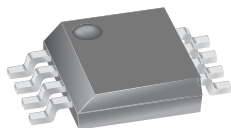


Automotive Grade, Fully Integrated, Hall Effect-Based Linear Current Sensor with 2.1 kVRMS Voltage Isolation and a Low-Resistance Current Conductor

Features and Benefits

- Low-noise analog signal path
- Device bandwidth is set via the FILTER pin
- 5 μ s output rise time in response to step input current
- 80 kHz bandwidth
- Total output error 1.5% typical, at $T_A = 25^\circ\text{C}$
- Small footprint, low-profile SOIC8 package
- 1.2 m Ω internal conductor resistance
- 2.1 kV_{RMS} minimum isolation voltage from pins 1-4 to pins 5-8
- 5.0 V, single supply operation
- 66 to 185 mV/A output sensitivity
- Output voltage proportional to AC or DC currents
- Factory-trimmed for accuracy
- Extremely stable output offset voltage
- Nearly zero magnetic hysteresis
- Ratiometric output from supply voltage
- Operating temperature range, -40°C to 150°C

Package: 8 pin SOIC (suffix LC)



Approximate Scale 1:1



Description

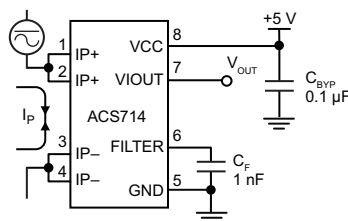
The Allegro[®] ACS714 provides economical and precise solutions for AC or DC current sensing in automotive systems. The device package allows for easy implementation by the customer. Typical applications include motor control, load detection and management, switched-mode power supplies, and overcurrent fault protection.

The device consists of a precise, low-offset, linear Hall sensor circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which is sensed by the integrated Hall IC and converted into a proportional voltage. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer. A precise, proportional voltage is provided by the low-offset, chopper-stabilized BiCMOS Hall IC, which is programmed for accuracy after packaging.

The output of the device has a positive slope ($>V_{IOUT(Q)}$) when an increasing current flows through the primary copper conduction path (from pins 1 and 2, to pins 3 and 4), which is the path used for current sensing. The internal resistance of this conductive path is 1.2 m Ω typical, providing low power loss. The thickness of the copper conductor allows survival

Continued on the next page...

Typical Application



Application 1. The ACS714 outputs an analog signal, V_{OUT} , that varies linearly with the uni- or bi-directional AC or DC primary sensed current, I_P , within the range specified. C_F is recommended for noise management, with values that depend on the application.

ACS714

Automotive Grade, Fully Integrated, Hall Effect-Based Linear Current Sensor with 2.1 kVRMS Voltage Isolation and a Low-Resistance Current Conductor

Description (continued)

of the device at up to 5× overcurrent conditions. The terminals of the conductive path are electrically isolated from the sensor leads (pins 5 through 8). This allows the ACS714 current sensor to be used in applications requiring electrical isolation without the use of opto-isolators or other costly isolation techniques.

The ACS714 is provided in a small, surface mount SOIC8 package. The leadframe is plated with 100% matte tin, which is compatible with standard lead (Pb) free printed circuit board assembly processes. Internally, the device is Pb-free, except for flip-chip high-temperature Pb-based solder balls, currently exempt from RoHS. The device is fully calibrated prior to shipment from the factory.

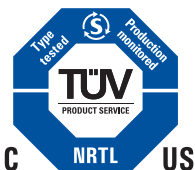
Selection Guide

| Part Number | Optimized Range, I _P (A) | Sensitivity, Sens (Typ) (mV/A) | T _A (°C) | Packing* |
|-------------------|--|-----------------------------------|------------------------|---------------------------------|
| ACS714ELCTR-05B-T | ±5 | 185 | −40 to 85 | Tape and reel, 3000 pieces/reel |
| ACS714ELCTR-20A-T | ±20 | 100 | | |
| ACS714ELCTR-30A-T | ±30 | 66 | | |
| ACS714LLCTR-05B-T | ±5 | 185 | −40 to 150 | |
| ACS714LLCTR-20A-T | ±20 | 100 | | |
| ACS714LLCTR-30A-T | ±30 | 66 | | |

*Contact Allegro for additional packing options.

Absolute Maximum Ratings

| Characteristic | Symbol | Notes | Rating | Units |
|---------------------------------------|--------------------|---|------------|----------|
| Supply Voltage | V_{CC} | | 8 | V |
| Reverse Supply Voltage | V_{RCC} | | -0.1 | V |
| Output Voltage | V_{IOUT} | | 8 | V |
| Reverse Output Voltage | V_{RIOUT} | | -0.1 | V |
| Reinforced Isolation Voltage | V_{ISO} | Pins 1-4 and 5-8; 60 Hz, 1 minute, $T_A=25^\circ\text{C}$ | 2100 | V |
| Rated Input Voltage | $V_{working}$ | Voltage applied to leadframe (Ip+ pins) | 184 | V AC Max |
| Output Current Source | $I_{IOUT(SOURCE)}$ | | 3 | mA |
| Output Current Sink | $I_{IOUT(SINK)}$ | | 10 | mA |
| Overcurrent Transient Tolerance | I_P | 1 pulse, 100 ms | 100 | A |
| Nominal Operating Ambient Temperature | T_A | Range E | -40 to 85 | °C |
| | | Range L | -40 to 150 | °C |
| Maximum Junction Temperature | $T_{J(max)}$ | | 165 | °C |
| Storage Temperature | T_{stg} | | -65 to 170 | °C |



TÜV America
Certificate Number:
U8V 06 05 54214 010

| Parameter | Specification |
|-------------------------|--|
| Fire and Electric Shock | CAN/CSA-C22.2 No. 60950-1-03 UL 60950-1:2003 EN 60950-1:2001 |

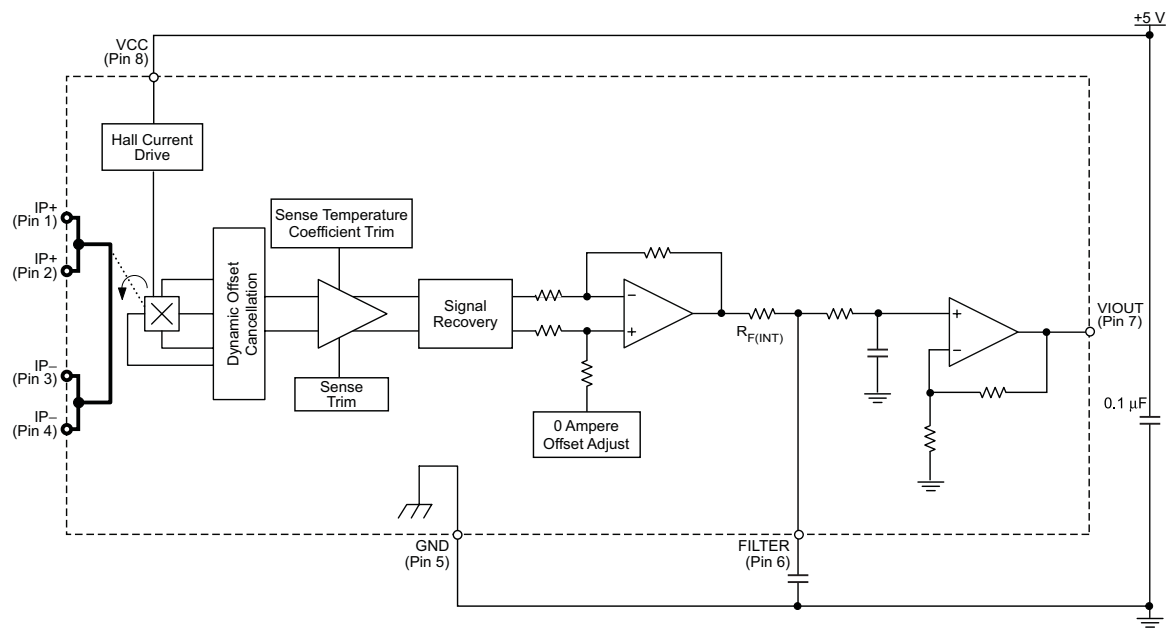


Allegro MicroSystems, Inc.
115 Northeast Cutoff, Box 15036
Worcester, Massachusetts 01615-0036 (508) 853-5000
www.allegromicro.com

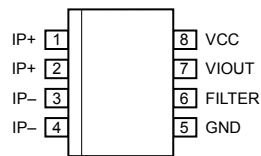
ACS714

Automotive Grade, Fully Integrated, Hall Effect-Based Linear Current Sensor
with 2.1 kVRMS Voltage Isolation and a Low-Resistance Current Conductor

Functional Block Diagram



Pin-out Diagram



Terminal List Table

| Number | Name | Description |
|---------|--------|--|
| 1 and 2 | IP+ | Terminals for current being sensed; fused internally |
| 3 and 4 | IP- | Terminals for current being sensed; fused internally |
| 5 | GND | Signal ground terminal |
| 6 | FILTER | Terminal for external capacitor that sets bandwidth |
| 7 | VIOUT | Analog output signal |
| 8 | VCC | Device power supply terminal |

COMMON OPERATING CHARACTERISTICS¹ over full range of T_A , $C_F = 1$ nF, and $V_{CC} = 5$ V, unless otherwise specified

| Characteristic | Symbol | Test Conditions | Min. | Typ. | Max. | Units |
|---|---------------|--|------|---------------------|------|---------------|
| ELECTRICAL CHARACTERISTICS | | | | | | |
| Supply Voltage | V_{CC} | | 4.5 | 5.0 | 5.5 | V |
| Supply Current | I_{CC} | $V_{CC} = 5.0$ V, output open | – | 10 | 13 | mA |
| Output Capacitance Load | C_{LOAD} | V _{IOUT} to GND | – | – | 10 | nF |
| Output Resistive Load | R_{LOAD} | V _{IOUT} to GND | 4.7 | – | – | k Ω |
| Primary Conductor Resistance | $R_{PRIMARY}$ | $T_A = 25^\circ\text{C}$ | – | 1.2 | – | m Ω |
| Rise Time | t_r | $I_P = I_P(\text{max})$, $T_A = 25^\circ\text{C}$, $C_{OUT} = \text{open}$ | – | 5 | – | μs |
| Frequency Bandwidth | f | –3 dB, $T_A = 25^\circ\text{C}$; I_P is 10 A peak-to-peak | – | 80 | – | kHz |
| Nonlinearity | E_{LIN} | Over full range of I_P | – | 1.5 | – | % |
| Symmetry | E_{SYM} | Over full range of I_P | 98 | 100 | 102 | % |
| Zero Current Output Voltage | $V_{IOUT(Q)}$ | Bidirectional; $I_P = 0$ A, $T_A = 25^\circ\text{C}$ | – | $V_{CC} \times 0.5$ | – | V |
| Power-On Time | t_{PO} | Output reaches 90% of steady-state level, $T_J = 25^\circ\text{C}$, 20 A present on leadframe | – | 35 | – | μs |
| Magnetic Coupling ² | | | – | 12 | – | G/A |
| Internal Filter Resistance ³ | $R_{F(INT)}$ | | | 1.7 | | k Ω |

¹Device may be operated at higher primary current levels, I_P , and ambient, T_A , and internal leadframe temperatures, T_A , provided that the Maximum Junction Temperature, $T_J(\text{max})$, is not exceeded.

²1G = 0.1 mT.

³ $R_{F(INT)}$ forms an RC circuit via the FILTER pin.

COMMON THERMAL CHARACTERISTICS¹

| | | | Min. | Typ. | Max. | Units |
|--|------------------|---|------|------|-------|-------|
| Operating Internal Leadframe Temperature | T _A | E range | −40 | − | 85 | °C |
| | | L range | −40 | − | 150 | °C |
| | | | | | Value | Units |
| Junction-to-Lead Thermal Resistance ² | R _{θJL} | Mounted on the Allegro ASEQ 714 evaluation board | | | 5 | °C/W |
| Junction-to-Ambient Thermal Resistance | R _{θJA} | Mounted on the Allegro 85-0322 evaluation board, includes the power consumed by the board | | | 23 | °C/W |

¹Additional thermal information is available on the Allegro website.

²The Allegro evaluation board has 1500 mm² of 2 oz. copper on each side, connected to pins 1 and 2, and to pins 3 and 4, with thermal vias connecting the layers. Performance values include the power consumed by the PCB. Further details on the board are available from the Frequently Asked Questions document on our website. Further information about board design and thermal performance also can be found in the Applications Information section of this datasheet.

x05B PERFORMANCE CHARACTERISTICS over Range E: $T_A = -40^{\circ}\text{C}$ to 85°C ¹, $C_F = 1\text{ nF}$, and $V_{CC} = 5\text{ V}$, unless otherwise specified

| Characteristic | Symbol | Test Conditions | Min. | Typ. | Max. | Units |
|---------------------------------|----------------------------|---|------|-----------|------|--------------------------|
| Optimized Accuracy Range | I_P | | -5 | — | 5 | A |
| Sensitivity | Sens | Over full range of I_P , $T_A = 25^{\circ}\text{C}$ | 180 | 185 | 190 | mV/A |
| Noise | $V_{\text{NOISE(PP)}}$ | Peak-to-peak, $T_A = 25^{\circ}\text{C}$, 185 mV/A programmed Sensitivity, $C_F = 47\text{ nF}$, $C_{\text{OUT}} = \text{open}$, 2 kHz bandwidth | — | 21 | — | mV |
| Zero Current Output Slope | $\Delta I_{\text{OUT(Q)}}$ | $T_A = -40^{\circ}\text{C}$ to 25°C | — | -0.26 | — | mV/ $^{\circ}\text{C}$ |
| | | $T_A = 25^{\circ}\text{C}$ to 150°C | — | -0.08 | — | mV/ $^{\circ}\text{C}$ |
| Sensitivity Slope | ΔSens | $T_A = -40^{\circ}\text{C}$ to 25°C | — | 0.054 | — | mV/A/ $^{\circ}\text{C}$ |
| | | $T_A = 25^{\circ}\text{C}$ to 150°C | — | -0.008 | — | mV/A/ $^{\circ}\text{C}$ |
| Electrical Offset Voltage | V_{OE} | $I_P = 0\text{ A}$ | -40 | — | 40 | mV |
| Total Output Error ² | E_{TOT} | $I_P = \pm 5\text{ A}$, $T_A = 25^{\circ}\text{C}$ | — | ± 1.5 | — | % |

¹Device may be operated at higher primary current levels, I_P , and ambient temperatures, T_A , provided that the Maximum Junction Temperature, $T_{J(\text{max})}$, is not exceeded.

²Percentage of I_P , with $I_P = 5\text{ A}$. Output filtered.

x05B PERFORMANCE CHARACTERISTICS over Range L: $T_A = -40^{\circ}\text{C}$ to 150°C ¹, $C_F = 1\text{ nF}$, and $V_{CC} = 5\text{ V}$, unless otherwise specified

| Characteristic | Symbol | Test Conditions | Min. | Typ. | Max. | Units |
|---------------------------------|----------------------------|---|------|-----------|------|--------------------------|
| Optimized Accuracy Range | I_P | | -5 | — | 5 | A |
| Sensitivity | Sens | Over full range of I_P , $T_A = 25^{\circ}\text{C}$ | — | 185 | — | mV/A |
| | | Over full range of I_P , $T_A = -40^{\circ}\text{C}$ to 150°C | 161 | — | 190 | mV/A |
| Noise | $V_{\text{NOISE(PP)}}$ | Peak-to-peak, $T_A = 25^{\circ}\text{C}$, 185 mV/A programmed Sensitivity, $C_F = 47\text{ nF}$, $C_{\text{OUT}} = \text{open}$, 2 kHz bandwidth | — | 21 | — | mV |
| Zero Current Output Slope | $\Delta I_{\text{OUT(Q)}}$ | $T_A = -40^{\circ}\text{C}$ to 25°C | — | -0.26 | — | mV/ $^{\circ}\text{C}$ |
| | | $T_A = 25^{\circ}\text{C}$ to 150°C | — | -0.08 | — | mV/ $^{\circ}\text{C}$ |
| Sensitivity Slope | ΔSens | $T_A = -40^{\circ}\text{C}$ to 25°C | — | 0.054 | — | mV/A/ $^{\circ}\text{C}$ |
| | | $T_A = 25^{\circ}\text{C}$ to 150°C | — | -0.008 | — | mV/A/ $^{\circ}\text{C}$ |
| Electrical Offset Voltage | V_{OE} | $I_P = 0\text{ A}$ | -60 | — | 60 | mV |
| Total Output Error ² | E_{TOT} | $I_P = \pm 5\text{ A}$, $T_A = 25^{\circ}\text{C}$ | — | ± 1.5 | — | % |
| | | $I_P = \pm 5\text{ A}$, $T_A = -40^{\circ}\text{C}$ to 150°C | -7 | — | 7 | % |

¹Device may be operated at higher primary current levels, I_P , and ambient temperatures, T_A , provided that the Maximum Junction Temperature, $T_{J(\text{max})}$, is not exceeded.

²Percentage of I_P , with $I_P = 5\text{ A}$. Output filtered.

x20A PERFORMANCE CHARACTERISTICS over Range E: $T_A = -40^{\circ}\text{C}$ to 85°C ¹, $C_F = 1\text{ nF}$, and $V_{CC} = 5\text{ V}$, unless otherwise specified

| Characteristic | Symbol | Test Conditions | Min. | Typ. | Max. | Units |
|---------------------------------|----------------------------|---|------|-----------|------|--------------------------|
| Optimized Accuracy Range | I_P | | -20 | — | 20 | A |
| Sensitivity | Sens | Over full range of I_P , $T_A = 25^{\circ}\text{C}$ | 96 | 100 | 104 | mV/A |
| Noise | $V_{\text{NOISE(PP)}}$ | Peak-to-peak, $T_A = 25^{\circ}\text{C}$, 100 mV/A programmed Sensitivity, $C_F = 47\text{ nF}$, $C_{\text{OUT}} = \text{open}$, 2 kHz bandwidth | — | 11 | — | mV |
| Zero Current Output Slope | $\Delta I_{\text{OUT(Q)}}$ | $T_A = -40^{\circ}\text{C}$ to 25°C | — | -0.34 | — | mV/ $^{\circ}\text{C}$ |
| | | $T_A = 25^{\circ}\text{C}$ to 150°C | — | -0.07 | — | mV/ $^{\circ}\text{C}$ |
| Sensitivity Slope | ΔSens | $T_A = -40^{\circ}\text{C}$ to 25°C | — | 0.017 | — | mV/A/ $^{\circ}\text{C}$ |
| | | $T_A = 25^{\circ}\text{C}$ to 150°C | — | -0.004 | — | mV/A/ $^{\circ}\text{C}$ |
| Electrical Offset Voltage | V_{OE} | $I_P = 0\text{ A}$ | -30 | — | 30 | mV |
| Total Output Error ² | E_{TOT} | $I_P = \pm 20\text{ A}$, $T_A = 25^{\circ}\text{C}$ | — | ± 1.5 | — | % |

¹Device may be operated at higher primary current levels, I_P , and ambient temperatures, T_A , provided that the Maximum Junction Temperature, $T_J(\text{max})$, is not exceeded.

²Percentage of I_P , with $I_P = 20\text{ A}$. Output filtered.

x20A PERFORMANCE CHARACTERISTICS over Range L: $T_A = -40^{\circ}\text{C}$ to 150°C ¹, $C_F = 1\text{ nF}$, and $V_{CC} = 5\text{ V}$, unless otherwise specified

| Characteristic | Symbol | Test Conditions | Min. | Typ. | Max. | Units |
|---------------------------------|----------------------------|---|------|-----------|------|--------------------------|
| Optimized Accuracy Range | I_P | | -20 | — | 20 | A |
| Sensitivity | Sens | Over full range of I_P , $T_A = 25^{\circ}\text{C}$ | — | 100 | — | mV/A |
| | | Over full range of I_P , $T_A = -40^{\circ}\text{C}$ to 150°C | 94 | — | 104 | mV/A |
| Noise | $V_{\text{NOISE(PP)}}$ | Peak-to-peak, $T_A = 25^{\circ}\text{C}$, 100 mV/A programmed Sensitivity, $C_F = 47\text{ nF}$, $C_{\text{OUT}} = \text{open}$, 2 kHz bandwidth | — | 11 | — | mV |
| Zero Current Output Slope | $\Delta I_{\text{OUT(Q)}}$ | $T_A = -40^{\circ}\text{C}$ to 25°C | — | -0.34 | — | mV/ $^{\circ}\text{C}$ |
| | | $T_A = 25^{\circ}\text{C}$ to 150°C | — | -0.07 | — | mV/ $^{\circ}\text{C}$ |
| Sensitivity Slope | ΔSens | $T_A = -40^{\circ}\text{C}$ to 25°C | — | 0.017 | — | mV/A/ $^{\circ}\text{C}$ |
| | | $T_A = 25^{\circ}\text{C}$ to 150°C | — | -0.004 | — | mV/A/ $^{\circ}\text{C}$ |
| Electrical Offset Voltage | V_{OE} | $I_P = 0\text{ A}$ | -40 | — | 40 | mV |
| Total Output Error ² | E_{TOT} | $I_P = \pm 20\text{ A}$, $T_A = 25^{\circ}\text{C}$ | — | ± 1.5 | — | % |
| | | $I_P = \pm 20\text{ A}$, $T_A = -40^{\circ}\text{C}$ to 150°C | -5 | — | 5 | % |

¹Device may be operated at higher primary current levels, I_P , and ambient temperatures, T_A , provided that the Maximum Junction Temperature, $T_J(\text{max})$, is not exceeded.

²Percentage of I_P , with $I_P = 20\text{ A}$. Output filtered.

x30A PERFORMANCE CHARACTERISTICS over Range E: $T_A = -40^{\circ}\text{C}$ to 85°C ¹, $C_F = 1\text{ nF}$, and $V_{CC} = 5\text{ V}$, unless otherwise specified

| Characteristic | Symbol | Test Conditions | Min. | Typ. | Max. | Units |
|---------------------------------|----------------------------|--|------|-----------|------|--------------------------|
| Optimized Accuracy Range | I_P | | -30 | — | 30 | A |
| Sensitivity | Sens | Over full range of I_P , $T_A = 25^{\circ}\text{C}$ | 64 | 66 | 68 | mV/A |
| Noise | $V_{\text{NOISE(PP)}}$ | Peak-to-peak, $T_A = 25^{\circ}\text{C}$, 66 mV/A programmed Sensitivity, $C_F = 47\text{ nF}$, $C_{\text{OUT}} = \text{open}$, 2 kHz bandwidth | — | 7 | — | mV |
| Zero Current Output Slope | $\Delta I_{\text{OUT(Q)}}$ | $T_A = -40^{\circ}\text{C}$ to 25°C | — | -0.35 | — | mV/ $^{\circ}\text{C}$ |
| | | $T_A = 25^{\circ}\text{C}$ to 150°C | — | -0.08 | — | mV/ $^{\circ}\text{C}$ |
| Sensitivity Slope | ΔSens | $T_A = -40^{\circ}\text{C}$ to 25°C | — | 0.007 | — | mV/A/ $^{\circ}\text{C}$ |
| | | $T_A = 25^{\circ}\text{C}$ to 150°C | — | -0.002 | — | mV/A/ $^{\circ}\text{C}$ |
| Electrical Offset Voltage | V_{OE} | $I_P = 0\text{ A}$ | -30 | — | 30 | mV |
| Total Output Error ² | E_{TOT} | $I_P = \pm 30\text{ A}$, $T_A = 25^{\circ}\text{C}$ | — | ± 1.5 | — | % |

¹Device may be operated at higher primary current levels, I_P , and ambient temperatures, T_A , provided that the Maximum Junction Temperature, $T_J(\text{max})$, is not exceeded.

²Percentage of I_P , with $I_P = 30\text{ A}$. Output filtered.

x30A PERFORMANCE CHARACTERISTICS over Range L: $T_A = -40^{\circ}\text{C}$ to 150°C ¹, $C_F = 1\text{ nF}$, and $V_{CC} = 5\text{ V}$, unless otherwise specified

| Characteristic | Symbol | Test Conditions | Min. | Typ. | Max. | Units |
|---------------------------------|----------------------------|--|------|-----------|------|--------------------------|
| Optimized Accuracy Range | I_P | | -30 | — | 30 | A |
| Sensitivity | Sens | Over full range of I_P , $T_A = 25^{\circ}\text{C}$ | — | 66 | — | mV/A |
| | | Over full range of I_P , $T_A = -40^{\circ}\text{C}$ to 150°C | 63 | — | 69 | mV/A |
| Noise | $V_{\text{NOISE(PP)}}$ | Peak-to-peak, $T_A = 25^{\circ}\text{C}$, 66 mV/A programmed Sensitivity, $C_F = 47\text{ nF}$, $C_{\text{OUT}} = \text{open}$, 2 kHz bandwidth | — | 7 | — | mV |
| Zero Current Output Slope | $\Delta I_{\text{OUT(Q)}}$ | $T_A = -40^{\circ}\text{C}$ to 25°C | — | -0.35 | — | mV/ $^{\circ}\text{C}$ |
| | | $T_A = 25^{\circ}\text{C}$ to 150°C | — | -0.08 | — | mV/ $^{\circ}\text{C}$ |
| Sensitivity Slope | ΔSens | $T_A = -40^{\circ}\text{C}$ to 25°C | — | 0.007 | — | mV/A/ $^{\circ}\text{C}$ |
| | | $T_A = 25^{\circ}\text{C}$ to 150°C | — | -0.002 | — | mV/A/ $^{\circ}\text{C}$ |
| Electrical Offset Voltage | V_{OE} | $I_P = 0\text{ A}$ | -40 | — | 40 | mV |
| Total Output Error ² | E_{TOT} | $I_P = \pm 30\text{ A}$, $T_A = 25^{\circ}\text{C}$ | — | ± 1.5 | — | % |
| | | $I_P = \pm 30\text{ A}$, $T_A = -40^{\circ}\text{C}$ to 150°C | -5 | — | 5 | % |

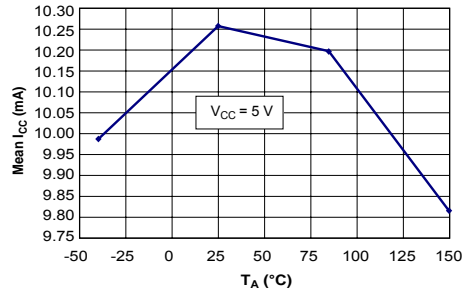
¹Device may be operated at higher primary current levels, I_P , and ambient temperatures, T_A , provided that the Maximum Junction Temperature, $T_J(\text{max})$, is not exceeded.

²Percentage of I_P , with $I_P = 30\text{ A}$. Output filtered.

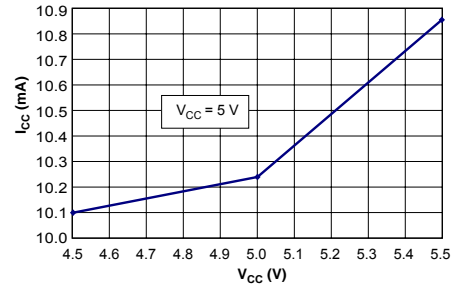
Characteristic Performance

$I_P = 5\text{ A}$, unless otherwise specified

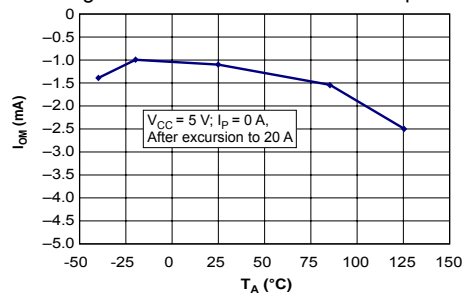
Mean Supply Current versus Ambient Temperature



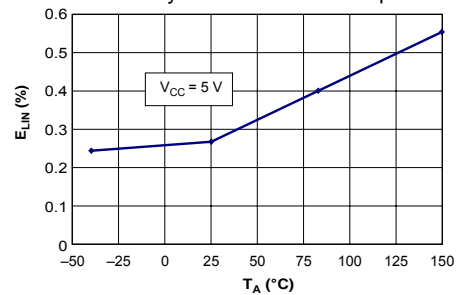
Supply Current versus Supply Voltage



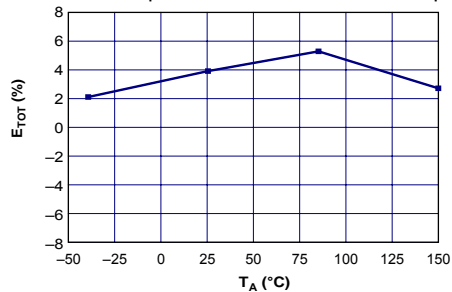
Magnetic Offset versus Ambient Temperature



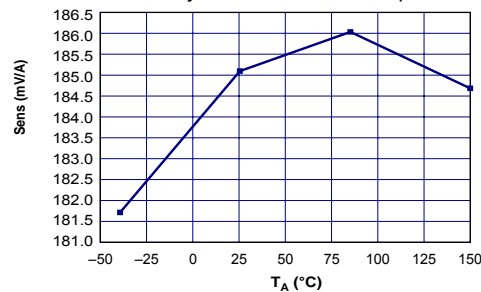
Nonlinearity versus Ambient Temperature



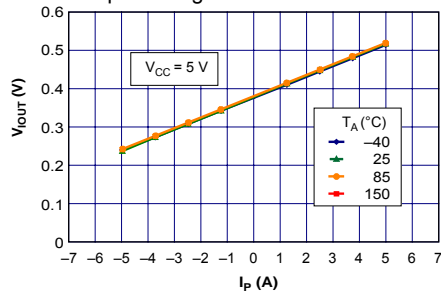
Mean Total Output Error versus Ambient Temperature



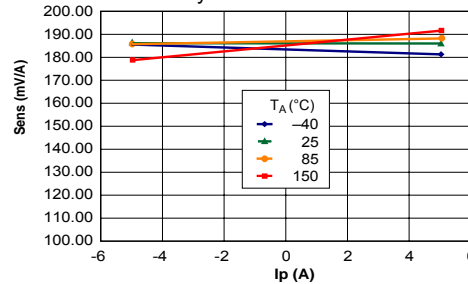
Sensitivity versus Ambient Temperature



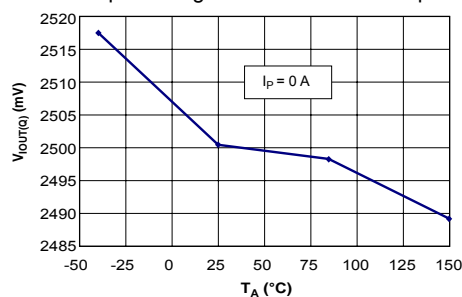
Output Voltage versus Sensed Current



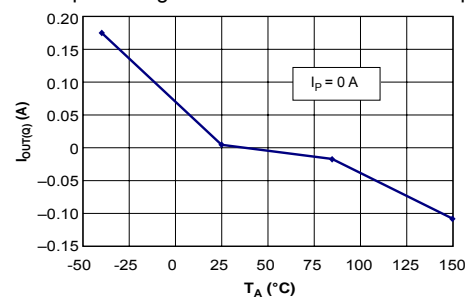
Sensitivity versus Sensed Current



0 A Output Voltage versus Ambient Temperature

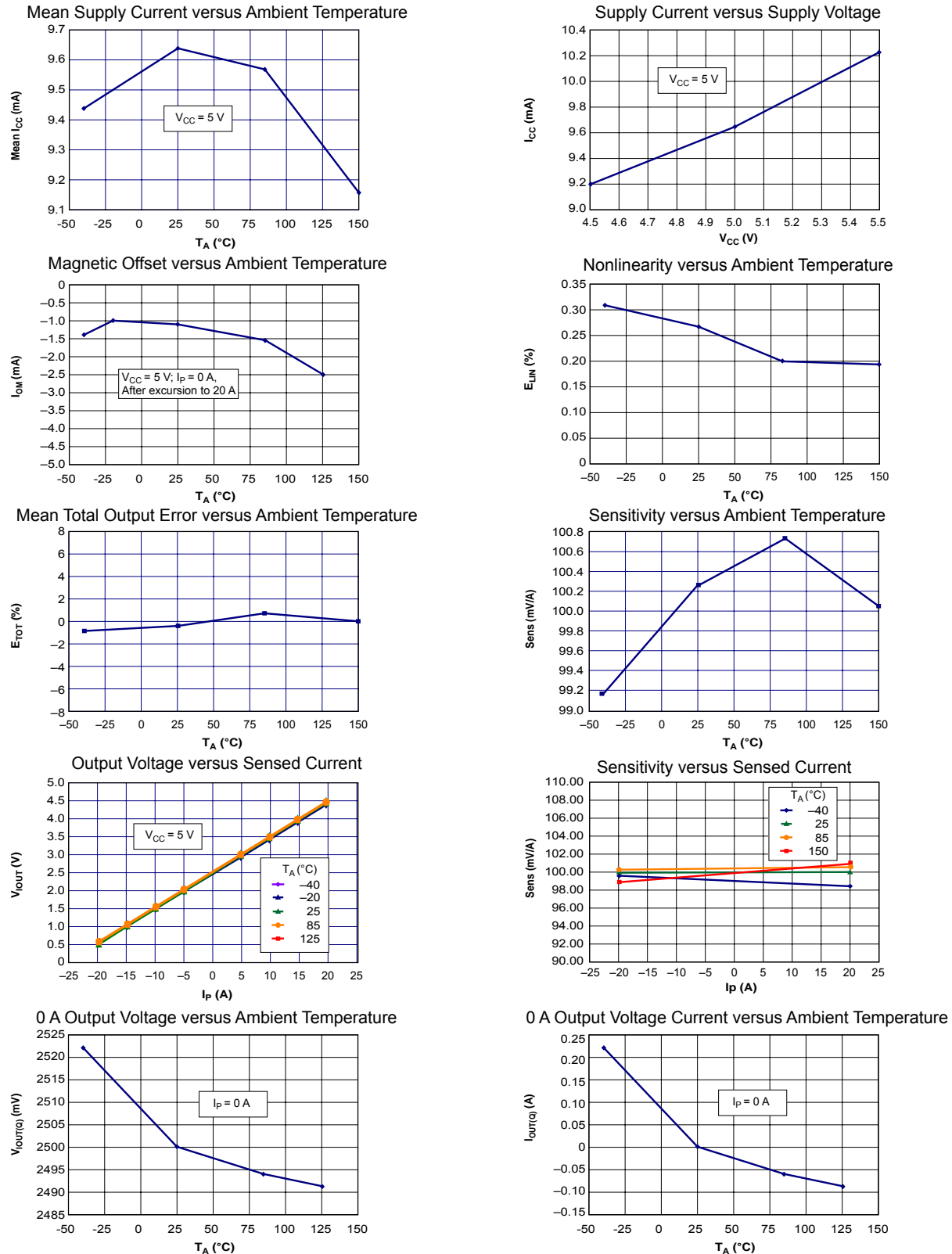


0 A Output Voltage Current versus Ambient Temperature



Characteristic Performance

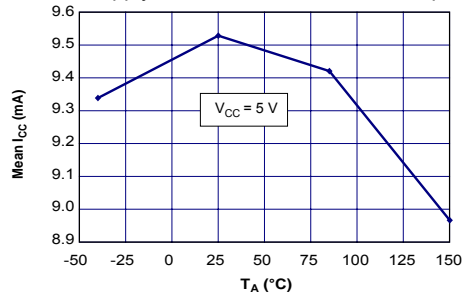
$I_P = 20$ A, unless otherwise specified



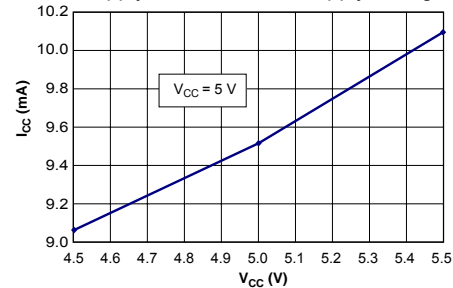
Characteristic Performance

$I_P = 30$ A, unless otherwise specified

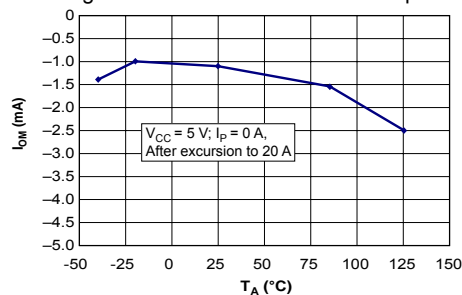
Mean Supply Current versus Ambient Temperature



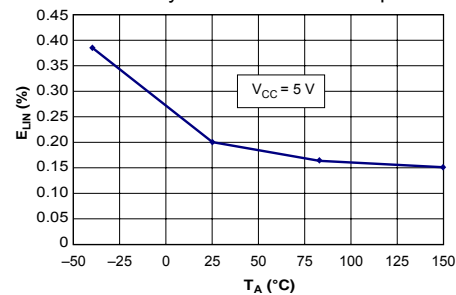
Supply Current versus Supply Voltage



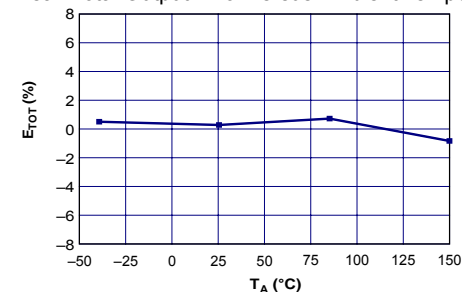
Magnetic Offset versus Ambient Temperature



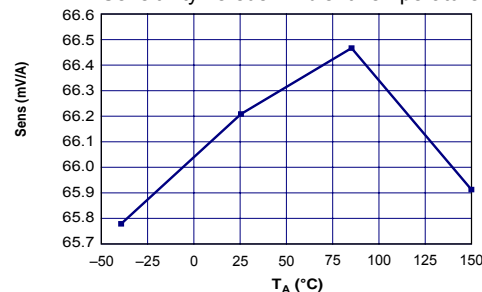
Nonlinearity versus Ambient Temperature



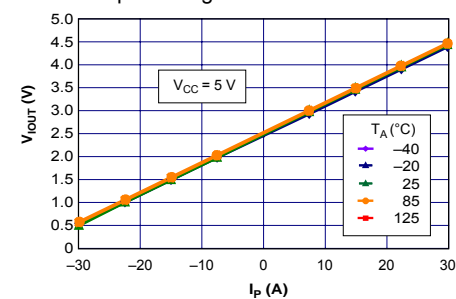
Mean Total Output Error versus Ambient Temperature



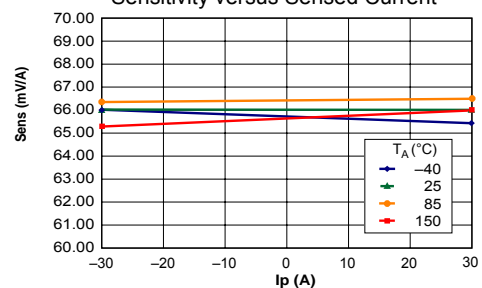
Sensitivity versus Ambient Temperature



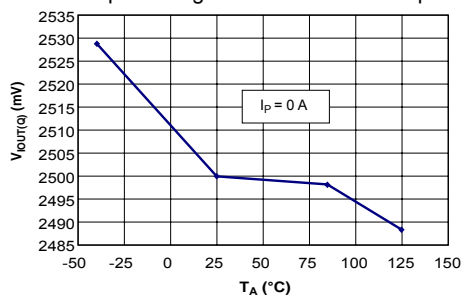
Output Voltage versus Sensed Current



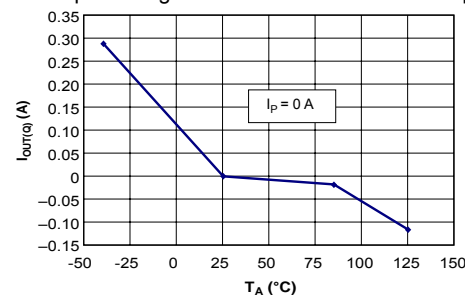
Sensitivity versus Sensed Current



0 A Output Voltage versus Ambient Temperature

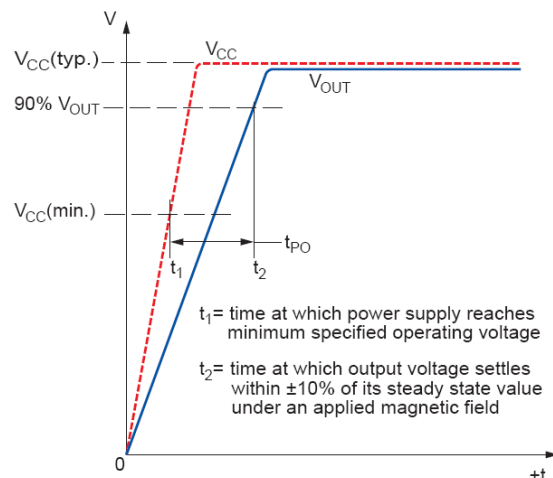


0 A Output Voltage Current versus Ambient Temperature

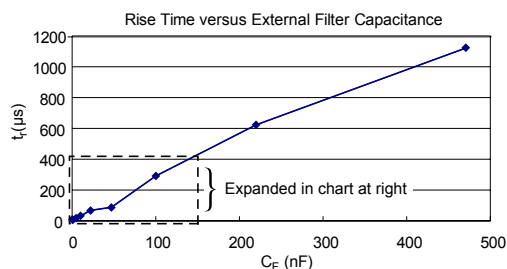
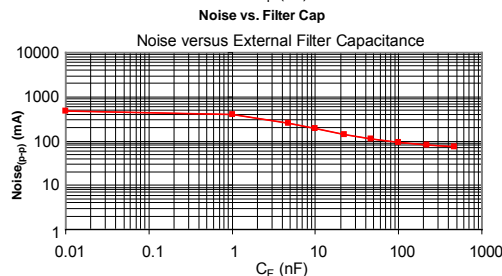
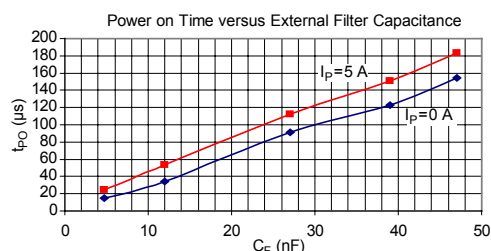
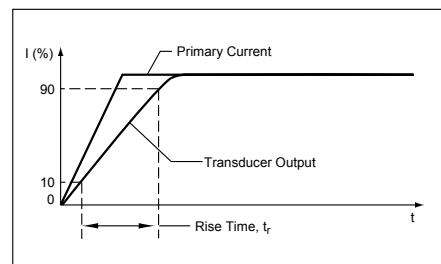


Definitions of Dynamic Response Characteristics

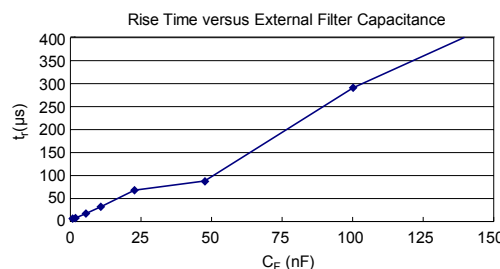
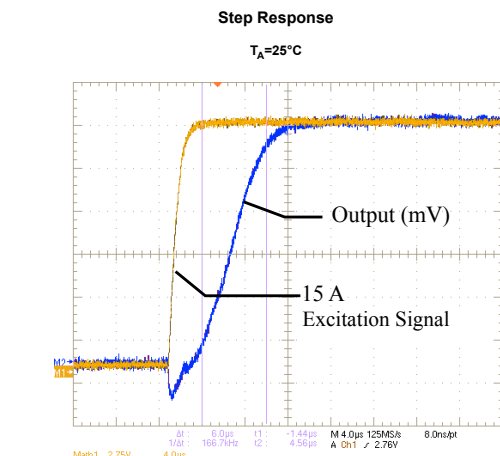
Power-On Time (t_{PO}). When the supply is ramped to its operating voltage, the device requires a finite time to power its internal components before responding to an input magnetic field. Power-On Time, t_{PO} , is defined as the time it takes for the output voltage to settle within $\pm 10\%$ of its steady state value under an applied magnetic field, after the power supply has reached its minimum specified operating voltage, $V_{CC(min)}$, as shown in the chart at right.



Rise time (t_r). The time interval between a) when the sensor reaches 10% of its full scale value, and b) when it reaches 90% of its full scale value. The rise time to a step response is used to derive the bandwidth of the current sensor, in which $f(-3 \text{ dB}) = 0.35/t_r$. Both t_r and $t_{RESPONSE}$ are detrimentally affected by eddy current losses observed in the conductive IC ground plane.



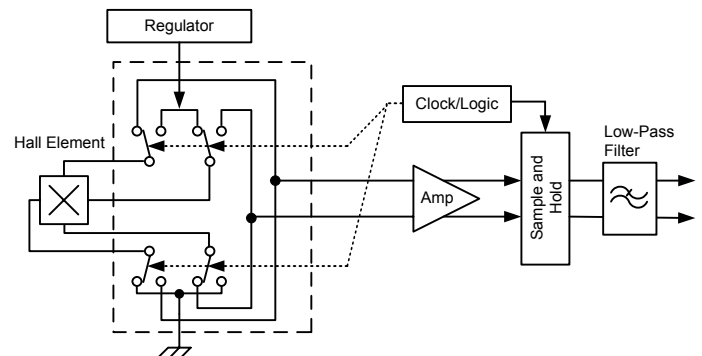
| C_F (nF) | t_r (μs) |
|------------|------------|
| 0 | 6.6 |
| 1 | 7.7 |
| 4.7 | 17.4 |
| 10 | 32.1 |
| 22 | 68.2 |
| 47 | 88.2 |
| 100 | 291.3 |
| 220 | 623.0 |
| 470 | 1120.0 |



Chopper Stabilization Technique

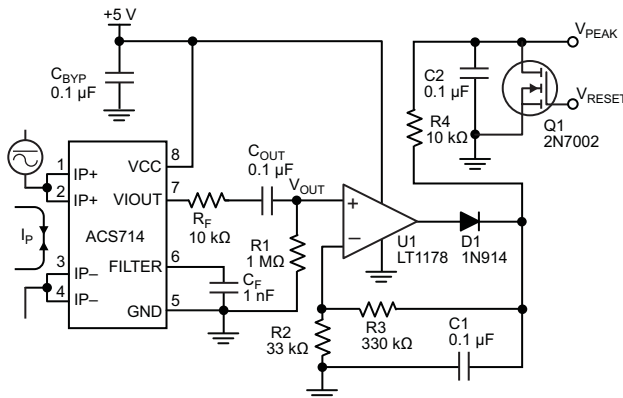
Chopper Stabilization is an innovative circuit technique that is used to minimize the offset voltage of a Hall element and an associated on-chip amplifier. Allegro patented a Chopper Stabilization technique that nearly eliminates Hall IC output drift induced by temperature or package stress effects. This offset reduction technique is based on a signal modulation-demodulation process. Modulation is used to separate the undesired dc offset signal from the magnetically induced signal in the frequency domain. Then, using a low-pass filter, the modulated dc offset is suppressed while the magnetically induced signal passes through the filter. As a result of this chopper stabilization approach, the output voltage from the Hall IC is desensitized to the effects of temperature and mechanical stress. This technique produces devices that have an extremely stable Electrical Offset Voltage, are immune to thermal stress, and have precise recoverability after temperature cycling.

This technique is made possible through the use of a BiCMOS process that allows the use of low-offset and low-noise amplifiers in combination with high-density logic integration and sample and hold circuits.

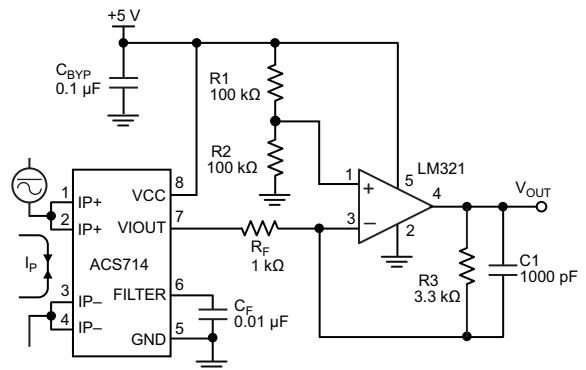


Concept of Chopper Stabilization Technique

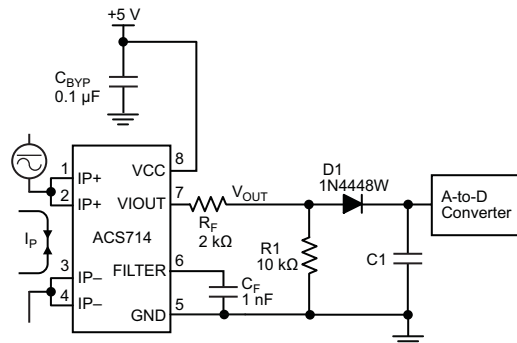
Typical Applications



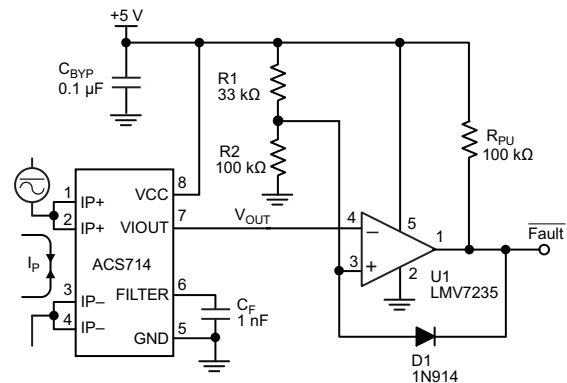
Application 2. Peak Detecting Circuit



Application 3. This configuration increases gain to 610 mV/A (tested using the ACS714ELC-05A).



Application 4. Rectified Output. 3.3 V scaling and rectification application for A-to-D converters. Replaces current transformer solutions with simpler ACS circuit. $C1$ is a function of the load resistance and filtering desired. $R1$ can be omitted if the full range is desired.



Application 5. 10 A Overcurrent Fault Latch. Fault threshold set by $R1$ and $R2$. This circuit latches an overcurrent fault and holds it until the 5 V rail is powered down.

Improving Sensing System Accuracy Using the FILTER Pin

In low-frequency sensing applications, it is often advantageous to add a simple RC filter to the output of the sensor. Such a low-pass filter improves the signal-to-noise ratio, and therefore the resolution, of the sensor output signal. However, the addition of an RC filter to the output of a sensor IC can result in undesirable sensor output attenuation — even for dc signals.

Signal attenuation, ΔV_{ATT} , is a result of the resistive divider effect between the resistance of the external filter, R_F (see Application 6), and the input impedance and resistance of the customer interface circuit, R_{INTFC} . The transfer function of this resistive divider is given by:

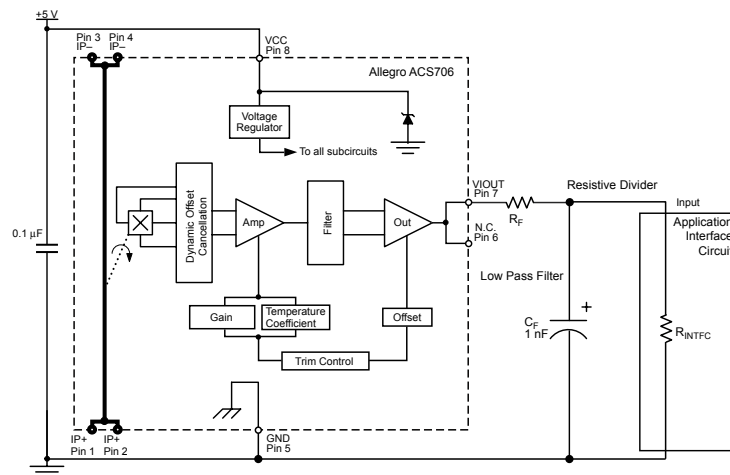
$$\Delta V_{ATT} = V_{IOUT} \left(\frac{R_{INTFC}}{R_F + R_{INTFC}} \right)$$

Even if R_F and R_{INTFC} are designed to match, the two individual resistance values will most likely drift by different amounts over

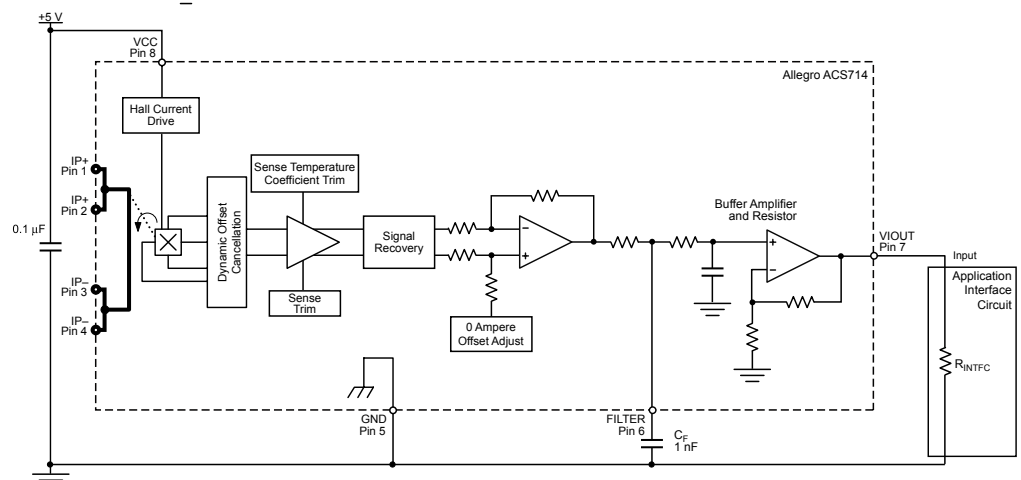
temperature. Therefore, signal attenuation will vary as a function of temperature. Note that, in many cases, the input impedance, R_{INTFC} , of a typical analog-to-digital converter (ADC) can be as low as 10 k Ω .

The ACS714 contains an internal resistor, a FILTER pin connection to the printed circuit board, and an internal buffer amplifier. With this circuit architecture, users can implement a simple RC filter via the addition of a capacitor, C_F (see Application 7) from the FILTER pin to ground. The buffer amplifier inside of the ACS714 (located after the internal resistor and FILTER pin connection) eliminates the attenuation caused by the resistive divider effect described in the equation for ΔV_{ATT} . Therefore, the ACS714 device is ideal for use in high-accuracy applications that cannot afford the signal attenuation associated with the use of an external RC low-pass filter.

Application 6. When a low pass filter is constructed externally to a standard Hall effect device, a resistive divider may exist between the filter resistor, R_F , and the resistance of the customer interface circuit, R_{INTFC} . This resistive divider will cause excessive attenuation, as given by the transfer function for ΔV_{ATT} .



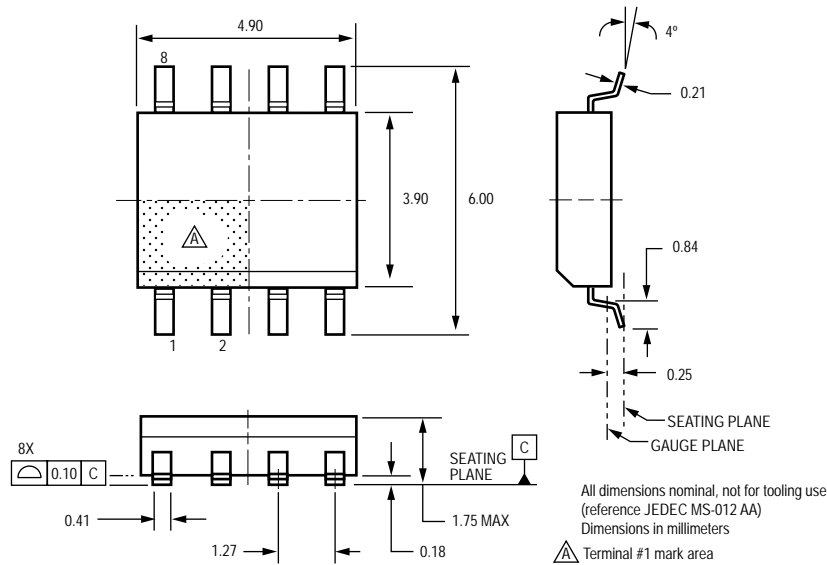
Application 7. Using the FILTER pin provided on the ACS714 eliminates the attenuation effects of the resistor divider between R_F and R_{INTFC} , shown in Application 6.



ACS714

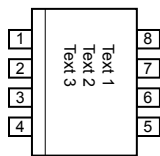
Automotive Grade, Fully Integrated, Hall Effect-Based Linear Current Sensor
with 2.1 kVRMS Voltage Isolation and a Low-Resistance Current Conductor

Package LC, 8-pin SOIC



Package Branding

Two alternative patterns are used



| | | |
|----------------------------|-----|---|
| ACS714T RLCPPP YYWWA | ACS | Allegro Current Sensor |
| | 714 | Device family number |
| | T | Indicator of 100% matte tin leadframe plating |
| | R | Operating ambient temperature range code |
| | LC | Package type designator |
| YYWWA | PPP | Primary sensed current |
| | YY | Date code: Calendar year (last two digits) |
| | WW | Date code: Calendar week |
| | A | Date code: Shift code |
| | | |

| | | |
|------------------------------------|-------|---|
| ACS714T RLCPPP L...L YYWW | ACS | Allegro Current Sensor |
| | 714 | Device family number |
| | T | Indicator of 100% matte tin leadframe plating |
| | R | Operating ambient temperature range code |
| | LC | Package type designator |
| YYWW | PPP | Primary sensed current |
| | L...L | Lot code |
| | YY | Date code: Calendar year (last two digits) |
| | WW | Date code: Calendar week |
| | | |

Copyright ©2006,2007, Allegro MicroSystems, Inc.

The products described herein are manufactured under one or more of the following U.S. patents: 5,045,920; 5,264,783; 5,442,283; 5,389,889; 5,581,179; 5,517,112; 5,619,137; 5,621,319; 5,650,719; 5,686,894; 5,694,038; 5,729,130; 5,917,320; and other patents pending.

Allegro MicroSystems, Inc. reserves the right to make, from time to time, such departures from the detail specifications as may be required to permit improvements in the performance, reliability, or manufacturability of its products. Before placing an order, the user is cautioned to verify that the information being relied upon is current.

Allegro’s products are not to be used in life support devices or systems, if a failure of an Allegro product can reasonably be expected to cause the failure of that life support device or system, or to affect the safety or effectiveness of that device or system.

The information included herein is believed to be accurate and reliable. However, Allegro MicroSystems, Inc. assumes no responsibility for its use; nor for any infringement of patents or other rights of third parties which may result from its use.

For the latest version of this document, visit our website:

www.allegromicro.com

