



High Accuracy Current Sensor IC with 5.0MHz 3dB Bandwidth and Isolation $\pm 5A$, $\pm 20A$, $\pm 50A$, $\pm 65A$, 3.3V, Fixed Gain



MCA2101-xx-3

FEATURES

- AEC-Q100 qualified
- AMR based integrated current sensor
- Superior Range & Accuracy
 - 0.6% typical total error @25°C (MCA2101-20-3)
 - 2.0% max error over temperature (MCA2101-20-3)
- Superior Frequency Response
 - 5.0 MHz (typical 3dB Magnitude BW)
 - 1.3 MHz (typical 3dB Phase BW)
- Fast output response time (80ns typical)
- Low Primary Resistance (0.9 mΩ)
- Single 3.3V Supply Operation
- Low power consumption (4.5mA typical)
- Zero-Current Reference Pin (Vref)
- Overcurrent fault detection
- SOIC-16 package (RoHS/REACH compliant)
- -40 to +125°C Operating Temperature Range
- UL/IEC/EN62368-1 Certified
 - 4.8 kV Dielectric Strength Voltage
 - 1118 VRMS Basic Isolation Voltage

557 VRMS Reinforced Isolation Voltage

APPLICATIONS

Server, Telecom, & Industrial Power Supplies

Power Aggregation, Over-Current Protection
Dynamic Current Sensing in Feedback Loops
PFC and Inverter Control

Motor Control Loops & Protection

Automation, Robotics, Servo Systems
Automotive & EV Power Systems

Solar Inverters and Optimizers

Grid-Tie and Storage Current Monitoring
MPPT Circuit Current Monitoring
Central Inverter Current Monitoring

Consumer

Motor Balance and Remote Device Monitoring
Home Automation Control & IOT remote sensing

DESCRIPTION

The MCA2101 products are $\pm 5A$, $\pm 20A$, $\pm 50A$, $\pm 65A$ fully integrated bi-directional analog output current sensors that deliver both high accuracy and high bandwidth. ACEINNA's state-of-the-art Anisotropic Magneto Resistive (AMR) sensor technology provides inherently low noise, excellent linearity and repeatability.

A fully isolated current path is provided by a low resistance copper conductor integrated into the package making it suitable for both high-side and low side bi-directional current sensing. The high bandwidth of 5.0MHz (3dB) and low phase delay makes it ideal for current sense feedback loops in motor control, inverters, uninterruptible power supplies, battery management, power factor correction, high voltage distribution bus converters and power supply applications, including those with fast switching wide-bandgap SiC and GaN based power stages.

These devices are factory-calibrated to achieve low offset error and provide a precise analog voltage output that is linearly proportional to the conduction current (AC or DC) with sensitivity (mV/A) compatible with A/D converters and analog control loops in power systems. The AMR sensor device structure is designed to eliminate sensitivity to stray and common mode magnetic fields.

Due to the inherently low output noise of ACEINNA's sensor technology, additional filtering is not required to reduce noise that reduces accuracy at low-level currents in systems with dynamic load profiles.

The MCA2101 products in SOIC-16 package are simple to use with no or minimal external components (other than decoupling capacitor) enabling fast design, supports high isolation and are UL/IEC/EN62368-1 certified.

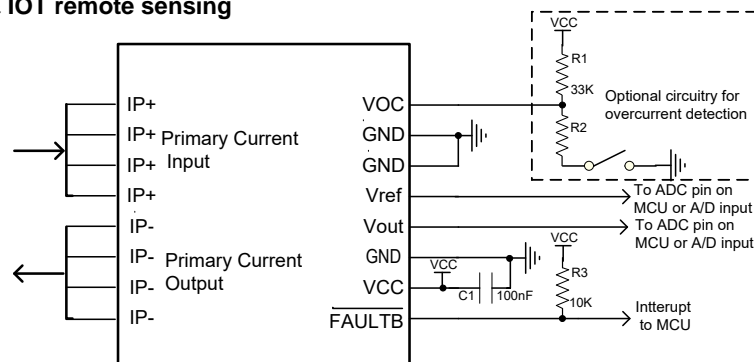


Figure 1 - Application Circuit

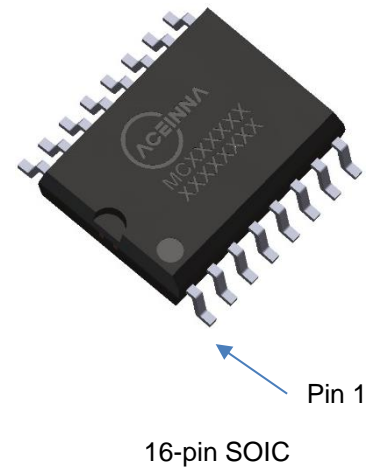
ORDERING PART NUMBER

| Ordering PART NUMBER | Part Marking (See Page 12) | Current Range | Gain | VCC (typical) | Dielectric Strength | Package | Qty per Reel |
|----------------------|-------------------------------|---------------|-------|---------------|---------------------|--------------|--------------|
| MCA2101-5-3 | MCA21053 | ±5 Amp | Fixed | 3.3V | 4800V | 16 Lead SOIC | 1000 pcs |
| MCA2101-20-3 | MCA21203 | ±20 Amp | Fixed | 3.3V | 4800V | 16 Lead SOIC | 1000 pcs |
| MCA2101-50-3 | MCA21503 | ±50 Amp | Fixed | 3.3V | 4800V | 16 Lead SOIC | 1000 pcs |
| MCA2101-65-3 | MCA21653 | ±65 Amp | Fixed | 3.3V | 4800V | 16 Lead SOIC | 1000 pcs |

Note: Evaluation boards are available for each product version (order EVB-MCx2101-xx-x)

PIN DESCRIPTION

| Pin # 16L SOIC | Name | Description |
|-------------------|--------|---|
| 1,2,3,4 | IP+ | Input of Primary Current Path for Sensing, Fused internally |
| 5,6,7,8 | IP- | Output of Primary Current Path for Sensing, Fused internally |
| 9 | FAULTB | Overcurrent FAULTB open drain output. Active low. |
| 10 | VCC | System Power Supply |
| 11 | GND | Recommended to connect to ground |
| 12 | Vout | Analog Output Signal linearly proportional to Primary Path Current |
| 13 | Vref | Zero Current Analog Reference Output |
| 14 | GND | Used during initial factory calibration. This pin should be connected to ground or left floating during normal operation. |
| 15 | GND | Connect to ground |
| 16 | VOC | Input pin. Voltage on this pin defines the overcurrent detection OCD threshold level. Briefly driving this pin to VCC resets and re-arms OCD circuit. |



BLOCK DIAGRAM

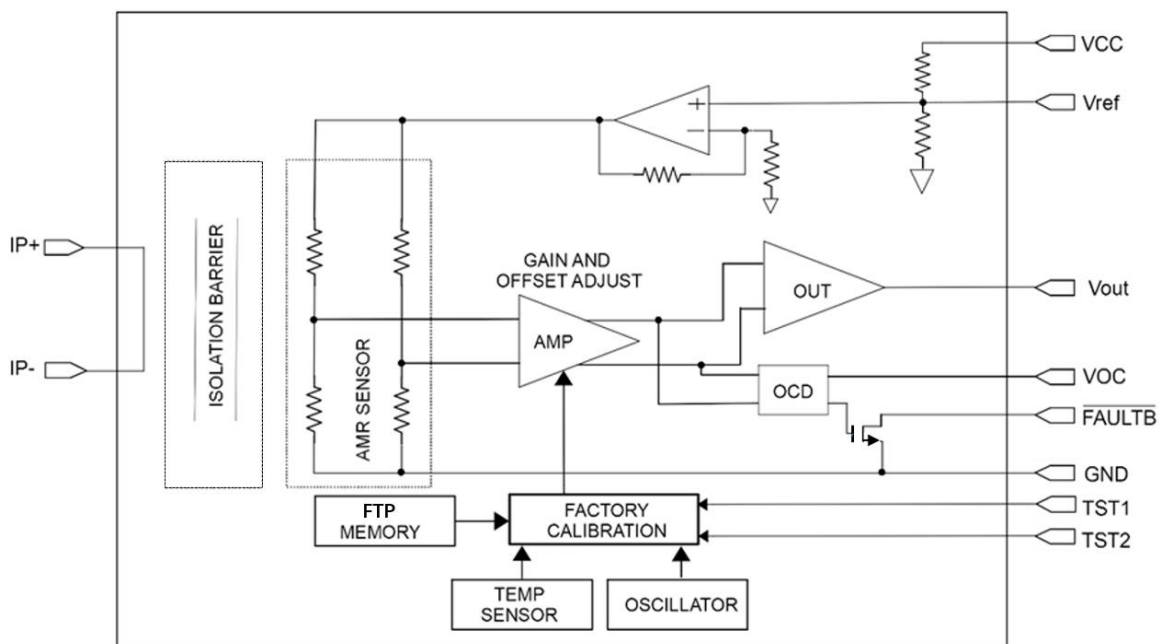


Figure 2 - Block diagram for fixed gain products

Table 1 – ABSOLUTE MAXIMUM RATINGS

Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation at these or any other conditions beyond those specified is not implied.

| Parameters / Test Conditions | Symbol | Value | Unit |
|--|-------------------------|-----------------------|------|
| Supply Voltage | $V_{CC_{MAX}}$ | -0.5 to 6 | V |
| FAULTB Output Voltage | $V_{\overline{FAULTB}}$ | -0.5 to $V_{CC}+0.5V$ | V |
| Sensor Current (IP+, IP-), 5Amp products | IP_{MAX} | ± 10 | A |
| Sensor Current (IP+, IP-), 20Amp products | IP_{MAX} | ± 50 | A |
| Sensor Current (IP+, IP-), 50Amp products | IP_{MAX} | ± 100 | A |
| Sensor Current (IP+, IP-), 65Amp products | IP_{MAX} | ± 100 | A |
| Maximum Device Junction Temperature | $T_{J_{MAX}}$ | 150 | °C |
| Storage Temperature | T_{STG} | -65 to +150 | °C |
| Operating Ambient Temperature Range | T_A | -40 to 125 | °C |
| ESD Human Body Model / per ANSI/ESDA/JEDEC JS-001 | HBM | 8000 | V |
| ESD Charged Device Model / per JEDEC specification JESD22-C101 | CDM | 2000 | V |
| MSL Rating | MSL | 3 | |
| Maximum Soldering Temperature, 10 seconds. | T_{SOLDER} | 260 | °C |

Table 2 – ISOLATION CHARACTERISTICS

| Parameters / Test Conditions | Symbol | Value | Unit |
|--|-------------------|-------------|------|
| Dielectric Strength Test Voltage (Agency type-tested for 60 seconds per UL standard 62368-1 (edition 2). Production tested at 3kVrms per UL 62368-1. | V _{ISO} | 4800 | V |
| Working Voltage for Basic Isolation. Maximum approved working voltage according to UL 62368-1 (edition 2)- (V _{PK/DC} / V _{RMS}) | V _{WVBI} | 1582 / 1118 | V |
| Working Voltage for Reinforced Isolation (V _{PK/DC} / V _{RMS}) | V _{WVRI} | 788 / 557 | V |
| Clearance (Minimum distance through air from IP leads to signal leads) | D _{CL} | 8.0 | mm |
| Creepage (Minimum distance along package body from IP leads to signal leads) | D _{CR} | 8.0 | mm |

Table 3 – THERMAL CHARACTERISTICS

| Parameters / Test Conditions | Symbol | Value | Unit |
|---|------------------|-------|------|
| Junction-to-Ambient Thermal Resistance (Note 1) | R _{θJA} | 27 | °C/W |
| Junction-to-Lead Thermal Resistance | R _{θJC} | 10 | °C/W |

Note 1 – The R_{θJA} measured on the EB0011- evaluation board with 800mm² of 4oz copper on each layer(top and bottom), thermal vias connecting the layers. The performance values include the power consumed by the PCB.

Table 4 – ELECTRICAL CHARACTERISTICS COMMON TO ALL VERSIONS

Unless otherwise noted: 3.15V ≤ VCC ≤ 3.45V, -40°C ≤ T_A ≤ 125°C, I (Vout) = I (Vref) = 0 (Recommended Operating Conditions). Typical values are for VCC = 3.3V and T_A = 25°C.

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|-------------------------------------|-----------------------|---|-----|------|-----|----------|
| Vout Output | | | | | | |
| Load Regulation | V _{outLR} | Increase I (Vout) from 0 to -250μA. Measure change in Vout voltage | | 0.7 | 4 | mV |
| Source Current | V _{outSRC} | Vout shorted to GND | | | 50 | mA |
| Sink Current | V _{outSNK} | Vout shorted to VCC | | | 30 | mA |
| Magnitude Frequency Response (-3dB) | V _{outBW} | (Note 2) | | 5000 | | kHz |
| Capacitive Loading | C _{VoutMAX} | (Note 2) | | | 200 | pF |
| Resistive Loading | R _{LMIN} | Minimum load resistance on Vout & Vref. (Note 2 and Note 3) | 10 | | | kohm |
| Response Time | t _{RESP} | IP± = 0 to +/-100% step input, Interval from 80% of the IP to 80% of the Vout. (Note 2) | | 80 | | ns |
| Noise Density | I _{ND} | Input Referred, VCC=3.3V, T _A = 25°C, CL=200pF, DC to 100kHz | | 35 | | μA/√Hz |
| Noise (Input Referred) | V _{outNOISE} | IP± = 0, Measure (Vout – Vref). DC to 100 kHz. (Note 2) | | 12 | | mA (rms) |
| Power Supply Rejection Ratio Offset | PSRR _O | T _A = 25°C, 1kHz, 200mV pk-pk ripple around VCC=3.3V, IP± = 0 | | -80 | | dB |

Note 2 – Guaranteed by design and characterization. Not production tested.

Note 3 – Vref pin supply capability limited to Fixed Gain mode.

Table 5 – ELECTRICAL CHARACTERISTICS COMMON TO ALL VERSIONS

Unless otherwise noted: $3.15V \leq VCC \leq 3.45V$, $-40^{\circ}C \leq T_A \leq 125^{\circ}C$, $I(V_{out}) = I(V_{ref}) = 0$ (Recommended Operating Conditions). Typical values are for $VCC = 3.3V$ and $T_A = 25^{\circ}C$.

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|------------------------------|----------------------|--|-------|-------|-------|------------|
| Vref Output | | | | | | |
| Output Voltage | Vref | I (Vref) = 0 to -1mA, Fixed Gain Products (Note 1) | 1.485 | 1.500 | 1.515 | V |
| Load Regulation | Vref _{LR} | Increase I (Vref) from 0 to -250 μ A. Measure change in Vref voltage. (Note 3) | | 0.7 | 4 | mV |
| Source Current | Vref _{SRC} | Vref shorted to GND. (Note 3) | | | 10 | mA |
| Sink Current | Vref _{SNK} | Vref shorted to VCC. (Note 3) | | | 10 | mA |
| Capacitive Loading | CVref _{MAX} | (Note 2) | | | 100 | pF |
| VCC Bias Supply | | | | | | |
| Supply Voltage | VCC | | 3.15 | | 3.45 | V |
| Supply Current | IVCC | VCC=3.3 V | | 4.5 | 6 | mA |
| Power Up Time | TVCC | Time from VCC > 3.0V to valid Vout and Vref (Note 2) | | 0.75 | 1.25 | ms |
| Primary Side Input | | | | | | |
| Primary Conductor Resistance | R _{PC} | Measure resistance between IP+ and IP-MCA2101-65, MCA2101-50 Versions (Note 2) | | 0.9 | | m Ω |
| | | Measure resistance between IP+ and IP-MCA2101-20, MCA2101-5 Versions (Note 2) | | 1.3 | | |

Note 1 – Guaranteed by design and characterization, min/max values are 3σ

Note 2 – Guaranteed by design and characterization. Not production tested.

Note 3 – Vref pin supply capability limited to Fixed Gain mode.

Table 6 – PERFORMANCE CHARACTERISTICS- 65A VERSIONS (MCA2101-65-3)

Unless otherwise noted: $3.15V \leq VCC \leq 3.45V$, $I(V_{out}) = I(V_{ref}) = 0$, Typical values are for $VCC = 3.3V$ and $T_A = 25^\circ C$.

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|--|-----------------|--|------|-----------|-----|------|
| NOMINAL TRANSFER FUNCTION | | | | | | |
| MCA2101-65-3, $V_{out} = V_{ref} + I_{IN} \times 20mV/A$ | | | | | | |
| Input Range | I_{IN} | Calibrated Range | -65 | | +65 | A |
| Sensitivity | GAIN | MCA2101-65-3 (Fixed Gain) | | 20 | | mV/A |
| DC ACCURACY | | | | | | |
| Zero Current Offset | I_{OFFSET} | $I_{IN} = 0$, $T_A = 25^\circ C$ to $125^\circ C$ (Note 4) | -240 | ± 80 | 240 | mA |
| | | $I_{IN} = 0$, $T_A = -40^\circ C$ to $25^\circ C$ (Note 5) | -300 | ± 100 | 300 | |
| Sensitivity Error | E_S | $I_{IN} = I_{FS}$, $T_A = 25^\circ C$ to $125^\circ C$ (Note 4) | -2.4 | ± 0.8 | 2.4 | % |
| | | $I_{IN} = I_{FS}$, $T_A = -40^\circ C$ to $25^\circ C$ (Note 5) | -2.4 | ± 0.6 | 2.4 | |
| Linearity Error | E_L | $I_{IN} = I_{FS}$, $T_A = 25^\circ C$ to $125^\circ C$ (Note 4) | -6.0 | ± 3.0 | 6.0 | %FS |
| | | $I_{IN} = I_{FS}$, $T_A = -40^\circ C$ to $25^\circ C$ (Note 5) | -6.0 | ± 3.0 | 6.0 | |
| Total Error | E_{TOT} | $I_{IN} = \pm 19.5A \sim \pm 65A$, $T_A = 25^\circ C$ to $125^\circ C$ (Note 4) | -7.5 | ± 4.0 | 7.5 | %RD |
| | | $I_{IN} = \pm 19.5A \sim \pm 65A$, $T_A = -40^\circ C$ to $25^\circ C$ (Note 5) | -8.0 | ± 4.0 | 8.0 | |
| LIFETIME DRIFT CHARACTERISTICS | | | | | | |
| Zero Current Offset Drift | $I_{OFFSET(D)}$ | (Note 6) | | ± 380 | | mA |
| Sensitivity Drift | $E_{S(D)}$ | (Note 6) | | ± 0.4 | | % |
| Total Error Drift | $E_{TOT(D)}$ | (Note 6) | | ± 1.4 | | %FS |

Note 4: Typ values are $1\sigma(|mean|+\sigma)$. Min/max values are guaranteed by production test at $T_A=25^\circ C$ and $T_A=125^\circ C$.

Note 5: Guaranteed by design and characterization. Typ values are $1\sigma(|mean|+\sigma)$, min/max values are $3\sigma(|mean|+/-3\sigma)$.

Note 6: Numbers are based on 3 lots qualification data, taking the shifts from among HTOL (1000 hours). Typical numbers are $1\sigma(|mean|+\sigma)$.

Table 7 – PERFORMANCE CHARACTERISTICS- 50A VERSIONS (MCA2101-50-3)

Unless otherwise noted: $3.15V \leq VCC \leq 3.45V$, $I(V_{out}) = I(V_{ref}) = 0$, Typical values are for $VCC = 3.3V$ and $T_A = 25^\circ C$.

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|--|-----------------|--|------|-----------|-----|------|
| NOMINAL TRANSFER FUNCTION | | | | | | |
| MCA2101-50-3, $V_{out} = V_{ref} + I_{IN} \times 25mV/A$ | | | | | | |
| Input Range | I_{IN} | Calibrated Range | -50 | | +50 | A |
| Sensitivity | GAIN | MCA2101-50-3 (Fixed Gain) | | 25 | | mV/A |
| DC ACCURACY | | | | | | |
| Zero Current Offset | I_{OFFSET} | $I_{IN} = 0$, $T_A = 25^\circ C$ to $125^\circ C$ (Note 4) | -240 | ± 80 | 240 | mA |
| | | $I_{IN} = 0$, $T_A = -40^\circ C$ to $25^\circ C$ (Note 5) | -300 | ± 100 | 300 | |
| Sensitivity Error | E_S | $I_{IN} = I_{FS}$, $T_A = 25^\circ C$ to $125^\circ C$ (Note 4) | -1.9 | ± 0.6 | 1.9 | % |
| | | $I_{IN} = I_{FS}$, $T_A = -40^\circ C$ to $25^\circ C$ (Note 5) | -2.4 | ± 0.8 | 2.4 | |
| Linearity Error | E_L | $I_{IN} = I_{FS}$, $T_A = 25^\circ C$ to $125^\circ C$ (Note 4) | -2.2 | ± 0.7 | 2.2 | %FS |
| | | $I_{IN} = I_{FS}$, $T_A = -40^\circ C$ to $25^\circ C$ (Note 5) | -2.2 | ± 0.7 | 2.2 | |
| Total Error | E_{TOT} | $I_{IN} = \pm 15A \sim \pm 50A$, $T_A = 25^\circ C$ to $125^\circ C$ (Note 4) | -2.5 | ± 1.5 | 2.5 | %RD |
| | | $I_{IN} = \pm 15A \sim \pm 50A$, $T_A = -40^\circ C$ to $25^\circ C$ (Note 5) | -3.6 | ± 1.5 | 3.6 | |
| LIFETIME DRIFT CHARACTERISTICS | | | | | | |
| Zero Current Offset Drift | $I_{OFFSET(D)}$ | (Note 6) | | ± 380 | | mA |
| Sensitivity Drift | $E_{S(D)}$ | (Note 6) | | ± 0.4 | | % |
| Total Error Drift | $E_{TOT(D)}$ | (Note 6) | | ± 1.4 | | %FS |

Note 4: Typ values are $1\sigma(|mean|+\sigma)$. Min/max values are guaranteed by production test at $T_A=25^\circ C$ and $T_A=125^\circ C$.

Note 5: Guaranteed by design and characterization. Typ values are $1\sigma(|mean|+\sigma)$, min/max values are $3\sigma(|mean|+/-3\sigma)$.

Note 6: Numbers are based on 3 lots qualification data, taking the shifts from among HTOL (1000 hours). Typical numbers are $1\sigma(|mean|+\sigma)$.

Table 8 – PERFORMANCE CHARACTERISTICS- 20A VERSIONS (MCA2101-20-3)

Unless otherwise noted: $3.15V \leq VCC \leq 3.45V$, $I(Vout) = I(Vref) = 0$, Typical values are for $VCC = 3.3V$ and $T_A = 25^\circ C$.

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|--|-----------------|---|------|-----------|------|------|
| NOMINAL TRANSFER FUNCTION | | | | | | |
| MCA2101-20-3, $V_{out} = V_{ref} + I_{IN} \times 60mV/A$ | | | | | | |
| Input Range | I_{IN} | Calibrated Range | -20 | | +20 | A |
| Sensitivity | GAIN | MCA2101-20-3 (Fixed Gain) | | 60 | | mV/A |
| DC ACCURACY | | | | | | |
| Zero Current Offset | I_{OFFSET} | $I_{IN} = 0$, $T_A = 25^\circ C$ to $125^\circ C$ (Note 4) | -100 | ± 30 | 100 | mA |
| | | $I_{IN} = 0$, $T_A = -40^\circ C$ to $25^\circ C$ (Note 5) | -200 | ± 60 | 200 | |
| Sensitivity Error | E_S | $I_{IN} = I_{FS}$, $T_A = 25^\circ C$ to $125^\circ C$ (Note 4) | -1.5 | ± 0.5 | 1.5 | % |
| | | $I_{IN} = I_{FS}$, $T_A = -40^\circ C$ to $25^\circ C$ (Note 5) | -1.5 | ± 0.5 | 1.5 | |
| Linearity Error | E_L | $I_{IN} = I_{FS}$, $T_A = 25^\circ C$ to $125^\circ C$ (Note 4) | -1.8 | ± 0.6 | 1.8 | %FS |
| | | $I_{IN} = I_{FS}$, $T_A = -40^\circ C$ to $25^\circ C$ (Note 5) | -1.8 | ± 0.6 | -1.8 | |
| Total Error | E_{TOT} | $I_{IN} = \pm 6A \sim \pm 20A$, $T_A = 25^\circ C$ to $125^\circ C$ (Note 4) | -2.0 | ± 0.6 | 2.0 | %RD |
| | | $I_{IN} = \pm 6A \sim \pm 20A$, $T_A = -40^\circ C$ to $25^\circ C$ (Note 5) | -3.0 | ± 1.0 | 3.0 | |
| LIFETIME DRIFT CHARACTERISTICS | | | | | | |
| Zero Current Offset Drift | $I_{OFFSET(D)}$ | (Note 6) | | ± 380 | | mA |
| Sensitivity Drift | $E_{S(D)}$ | (Note 6) | | ± 0.4 | | % |
| Total Error Drift | $E_{TOT(D)}$ | (Note 6) | | ± 1.4 | | %FS |

Note 4: Typ values are $1\sigma(|mean|+\sigma)$. Min/max values are guaranteed by production test at $T_A=25^\circ C$ and $T_A=125^\circ C$.

Note 5: Guaranteed by design and characterization. Typ values are $1\sigma(|mean|+\sigma)$, min/max values are $3\sigma(|mean|+/-3\sigma)$.

Note 6: Numbers are based on 3 lots qualification data, taking the shifts from among HTOL (1000 hours). Typical numbers are $1\sigma(|mean|+\sigma)$.

Table 9 – PERFORMANCE CHARACTERISTICS- 5A VERSIONS (MCA2101-5-3)

Unless otherwise noted: $3.15V \leq VCC \leq 3.45V$, $I(V_{out}) = I(V_{ref}) = 0$, Typical values are for $VCC = 3.3V$ and $T_A = 25^\circ C$.

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|--|-----------------|--|------|-----------|-----|------|
| NOMINAL TRANSFER FUNCTION | | | | | | |
| MCA2101-5-3, $V_{out} = V_{ref} + I_{IN} \times 230mV/A$ | | | | | | |
| Input Range | I_{IN} | Calibrated Range | -5 | | +5 | A |
| Sensitivity | GAIN | MCA2101-5-3 (Fixed Gain) | | 230 | | mV/A |
| DC ACCURACY | | | | | | |
| Zero Current Offset | I_{OFFSET} | $I_{IN} = 0$, $T_A = 25^\circ C$ to $125^\circ C$ (Note 4) | -100 | ± 30 | 100 | mA |
| | | $I_{IN} = 0$, $T_A = -40^\circ C$ to $25^\circ C$ (Note 5) | -200 | ± 60 | 200 | |
| Sensitivity Error | E_S | $I_{IN} = I_{FS}$, $T_A = 25^\circ C$ to $125^\circ C$ (Note 4) | -1.5 | ± 0.5 | 1.5 | % |
| | | $I_{IN} = I_{FS}$, $T_A = -40^\circ C$ to $25^\circ C$ (Note 5) | -1.5 | ± 0.5 | 1.5 | |
| Linearity Error | E_L | $I_{IN} = I_{FS}$, $T_A = 25^\circ C$ to $125^\circ C$ (Note 4) | -2.0 | ± 0.6 | 2.0 | %FS |
| | | $I_{IN} = I_{FS}$, $T_A = -40^\circ C$ to $25^\circ C$ (Note 5) | -2.0 | ± 0.6 | 2.0 | |
| Total Error | E_{TOT} | $I_{IN} = \pm 3A \sim \pm 5A$, $T_A = 25^\circ C$ to $125^\circ C$ (Note 4) | -2.0 | ± 1.0 | 2.0 | %RD |
| | | $I_{IN} = \pm 3A \sim \pm 5A$, $T_A = -40^\circ C$ to $25^\circ C$ (Note 5) | -3.0 | ± 2.0 | 3.0 | |
| LIFETIME DRIFT CHARACTERISTICS | | | | | | |
| Zero Current Offset Drift | $I_{OFFSET(D)}$ | (Note 6) | | ± 380 | | mA |
| Sensitivity Drift | $E_{S(D)}$ | (Note 6) | | ± 0.4 | | % |
| Total Error Drift | $E_{TOT(D)}$ | (Note 6) | | ± 1.4 | | %FS |

Note 4: Typ values are $1\sigma(|mean|+\sigma)$. Min/max values are guaranteed by production test at $T_A=25^\circ C$ and $T_A=125^\circ C$.

Note 5: Guaranteed by design and characterization. Typ values are $1\sigma(|mean|+\sigma)$, min/max values are $3\sigma(|mean|+/-3\sigma)$.

Note 6: Numbers are based on 3 lots qualification data, taking the shifts from among HTOL (1000 hours). Typical numbers are $1\sigma(|mean|+\sigma)$.

Table 10 – OCD ELECTRICAL CHARACTERISTICS

Unless otherwise noted: $3.15V \leq VCC \leq 3.45V$, $-40^{\circ}C \leq T_A \leq 125^{\circ}C$, $I(V_{out}) = I(V_{ref}) = 0$, Typical values are for $VCC = 3.3V$ and $T_A = 25^{\circ}C$.

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|--|-------------------------|--|---------|-----|-------|------------------|
| OVERCURRENT FAULT CHARACTERISTICS | | | | | | |
| \overline{FAULTB} Response Time | $t_{RESPONSE}$ | Time from $IP > I_{\overline{FAULTB}}$ to when \overline{FAULTB} pin is pulled below $V_{\overline{FAULTB}}$; input current step from 0 to $1.5 \times I_{\overline{FAULTB}}$ | | 0.2 | | μs |
| \overline{FAULTB} Range | $I_{\overline{FAULTB}}$ | For parts rated for $IP=5A$; VOC voltage between 0 and $0.225 \times VCC$ | | 6 | | A |
| | | For parts rated for $IP=5A$; VOC voltage between $0.225 \times VCC$ and $0.35 \times VCC$ | | 7.5 | | |
| | | For parts rated for $IP=5A$; VOC voltage between $0.35 \times VCC$ and $0.5 \times VCC$ | | 10 | | |
| | | For parts rated for $IP=20A$; VOC voltage between 0 and $0.225 \times VCC$ | | 24 | | |
| | | For parts rated for $IP=20A$; VOC voltage between $0.225 \times VCC$ and $0.5 \times VCC$ | | 30 | | |
| | | For parts rated for $IP=50A$; VOC voltage between 0 and $0.5 \times VCC$ | | 60 | | |
| | | For parts rated for $IP=65A$; VOC voltage between 0 and $0.5 \times VCC$ | | 78 | | |
| \overline{FAULTB} Output Low Voltage | $V_{\overline{FAULTB}}$ | In fault condition; $R_{FPU} = 2-10 \text{ k}\Omega$ | | 0.2 | | V |
| \overline{FAULTB} Output High Voltage | $V_{\overline{FAULTB}}$ | In fault condition; $R_{FPU} = 2-10 \text{ k}\Omega$ | | | VCC | V |
| \overline{FAULTB} Pull-Up Resistance | R_{FPU} | | 2 | | 10 | $\text{k}\Omega$ |
| OCD Threshold Setting Error | $E_{\overline{FAULTB}}$ | | | 6 | | % |
| VOC Input Range | V_{VOC} | For setting OCD trig threshold | 0 | | VCC/2 | V |
| VOC high input level to reset OCD | V_{IHocd} | | VCC-0.5 | | VCC | V |
| VOC High State Duration | T_{HVOC} | | 1 | | | μs |

AMR TECHNOLOGY

Anisotropic magnetoresistance (AMR) makes use of a common material, Permalloy, to act as a magnetometer. Permalloy is an alloy containing roughly 80% nickel and 20% iron. The alloy's resistance depends on the angle between the magnetization and the direction of current flow. In a magnetic field, magnetization rotates toward the direction of the magnetic field and the rotation angle depends on the external field's magnitude. Permalloy's resistance decreases as the direction of magnetization rotates away from the direction in which current flows, and is lowest when the magnetization is perpendicular to the direction of current flow. The resistance changes roughly as the square of the cosine of the angle between the magnetization and the direction of current flow. Permalloy is deposited on a silicon wafer and patterned as a resistive strip. The film's properties cause it to change resistance in the presence of a magnetic field. In a current sensor application, two of these resistors are connected in a Wheatstone bridge configuration to permit the measurement of the magnitude of the magnetic field produced by the current.

AMR properties are well behaved when the film's magnetic domains are aligned in the same direction. This configuration ensures high sensitivity, good repeatability, and minimal hysteresis. During fabrication, the film is deposited in a strong magnetic field that sets the preferred orientation, or "easy" axis, of the magnetization vector in the Permalloy resistors. AMR has better sensitivity than other methods and reasonably good temperature stability. The AMR sensor has sensitivity which is approximately a linear function of temperature.

FUNCTIONAL DESCRIPTION

Figure 2 provide block diagrams of the fixed gain. The AMR sensor monitors the magnetic field generated by the current flowing through the U shaped IP+/IP- package lead frame. The AMR sensor produces a voltage proportional to the magnetic field created by the positive or negative current in the IP+/IP- current loop while rejecting external magnetic interference. The sensor voltage is fed into a differential amplifier whose gain is temperature compensated. This is followed by an instrumentation amplifier output stage that provides a voltage that indicates the current passing through the IP+/IP- pins. To provide both positive and negative current data the Vout output pin is referenced to the Vref output pin. The voltage on the Vref output is typically one half of the full scale positive and negative range of the Vout current sense output signal. With no current flowing in the IP+/IP- pins, the voltage on the Vout output will typically equal the voltage on the Vref output. Positive IP+/IP- current causes the voltage on Vout to increase relative to Vref while negative IP+/IP- current will cause it to decrease.

GAIN

The sensor resistors are biased by an internal 3.0V reference voltage and the voltage on the Vref output is 1.5V (typical). This arrangement provides a fixed gain and enhanced supply rejection. The Vout pin drives to approximately 2.8V at full positive current and 0.3V at full negative current.

POWER UP / DOWN

An under-voltage lockout circuit monitors the voltage on the VCC pin. If the VCC voltage is less than the under-voltage threshold the MCA2101 is in an inactive state. Vout and Vref

both drive to ground. If the VCC voltage exceeds the under-voltage threshold Vout and Vref are released and will drive to approximately half the VCC supply voltage and an initial calibration will commence. Once the initial calibration has completed the MCA2101 becomes active. Vout will slew to indicate the value of current flowing in the IP+/- conductor. Current flow in the IP+/- conductor with a VCC voltage less than the under-voltage threshold will not cause damage to the sensor.

OVERCURRENT DETECTION (OCD)

The MCA2101 have fast and accurate overcurrent fault detection circuitry. The overcurrent fault threshold ($I_{\overline{FAULTB}}$) is user-configurable via an external resistor divider and supports a range of 120% to 200% of the full-scale primary input (IP). The overcurrent fault threshold ($I_{\overline{FAULTB}}$) is set via a resistor divider from VCC to ground on the VOC pin. The voltage on the VOC pin (V_{VOC}), may range from $0 \times VCC$ to $0.5 \times VCC$.

For +/-5A parts

For V_{VOC} between $0 \times VCC$ and $0.225 \times VCC$, the $I_{\overline{FAULTB}}$ threshold level is $1.2 \times IP$.

For V_{VOC} between $0.225 \times VCC$ and $0.35 \times VCC$, the $I_{\overline{FAULTB}}$ threshold level is $1.5 \times IP$.

For V_{VOC} between $0.35 \times VCC$ and $0.5 \times VCC$, the $I_{\overline{FAULTB}}$ threshold level is $2 \times IP$.

For +/-20A parts

For V_{VOC} between $0 \times VCC$ and $0.225 \times VCC$, the $I_{\overline{FAULTB}}$ threshold level is $1.2 \times IP$.

For V_{VOC} between $0.225 \times VCC$ and $0.5 \times VCC$, the $I_{\overline{FAULTB}}$ threshold level is $1.5 \times IP$.

For +/-50A parts

For V_{VOC} between $0 \times VCC$ and $0.5 \times VCC$, the $I_{\overline{FAULTB}}$ threshold level is $1.2 \times IP$.

For +/-65A parts

For V_{VOC} between $0 \times VCC$ and $0.5 \times VCC$, the $I_{\overline{FAULTB}}$ threshold level is $1.2 \times IP$.

If the input current exceeds the OCD threshold value $I_{\overline{FAULTB}}$, the output pin \overline{FAULTB} will transition low and stay low, even if input current drops below the threshold. In order to reset the \overline{FAULTB} output, the user needs to bring VOC pin to VCC and hold it there for at least TH_{voc} . Once the OCD function is reset, the VOC voltage should return back to its normal operating voltage V_{voc} . A switch SW1 on Figure 1 can be used for this. Other methods are available as well.

If OCD function is used, an OCD reset must be applied to the VOC pin after system power up, to put the OCD function and \overline{FAULTB} pin in a known state.

The \overline{FAULTB} output is active low open drain. A pull-up resistor should be connected between \overline{FAULTB} and VCC. The VCC voltage will determine the high level of \overline{FAULTB} signal. \overline{FAULTB} low output voltage is below 200mV. The value of pull-up resistor is 2-10kOhm.

FREQUENCY RESPONSE

The MCA1101 offers a low noise and wideband response, with a 3dB magnitude bandwidth of 5.0MHz and 3dB phase bandwidth of 1.3MHz, as shown in the plots below.

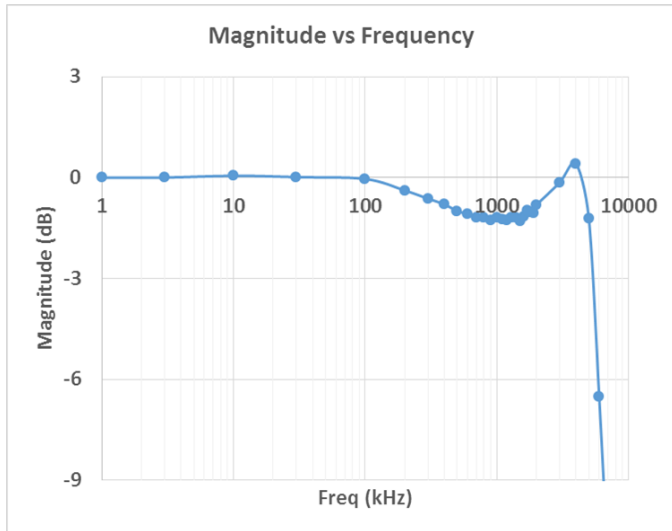


Figure 3 - Magnitude vs Frequency

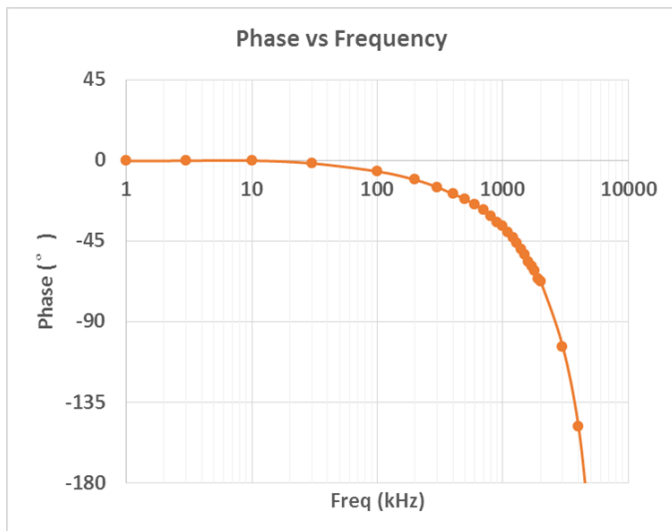


Figure 4 - Phase vs Frequency

RESPONSE TIME

Vout response time is the time interval from 80% of the IP to 80% of the Vout. The response time is 80ns typical.

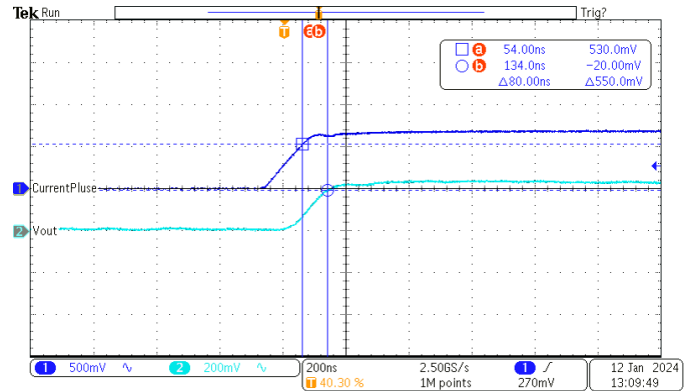


Figure 5 - Vout response time

APPLICATIONS INFORMATION

The MCA2101 detects current by measuring the magnetic field generated by that current. Therefore, it's important to consider the effect of externally generated magnetic fields, whether from another current flowing in the system, a magnet, or electro-magnetic component.

In order to provide immunity to external fields, MCA2101 senses a differential field generated by the primary current, which flows through a U-shaped conductor inside the package. Therefore, to first order, the sensor will reject any common mode field originating from outside of its package.

However, it's still prudent to minimize the exposure to external fields. The MCA2101 is most sensitive to magnetic fields in the X-Y plane (i.e. the plane of the PCB surface), and is relatively insensitive to fields in the Z direction (perpendicular to the PCB surface). Thus when laying out the PCB, care should be taken to avoid a current passing directly underneath the device itself, because the magnetic field generated by that current will be parallel to the PCB surface.

When laying out the PCB, the traces carrying the input and output currents should approach the two sets of 4 input/output pins in a symmetric manner, from a direction perpendicular to the edge of the package (see Figure 6 below).

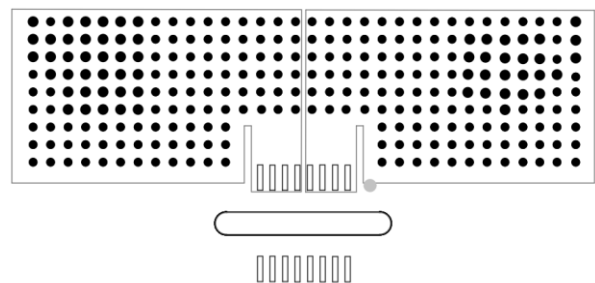


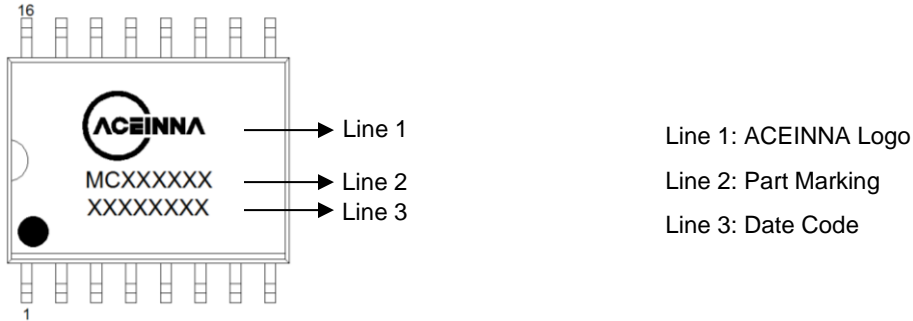
Figure 6 - Layout for current traces

Note:

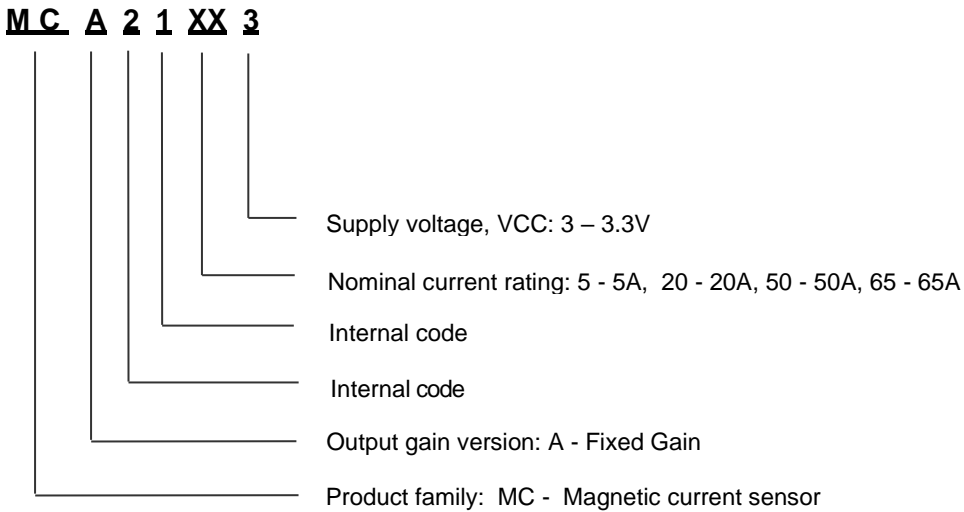
The via break in the metal at either end of the package. The purpose of these is to prevent the input current from approaching the input pins from the lateral direction.

DEVICE MARKING

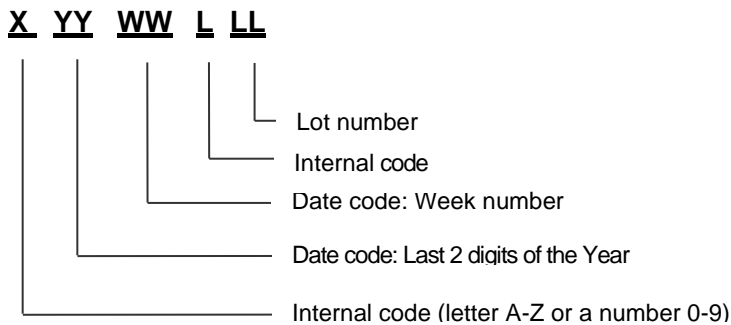
Production information is printed on the package surface by laser marking. Markings consist of 3 lines of characters including ACEINNA logo.



PART MARKING (Line 2)

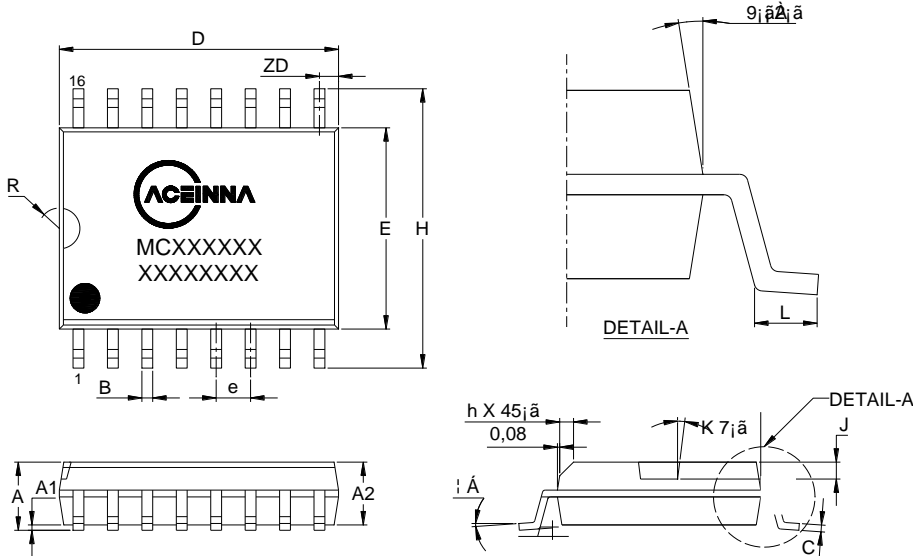


DATE CODE (Line 3)



PACKAGE OUTLINE & RECOMMENDED LAND PATTERN INFORMATION – 16-pin SOIC

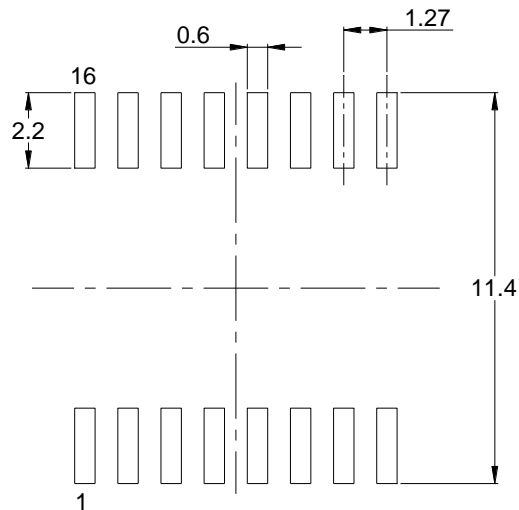
PACKAGE OUTLINE DRAWING



| SYMBOL | SOIC-16LD | |
|--------|-------------|-------|
| | MILLIMETERS | |
| | MIN | MAX |
| A | 2.44 | 2.64 |
| A1 | 0.10 | 0.30 |
| A2 | 2.24 | 2.44 |
| B | 0.36 | 0.46 |
| C | 0.23 | 0.32 |
| D | 10.11 | 10.31 |
| E | 7.40 | 7.60 |
| e | 1.27 BSC | |
| H | 10.11 | 10.51 |
| h | 0.31 | 0.71 |
| J | 0.381 REF | |
| K | 9° BSC | |
| L | 0.51 | 1.01 |
| R | 0.76 REF | |
| ZD | 0.66 REF | |
| α | 0° | 8° |

RECOMMENDED LAND PATTERN

Unit: mm



Note:

Recommended land pattern reference IPC7351B;
Adjust as necessary to meet application requirements and PCB layout tolerances.

RECOMMENDED REFLOW PROFILE

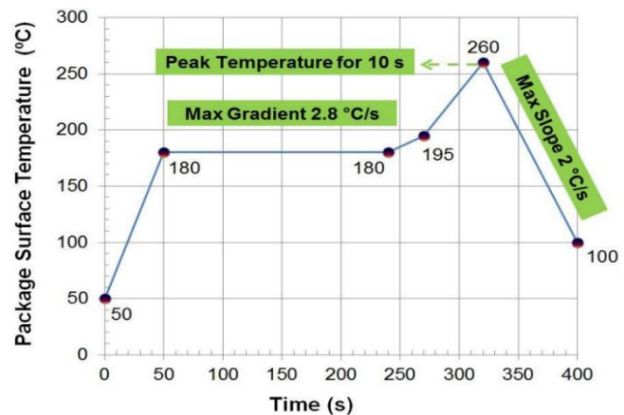


Figure 7- Recommended Reflow Profile

Note:

Reflow is limited by 2 times;
The 2nd reflow cycle should be applied after device has cooled down at 25°C (room temperature);
The peak temperature is recommended to be in the range of 235°C to 250°C (not to exceed 260°C for 10 seconds);
Use no clean flux to avoid product contaminated by cleaning solvent.