MCS1823

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

PRELIMINARY SPECIFICATIONS SUBJECT TO CHANGE

DESCRIPTION

The MCS1823 is a linear Hall-effect current sensor IC for AC or DC current sensing. The Hall array is differential to cancel out any stray magnetic field.

A low resistance primary conductor (0.6mΩ) allows large current to flow within close proximity of an integrated circuit containing 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 proportional to the applied current. Spinning current technique is used for a low stable offset.

The MCS1823 integrates over current detection, which is easy for monitoring system over current events.

The MCS1823 is available in an ultra-small package QFN-12 (3mmx3mm). The small footprint saves board area and is ideal for space-constrained applications.

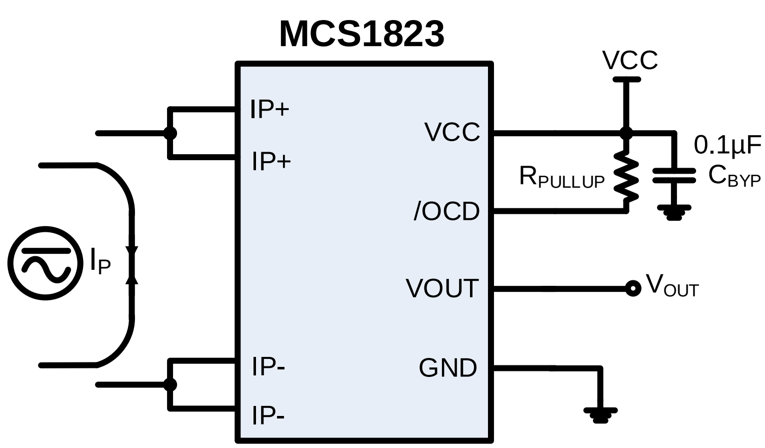
FEATURES

- 3.3V or 5V single supply optional
- Immune to external magnetic fields by differential sensing
- 0.6mΩ internal conductor resistance
- ±2.5% total accuracy
- 5 to 50 A range (see ordering information)
- 120kHz Bandwidth
- Over current detection, 1μs response time
- Output proportional to AC or DC currents
- Ratiometric or absolute output from supply voltage optional
- Factory-trimmed for accuracy
- No magnetic hysteresis
- 3mm x 3mm QFN-12 package

APPLICATIONS

- Motor control
- Automotive systems
- Load detection & management
- Switched-mode power supplies
- Over-current fault protection

TYPICAL APPLICATION



ORDERING INFORMATION

Part Number*	Typ. Supply Voltage(V)	Optimized Primary Current Range (A)	Typ. Sensitivity (Sens) (mV/A)	/OCD Trigger Point (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-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		
More variants TBD						

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

PART NUMBERING

MCS1823GQTE-ABBCDEFF

G	Operating temperature T_J: -40°C to +125°C
QTE	Package code for QFN-12
A	Supply current 3 for 3.3V supply 5 for 5V supply
BB	Nominal current I_P
C	Current polarity B = bidirectional U = unidirectional
D	Ratiometry R = ratiometric A = absolute
E	/OCD output mode N = non-latched output L = latched /OCD output
FF	Custom /OCD level [blank] = 100% I_{PMAX} If FF≥50: 90=90% I_{PMAX} If FF<50: 15=150% I_{PMAX}

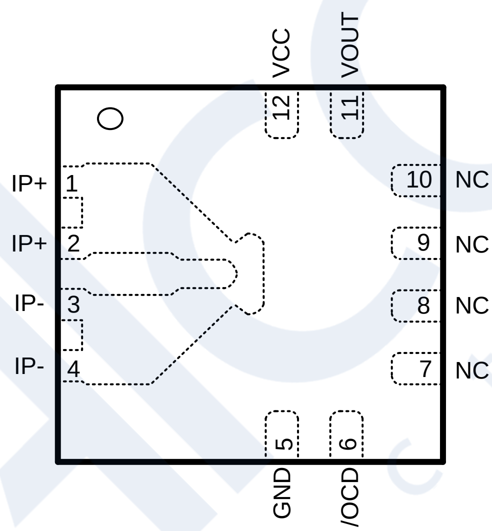
TOP MARKING

BXPY
LLLL

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

PACKAGE REFERENCE

TOP VIEW



Package Diagram

QFN-12 (3mmx3mm)

PIN FUNCTIONS

Package Pin #	Name	Description
1,2	IP+	**Primary current +** Terminals for current being sampled; fused internally.
3,4	IP-	**Primary current -** Terminals for current being sampled; fused internally.
5	GND	**Ground.** Signal ground terminal.
6	/OCD	**Overcurrent detection.** Open drain, active low, connect a resistor (10kΩ to 500kΩ) from /OCD to VCC, custom /OCD level from 50% to 240% of I_{PMAX}
7, 8, 9, 10	NC	**Not connected.**
11	VOUT	**Analog output signal.**
12	VCC	**Voltage Supply.** Connect a bypass capacitor (0.1µF to 1µF) from VCC to GND.

ABSOLUTE MAXIMUM RATINGS [1]

Supply Voltage VCC .... -0.3V to 6.5V
Output Voltage VOUT .... -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 Rating

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

Recommended Operating Conditions [2]

Supply voltage (VCC) of 3.3V option.................
.... 3.0V to 3.6V
Supply voltage (VCC) of 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 [3]

Typical values are VCC=3.3V for 3.3V option and VCC=5V for 5V option, T_J=-40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ[7]	Max	Units
Supply Voltage	VCC	3.3V option	3.0		3.6	V
		5V option	4.5		5.5	V
VCC Under-voltage Lockout Threshold	VCC_{UVLO}	VCC rising	2	2.5	3	V
VCC Under-voltage Lockout Hysteresis	VCC_{UVLO_HYS}			400	500	mV
Operating Supply Current	I_{CC}	VCC=3.3V for 3.3V option		8	12	mA
		VCC=5V for 5V option		8	12	mA
Output Capacitance Load	C_L	From VOUT to GND			4.7	nF
Output Resistive Load	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
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		150		µA(rms)/√Hz
Noise	I_N	Input referred noise, 120kHz BW		52		$mA_{(rms)}$
Nonlinearity	E_{LIN}	Over full range of I_P		0.5		%
Ratiometry[8] (for ratiometric option)	K_{sens}	$VCC=VCC_{min}$ to VCC_{max}	98	100	102	%
	K_{V0}	$VCC= VCC_{min}$ to VCC_{max}, I_P=0A	99	100	101	%
Zero Current Output Voltage	$V_{OUT(Q)}$ (I_P=0A)	Ratiometric option		VCC/2		V
		Absolute option: 5V option,		2.5		V
		Absolute option: 3.3V option		1.65		V
First Hall Magnetic Coupling Facto	P_{MCF1}			0.6		mT/A
Second Hall Magnetic Coupling Factor	P_{MCF2}			0.3		mT/A
Hall Plate Matching	M_H			±1		%
Saturation Voltage [4]	$V_{OUT(H)}$	3.3V option, R_L=4.7kΩ, T_J=25°C	VCC – 0.3			V
		5V option, R_L=4.7kΩ, T_J=25°C	VCC – 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	$V_{/OCD\_L}$	/OCD triggered, R_{PULLUP}=10 kΩ			0.3	V
/OCD External Pull-up Resistance	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	$T_{RESPONSE\_/OCD}$	Time from I_P > $I_{/OCD}$ to $V_{/OCD}$ below $V_{/OCD\_L}$		1	1.5	µs

MCS1823GQTE-305BRN96 PERFORMANCE CHARACTERISTICS (3)

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

Parameters	Symbol	Condition	Min	Typ(7)	Max	Units
Optimized Accuracy 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		±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=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 Trigger Point	$I_{/OCD}$			±96% × I_{PMAX}		A

MCS1823GQTE-305BRN23 PERFORMANCE CHARACTERISTICS (3)

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

Parameters	Symbol	Condition	Min	Typ(7)	Max	Units
Optimized Accuracy 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		±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=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 Trigger Point	$I_{/OCD}$			±230% × I_{PMAX}		A

MCS1823GQTE-310BRN PERFORMANCE CHARACTERISTICS (3)

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

Parameters	Symbol	Condition	Min	Typ(7)	Max	Units
Optimized Accuracy 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		±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=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 Trigger Point	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-320BRN PERFORMANCE CHARACTERISTICS (3)

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

Parameters	Symbol	Condition	Min	Typ(7)	Max	Units
Optimized Accuracy 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		±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=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 Trigger Point	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-330BRN PERFORMANCE CHARACTERISTICS (3)

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

Parameters	Symbol	Condition	Min	Typ(7)	Max	Units
Optimized Accuracy 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		±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		%
/OCD Trigger Point	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-340BRN PERFORMANCE CHARACTERISTICS (3)

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

Parameters	Symbol	Condition	Min	Typ(7)	Max	Units
Optimized Accuracy 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		±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=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 Trigger Point	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-350BRN PERFORMANCE CHARACTERISTICS (3)

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

Parameters	Symbol	Condition	Min	Typ(7)	Max	Units
Optimized Accuracy 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		±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=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 Trigger Point	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-505BRN PERFORMANCE CHARACTERISTICS (3)

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

Parameters	Symbol	Condition	Min	Typ(7)	Max	Units
Optimized Accuracy 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		±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=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 Trigger Point	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-510BRN PERFORMANCE CHARACTERISTICS (3)

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

Parameters	Symbol	Condition	Min	Typ(7)	Max	Units
Optimized Accuracy 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		±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=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 Trigger Point	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-520BRN PERFORMANCE CHARACTERISTICS (3)

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

Parameters	Symbol	Condition	Min	Typ(7)	Max	Units
Optimized Accuracy 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		±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=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 Trigger Point	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-530BRN PERFORMANCE CHARACTERISTICS (3)

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

Parameters	Symbol	Condition	Min	Typ(7)	Max	Units
Optimized Accuracy 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		±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		%
/OCD Trigger Point	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-540BRN PERFORMANCE CHARACTERISTICS (3)

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

Parameters	Symbol	Condition	Min	Typ(7)	Max	Units
Optimized Accuracy 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		±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=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 Trigger Point	$I_{/OCD}$			±I_{PMAX}		A

MCS1823GQTE-550BRN PERFORMANCE CHARACTERISTICS (3)

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

Parameters	Symbol	Condition	Min	Typ(7)	Max	Units
Optimized Accuracy 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		±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=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 Trigger Point	$I_{/OCD}$			±I_{PMAX}		A

Notes:

(3) See below for the definitions of characteristics.
(4) Beyond the maximum specified current range (I_P), 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 specified range (I_P).
(5) Device may be operated at higher primary current levels I_P and ambient temperatures T_A, provided that the Maximum Junction Temperature T_J(MAX) is not exceeded.
(6) Offset Voltage does not incorporate any error due to external magnetic fields.
(7) Typical values with "±" are ±3 sigma values.
(8) Only for ratiometric option parts.

BLOCK DIAGRAM

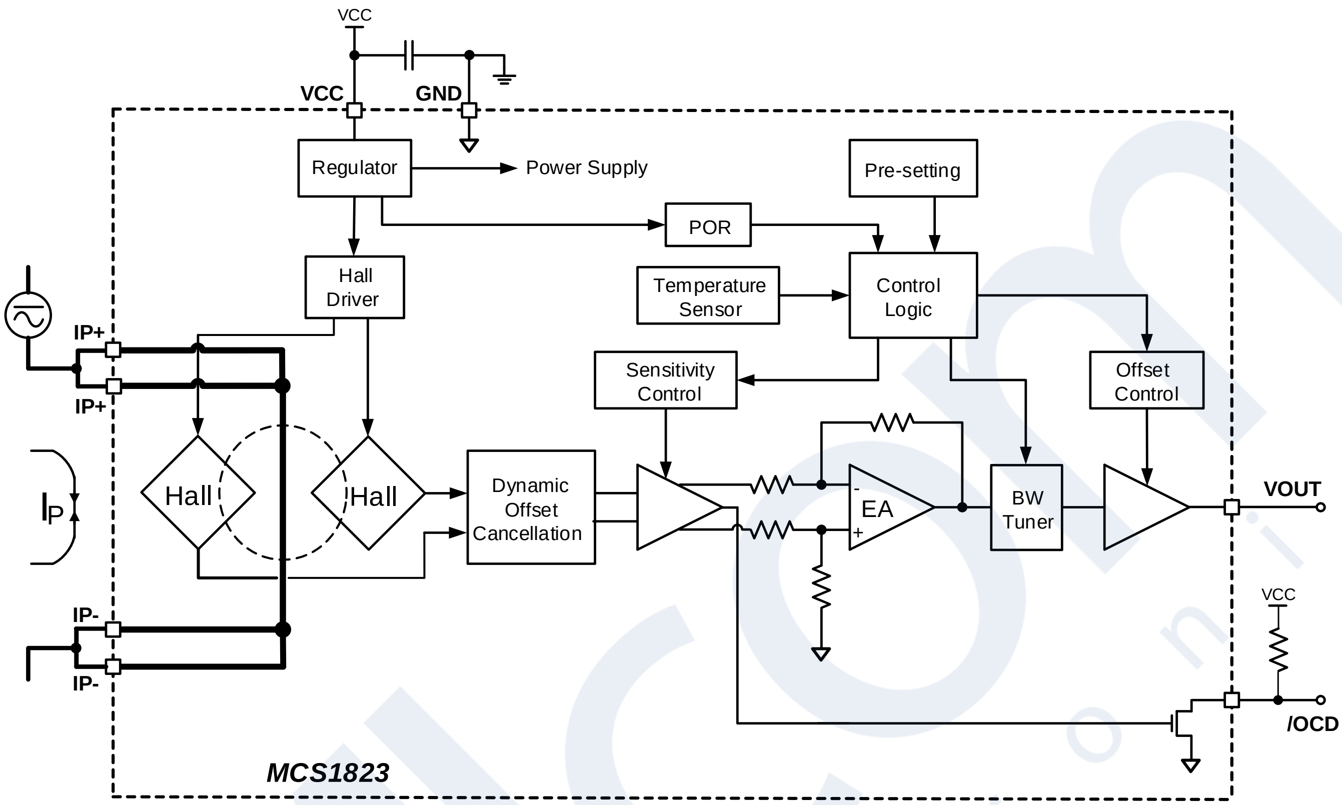


Figure 1: Functional Block Diagram

DEFINITIONS

Current rating

I_{PMAX} is the rated current. The sensor output is linear as a function of the primary current I_P and follows the specified performances when I_P is between $-I_{PMAX}$ and $+I_{PMAX}$.

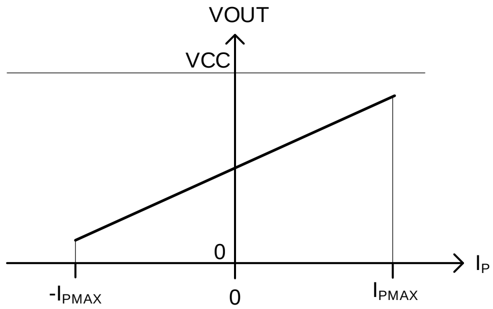


Figure 2 : sensor output function

Sensitivity (Sens)

The Sensitivity in mV/A indicates how much the output changes when the primary current changes. It is the product of the average between the 2 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 target sensitivity.

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

The first and second Hall magnetic coupling factor are defined as the amount of vertical magnetic field (see the arrows B_1 and B_2) produced at the sensing points 1 and 2, per unit of current injected in the primary conductor. Due to the non-symmetric shape of the primary conductor the magnetic field generated in the two sensing points are different.

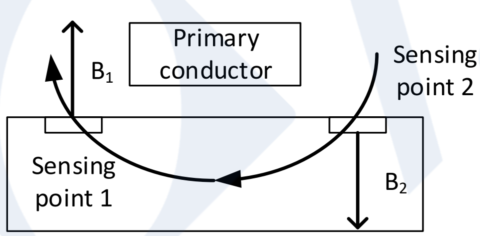


Figure 3: Schematic cross section of the sensor

Noise (V_{NOISE})

The noise is a random deviation and cannot be calibrated out. The input referred noise is the root mean square of sensor output noise in mV, divided by the sensitivity in mV/A. It represents the smallest current that the device is able to resolve, without any external signal treatment (it is generally accepted that the resolution is 3 times the rms noise).

Other deviations are systematic, meaning that they represent the average deviation over a large number of data points. They can be calibrated out.

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

$V_{OUT(Q)}$ is the voltage output when the primary current is zero. For ratiometric output option, the nominal value is VCC/2. For absolute output option, the nominal value is 1.65V for 3.3V option, 2.5V for 5V option. Variation in $V_{OUT(Q)}$ from the nominal value is due to thermal drift and the resolution limits of voltage offset trimming in the factory.

Offset Voltage (V_{OE})

The difference between the zero current output nominal value and the zero current output. To convert this voltage into amperes, divide by the sensitivity.

Nonlinearity (E_{LIN})

Ideally the primary current vs sensor output function is a straight line. The non-linearity is an indication of the worst deviation from this straight line.

The nonlinearity in % is defined by:

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

where $V_{LIN}(I_P)$ is the approximate straight line calculated by the least square method. Note: depending on the curvature of, E_{LIN} can be negative or positive.

Total Output Error (E_{TOT})

E_{TOT} in % is the relative difference between the sensor output and the ideal output at a given primary current I_P:

$$E_{TOT}(I_P) = \frac{V_{OUT}(I_P) - V_{OUT\_IDEAL}(I_P)}{Sens \cdot I_P} \times 100$$

where,

$$V_{OUT\_IDEAL}(I_P) = \frac{VCC}{2} + Sens \cdot I_P$$

The total output error incorporates all sources of error and is a function of I_P. At current close to I_{PMAX}, the E_{TOT} error is affected mainly by sensitivity error. At current close to zero, the E_{TOT} error is mostly due to the Offset Voltage (V_{OE}). Note that when $I_P = 0$, E_{TOT} diverges to infinity because of constant offset.

Ratiometry coefficients

For ratiometric options, ideally the sensor output is ratiometric, it means that the sensitivity and the zero current output scales with VCC. The ratiometry coefficients measures how good is this proportionality.

$$K_{SENS} = \frac{Sens(VCC)/Sens(VCC_{TYP})}{VCC/VCC_{TYP}}$$

$$K_{VO} = \frac{V_{OUT}(I_P = 0, VCC)/V_{OUT}(I_P = 0, VCC_{TYP})}{VCC/VCC_{TYP}}$$

Where $VCC_{TYP} = 3.3V$ for 3.3V VCC supply parts, $VCC_{TYP} = 5V$ for 5V VCC supply parts, ideally both K_{SENS} and K_{VO} are 1.

Power-On Time (t_{PO})

This reflects the time interval after power is first applied to the device until the output can be considered to correctly indicate the applied primary current. The Power-On Time (t_{PO}) is defined as the time taken between the supply reaching the minimum operating voltage VCC_{MIN} (t1), and the output voltage to settling to within ±10% of its steady state value under an applied primary current (t2) (See Figure 4).

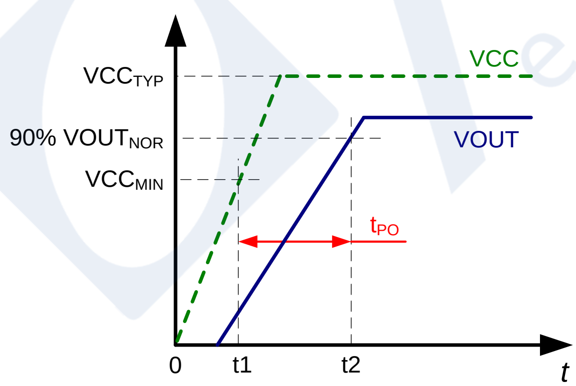


Figure 4: Power-On Time (t_{PO})

Propagation Delay (t_{pd})

The propagation delay represents the internal latency between an event to be measured and the sensor response. It is measured as a time interval between the primary current signal reaching 20% of I_{P_MAX} (t1) and the time for the voltage to reach 20% of $VOUT_{MAX}$ (t2). See Figure 5.

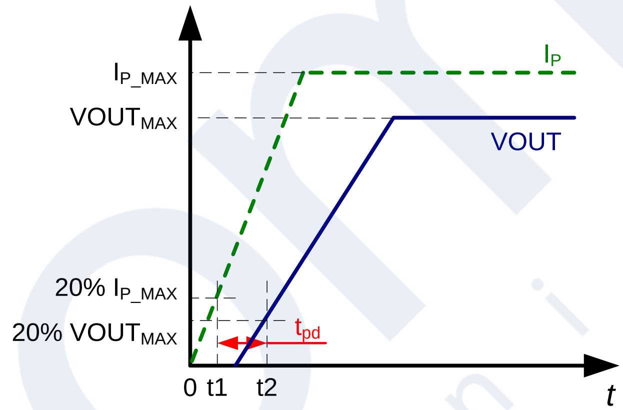


Figure 5: Propagation Delay (t_{pd})

Rise Time (t_r)

Rise Time is the time interval between the sensor VOUT reaching 10% of its full scale value (t1), and it reaching 90% of its full scale value (t2). See Figure 6.

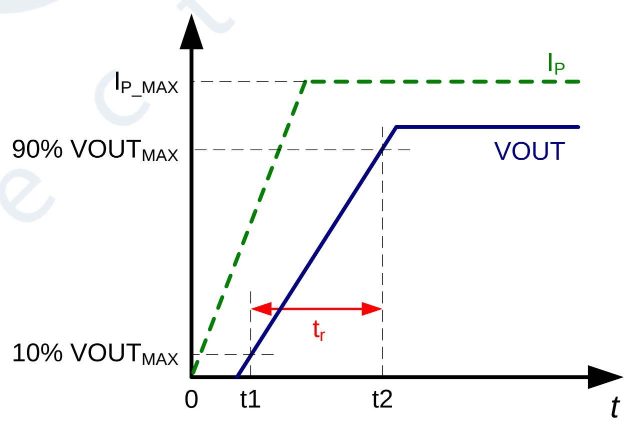


Figure 6: Rise Time (t_r)

Response Time ($t_{RESPONSE}$)

$t_{RESPONSE}$ is a combination of the previously defined times: it is the time interval between the primary current signal reaching 90% of its final value (t1), and the device VOUT reaching 90% of its output corresponding to the applied primary current (t2). (See Figure 7)

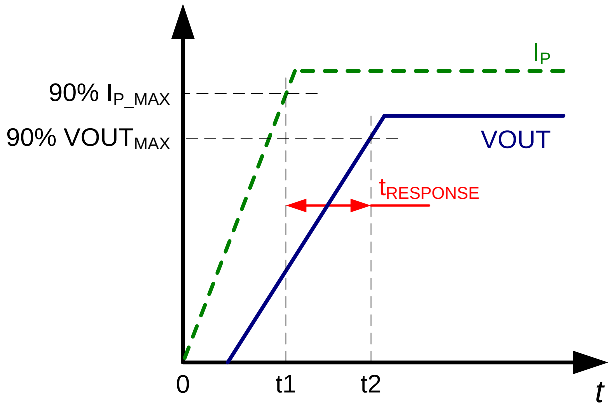


Figure 7: Response Time ($t_{RESPONSE}$)

APPLICATION INFORMATION

Over Current Detection (/OCD)

The MCS1823 integrates fast over current detection. When primary current exceeds the current limit ($I_{/OCD}$), a high-speed detection circuit will trigger an /OCD event within /OCD response time ($T_{RESPONSE\_/OCD}$). The current limit ($I_{/OCD}$) is preset with different part number. The MCS1823 implements latched and unlatched /OCD pin output modes when /OCD event is triggered.

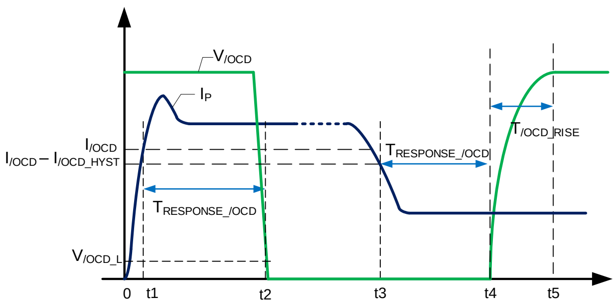


Figure 8: Unlatched /OCD Timing

Figure 8 shows the unlatched /OCD Timing. When primary current I_P reaches the over current limit $I_{/OCD}$ and stays longer than the /OCD response time $T_{RESPONSE\_/OCD}$, the /OCD pin voltage $V_{/OCD}$ will be pulled down to $V_{/OCD\_L}$. When primary current I_P goes below $I_{/OCD}$-$I_{/OCD\_HYST}$ over another $T_{RESPONSE\_/OCD}$, the /OCD pin voltage $V_{/OCD}$ starts to rise. The $T_{/OCD\_RISE}$ is the $V_{/OCD}$ rising time from logic low to logic high, it is dependent on the pull up resistor (R_{PULLUP}) value and the capacitance from /OCD pin to GND, a small RC will bring a fast rise time.

In /OCD latched mode, when an /OCD event occurs, the /OCD pin will remains latched low even the /OCD event has been quit (see Figure 9). The latched status will be reset after VCC power restarts.

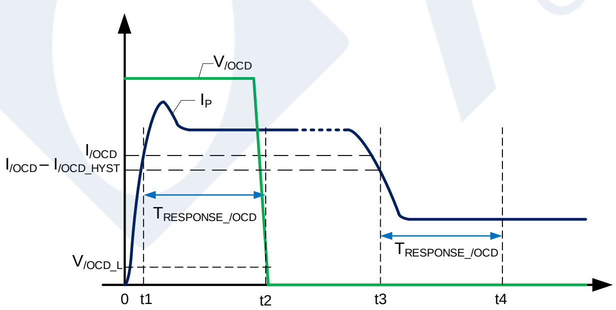


Figure 9: latched /OCD Timing

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 the IC junction temperature does not exceed the maximum value 165°C.

The thermal behavior strongly depends on thermal environment of the MCS1823 component and its cooling capacity, in particular the PCB copper area and thickness. The thermal response also depends on the profile of the current waveform which means on the amplitude and frequency for an AC current, and on the peaks and duty cycle for 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 MCS1823 demo board at 25°C T_A after 10 minutes of continuous current.

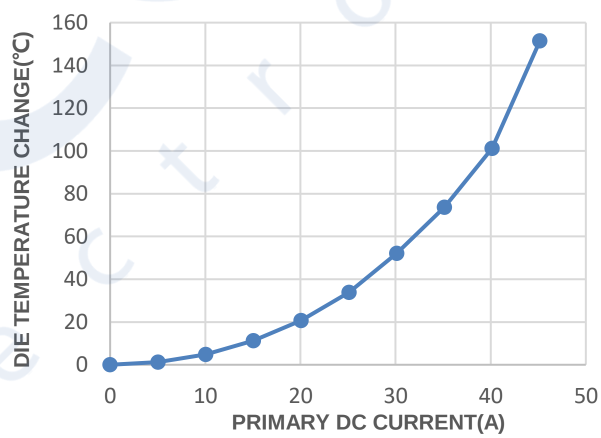


Figure 10: Self-heating Performance with DC Current Input

Figure 11 shows the top and bottom layers of the MCS1823 demo board, the board includes in total 570 mm^2, 2.5 oz (87 um) 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.

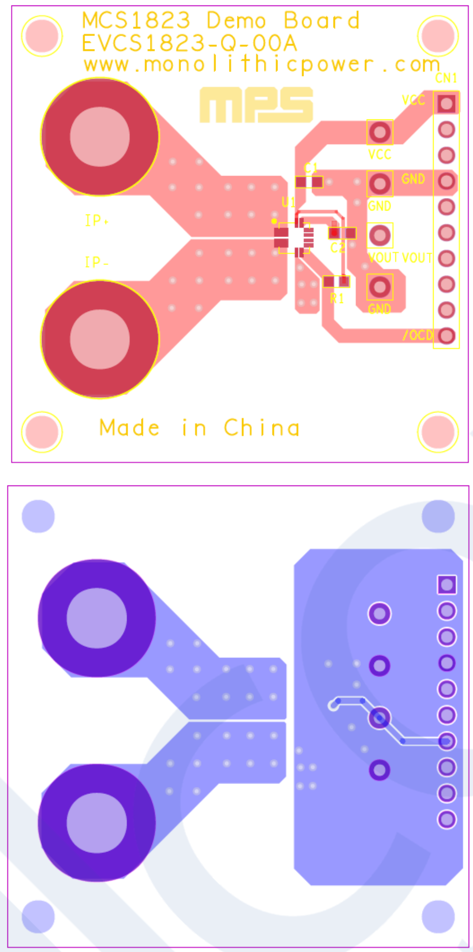


Figure 11: Top and Bottom Layers of MCS1823 Demo Board

TYPICAL APPLICATION CIRCUITS

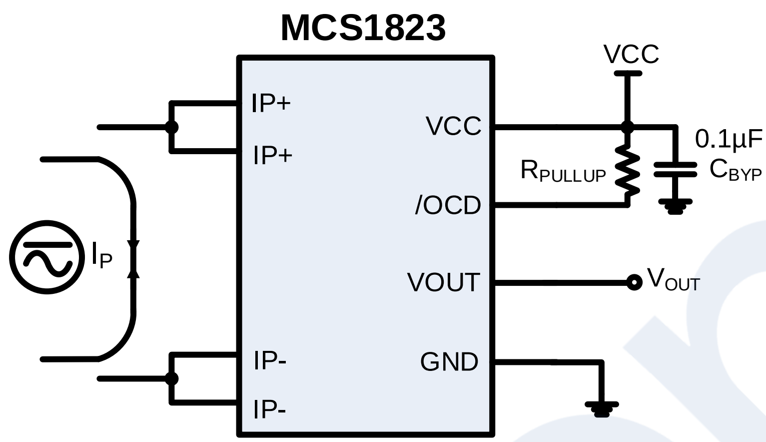
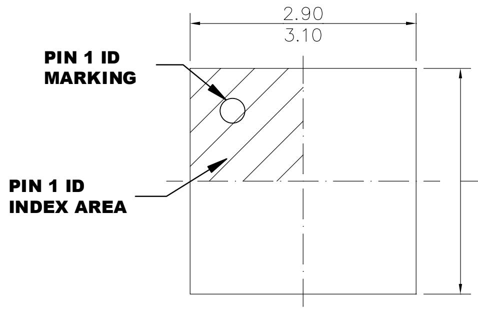


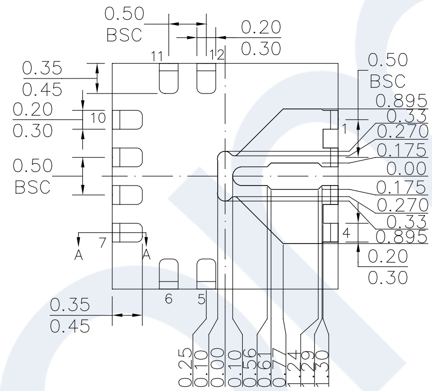
Figure 12: Application Circuit

PACKAGE INFORMATION

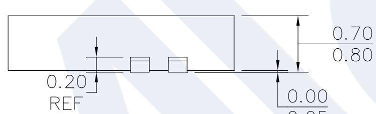
QFN-12 (3mmx3mm)



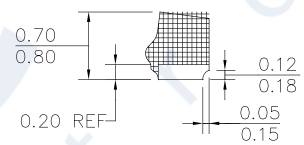
TOP VIEW



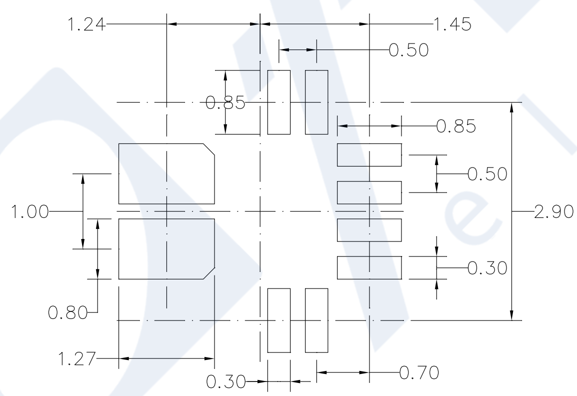
BOTTOM VIEW



SIDE VIEW



SECTION A-A

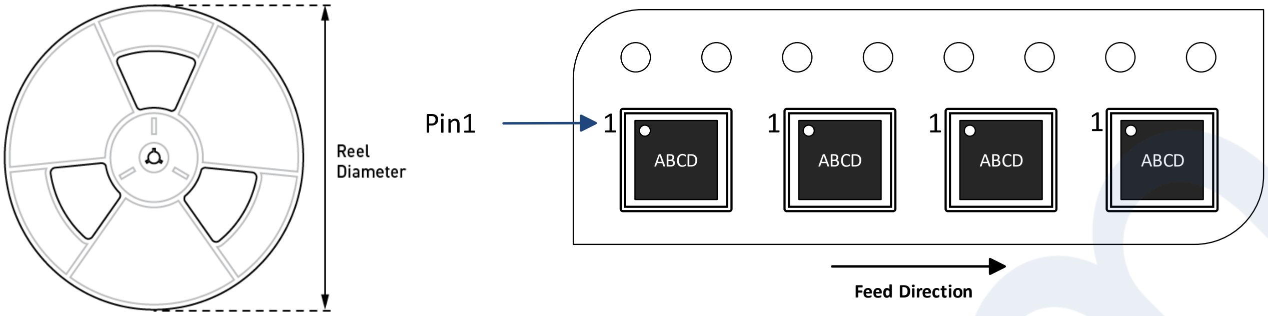


RECOMMENDED LAND PATTERN

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	QFN-12 (3mmx3mm)	5000	N/A	N/A	13in	12mm	8mm