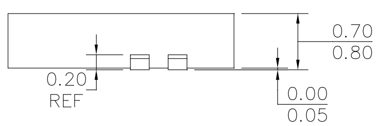
TQFN-12 (3mmx3mm)



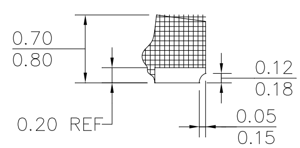
TOP VIEW



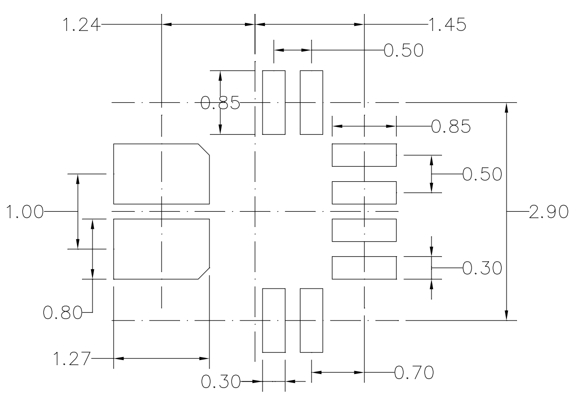
BOTTOM VIEW



SIDE VIEW



SECTION A-A

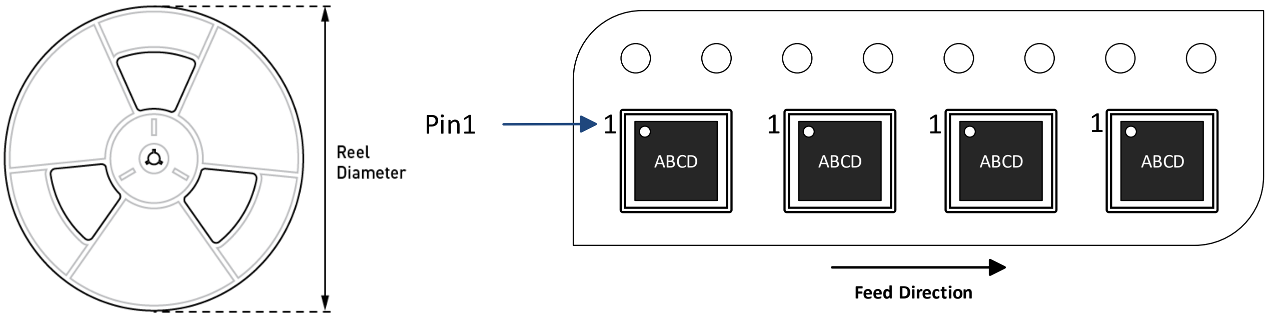


RECOMMENDED LAND PATTERN

NOTE:

1)THE LEAD SIDE IS WETTABLE.
2) ALL DIMENSIONS ARE IN MILLIMETERS.
3) LEAD COPLANARITY SHALL BE 0.08 MILLIMETERS MAX.
4) JEDEC REFERENCE IS MO-220.
5) 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
MCS1823GQTE-ABBCDEFF-Z	TQFN-12 (3mmx3mm)	5000	N/A	N/A	13in	12mm	8mm

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	4/14/2023	Initial Release	-