# MCS1805

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

## DESCRIPTION

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

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

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

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

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

## FEATURES

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

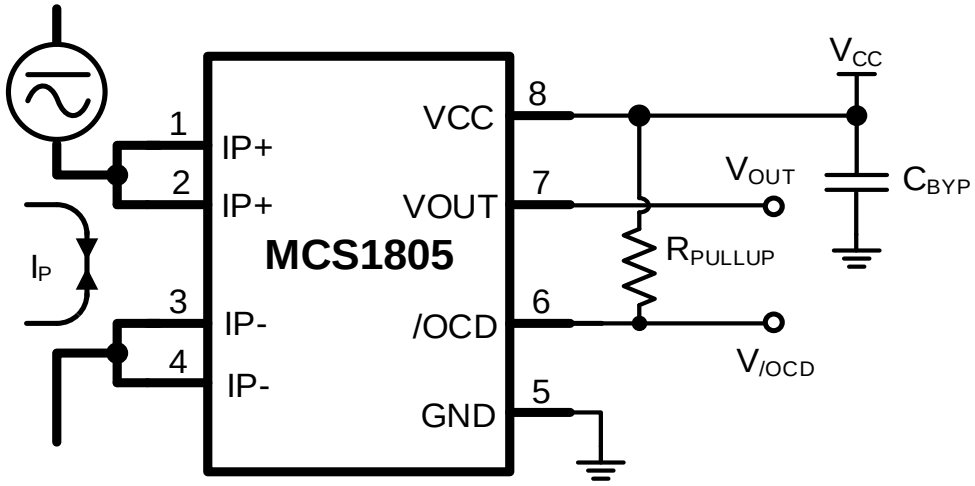
Certificate Number:
B 113824 0012 Rev.00
CBS 113824 0013 Rev.00

CB Certificate Number:
CA-11398-UL

## APPLICATIONS

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

## TYPICAL APPLICATION



## ORDERING INFORMATION

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

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

** Contact an MPS FAE for additional variants.

## PART NUMBERING
## (MCS1805GS-ABB-CDDD)

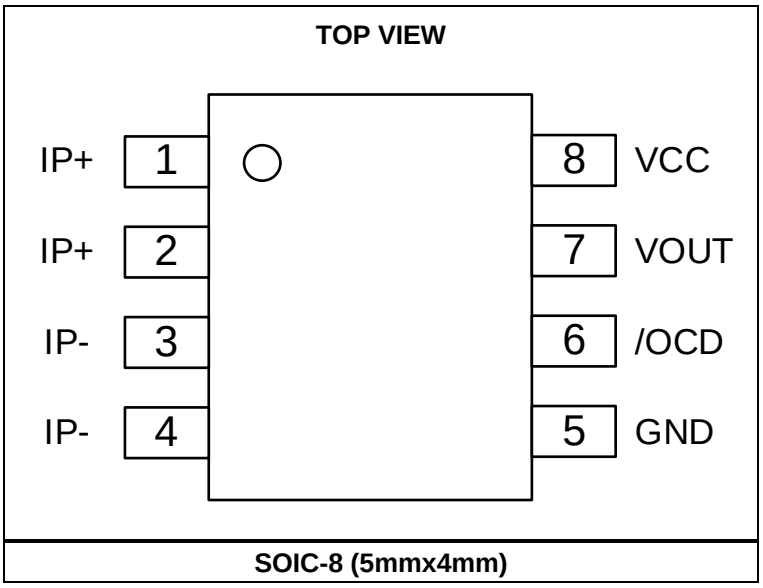
| | | | |
|---|---|---|---|
| G | Operating Temperature ($T_J$): -40°C to +125°C | BB | Rated Current Range |
| S | Package Code for SOIC-8 | C | Current Polarity:<br>B = Bidirectional<br>U = Unidirectional |
| A | Supply Voltage:<br>3 = 3.3V Supply<br>5 = 5V Supply | DDD | OCD Threshold:<br>Blank =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

## TOP MARKING

MCS1805
LLLLLLLL
MPSYWW

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

## PACKAGE REFERENCE




SOIC-8 (5mmx4mm)

## PIN FUNCTIONS

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

## ABSOLUTE MAXIMUM RATINGS (1)

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

### *ESD Ratings*

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

### *Recommended Operating Conditions* (2)

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

**Notes:**

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

## ISOLATION CHARACTERISTICS

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

## WITHSTANDING CURRENT CAPABILITY

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

**Note:**

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

## MCS1805GS COMMON ELECTRICAL CHARACTERISTICS

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

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

## MCS1805GS COMMON ELECTRICAL CHARACTERISTICS *(continued)*

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

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

## MCS1805GS-305-B PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-310-B PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-320-B PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-330-B PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-340-B PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-350-B PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-305-U PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-310-U PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-320-U PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-330-U PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-340-U PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-350-U PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-505-B PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-510-B PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-520-B PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-530-B PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-540-B PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-550-B PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-505-U PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-510-U PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-520-U PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-530-U PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-540-U PERFORMANCE CHARACTERISTICS

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

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

## MCS1805GS-550-U PERFORMANCE CHARACTERISTICS

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

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

**Notes:**

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

# FUNCTIONAL BLOCK DIAGRAM

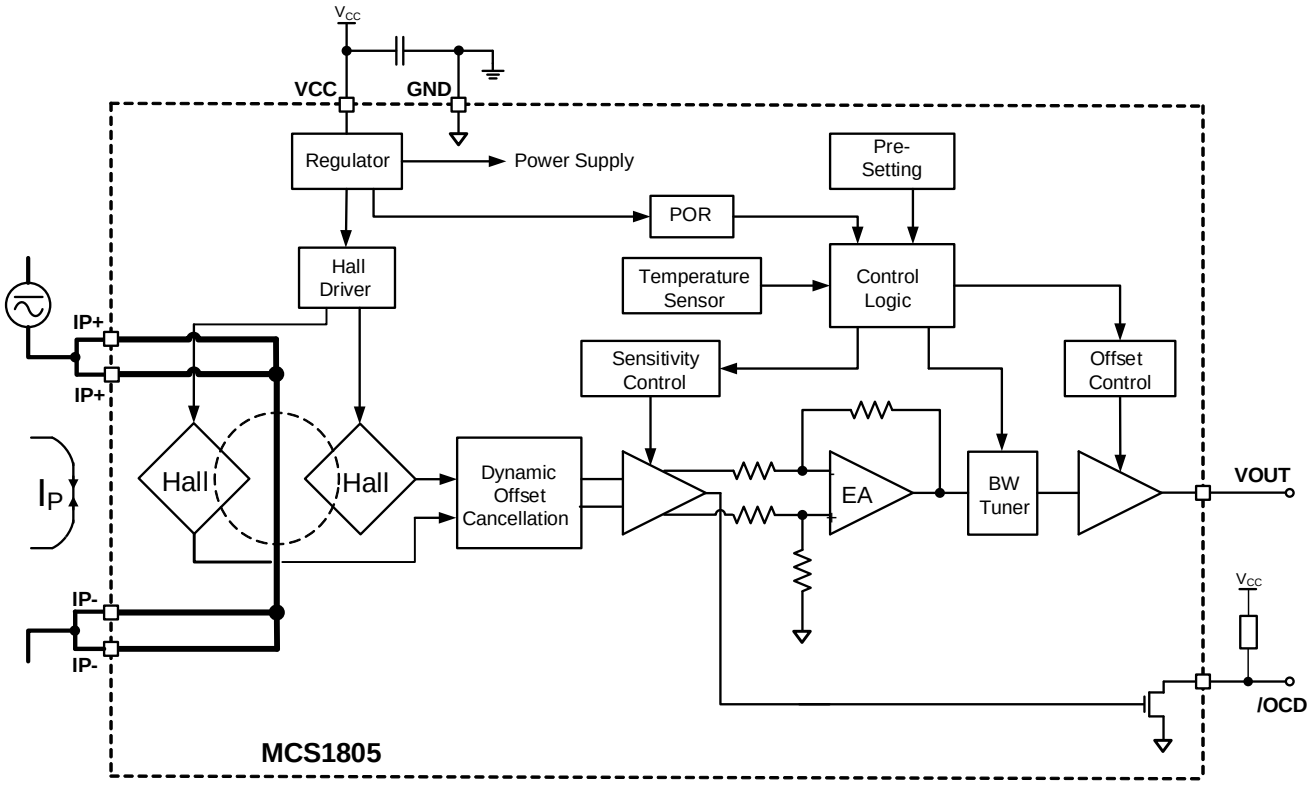



**Figure 1: Functional Block Diagram**

# DEFINITIONS

## Current Rating

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

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

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

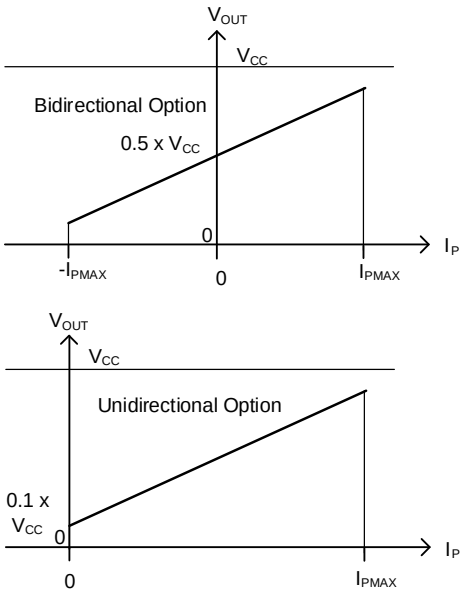



**Figure 2: Sensor Output Function**

## Sensitivity (SENS)

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

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

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

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

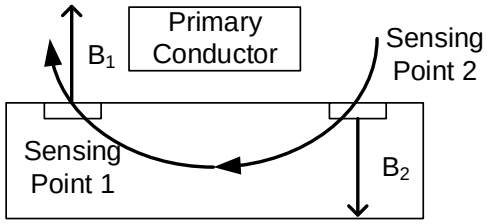



**Figure 3: Sensor's Cross-Section**

## Noise ($I_N$)

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

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

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

## Offset Voltage ($V_{OE}$)

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

## Nonlinearity ($E_{LIN}$)

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

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

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

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

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

### Total Output Error ($E_{TOT}$)

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

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

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

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

### Ratiometry Coefficients

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

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

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

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

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

Where $V_{CC\_TYP}$ = 3.3V for the 3.3V option, and $V_{CC\_TYP}$ = 5V for the 5V option.

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

### Power-On Time ($t_{PO}$)

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

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

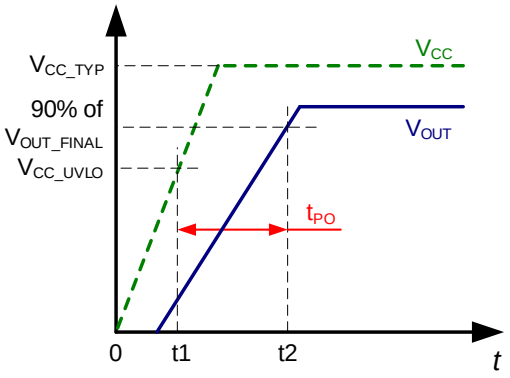



**Figure 4: Power-On Time ($t_{PO}$)**

### Propagation Delay ($t_{PD}$)

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

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

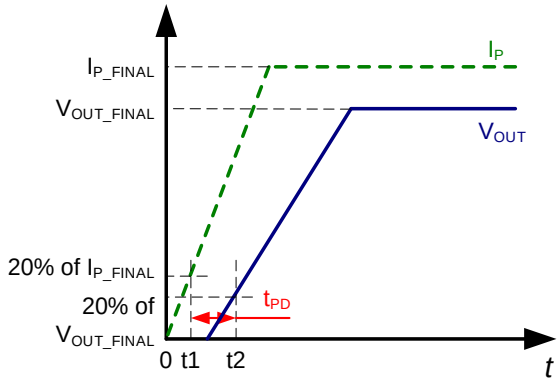



**Figure 5: Propagation Delay ($t_{PD}$)**

### Rise Time ($t_R$)

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

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

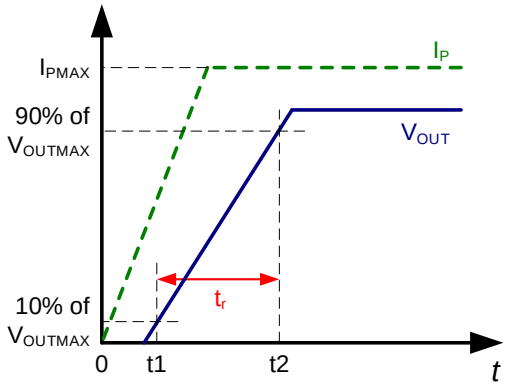



**Figure 6: Rising Time ($t_R$)**

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

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

### Response Time ($t_{RESPONSE}$)

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

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

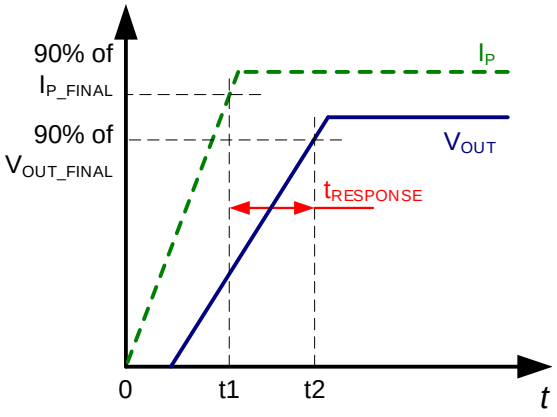



**Figure 7: Response Time ($t_{RESPONSE}$)**

# APPLICATION INFORMATION

## Over-Current Detection (OCD)

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

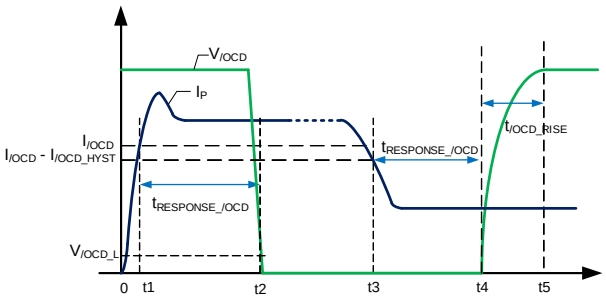



**Figure 8: OCD Timing**

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

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

## Self-Heating Performance

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

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

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

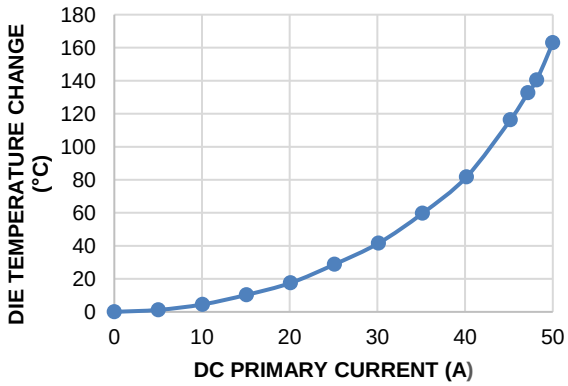
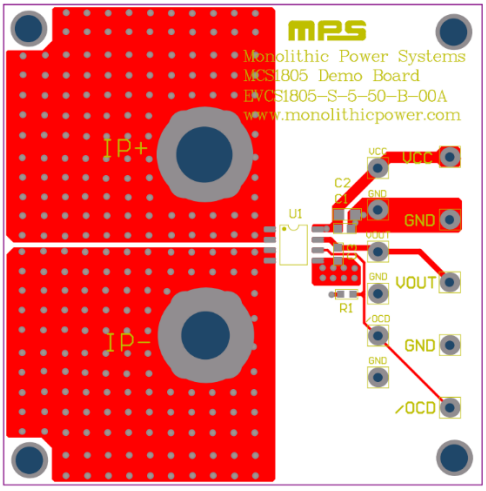
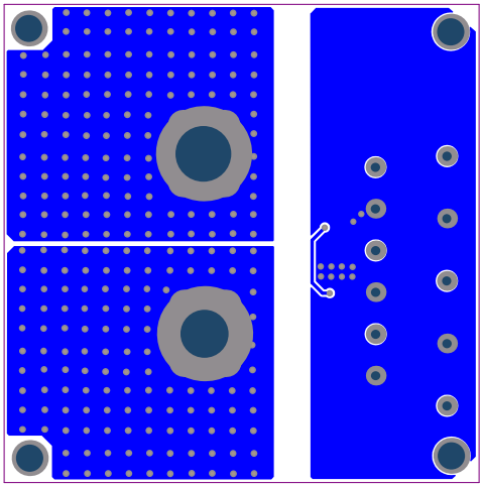



**Figure 9: Self-Heating Performance with DC Current Input**

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




**Top Layer**



**Bottom Layer**

**Figure 10: MCS1805 PCB**

## TYPICAL APPLICATION CIRCUIT

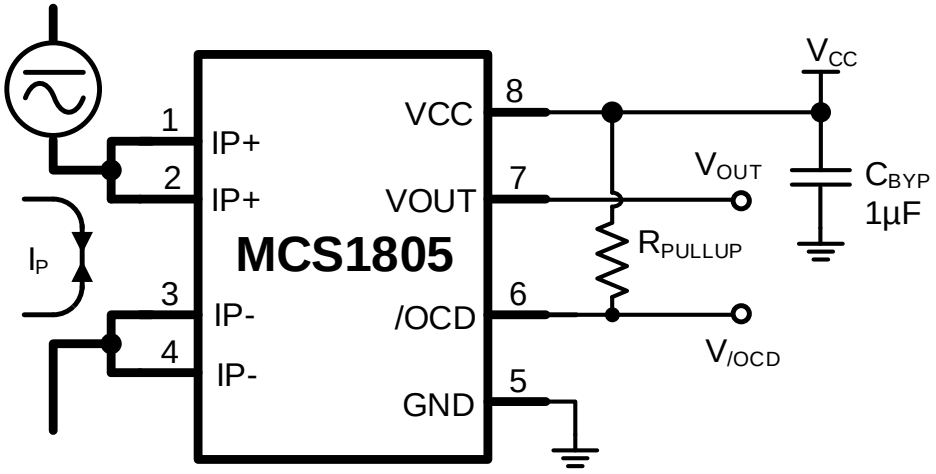
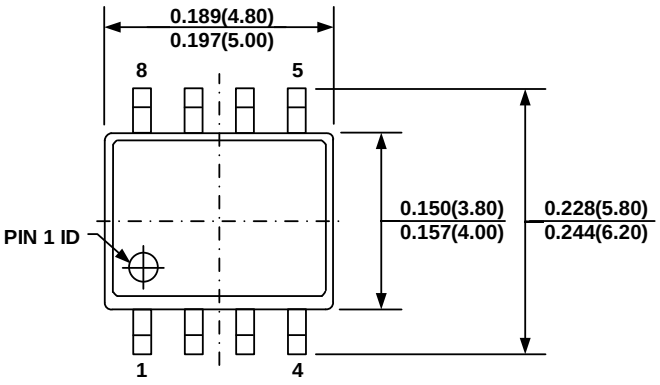


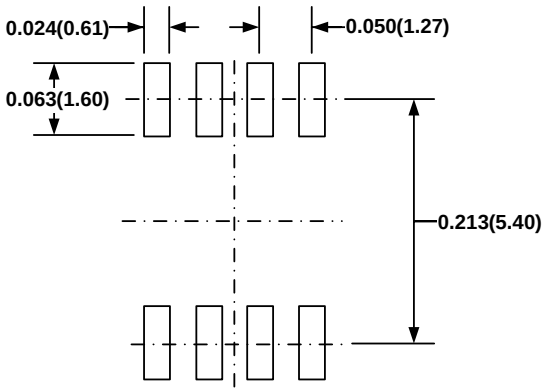

**Figure 11: Typical Application Circuit**

# PACKAGE INFORMATION

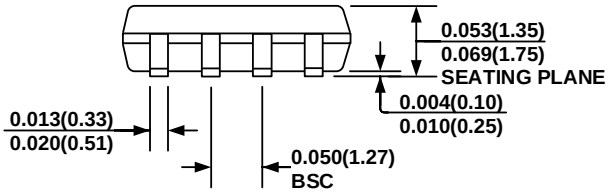
## SOIC-8



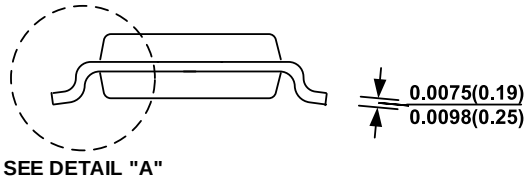

TOP VIEW



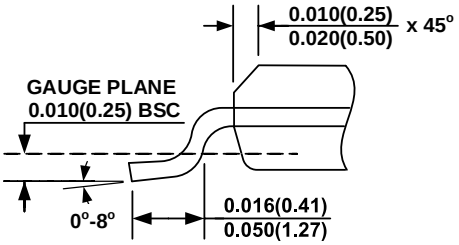

RECOMMENDED LAND PATTERN




FRONT VIEW




SIDE VIEW

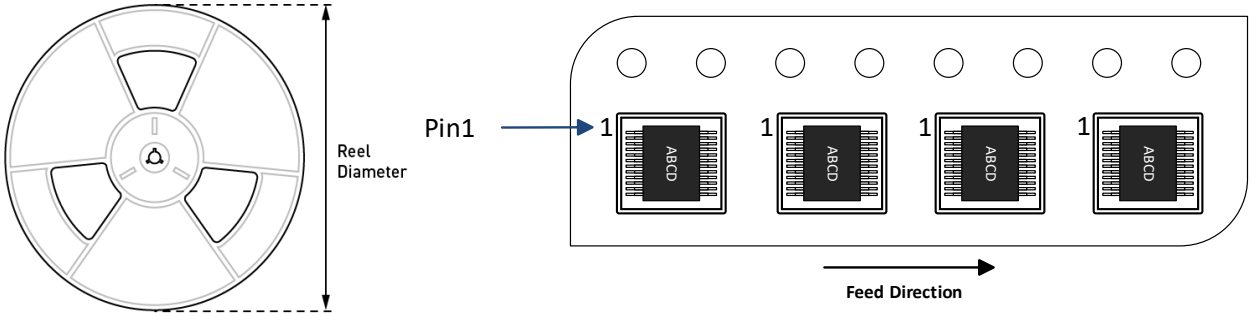



DETAIL "A"

**NOTE:**

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

## CARRIER INFORMATION




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

## REVISION HISTORY

| Revision # | Revision Date | Description | Pages Updated |
|---|---|---|---|
| 1.0 | 4/19/2023 | Initial Release | - |
| 1.01 | 4/23/2024 | Added the UL certification logo | 1 |