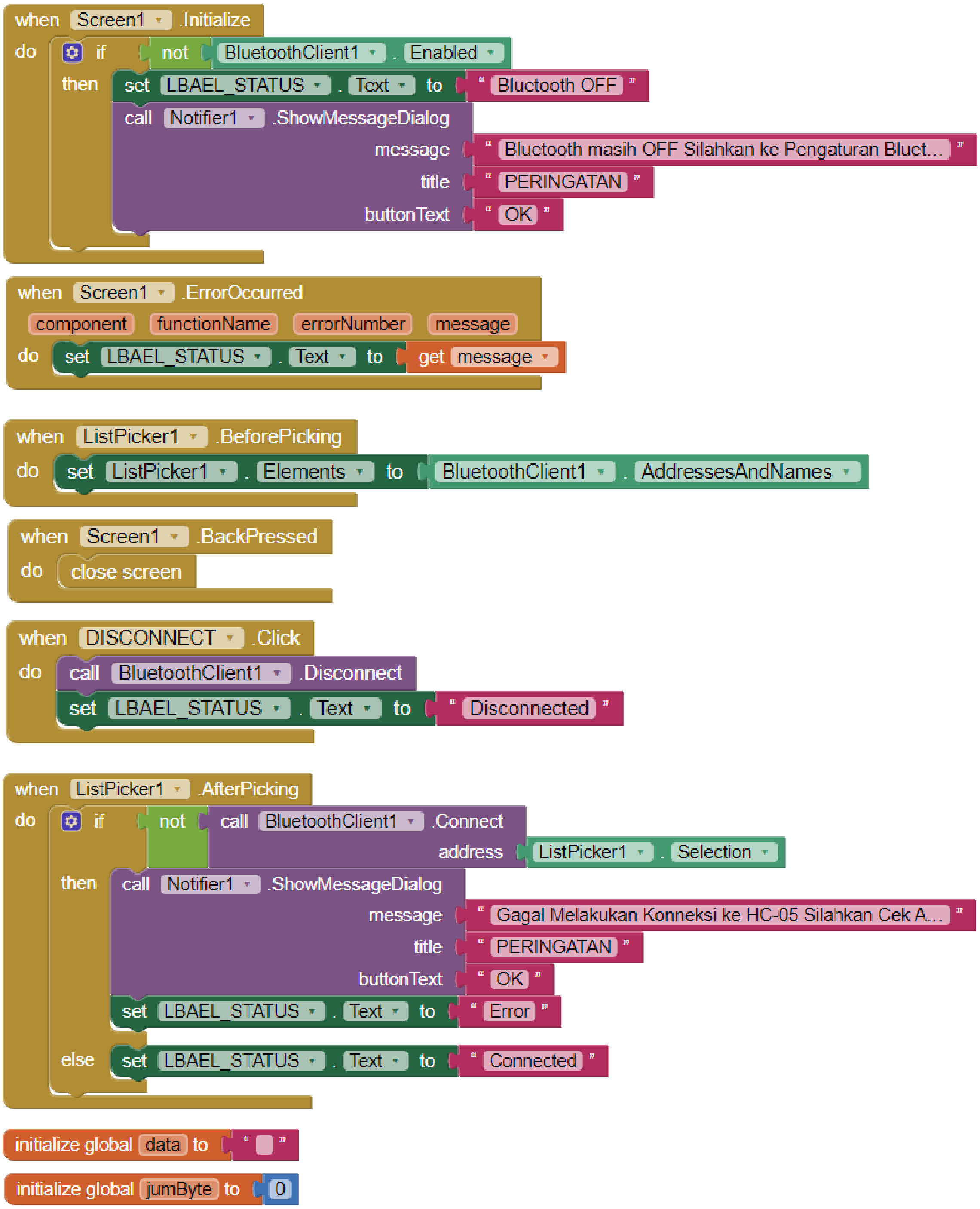
LAMPIRAN 1 : LISTING PROGRAM

```
#include <SoftwareSerial.h>
SoftwareSerial bt(9,10);
int a;int b;int c; //variable input tombol
int kuncia;int kuncib;int kuncic;int // variabel pengunci tombol
LEDA =6;int LEDB =7;int LEDC =8;int relaya =13;int relayb =12;int relayc =11; //pengalamatan PIN

int pa;int pb; int pc;//variabel pembacaan sensor arus
int xa;int xb;int xc;int ya;int yb;int yc;int za;int zb;int zc; // pembantu pembacaan sensor

int pera;int perb;int perc; // variabel hasil perhitungan data sensor
int detik,mulai,hasil;
char data; // penyimpan data masuk bluetooth
void setup ()
{
  bt.begin(9600);
  Serial.begin(9600);
  pinMode (2,INPUT);pinMode (3,INPUT);pinMode (4,INPUT);
  pinMode (6,OUTPUT);pinMode (7,OUTPUT);pinMode (8,OUTPUT);
  pinMode (11,OUTPUT);pinMode (12,OUTPUT);pinMode (13,OUTPUT);
  digitalWrite(LEDA,1);digitalWrite(LEDB,1);digitalWrite(LEDC,1);
  digitalWrite(relaya,1);digitalWrite(relayb,1);digitalWrite(relayc,1);
  detik=0;
}
void loop(){
   //Listing Program Pembacaan Bluetooth
  a=digitalRead(2);b=digitalRead(3);c=digitalRead(4);// pembacaan tombol oleh pin tombol
```

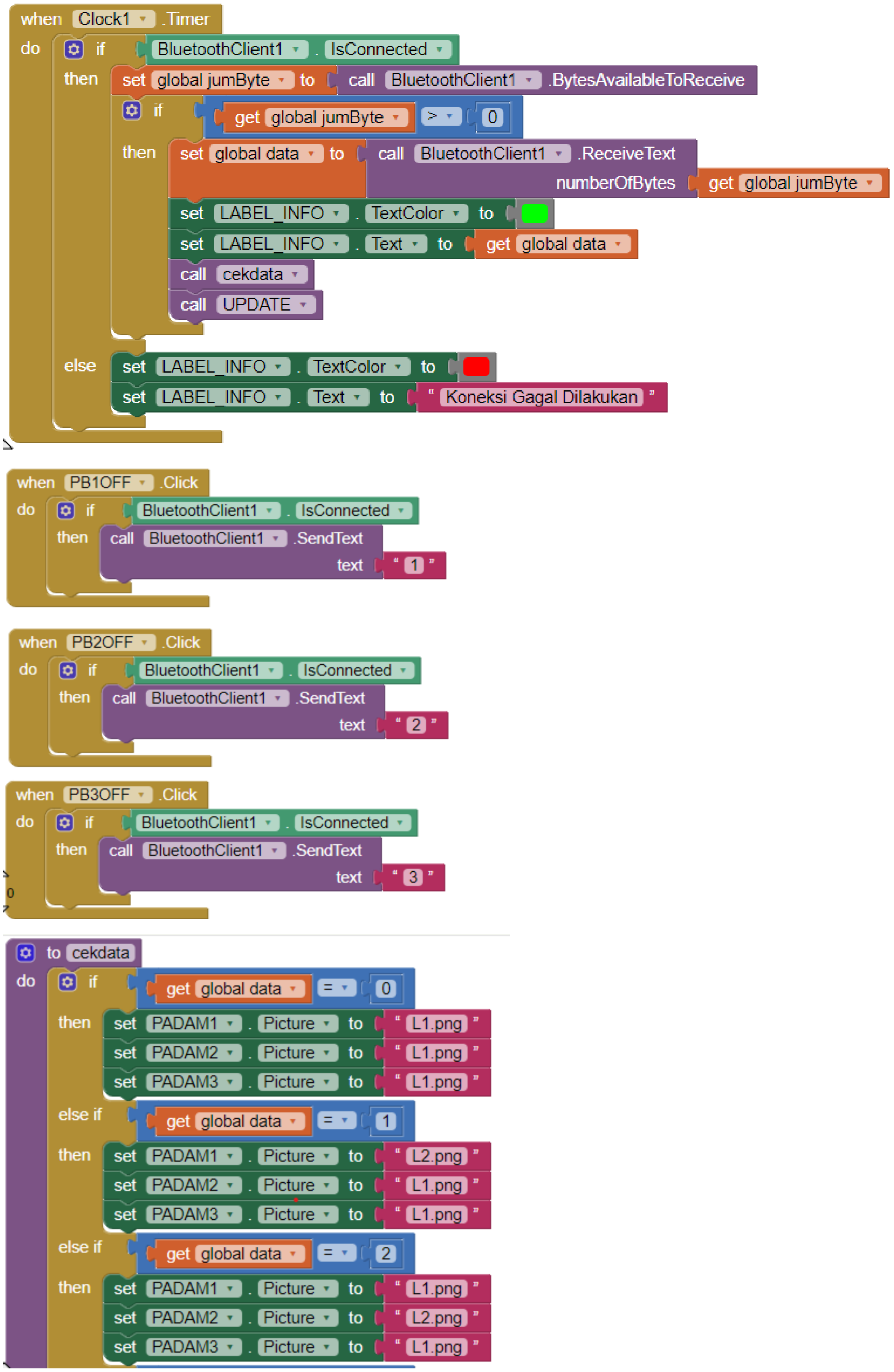
```
 pa=analogRead(0);pb=analogRead(1);pc=analogRead(2);// pembacaan sensor arus oleh pin analog
 pera=((pa-505)*4);perb=((pb-505)*4);perc=((pc-505)*4);


 //Listing Program Pembacaan Tombol

if(a==0){if(kuncia==0){digitalWrite(relaya,0);digitalWrite(LEDA,0);kuncia=1;};
 if(kuncia==2){digitalWrite(relaya,1);digitalWrite(LEDA,1);kuncia=3;};};
 if(a==1){if(kuncia==1){kuncia=2;};if(kuncia==3){kuncia=0;};};

if(b==0){if(kuncib==0){digitalWrite(relayb,0);digitalWrite(LEDB,0);kuncib=1;};
 if(kuncib==2){digitalWrite(relayb,1);digitalWrite(LEDB,1);kuncib=3;};};
 if(b==1){if(kuncib==1){kuncib=2;};if(kuncib==3){kuncib=0;};};

if(c==0){if(kuncic==0){digitalWrite(relayc,0);digitalWrite(LEDC,0);kuncic=1;};
 if(kuncic==2){digitalWrite(relayc,1);digitalWrite(LEDC,1);kuncic=3;};};
 if(c==1){if(kuncic==1){kuncic=2;};if(kuncic==3){kuncic=0;};};

 // Listing Program Pengolahan data Bluetooth
 if (bt.available()>0){data=bt.read();};

if(data=='1'){if(kuncia==0){digitalWrite(relaya,0);digitalWrite(LEDA,0);kuncia=1;data=0;};

if(kuncia==2){digitalWrite(relaya,1);digitalWrite(LEDA,1);kuncia=3;ya=0;data=0;};};

if(data=='2'){if(kuncib==0){digitalWrite(relayb,0);digitalWrite(LEDB,0);kuncib=1;data=0;};
```

```
if(kuncib==2){digitalWrite(relayb,1);digitalWrite(LEDB,1);;kuncib=3;yb=0;data
=0;};};

if(data=='3'){if(kuncic==0){digitalWrite(relayc,0);digitalWrite(LEDC,0);kuncic=
1;data=0;};

if(kuncic==2){digitalWrite(relayc,1);digitalWrite(LEDC,1);kuncic=3;yc=0;data=
0;};};

  if(kuncia==0){ya=0;};
  if(kuncib==0){yb=0;};
  if(kuncic==0){yc=0;};
  if (pera<13){ya=1;};
  if (perb<13){yb=1;};
  if (perc<13){yc=1;};
  hasil=((ya+yb*2)+yc*4);
  if (detik<21){detik++;};
  if (detik==20){Serial.println(perc);bt.print(hasil);detik=0;};
  delay(30);
}
```

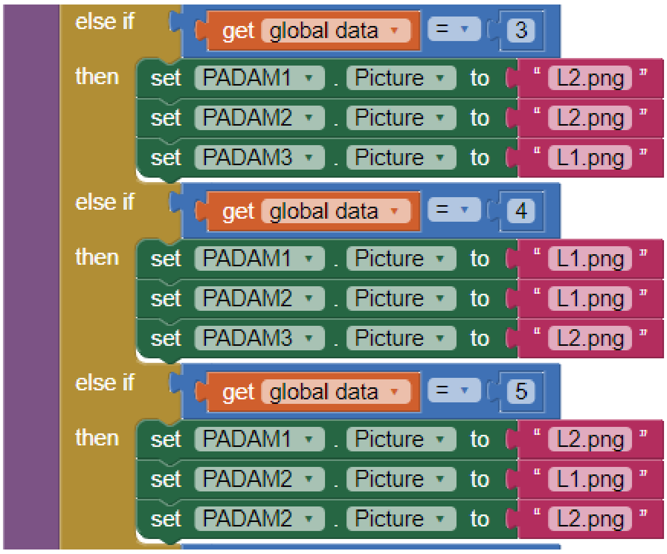
LAMPIRAN 2 : BLOCK APLIKASI ANDROID



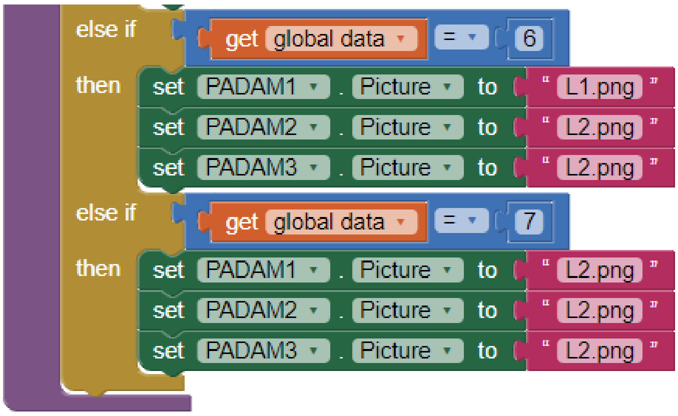
```
when Screen1 .Initialize
do  if  not BluetoothClient1 . Enabled
    then  set LBAEL_STATUS . Text to " Bluetooth OFF "
          call Notifier1 .ShowMessageDialog
                 message " Bluetooth masih OFF Silahkan ke Pengaturan Bluet... "
                   title " PERINGATAN "
              buttonText " OK "

when Screen1 .ErrorOccurred
  component  functionName  errorNumber  message
do  set LBAEL_STATUS . Text to  get message

when ListPicker1 .BeforePicking
do  set ListPicker1 . Elements to  BluetoothClient1 . AddressesAndNames

when Screen1 .BackPressed
do  close screen

when DISCONNECT .Click
do  call BluetoothClient1 .Disconnect
    set LBAEL_STATUS . Text to " Disconnected "

when ListPicker1 .AfterPicking
do  if  not  call BluetoothClient1 .Connect
                               address  ListPicker1 . Selection
    then  call Notifier1 .ShowMessageDialog
                 message " Gagal Melakukan Konneksi ke HC-05 Silahkan Cek A... "
                   title " PERINGATAN "
              buttonText " OK "
          set LBAEL_STATUS . Text to " Error "
    else  set LBAEL_STATUS . Text to " Connected "

initialize global data to " "

initialize global jumByte to 0
```



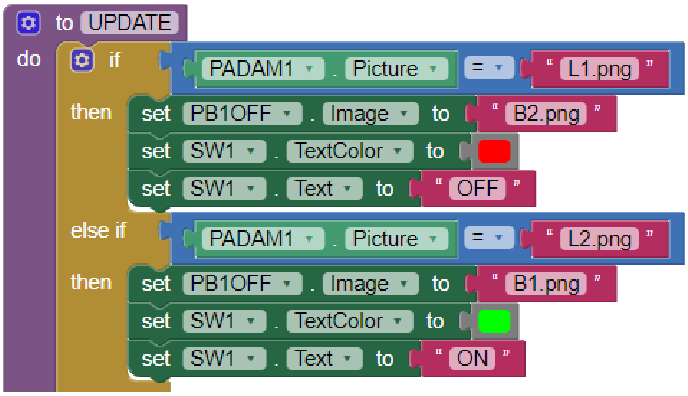
```
when Clock1 .Timer
do  if  BluetoothClient1 . IsConnected
    then  set global jumByte to  call BluetoothClient1 .BytesAvailableToReceive
          if  get global jumByte > 0
          then  set global data to  call BluetoothClient1 .ReceiveText
                                                numberOfBytes  get global jumByte
                set LABEL_INFO . TextColor to 🟩
                set LABEL_INFO . Text to  get global data
                call cekdata
                call UPDATE
    else  set LABEL_INFO . TextColor to 🟥
          set LABEL_INFO . Text to  " Koneksi Gagal Dilakukan "

when PB1OFF .Click
do  if  BluetoothClient1 . IsConnected
    then  call BluetoothClient1 .SendText
                                 text  " 1 "

when PB2OFF .Click
do  if  BluetoothClient1 . IsConnected
    then  call BluetoothClient1 .SendText
                                 text  " 2 "

when PB3OFF .Click
do  if  BluetoothClient1 . IsConnected
    then  call BluetoothClient1 .SendText
                                 text  " 3 "

to cekdata
do  if  get global data = 0
    then  set PADAM1 . Picture to  " L1.png "
          set PADAM2 . Picture to  " L1.png "
          set PADAM3 . Picture to  " L1.png "
    else if  get global data = 1
    then  set PADAM1 . Picture to  " L2.png "
          set PADAM2 . Picture to  " L1.png "
          set PADAM3 . Picture to  " L1.png "
    else if  get global data = 2
    then  set PADAM1 . Picture to  " L1.png "
          set PADAM2 . Picture to  " L2.png "
          set PADAM3 . Picture to  " L1.png "
```
]



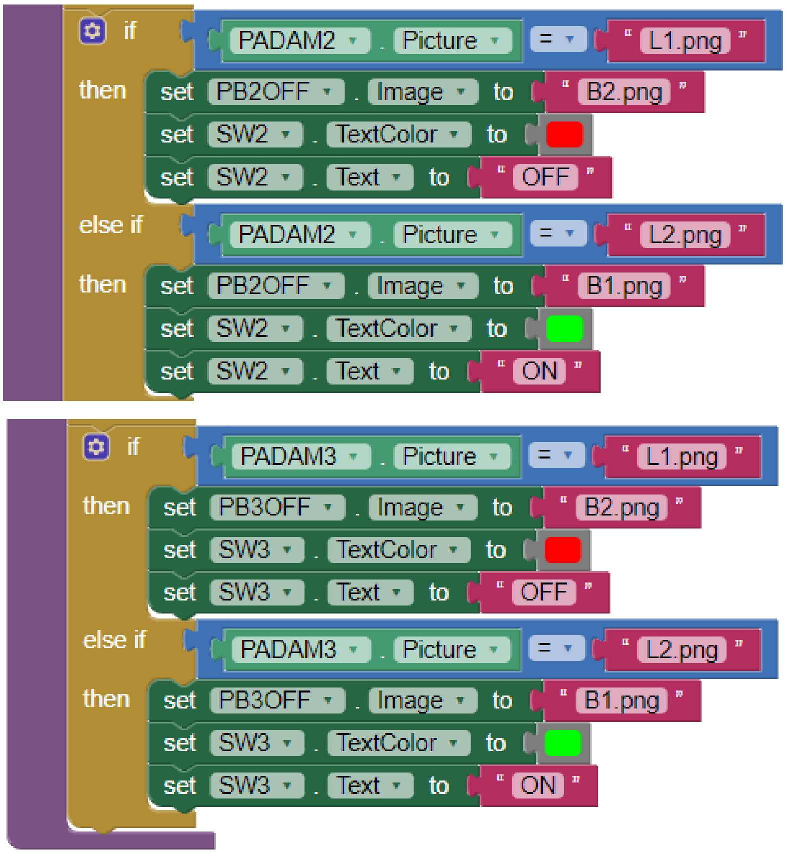
```
else if   get global data = 3
then      set PADAM1 . Picture to " L2.png "
          set PADAM2 . Picture to " L2.png "
          set PADAM3 . Picture to " L1.png "
else if   get global data = 4
then      set PADAM1 . Picture to " L1.png "
          set PADAM2 . Picture to " L1.png "
          set PADAM3 . Picture to " L2.png "
else if   get global data = 5
then      set PADAM1 . Picture to " L2.png "
          set PADAM2 . Picture to " L1.png "
          set PADAM2 . Picture to " L2.png "
```



```
else if   get global data = 6
then      set PADAM1 . Picture to " L1.png "
          set PADAM2 . Picture to " L2.png "
          set PADAM3 . Picture to " L2.png "
else if   get global data = 7
then      set PADAM1 . Picture to " L2.png "
          set PADAM2 . Picture to " L2.png "
          set PADAM3 . Picture to " L2.png "
```

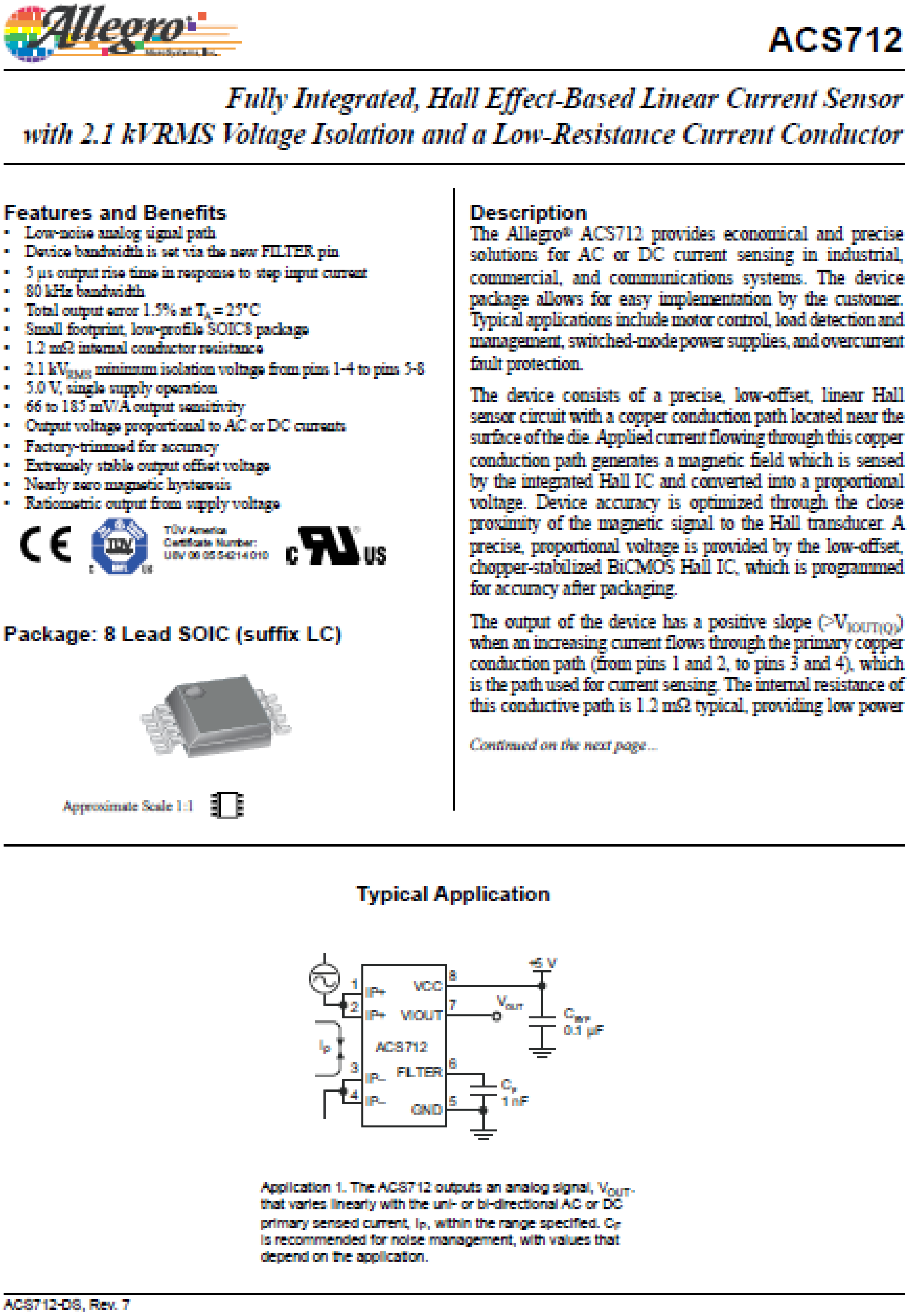


```
to UPDATE
do   if       PADAM1 . Picture = " L1.png "
     then     set PB1OFF . Image to " B2.png "
              set SW1 . TextColor to 🟥
              set SW1 . Text to " OFF "
     else if  PADAM1 . Picture = " L2.png "
     then     set PB1OFF . Image to " B1.png "
              set SW1 . TextColor to 🟩
              set SW1 . Text to " ON "
```



```
if      PADAM2 . Picture = " L1.png "
then    set PB2OFF . Image to " B2.png "
        set SW2 . TextColor to 🟥
        set SW2 . Text to " OFF "
else if PADAM2 . Picture = " L2.png "
then    set PB2OFF . Image to " B1.png "
        set SW2 . TextColor to 🟩
        set SW2 . Text to " ON "

if      PADAM3 . Picture = " L1.png "
then    set PB3OFF . Image to " B2.png "
        set SW3 . TextColor to 🟥
        set SW3 . Text to " OFF "
else if PADAM3 . Picture = " L2.png "
then    set PB3OFF . Image to " B1.png "
        set SW3 . TextColor to 🟩
        set SW3 . Text to " ON "
```

LAMPIRAN 3 : *DATA SHEET* ACS712



Allegro MicroSystems, Inc.

ACS712

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 new FILTER pin
- 5 µs output rise time in response to step input current
- 80 kHz bandwidth
- Total output error 1.5% at $T_A = 25°C$
- Small footprint, low-profile SOIC8 package
- 1.2 mΩ 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

TÜV America
Certificate Number:
U8V 06 05 54214 010

Package: 8 Lead SOIC (suffix LC)

Approximate Scale 1:1

Description

The Allegro® ACS712 provides economical and precise solutions for AC or DC current sensing in industrial, commercial, and communications 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.

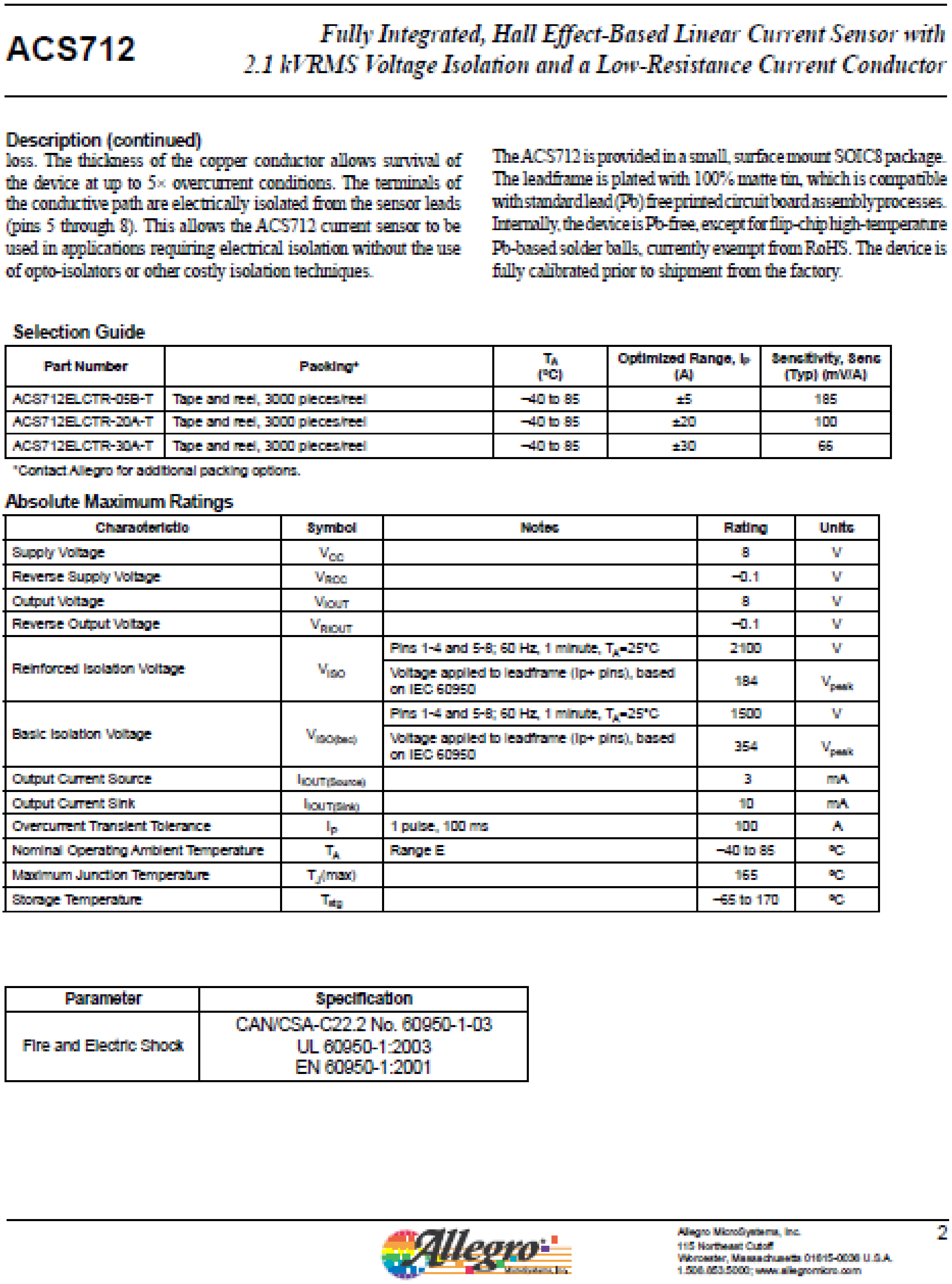
The device consists of a precise, low-offset, linear Hall sensor circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which is sensed by the integrated Hall IC and converted into a proportional 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 mΩ typical, providing low power

Continued on the next page…

Typical Application

Application 1. The ACS712 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.



Description (continued)

loss. The thickness of the copper conductor allows survival 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 ACS712 current sensor to be used in applications requiring electrical isolation without the use of opto-isolators or other costly isolation techniques.

The ACS712 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	Packing*	T_A (°C)	Optimized Range, I_P (A)	Sensitivity, Sens (Typ) (mV/A)
ACS712ELCTR-05B-T	Tape and reel, 3000 pieces/reel	–40 to 85	±5	185
ACS712ELCTR-20A-T	Tape and reel, 3000 pieces/reel	–40 to 85	±20	100
ACS712ELCTR-30A-T	Tape and reel, 3000 pieces/reel	–40 to 85	±30	66

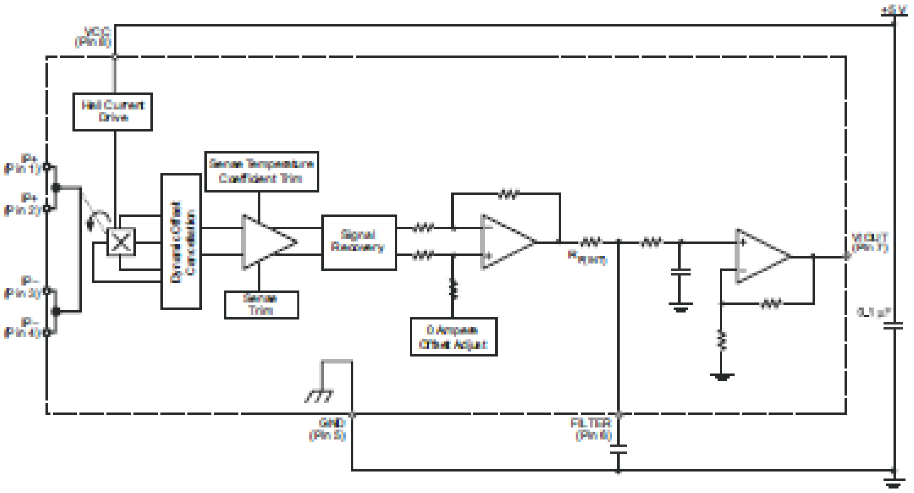
*Contact Allegro for additional packing options.

Absolute Maximum Ratings

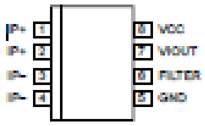
Characteristic	Symbol	Notes	Rating	Units
Supply Voltage	V_{CC}		8	V
Reverse Supply Voltage	V_{RCC}		–0.1	V
Output Voltage	V_{IOUT}		8	V
Reverse Output Voltage	V_{RIOUT}		–0.1	V
Reinforced Isolation Voltage	V_{ISO}	Pins 1-4 and 5-8; 60 Hz, 1 minute, T_A=25°C	2100	V
		Voltage applied to leadframe (Ip+ pins), based on IEC 60950	184	V_{peak}
Basic Isolation Voltage	$V_{ISO(bsc)}$	Pins 1-4 and 5-8; 60 Hz, 1 minute, T_A=25°C	1500	V
		Voltage applied to leadframe (Ip+ pins), based on IEC 60950	354	V_{peak}
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	ºC
Maximum Junction Temperature	T_J(max)		165	ºC
Storage Temperature	T_{stg}		–65 to 170	ºC

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

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 CHARACTERISTICS[1] 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}	VIOUT to GND	–	–	10	nF
Output Resistive Load	R_{LOAD}	VIOUT to GND	4.7	–	–	kΩ
Primary Conductor Resistance	$R_{PRIMARY}$	T_A = 25°C	–	1.2	–	mΩ
Rise Time	t_r	I_P = I_P(max), T_A = 25°C, C_{OUT} = open	–	5	–	μs
Frequency Bandwidth	f	−3 dB, T_A = 25°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°C	–	V_{CC} × 0.5	–	V
Power-On Time	t_{PO}	Output reaches 90% of steady-state level, T_J = 25°C, 20 A present on leadframe	–	35	–	μs
Magnetic Coupling[2]			–	12	–	G/A
Internal Filter Resistance[3]	$R_{F(INT)}$			1.7		kΩ

[1] Device 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(max), is not exceeded.

[2] 1G = 0.1 mT.

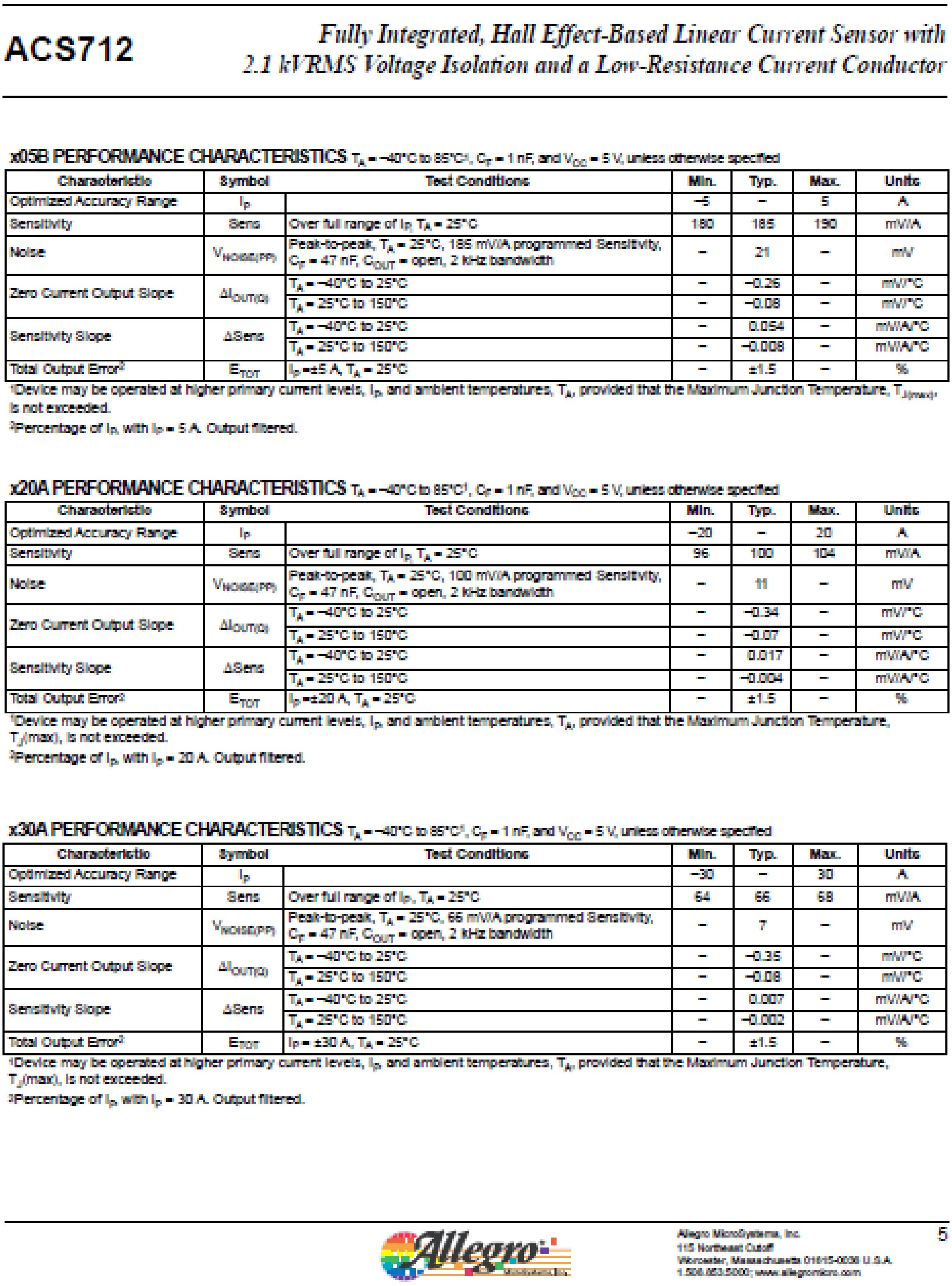
[3] $R_{F(INT)}$ forms an RC circuit via the FILTER pin.

COMMON THERMAL CHARACTERISTICS[1]

			Min.	Typ.	Max.	Units
Operating Internal Leadframe Temperature	T_A	E range	−40	–	85	°C
					Value	Units
Junction-to-Lead Thermal Resistance[2]	$R_{θJL}$	Mounted on the Allegro ASEK 712 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

[1] Additional thermal information is available on the Allegro website.

[2] The Allegro evaluation board has 1500 mm^2 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 T_A = −40°C to 85°C[1], C_F = 1 nF, and V_{CC} = 5 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°C	180	185	190	mV/A
Noise	$V_{NOISE(PP)}$	Peak-to-peak, T_A = 25°C, 185 mV/A programmed Sensitivity, C_F = 47 nF, C_{OUT} = open, 2 kHz bandwidth	–	21	–	mV
Zero Current Output Slope	$\Delta I_{OUT(Q)}$	T_A = −40°C to 25°C	–	−0.26	–	mV/°C
		T_A = 25°C to 150°C	–	−0.08	–	mV/°C
Sensitivity Slope	ΔSens	T_A = −40°C to 25°C	–	0.054	–	mV/A/°C
		T_A = 25°C to 150°C	–	−0.008	–	mV/A/°C
Total Output Error[2]	E_{TOT}	I_P = ±5 A, T_A = 25°C	–	±1.5	–	%

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

[2] Percentage of I_P, with I_P = 5 A. Output filtered.

x20A PERFORMANCE CHARACTERISTICS T_A = −40°C to 85°C[1], C_F = 1 nF, and V_{CC} = 5 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°C	96	100	104	mV/A
Noise	$V_{NOISE(PP)}$	Peak-to-peak, T_A = 25°C, 100 mV/A programmed Sensitivity, C_F = 47 nF, C_{OUT} = open, 2 kHz bandwidth	–	11	–	mV
Zero Current Output Slope	$\Delta I_{OUT(Q)}$	T_A = −40°C to 25°C	–	−0.34	–	mV/°C
		T_A = 25°C to 150°C	–	−0.07	–	mV/°C
Sensitivity Slope	ΔSens	T_A = −40°C to 25°C	–	0.017	–	mV/A/°C
		T_A = 25°C to 150°C	–	−0.004	–	mV/A/°C
Total Output Error[2]	E_{TOT}	I_P = ±20 A, T_A = 25°C	–	±1.5	–	%

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

[2] Percentage of I_P, with I_P = 20 A. Output filtered.

x30A PERFORMANCE CHARACTERISTICS T_A = −40°C to 85°C[1], C_F = 1 nF, and V_{CC} = 5 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°C	64	66	68	mV/A
Noise	$V_{NOISE(PP)}$	Peak-to-peak, T_A = 25°C, 66 mV/A programmed Sensitivity, C_F = 47 nF, C_{OUT} = open, 2 kHz bandwidth	–	7	–	mV
Zero Current Output Slope	$\Delta I_{OUT(Q)}$	T_A = −40°C to 25°C	–	−0.35	–	mV/°C
		T_A = 25°C to 150°C	–	−0.08	–	mV/°C
Sensitivity Slope	ΔSens	T_A = −40°C to 25°C	–	0.007	–	mV/A/°C
		T_A = 25°C to 150°C	–	−0.002	–	mV/A/°C
Total Output Error[2]	E_{TOT}	I_P = ±30 A, T_A = 25°C	–	±1.5	–	%

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

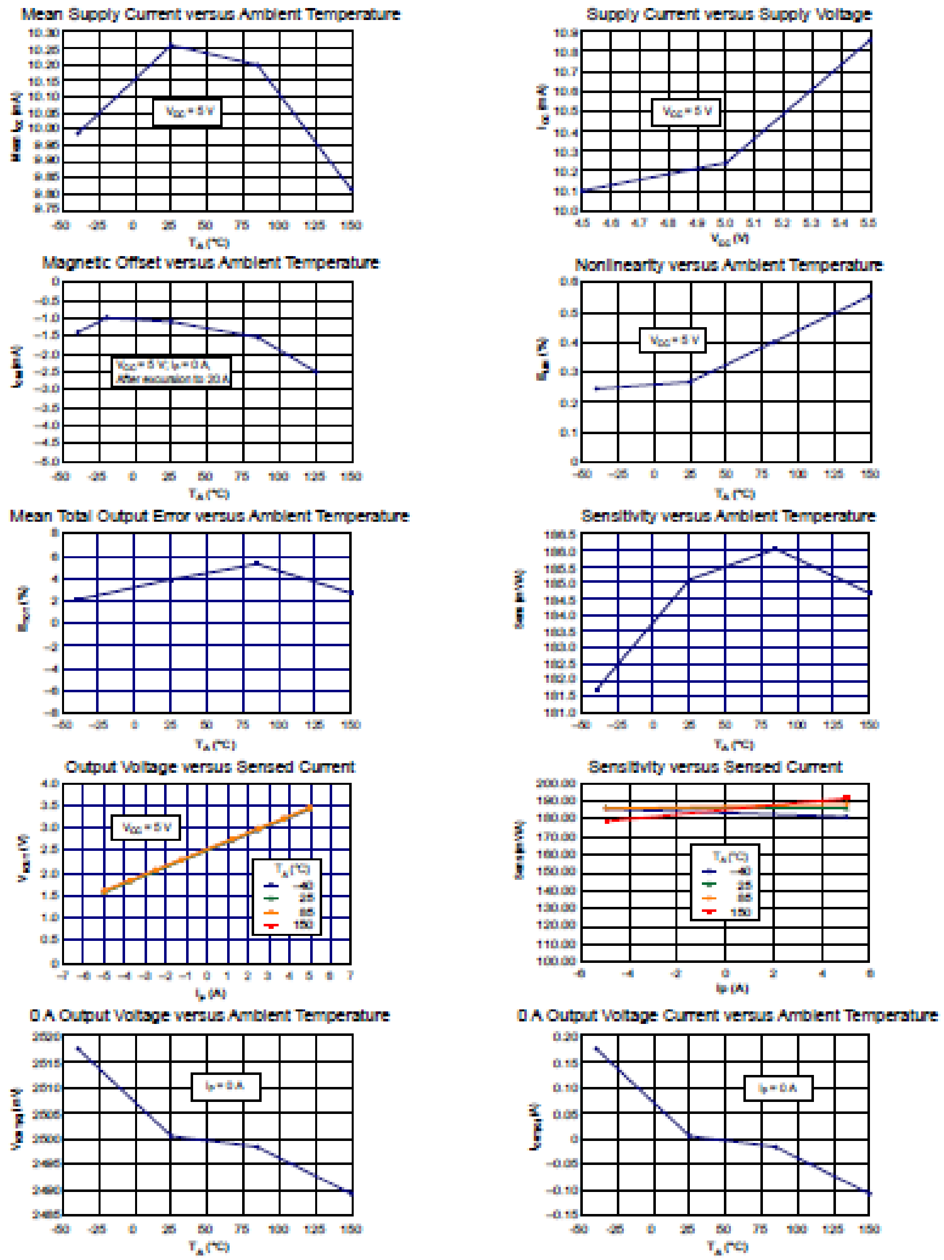
[2] Percentage of I_P, with I_P = 30 A. Output filtered.

ACS712

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

Characteristic Performance

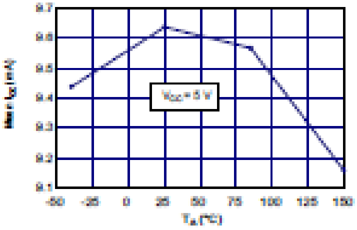
I_P = 5 A, unless otherwise specified



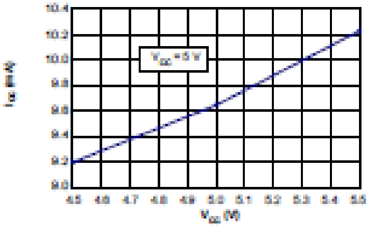
Characteristic Performance

I_P = 20 A, unless otherwise specified

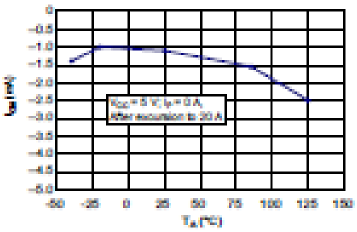
Mean Supply Current versus Ambient Temperature



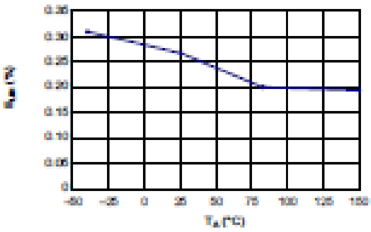
Supply Current versus Supply Voltage



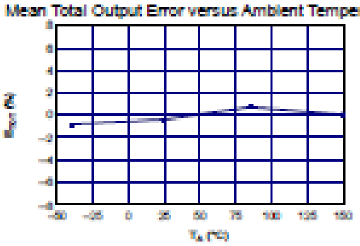
Magnetic Offset versus Ambient Temperature



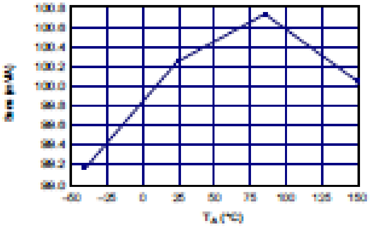
Nonlinearity versus Ambient Temperature



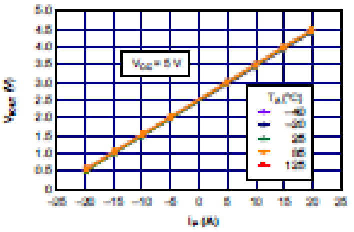
Mean Total Output Error versus Ambient Temperature



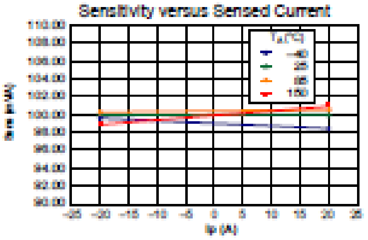
Sensitivity versus Ambient Temperature



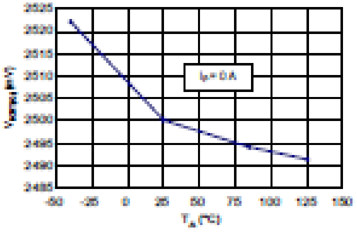
Output Voltage versus Sensed Current



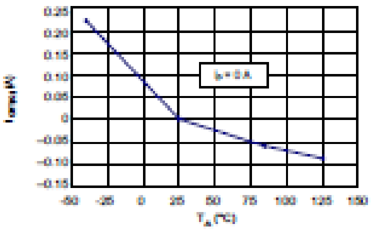
Sensitivity versus Sensed Current

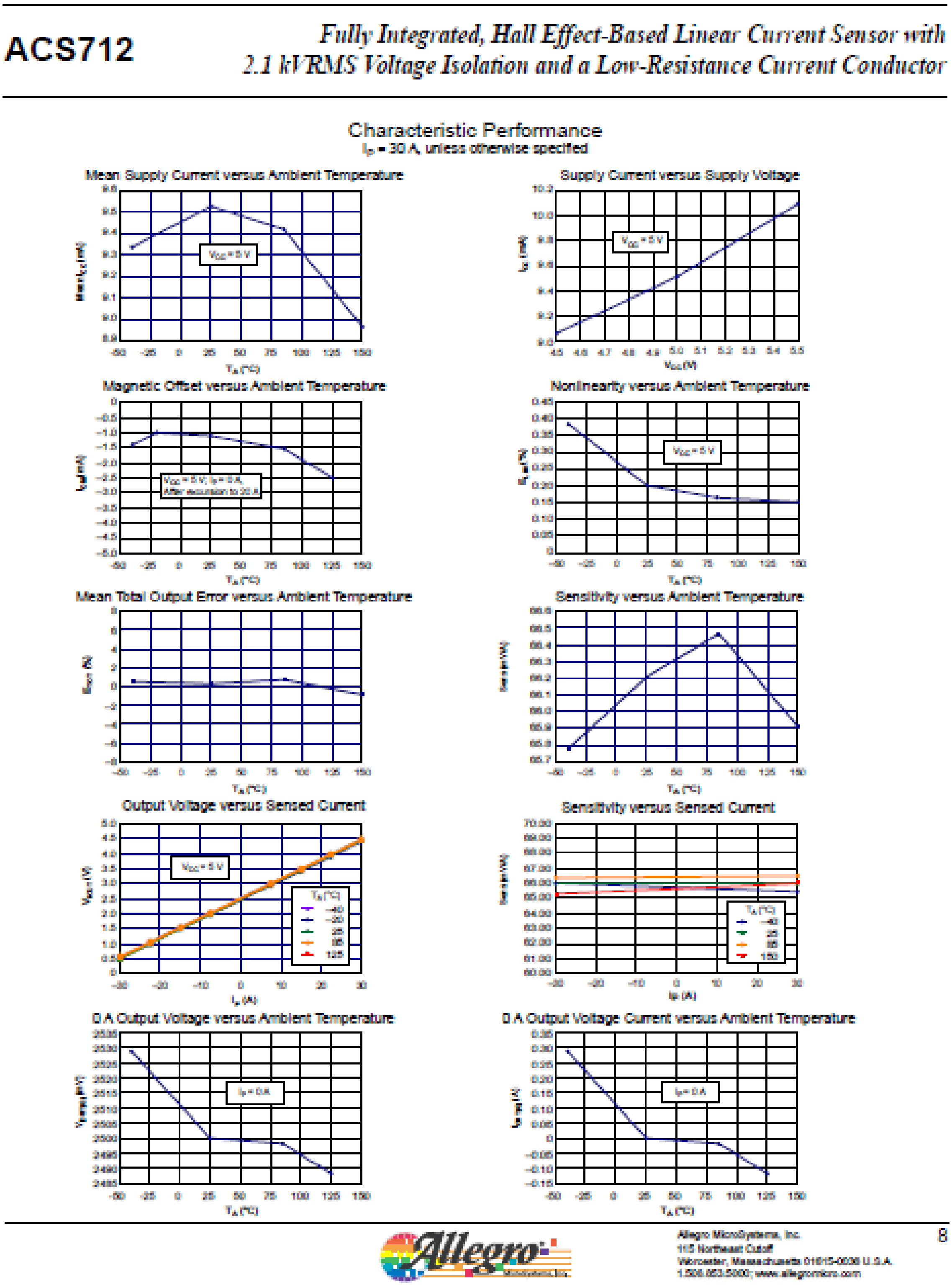


0 A Output Voltage versus Ambient Temperature



0 A Output Voltage Current versus Ambient Temperature





ACS712

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

Characteristic Performance

I_P = 30 A, unless otherwise specified

Allegro MicroSystems, Inc.
115 Northeast Cutoff
Worcester, Massachusetts 01615-0036 U.S.A.
1.508.853.5000; www.allegromicro.com

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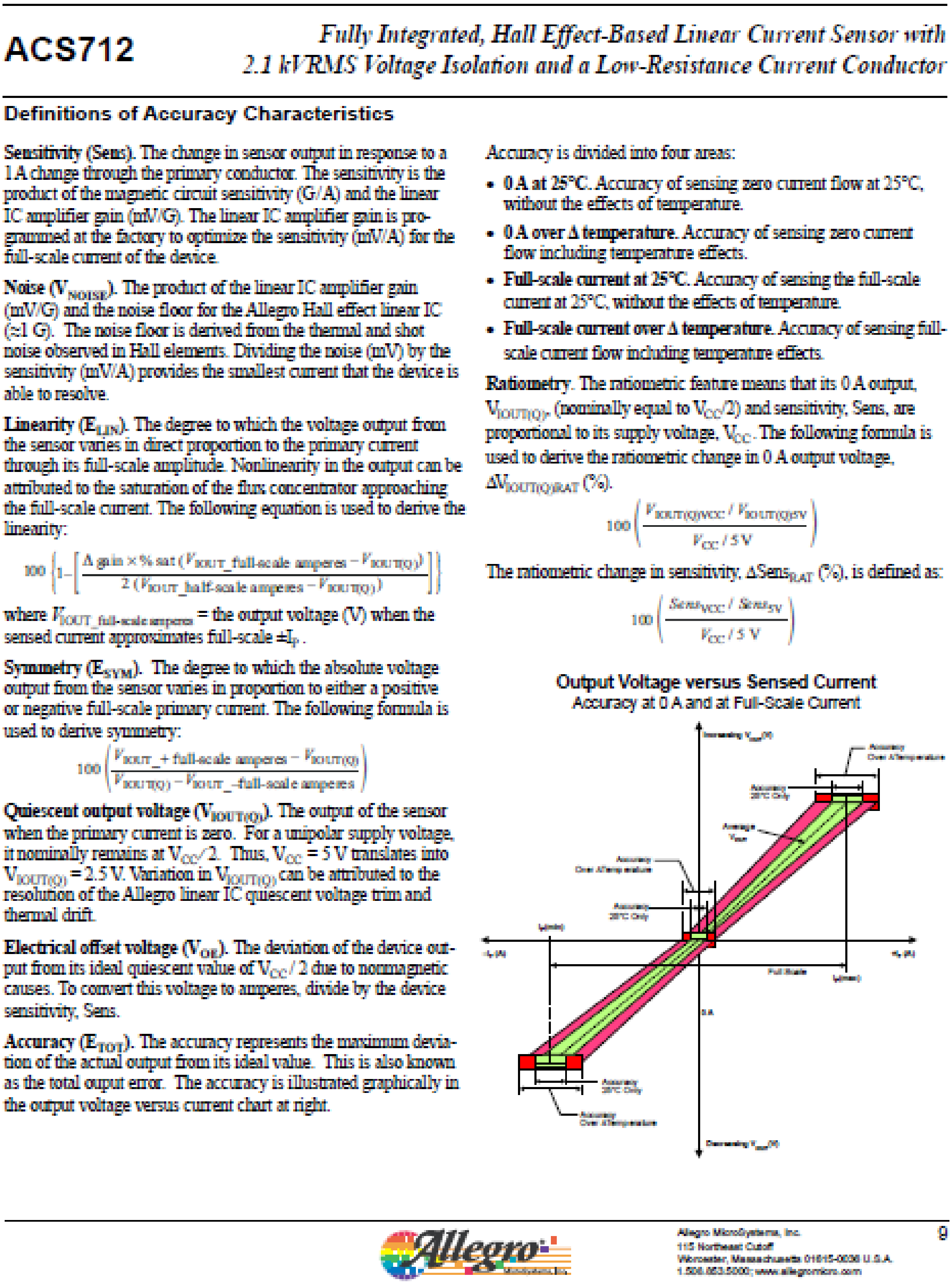


Definitions of Accuracy Characteristics

Sensitivity (Sens). The change in sensor output in response to a 1 A change through the primary conductor. The sensitivity is the product of the magnetic circuit sensitivity (G/A) and the linear IC amplifier gain (mV/G). The linear IC amplifier gain is programmed at the factory to optimize the sensitivity (mV/A) for the full-scale current of the device.

Noise (V_{NOISE}). The product of the linear IC amplifier gain (mV/G) and the noise floor for the Allegro Hall effect linear IC (≈1 G). The noise floor is derived from the thermal and shot noise observed in Hall elements. Dividing the noise (mV) by the sensitivity (mV/A) provides the smallest current that the device is able to resolve.

Linearity (E_{LIN}). The degree to which the voltage output from the sensor varies in direct proportion to the primary current through its full-scale amplitude. Nonlinearity in the output can be attributed to the saturation of the flux concentrator approaching the full-scale current. The following equation is used to derive the linearity:

$$100\left\{1-\left[\frac{\Delta\text{ gain}\times\%\text{ sat}\,(V_{IOUT\_full\text{-}scale\ amperes}-V_{IOUT(Q)})}{2\,(V_{IOUT\_half\text{-}scale\ amperes}-V_{IOUT(Q)})}\right]\right\}$$

where $V_{IOUT\_full\text{-}scale\ amperes}$ = the output voltage (V) when the sensed current approximates full-scale $\pm I_P$.

Symmetry (E_{SYM}). The degree to which the absolute voltage output from the sensor varies in proportion to either a positive or negative full-scale primary current. The following formula is used to derive symmetry:

$$100\left(\frac{V_{IOUT\_+full\text{-}scale\ amperes}-V_{IOUT(Q)}}{V_{IOUT(Q)}-V_{IOUT\_-full\text{-}scale\ amperes}}\right)$$

Quiescent output voltage ($V_{IOUT(Q)}$). The output of the sensor when the primary current is zero. For a unipolar supply voltage, it nominally remains at $V_{CC}/2$. Thus, V_{CC} = 5 V translates into $V_{IOUT(Q)}$ = 2.5 V. Variation in $V_{IOUT(Q)}$ can be attributed to the resolution of the Allegro linear IC quiescent voltage trim and thermal drift.

Electrical offset voltage (V_{OE}). The deviation of the device output from its ideal quiescent value of $V_{CC}/2$ due to nonmagnetic causes. To convert this voltage to amperes, divide by the device sensitivity, Sens.

Accuracy (E_{TOT}). The accuracy represents the maximum deviation of the actual output from its ideal value. This is also known as the total ouput error. The accuracy is illustrated graphically in the output voltage versus current chart at right.

Accuracy is divided into four areas:

- **0 A at 25°C.** Accuracy of sensing zero current flow at 25°C, without the effects of temperature.
- **0 A over Δ temperature.** Accuracy of sensing zero current flow including temperature effects.
- **Full-scale current at 25°C.** Accuracy of sensing the full-scale current at 25°C, without the effects of temperature.
- **Full-scale current over Δ temperature.** Accuracy of sensing full-scale current flow including temperature effects.

Ratiometry. The ratiometric feature means that its 0 A output, $V_{IOUT(Q)}$, (nominally equal to $V_{CC}/2$) and sensitivity, Sens, are proportional to its supply voltage, V_{CC}. The following formula is used to derive the ratiometric change in 0 A output voltage, $\Delta V_{IOUT(Q)RAT}$ (%).

$$100\left(\frac{V_{IOUT(Q)VCC}\,/\,V_{IOUT(Q)5V}}{V_{CC}\,/\,5\text{ V}}\right)$$

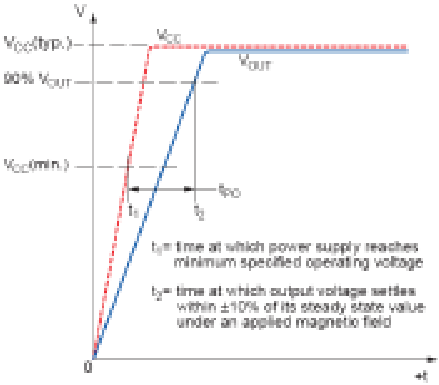
The ratiometric change in sensitivity, $\Delta Sens_{RAT}$ (%), is defined as:

$$100\left(\frac{Sens_{VCC}\,/\,Sens_{5V}}{V_{CC}\,/\,5\text{ V}}\right)$$

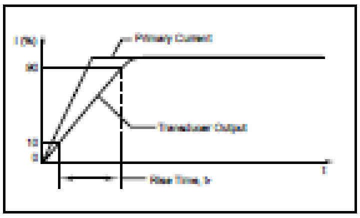
Output Voltage versus Sensed Current
Accuracy at 0 A and at Full-Scale Current

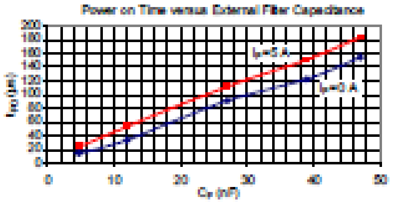
Definitions of Dynamic Response Characteristics

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 ±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.

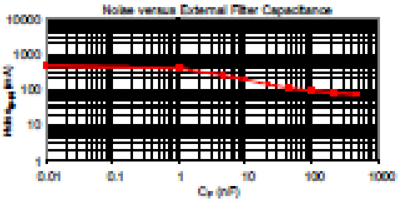


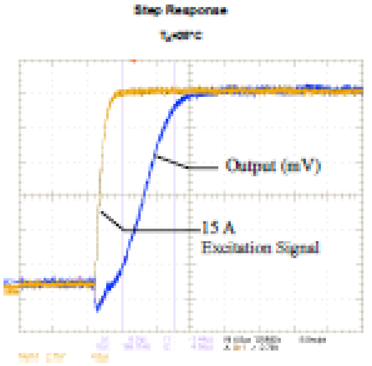
Rise time (t_r). The time interval between a) when the sensor reaches 10% of its full scale value, and b) when it reaches 90% of its full scale value. The rise time to a step response is used to derive the bandwidth of the current sensor, in which $f(-3\text{ dB}) = 0.35/t_r$. Both t_r and $t_{RESPONSE}$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

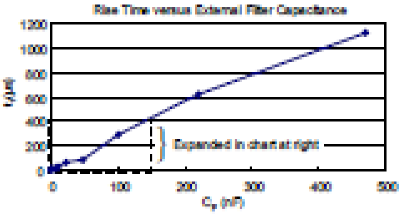




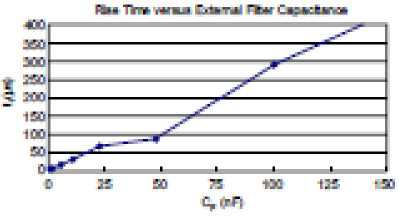
Noise vs. Filter Cap







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

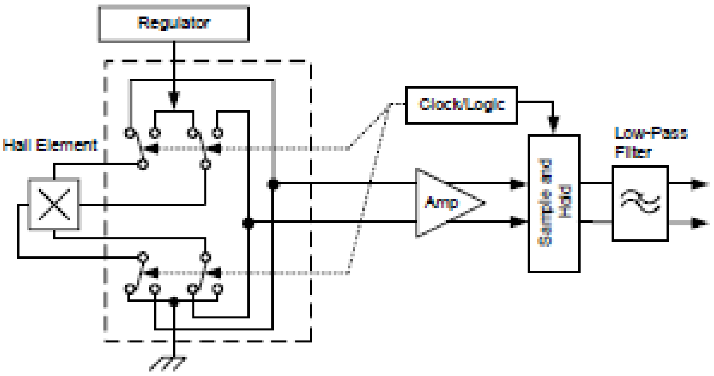


Chopper Stabilization Technique

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.

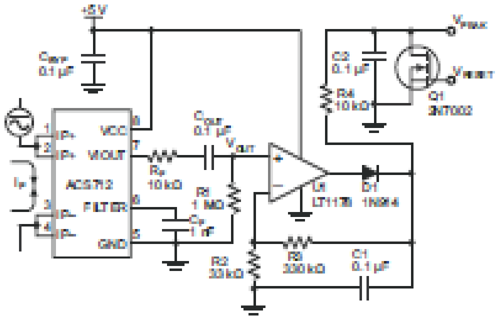
As a result of this chopper stabilization approach, the output voltage from the Hall IC is desensitized to the effects of temperature and mechanical stress. This technique produces devices that have an extremely stable Electrical Offset Voltage, are immune to thermal stress, and have precise recoverability 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.

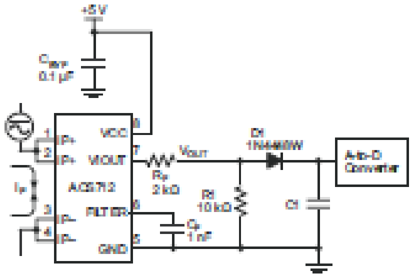


Concept of Chopper Stabilization Technique

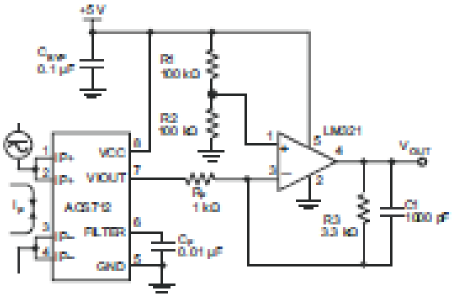
Typical Applications



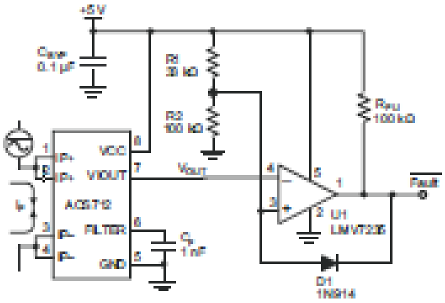
Application 2. Peak Detecting Circuit



Application 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 3. This configuration increases gain to 610 mV/A (tested using the ACS712ELC-05A).



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.

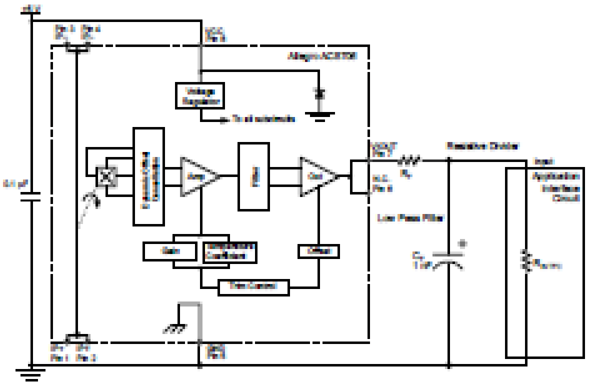
Signal attenuation, ΔV_{ATT}, is a result of the resistive divider effect between the resistance of the external filter, R_F (see Application 6), and the input impedance and resistance of the customer interface circuit, R_{INTFC}. The transfer function of this resistive divider is given by:

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

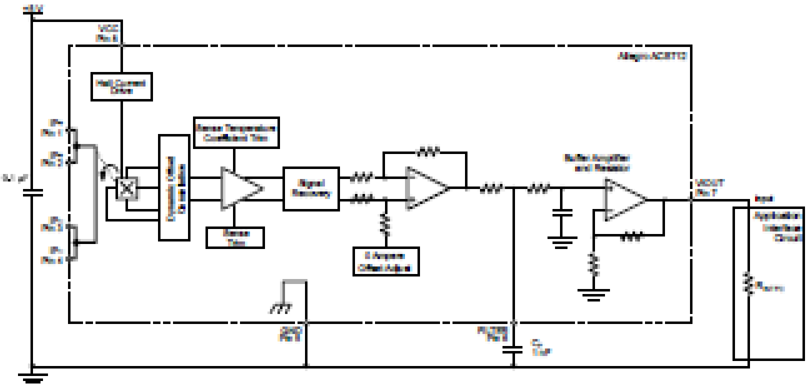
Even if R_F and R_{INTFC} are designed to match, the two individual resistance values will most likely drift by different amounts over temperature. Therefore, signal attenuation will vary as a function of temperature. Note that, in many cases, the input impedance, R_{INTFC}, of a typical analog-to-digital converter (ADC) can be as low as 10 kΩ.

The ACS712 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 ACS712 (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 ACS712 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.

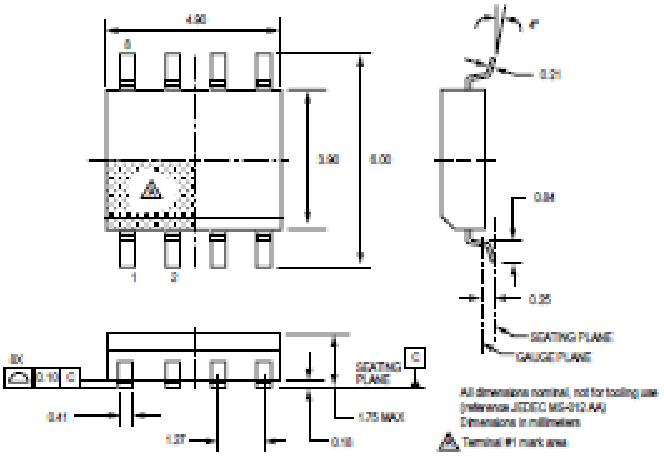
Application 6. When a low pass filter is constructed externally to a standard Hall effect device, a resistive divider may exist between the filter resistor, R_F, and the resistance of the customer interface circuit, R_{INTFC}. This resistive divider will cause excessive attenuation, as given by the transfer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



Application 7. Using the FILTER pin provided on the ACS712 eliminates the attenuation effects of the resistor divider between R_F and R_{INTFC}, shown in Application 6.



Package LC, 8-pin SOIC

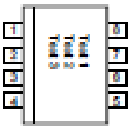


All dimensions nominal, not for tooling use
(reference JEDEC MS-012 AA)
Dimensions in millimeters

△ Terminal #1 mark area

Package Branding

Two alternative patterns are used



ACS712T RLCPPP YYWWA	ACS	Allegro Current Sensor
	712	Device family number
	T	Indicator of 100% matte tin leadframe plating
	R	Operating ambient temperature range code
	LC	Package type designator
	PPP	Primary sensed current
	YY	Date code: Calendar year (last two digits)
	WW	Date code: Calendar week
	A	Date code: Shift code

ACS712T RLCPPP L...L YYWW	ACS	Allegro Current Sensor
	712	Device family number
	T	Indicator of 100% matte tin leadframe plating
	R	Operating ambient temperature range code
	LC	Package type designator
	PPP	Primary sensed current
	L...L	Lot code
	YY	Date code: Calendar year (last two digits)
	WW	Date code: Calendar week

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.

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