ASEK37610

ACS37610 Evaluation Board User Guide

DESCRIPTION

This user guide documents the features, operation, and use of the ACS37610 current sensor with the ASEK37610 evaluation board. Allegro MicroSystems offers evaluation board units which offer a method for quickly evaluating the Allegro current sensor in a lab environment without needing a custom circuit board.

The evaluation board is used to evaluate the functionality of the ACS37610, an economical and precise solution for AC and DC current sensing in busbar and high-current PCB (printed circuit board) applications. Applied current through a busbar or PCB generates a magnetic field which is sensed by the Hall IC. The ACS37610 outputs an analog signal that varies linearly with the field sensed within the range specified. Differential sensing topology virtually eliminates error from common-mode stray magnetic fields. High isolation is achieved via the no-contact nature of this assembly.

This guide includes a schematic of the ASEK37610 EVB (evaluation board), reference documentation, measurement and operation techniques, printed circuit board (PCB) layouts, and a bill of materials (BOM). Table 1 below includes the test equipment document (TED) and description of each board for which this document is applicable.

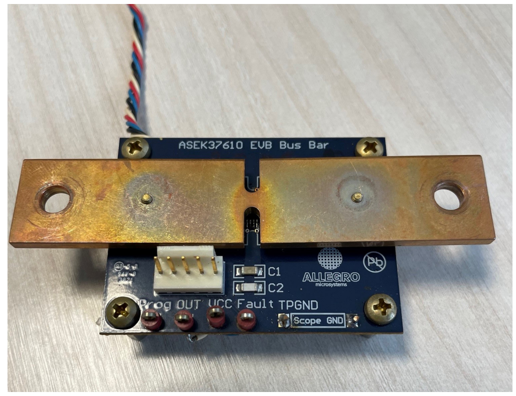

Figure 2: ASEK37610 Evaluation Board (board appearance will vary based on configuration)

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Table 1: ACS37610 Evaluation Board Configurations

Configuration Name	TED Number	Sensing Method	Key Benefits
ASEK37610, Board, EVB, 3.5 mm	TED-0003140	PCB Sensing	Reducing the width of the copper traces under the sensor (neckdown) increases the magnitude of the differential magnetic field measured by the ACS37610.
ASEK37610, Board, EVB, Q_RIFT_DC	TED-0003944	PCB Sensing	Good for high current PCB sensing (up to ≈300 to 400 A), high mechanical positioning tolerance.
ASEK37610, EVB, Busbar	TED-0003139	Busbar Current Sensing	Good for high current applications.
ASEK37610, ASEK-20 Daughterboard	TED-0003110	n/a	Daughterboard board used to communicate with ACS37610 sensor on ASEK37610 EVB.

FEATURES

The evaluation boards listed in Table 1 can be used for the evaluation of all gain options of the ACS37610, allowing for streamlined and fast evaluations of the device. The ASEK37610 evaluation boards feature test points for ease of access to the device pins. Several ASEK37610 evaluation boards are multilayer, allowing improved thermal performance, better power distribution, and higher signal integrity.

EVALUATION BOARD CONTENTS

ASEK37610, Board, EVB, 3.5 mm

The ASEK37610 evaluation board consists of eight layers; the top and bottom layers can be seen in the "Board Layouts" section below. The ASEK37610 PCB includes:

1. Footprint for 8-Pin TSSOP (DUT1)
2. Banana jacks (I_IN and I_OUT) for applied current
3. Header for wiring harness
4. Test points for fast connections

ASEK37610, Board, EVB, Q_RIFT_DC

The ASEK37610 evaluation board consists of six layers; the top and bottom layers can be seen in the "Board Layouts" section below. The ASEK37610 PCB includes:

1. Footprint for 8-Pin TSSOP (DUT1)
2. Banana jacks (I_IN and I_OUT) for applied current
3. Header for wiring harness
4. Test points for fast connection

ASEK37610, EVB, Busbar

The ASEK37610 EVB busbar evaluation board consists of two layers; the top and bottom layers can be seen in the "Board Layouts" section below. The ASEK37610 PCB includes:

1. Footprint for 8-Pin TSSOP
2. Holes for mounting the busbars
3. Header for wiring harness
4. Test points for fast connections
5. Test points ground for scope clips

An exploded view of the complete ASEK37610, EVB, Busbar evaluation board is shown in Figure 1. See the Bill of Materials section below for a detailed explanation of the components. The ASEK37610, EVB, Busbar includes:

1. Current busbar
2. Busbar standoffs
3. Current connection screws
4. Washer
5. Nut
6. Busbar mounting screws
7. Standoff mounting screw
8. PCB standoff

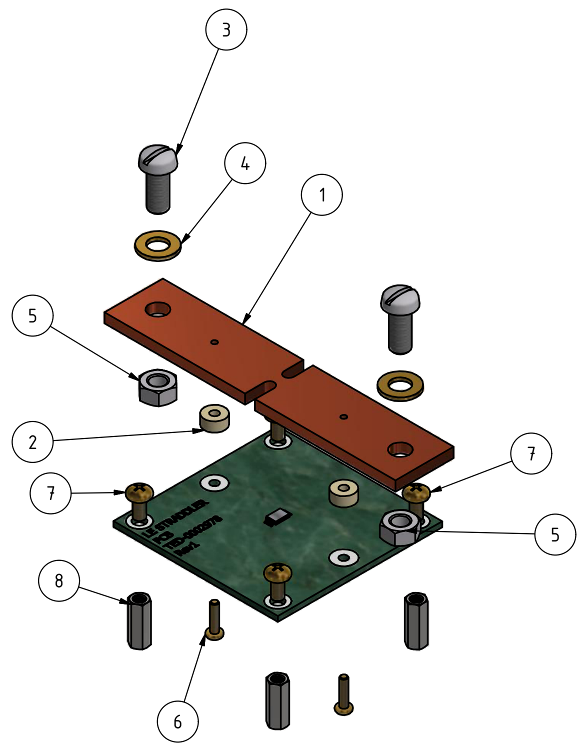

Figure 1: Exploded view of the ASEK37610, EVB, Busbar evaluation board

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USING THE EVALUATION BOARDS

Evaluation Board Connections

Note: Board appearance will be different based on the board configuration used. Concepts still apply. The supply voltage V_{CC} may be applied across the VCC and GND test points. The ACS37610 analog output V_{OUT} may be observed by attaching an oscilloscope probe or DMM to the OUT test point. The FAULT output may be observed by attaching an oscilloscope probe or DMM to the FAULT test point. These connections are shown on the ASEK37610 Busbar evaluation board for reference in Figure 3 below.

Figure 3: ASEK37610 Test Point Connections

High current may be applied directly to the busbar using the current connection screws. The high current connections are shown on the ASEK37610 evaluation board for reference below in Figure 4. If not using a busbar and using a PCB sensing ASEK37610 evaluation board, current connections will be applied to banana jacks (I_IN and I_OUT) on the PCB.

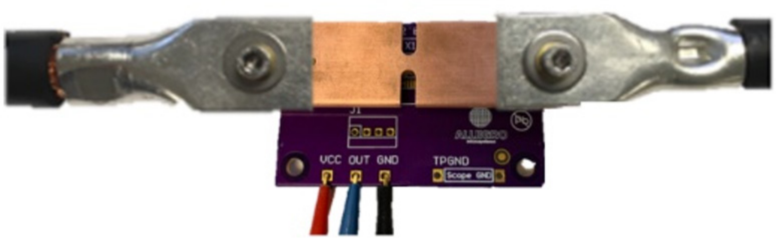

Figure 4: Primary Current Connections

Common Measurements

The ASEK37610 evaluation board is useful when measuring device characteristics such as quiescent output voltage, $V_{OUT(Q)}$, and sensitivity, sens.

To measure the ACS37610 quiescent output voltage, ensure the device is powered using the correct supply voltage, typically 3.3 V or 5 V. Using an oscilloscope, to view the output waveform, or a multimeter, to view the output voltage level, verify the VOUT pin on the evaluation board is $V_{CC}/2$ (for bidirectional devices) and $V_{CC}/10$ (for unidirectional devices). For example, in the case of a bidirectional output device with nominal V_{CC} = 5 V, $V_{OUT(Q)}$ = 2.5 V.

To measure device sensitivity, first ensure the evaluation board is powered using the VCC and GND test points. After confirming the device is powered, measure the device's quiescent output voltage. Apply a known current (I_P) to the device and measure the device output. Use the following equation below to calculate device sensitivity:

$$\text{sens}\left[\frac{\text{mV}}{A}\right]=\frac{V_{\text{OUT}}\,[\text{V}]-V_{\text{OUT (Q)}}\,[\text{V}]}{\text{IP [A]}}\times 1000$$

Equation 1: Measured Sensitivity Calculation for ACS37610

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Calculating Full-Scale Current Range using CF and IC Sensitivity

The ACS37610 is currently offered in several different gain selects: 5 mV/G, 10 mV/G, and 20 mV/G. The full-scale current sensing range of the device depends on the sensitivity of the sensor and the design of the reference busbar or PCB. To calculate the maximum current sensing range, coupling factor and IC sensitivity must be known. The example below demonstrates how to calculate the maximum current sensing using a coupling factor of 0.21 G/A and a device sensitivity of 10 mV/G. The desired output voltage swing is 2000 mV.

$$2000\ \text{mV} \times \frac{\text{G}}{10\ \text{mV}} \times \frac{\text{A}}{0.21\ \text{G}} = 952\ \text{A}$$

Equation 2: Full-Scale Current Calculation for ACS37610

For the above example, the maximum current sensing range would be 952 A.

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Using the ASEK-20 with the ACS37610 Daughterboard and ACS37610 Samples Programmer

Introduction

This section of the ASEK37610 user guide documents the use of the ACS37610 daughterboard and the ASEK-20 (Part #85-0540-004) with the Allegro ACS37610 samples programmer. The ASEK-20 chassis can be seen in Figure 1, and the top and bottom layers of the ASEK-20 ACS37610 daughterboard can be seen in Figure 2. The schematic for the ASEK37610 can be found in the appendix section below.

Figure 5: ASEK-20 Chassis

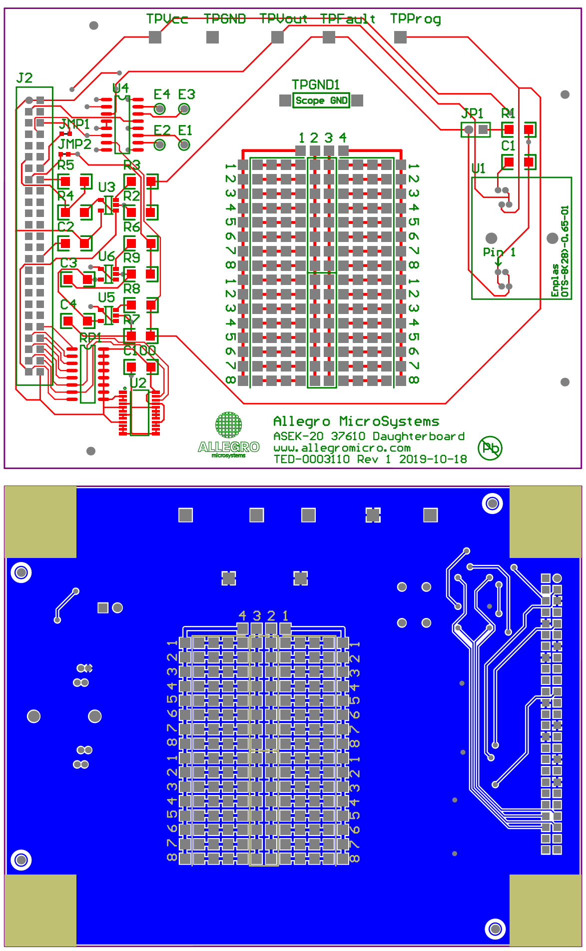

Figure 6: Top and Bottom Layers for ASEK-20 ACS37610 Daughterboard

Downloading the Programmer

1. Register for software on the Allegro Software Portal.
2. Ensure that the ASEK-20 being used has the most recent firmware downloaded. Refer to the ASEK-20 firmware webpage and the ASEK-20 quick guide under "Support Files" on the ASEK-20 firmware webpage.
3. After registering and logging in to the software portal, the user will be greeted with the dashboard page. Choose the "Find a Part" button highlighted in Figure 7.
4. Clicking "Find a Part" will bring the user to the "Available Parts & Software" page.
5. Search for "ACS37610" in the "Select by Part Number" search bar shown in Figure 8.
6. Searching for "ACS37610" will result in one search result. Click "View" next to the result as shown highlighted in Figure 9.
7. Click "Download" next to the ACS37610 Samples Programmer to open the Programming Application ZIP file as highlighted in red in Figure 10.
8. Open and extract the downloaded ZIP file and save to a known location.
9. Open the extracted ZIP file and open the folder "Allegro ACS37610 Samples Programmer V#".
10. Open the "Allegro ACS37610 Samples Programmer" application file (.exe file extension) to open the samples programmer.

Note that located on the ACS37610 software portal is the Allegro ACS37610 Busbar Calculator and the ACS37610 PCB Design Tool, helpful tools related to busbar geometry and design and PCB design.

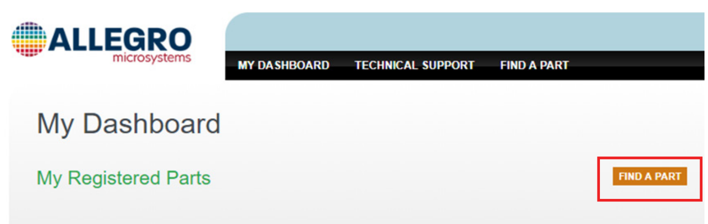

Figure 7: "Find a Part" button allowing the user to register specific devices

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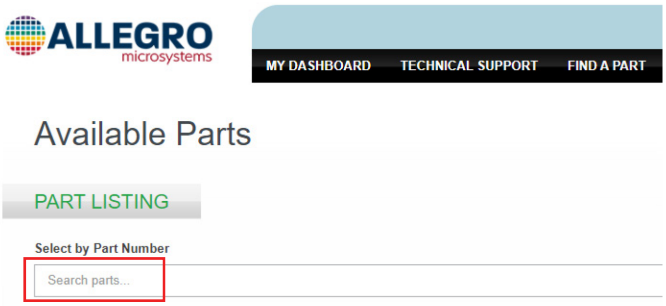

Figure 8: "Select by Part Number" on the Available Parts & Software page

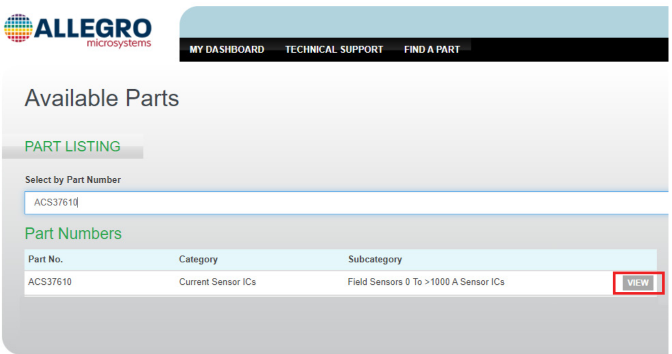

Figure 9: Select "View" next to "ACS37610" search result

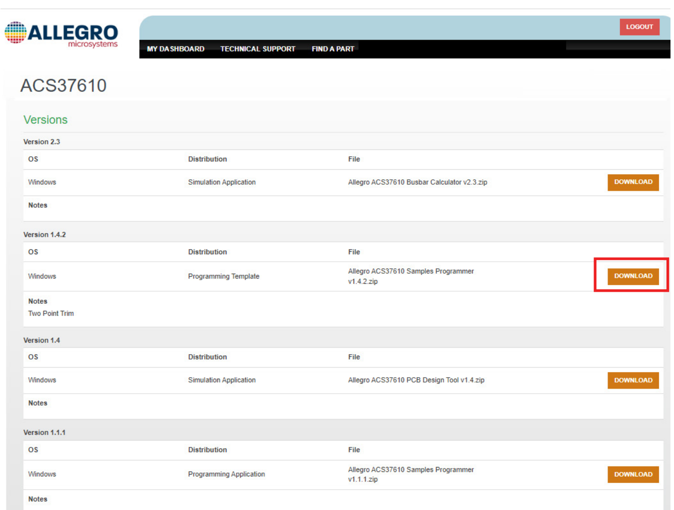

Figure 10: Select "Download" to open the Programming Application

Connecting the ASEK-20 to the PC and to the ACS37610 Daughterboard

1. Connect one end of the USB communications cable to the USB port of a personal computer.
2. Connect the other end of the USB communications cable to the "USB" port located on the front of the ASEK-20 chassis.
3. Connect a ribbon cable to the "J2" connector on the left-hand side of the ACS37610 daughterboard.
4. Connect the other end of the ribbon cable to the "Device Connection" port on the front of the ASEK-20 chassis as shown in Figure 11.

Figure 11: Connection between ASEK-20 and ACS37610 Daughterboard

5. Connect the DC Power Supply/Cable to the "5V" port on the ASEK-20 chassis.
6. Plug in the DC Power Supply to a 110/220AC 60/50 Hz outlet with the appropriate power adapter.

Inserting the ACS37610 into the ACS37610 Daughterboard

If using an ASEK37610 evaluation board with an ACS37610 populated, proceed to the Connecting the ASEK37610 Evaluation Board to the ASEK-20 ACS37610 Daughterboard section below. If using a standalone ACS37610 IC, see paragraph below.

The ACS37610 current sensor is provided in a small, low-profile, 8-pin surface mount TSSOP package, making the ACS37610 an ideal sensor for space constrained applications, while still allowing simple assembly. The package is shown in Figure 12 below. For more information, refer to the ACS37610 device datasheet.

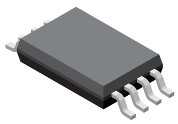

Figure 12: 8-Pin TSSOP package (suffix LU)

To insert the ACS37610 into the ACS37610 daughterboard, do the following:

1. Place the ACS37610 in the socket labeled "J1".
2. Secure the part in place.

Proceed to the Using the Programmer section below.

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Connecting the ASEK37610 Evaluation Board to the ASEK-20 ACS37610 Daughterboard

To connect the ASEK37610 evaluation board to the ACS37610 daughterboard, do the following:

1. Connect the VCC pin on the ASEK37610 evaluation board to the TPVCC pin on the ACS37610 daughterboard.
2. Connect the OUT pin on the ASEK37610 evaluation board to the TPGND pin on the ACS37610 daughterboard.
3. Connect the GND pin on the ASEK3761 evaluation board to the TPGND pin on the ACS37610 daughterboard.
4. See Figure 13 and Figure 14 below showing the connection setup between the VCC, OUT, and GND pins of the ASEK-20 ACS37610 daughterboard and the ASEK37610 evaluation board.

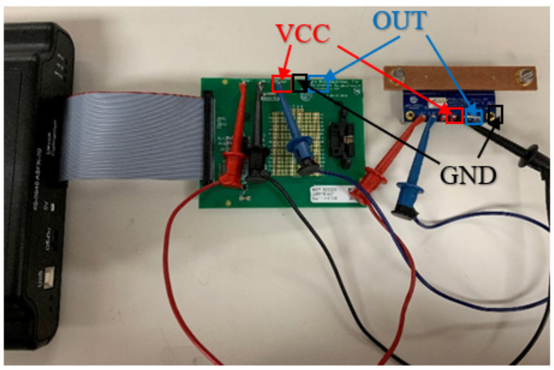

Figure 13: Connection between ACS37610 evaluation board and ASEK20 ACS37610 daughterboard

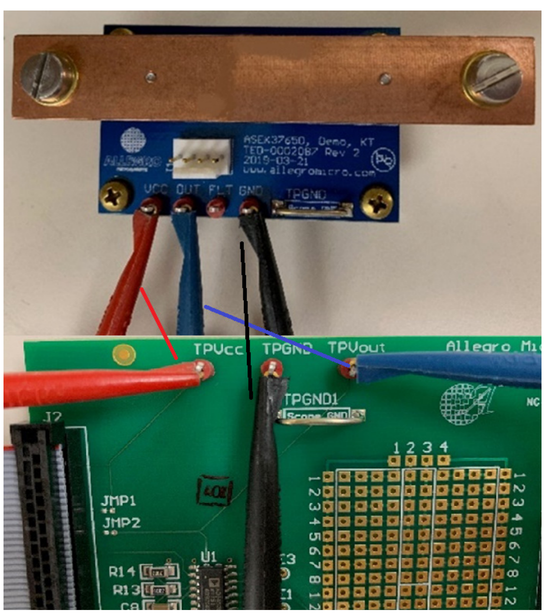

Figure 14: Closeup of VCC, OUT, and GND pin connections on the ACS37610 busbar evaluation board (top) to the ACS37610 daughterboard (bottom)

Note that the setup and connection for the ASEK37610 busbar EVB and the PCB sensing options are identical.

Using the Programmer

CONNECTING TO THE ASEK-20

Opening the programmer will result in a window identical to Figure 15.

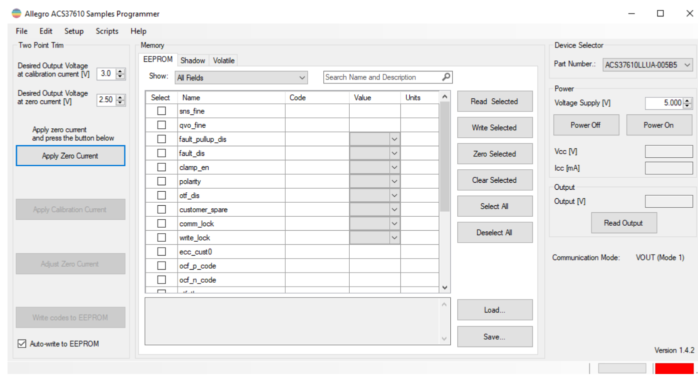

Figure 15: ACS37610 Programmer Application

To connect the ASEK-20, click "Setup", then "Communication Setup". The dialog box in Figure 16 will appear. Click the correct COM# in the pull-down menu next to COM Port. If the COM port is unknown, do the following:

1. Unplug the USB cable to the ASEK-20.
2. Click "Refresh" in the "Communication Setup" dialog window as highlighted in blue in Figure 16.
3. Click on the "COM Port" pull down menu.
4. Note which ports are in the menu.
5. Plug the USB cable back into the ASEK-20.
6. Click "Refresh".
7. Click the "COM Port" popup menu again.
8. Note the COM port not previously listed in the menu; this is the port connected to the ASEK-20.
9. Select this COM port to use.

Once the correct COM port is selected and the ASEK-20 is connected to the PC, verify next to "Communication" the status of the ASEK-20.

If the status is "Active", the ASEK-20 is powered and responding. If the status is "Inactive", the ASEK-20 is not responding or is not powered on. If this is the case, click "Refresh" and ensure the ASEK-20 chassis is plugged into the PC and the chassis is powered on.

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Click “OK” to exit the dialog box.

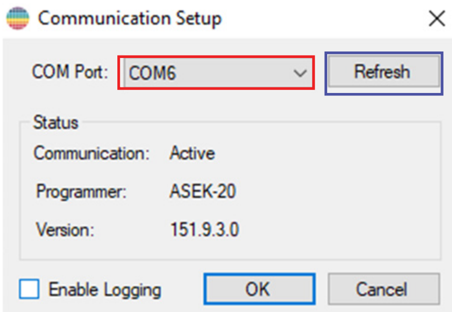

Figure 16: Communication Setup dialog box

Status Bar

The green or red colored rectangle on the bottom right of the programmer window, highlighted in red in Figure 17 below, indicates the status of the communication with the ASEK. If the status bar is red, the communication is not active and if green, the application is communicating with the ASEK. The COM port that is currently set is overlaid on the colored rectangle. Clicking on the rectangle will open the Communication setup dialog window.

Figure 17: Status bar on the bottom right side of GUI

Turning the Part ON and OFF

To power on the part using the ASEK-20, click “Power On” on the right-hand side of the programmer as show in red in Figure 18.

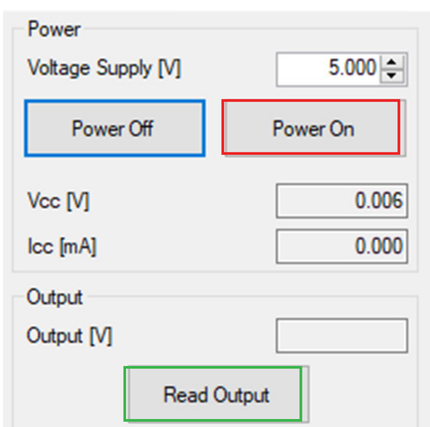

Figure 18: "Power On", “Power Off”, and “Read Output”

Once the part is powered on, values for “VCC [V]” and “ICC [mA]” will populate with the measured values. Verify that the voltage is what is desired and that the device is consuming approximately 10 to 17 mA.

To read the output of the ACS37610, select “Read Output” highlighted in green in Figure 18 above. Verify the Output [V] is a reasonable number, around 2.5 V with zero external field applied if testing a bidirectional part with 5 V typical V_{CC}.

To turn the part off, select “Power Off” to the left of “Power On”, highlighted in blue in Figure 18 above. Clicking “Power Off” will cause I_{CC} to fall to approximately 0 mA.

Read and Writing to the Part

Note before reading and writing to the part, the part must be connected and powered on using the programmer GUI.

It is strongly recommended that the user save the memory to a tabular file before experimenting with programming, allowing the user to return the device to its original factory programmed state, if necessary. See the Saving and Loading Memory Files section below.

To read a field, select the desired field by checking the box under “Select” to the left of the register name and click the “Read Selected” button highlighted in red in Figure 17.

To write to a field, select the desired field by checking the box under “Select” to the left of the name. Change the value under “Code” to the desired value and press Enter. Click “Write Selected” button highlighted in blue in Figure 17.

To verify that field was written to the device, do the following: click “Clear Selected” causing the values in the “Code” and “Value” cells to disappear. Then click “Read Selected”. The values that were written will reappear in the “Code” and “Value” cells verifying the user correctly wrote to the part.

Referencing DLLs

If using Visual Studio to build the application, the first step is to add references to the DLLs. All of the DLLs will require a reference to ASEKBase.dll. Right click on the project icon in the Solution Explorer; select “Add Reference…” from the menu. In the Add reference dialog, use the Browse tab to navigate to the ASEKBase.dll and selected it then click on the OK button. Perform the same actions to add ASEK20.dll and ASEK20_ACS37610.dll.

For additional information, reference the CHM help file which is provided with the samples programmer.

DEVICE PROGRAMMING

- The serial interface uses Manchester protocol to communicate.
- Device programming can be achieved with bidirectional communication on VOUT or on the dedicated PROG pin.
- The device has an internal charge pump to generate the EEPROM pulses.
- The PROG pin can be left unconnected or tied to GND or VCC when not used.

Serial Communication

The serial interface allows an external controller to read and write registers, including EEPROM, in the device using a point-to-point command/acknowledge protocol. The device does not initiate communication; it only responds to commands from the external controller. Each transaction consists of a command from the controller. If the command is a write, there is no acknowledging from the device. If the command is a read, the device responds by transmitting the requested data. Two modes are available for device communication.

Mode 1, Programming on VOUT pin (see Figure 19)

Voltage is raised on V_{CC} (V_{OVDE}) for at least t_{OVDE} followed by access code on VOUT to enable bidirectional programming on VOUT. If COM_LOCK bit is set (=1), bidirectional programming on VOUT is disabled. If COM_LOCK bit is not set (=0), there is no timeout limit to send the access code as long as V_{CC} stays above V_{OVDE} for at least t_{OVDE}. The start of any Manchester command should begin with holding the output low for t_{BIT} to ensure reset of Manchester state machine. If an incorrect access code is sent, VOUT remains in the normal analog mode (responds to magnetic stimulus) and the device remains locked for communication on VOUT until a power reset occurs.

When writing into non-volatile memory (EEPROM), V_{CC} must not exceed 5 V to ensure safe EEPROM writing. To achieve this, two methods can be used:

<u>Method 1 (to write EEPROM in Mode 1):</u>

Locking VOUT into communication mode such that VCC can returned to normal supply voltage (5 V / 3.3 V):

1. Set V_{CC} to V_{OVDE} (OVD).
2. Send Access code + COMM_EN.
3. Set V_{CC} back to normal level (5 V / 3.3 V).
4. Send EEPROM write commands.
5. Power-cycle the device to re-enable Analog output on VOUT.

<u>Method 2 (to write EEPROM in Mode 1)</u>

Reducing V_{CC} back to normal supply voltage (5 V / 3.3 V) after sending the EEPROM write sequence:

1. Set V_{CC} to V_{OVDE} (OVD).
2. Send Access code.
3. Send EEPROM write commands.
4. Set V_{CC} to normal level (5 V / 3.3 V).
5. Wait 20 ms for EEPROM write.

With method 2, PROG pin must not be connected to GND (can be left floating or connect to VCC).

See access code section and Manchester protocol figures for more details. When not used, it is recommended to tie PROG pin to VCC (for Broken GND feature).

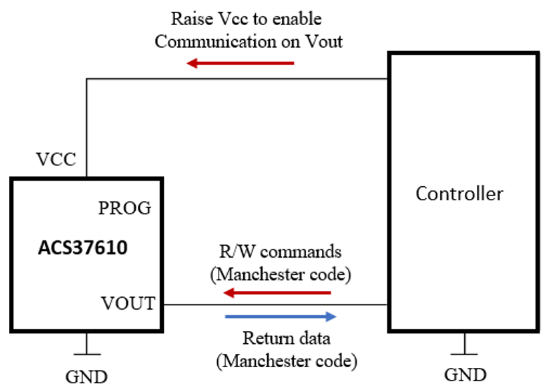

Figure 19: Programming Connection – Mode 1

Mode 2, Programming on PROG pin (see Figure 20)

V_{CC} remains 5 V (below V_{OVDE}), and bidirectional programming is achieved on PROG pin by sending an Access code (independently of COM_LOCK value). No pull-up is required on PROG pin.

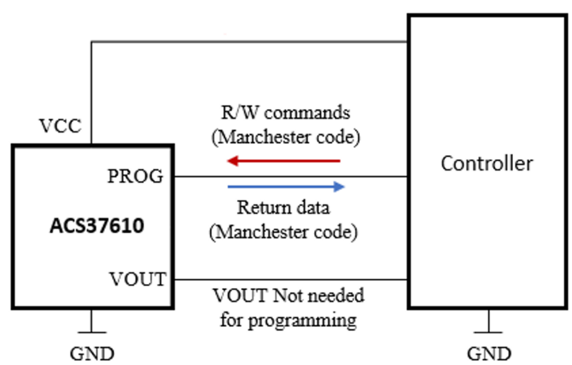

Figure 20: Programming Connections – Mode 2

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Programming Guidelines

INITIATING COMMUNICATIONS

The controller must open the serial communication with the device by sending an access code. The access code can be sent at any time on the PROG pin to enable communication via the PROG pin. For VOUT communication, an OVD event must be sent followed by the access code on VOUT. An OVD event must be maintained during the first full transaction.

Register Address	Address (Hex)	Data (Hex)
Customer Access	0x31	0x2C413736
Customer Access + Com_Enable	0x31	0x2C413737

There are two built-in memory locking functions that can be implemented in conjunction with the access code:

1. The EEPROM COMM_LOCK bit can be set to make the ACS37610 only use the PROG pin for serial communication. When COMM_LOCK is set to 1 the OVLO condition will be ignored, and the PROG pin will always be selected.
2. Lock bit after EEPROM has been programmed by the user. The WRITE_LOCK bit can be set to 1 and VCC power-cycles to permanently disable the ability to write to any EEPROM register. Volatile register can still be written to.

Communications Protocol

The serial interface uses a Manchester-encoding-based protocol per G.E. Thomas (0 = rising edge, 1 = falling edge), with address and data transmitted MSB first. Four commands are recognized by the device: Write Access Code, Write to Volatile Memory, Write to Non-Volatile Memory (EEPROM) and Read. One frame type, Read Acknowledge, is sent by the device in response to a Read command.

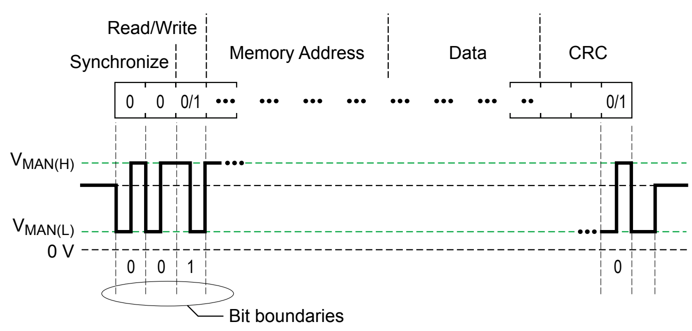

Figure 21: General Format for Serial Interface Commands

Read (Controller to Device)

The fields for the Read command are:

- Sync (2 zero bits)
- Read/Write (1 bit)
- Address (6 bit)
- CRC (3 bits)

Figure 22 shows the sequence for a Read command.

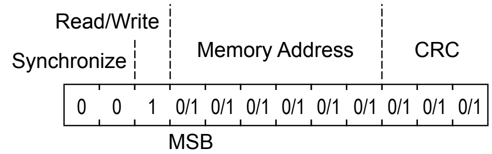

Figure 22: Read Sequence

Read Acknowledge (Device to Controller)

The fields for the data return frame are:

- Sync (2 zero bits)
- Data (32 bits):
  - □ [31:28] Don't Care
  - □ [27:26] ECC Pass/Fail
  - □ [25:0] Data
- CRC (3 bits)

Figure 23 shows the sequence for a Read Acknowledge. Refer to the Detecting ECC Error section for instructions on how to detect Read/ Write Synchronize Memory Address Data (32 bits) and ECC failure.

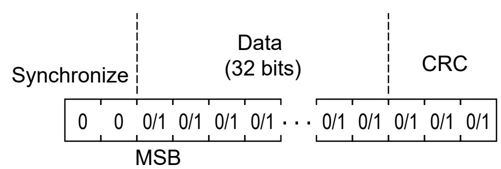

Figure 23: Read Acknowledge Sequence

Write (Controller to Device)

The fields for the Write command are:

- Sync (2 zero bits)
- Read/Write (1 bit, must be 0 for write)
- Address (6 bits)
- Data (32 bits):
  - □ [31:26] Don't Care
  - □ [25:0] Data
- CRC (3 bits)

Figure 24 shows the sequence for a Write command. Bits [31:26] are Don't Care because the device automatically generates 6 ECC bits based on the content of bits [25:0]. These ECC bits will be stored in EEPROM at locations [31:26].

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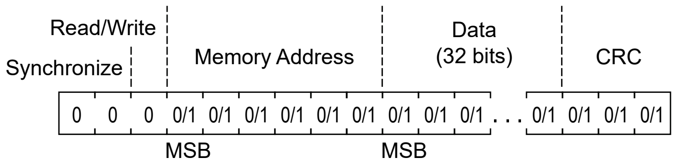

Figure 24: Write Sequence

Write Access Code (Controller to Device)

The fields for the Access Code command are:

- Sync (2 zero bits)
- Read/Write (1 bit, must be 0 for write)
- Address (6 bits)
- Data (32 bits)
- CRC (3 bits)

shows the sequence for an Access Code command.

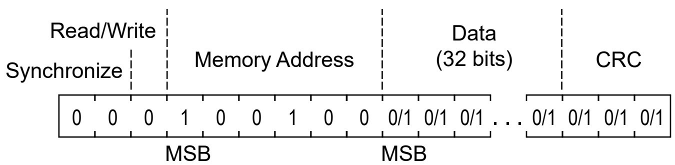

Figure 25: Write Access Code

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ACS37610 Calibration

V_{REF}, offset voltage (QVO), and sensitivity of the ACS37610 are factory-trimmed. It is recommended that an end-of-line calibration be performed for optimal system accuracy.

The recommended order of system trims during calibration is sensitivity followed by QVO. It is expected that the factory-trimmed value for V_{REF} is sufficient so an end-of-line V_{REF} trim should not be required. There are coarse and fine trims for each parameter; however, only the fine trims should need to be adjusted during calibration. The fine trims for QVO and sensitivity are each controlled by a 9-bit two's complement trim code: VOFF_FINE and SENS_FINE, respectively. The step size of a 1 LSB adjustment for each of these trims is shown in Table 2. To allow margin for temperature and supply variation, it is recommended that codes used are restricted to 0-223 and 288-511. The transfer function for each of the trimmable parameters is shown below (see Figure 26 and Figure 27).

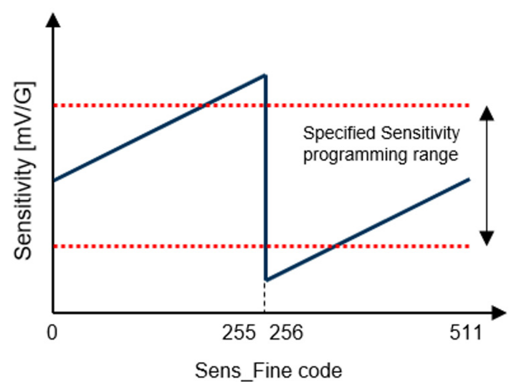

Figure 26: Sensitivity Trim Range

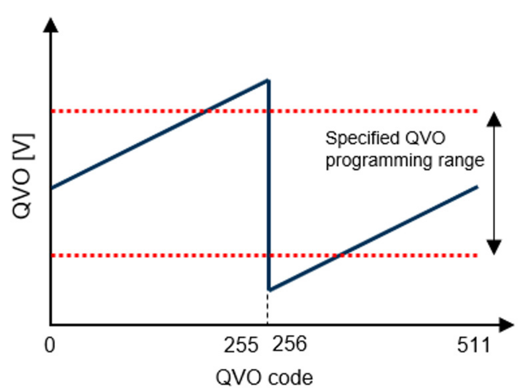

Figure 27: QVO Trim Range

SENSITIVITY TRIM

Prior to beginning the trims, measure V_{OUT} with zero field applied. Retain this value as V_{QVO}. Once that measurement is made, sensitivity should be trimmed first. It is recommended to trim sensitivity prior to offset because the sensitivity trim may impact the offset. Use the following procedure to trim sensitivity:

1. Read the contents of the SENS_FINE register and apply maximum magnetic field to the device. The maximum magnetic field is determined by the maximum magnetic field that is expected to be seen by the device in the end application Alternatively, a scaled-down magnetic field can be applied during end-of-line testing and the result can be scaled appropriately.

2. Measure V_{OUT}. This will be V_{MAX}.

3. Compare $V_{MAX} – V_{QVO}$ to the target full-scale output voltage swing for maximum magnetic field, V_{FS}. $V_{\Delta SENS} = V_{FS} – (V_{MAX} – V_{QVO})$.

4. Adjust SENS_FINE to trim sensitivity:
   SENS_FINE = SENS_FINE + $V_{\Delta SENS}/SENS_{STEP}$ where $SENS_{STEP}$ is the sensitivity trim step size.

5. Repeat steps 2-4 until $V_{\Delta SENS} < 0.5 \times SENS_{STEP}$.

OFFSET VOLTAGE (QVO) TRIM

Assuming the desired value of V_{OUT} when no magnetic field is applied is to be equal to V_{REF}, use the following procedure to trim QVO:

1. Read the contents of the QVO_Fine register.

2. Measure V_{OUT} with no magnetic field applied.

3. Adjust QVO_Fine to set QVO to desired voltage (2.5 V for bidirectional, 0.5 V for unidirection).

ADDED MEMORY LOCK PROTECTION

Once calibration is complete, it is strongly recommended that ANALOG_LOCK (register bit 0x0F[24]) and UNLOCK_CODE (register bit 0x0F[25]) be set to 1 to lock the memory and ensure against accidental programming in the field.

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MEMORY MAP

Register Name	Address	Parameter Name	Description	Access	Size	MSB	LSB
EEPROM: (EE_CUST0) Shadow register [1]: (SH_CUST0)	EEPROM: (0x09) Shadow register [1]: (0x19)	WRITE_LOCK	Lock the device	R/W	1	25	25
		COM_LOCK	Disables communication on VOUT / disables OVD	R/W	1	24	24
		SPARE	n/a	R/W	1	23	23
		OTF_DIS	Disable overtemperature fault	R/W	1	22	22
		POL	Change output polarity	R/W	1	21	21
		CLAMP_EN	Enable output clamps	R/W	1	20	20
		FAULT_DIS	Disable fault	R/W	1	19	19
		FAULTPUP_DIS	Disconnect fault internal pull-up resistor	R/W	1	18	18
		QVO	Offset adjustment	R/W	9	17	9
		SNS_FINE	Sensitivity fine adjustment	R/W	9	8	0
EEPROM: (EE_CUST1) Shadow register [1]: (SH_CUST1)	EEPROM: (0x0A) Shadow register [1]: (0x1a)	OCF_HYST	Overcurrent fault hysteresis	R/W	2	25	24
		FAULT_LATCH	Enable fault latch	R/W	1	23	23
		OCF_P_DIS	Disable positive overcurrent fault	R/W	1	22	22
		OCF_N_DIS	Disable negative overcurrent fault	R/W	1	21	21
		OCF_QUALIFIER	Overcurrent fault qualifier / short pulse filter	R/W	3	20	18
		OTF_THRESH	Overtemperature fault threshold	R/W	4	17	14
		OCF_N_THRES	Negative overcurrent fault threshold	R/W	7	13	7
		OCF_P_THRES	Positive overcurrent fault threshold	R/W	7	6	0
EEPROM: (EE_CUST2)	EEPROM: (0x0B)	C_SPARE	Customer scratchpad No effect on device functionality	R/W	26	25	0
Volatile register: (FAULT_STATUS)	Volatile register: (0x20)	TEMP_OUT	Temperature output	R	12	27	16
		UV_STAT	Undervoltage status	R	1	12	12
		OV_STAT	Overvoltage status	R	1	11	11
		OC_STAT	Overcurrent status	R	1	10	10
		OT_STAT	Overtemperature status	R	1	9	9
		FP_STAT	FAULT pin status	R	1	8	8
		UV_EV	Undervoltage event	R	1	4	4
		OV_EV	Overvoltage event	R	1	3	3
		OC_EV	Overcurrent event	R	1	2	2
		OT_EV	Overtemperature event	R	1	1	1
		FP_EV	FAULT pin event	R	1	0	0

[1] Shadow registers are volatile memory, upon startup device loads EEPROM memory into shadow registers. Shadow registers can be used to test different programming options without erasing EEPROM (e.g., finding sensitivity and QVO codes before writing into EEPROM).

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EVALUATION BOARD PERFORMANCE DATA

Self-heating due to the flow of current should be considered during the design of any current sensing system. The sensor, the printed circuit board (PCB), and contacts to the PCB will generate heat as current moves through the system. The thermal response is highly dependent on PCB layout, copper thickness, cooling techniques, and the profile of the injected current.

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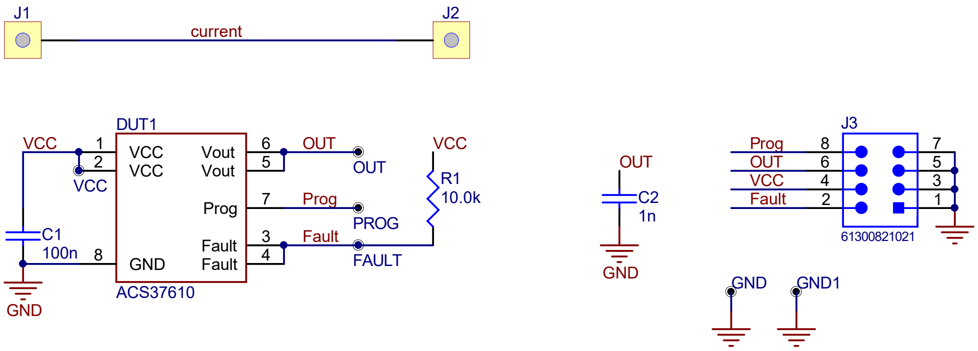
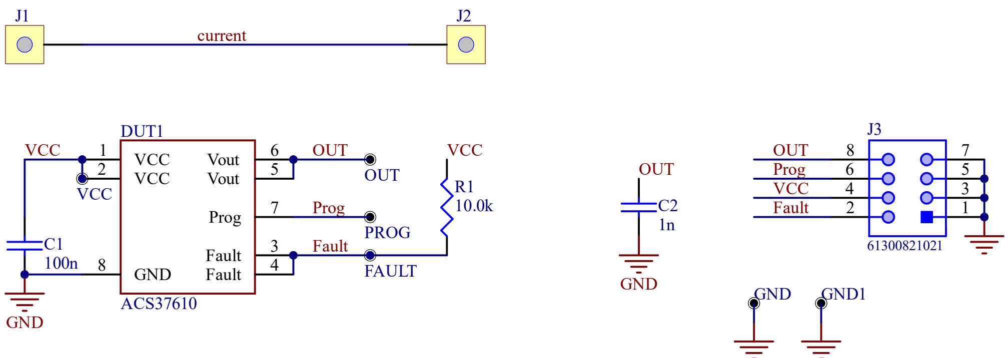
BOARD SCHEMATICS

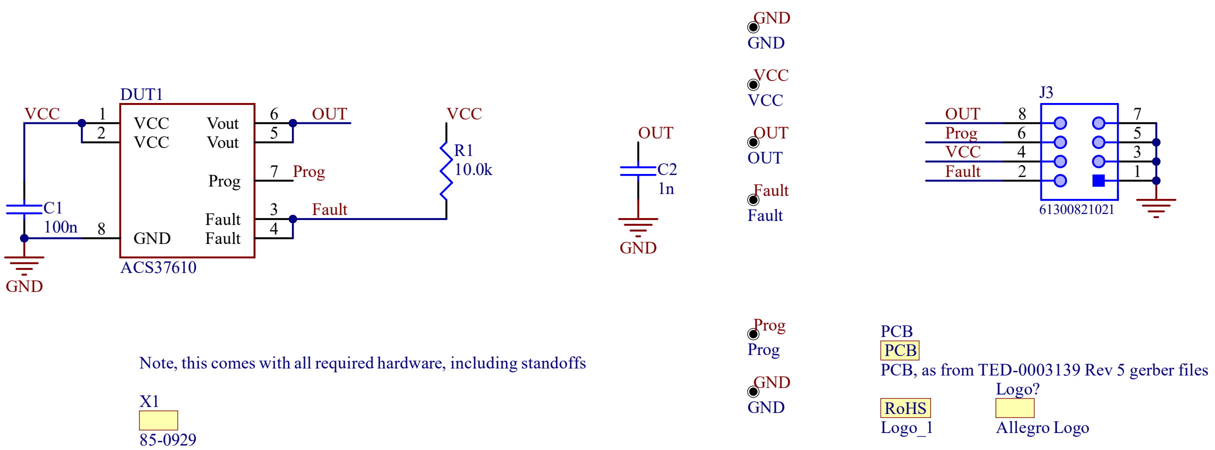
ASEK37610, Board, EVB, 3.5 mm



ASEK37610, Board, EVB, Q_RIFT_DC



ASEK37610, EVB, Busbar



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BOARD LAYOUTS

ASEK37610, Board, EVB, 3.5 mm

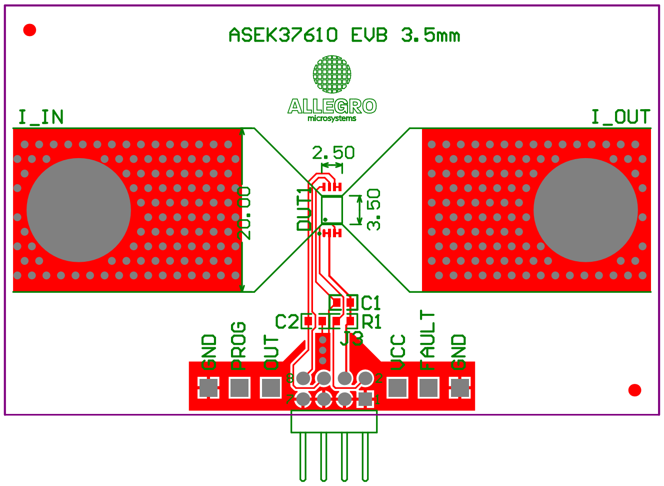

Figure 28: ASEK37610, Board, EVB, 3.5 mm Top Layout

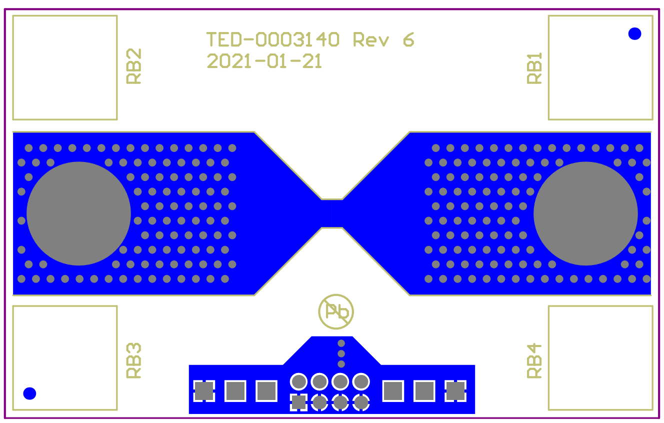

Figure 29: ASEK37610, Board, EVB, 3.5 mm Bottom Layout

ASEK37610, Board, EVB, Q_RIFT_DC

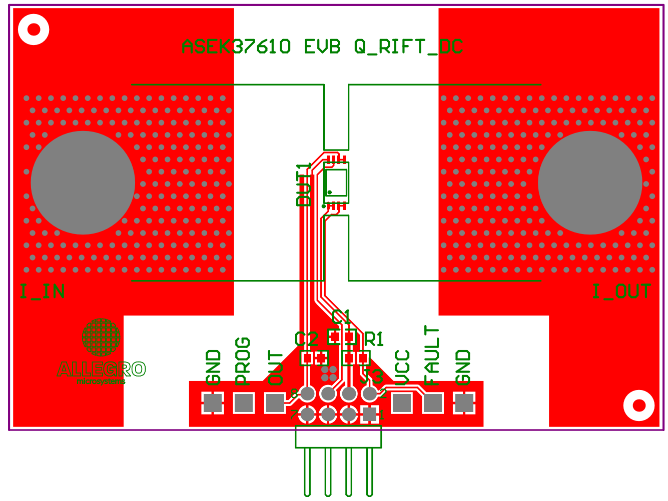

Figure 30: ASEK37610, Board, EVB, Q_RIFT_DC Top Layout

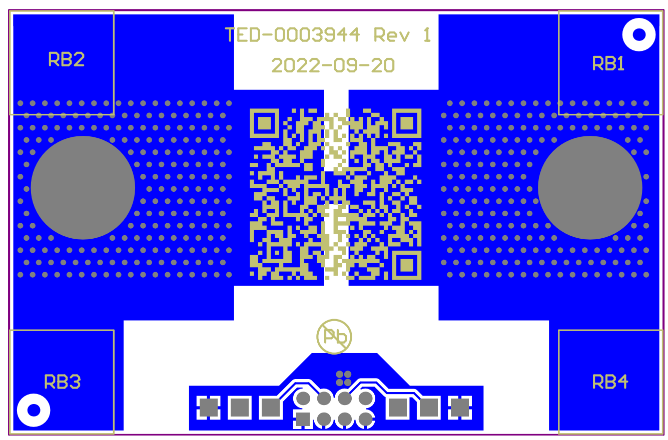

Figure 31: ASEK37610, Board, EVB, Q_RIFT_DC Bottom Layout

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ASEK37610, EVB, Busbar

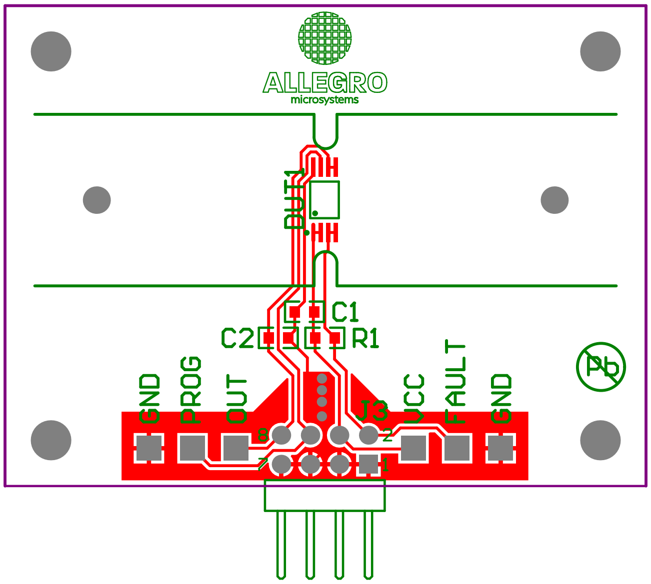

Figure 32: ASEK37610, EVB, Busbar Top Layout

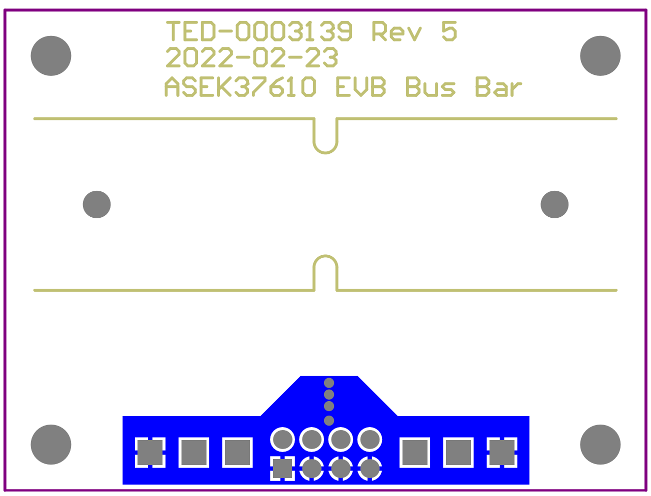

Figure 33: ASEK37610, EVB, Busbar Bottom Layout

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BILL OF MATERIALS (BOM)

Table 2: ASEK37610, Board, EVB, 3.5mm Board Bill of Materials

Designator/PCB Label	Quantity	Description	Manufacturer	Manufacturer Part Number
DUT1	1	IC, TSSOP-8, sensor	Allegro	ACS37610LLUA-10B5
C2	1	Capacitor, 0603, mono, C0G, 50 V, 1 nF	AVX	06035A102JAT2A
C1	1	Capacitor, 0603, mono, X7R, 50 V, 100 nF	AVX	06035C104K4T2A
R1	1	Resistor, 0603, 100 mW, thick film, 1%, 10.0 kΩ	Panasonic	ERJ-3EKF1002V
J1	1	Do not install		
J2	1	Do not install		
J3	1	Connector header through hole, right angle 8 position 0.100" (2.54mm)	Würth Elektronik	61300821021
GND1	1	Testpoint, thro, compact, for 62 mil PCB, red	Keystone	5005
FAULT, GND, OUT, PROG, VCC	5	Testpoint, thro, compact, for 62 mil PCB, red	Keystone	5005
RB1, RB2, RB3, RB4	4	Bumpon, rubber, 0.5 inch square, black	3M	SJ-5518 (black)
F1, F2	2	Nothing to install — fiducial mark for PCB		
PCB	1	PCB, as from TED-0003140 Rev 6 gerber files	Allegro	TED-0003140

Table 3: ASEK37610, Board, EVB, Q_RIFT_DC Board Bill of Materials

Designator/PCB Label	Quantity	Description	Manufacturer	Manufacturer Part Number
DUT1	1	IC, TSSOP-8, sensor	Allegro	ACS37610LLUA-20B5
C2	1	Capacitor, 0603, mono, C0G, 50 V, 1 nF	AVX	06035A102JAT2A
C1	1	Capacitor, 0603, mono, X7R, 50 V, 100 nF	AVX	06035C104K4T2A
R1	1	Resistor, 0603, 100 mW, thick film, 1%, 10.0 kΩ	Yageo	RC0603FR-0710KL
J1	1	Do not install		
J2	1	Do not install		
J3	1	Connector header through hole, right angle 8 position 0.100" (2.54mm)	Würth Elektronik	61300821021
FAULT, GND, GND1, OUT, PROG, VCC	6	Testpoint, thro, compact, for 62 mil PCB, red	Keystone	5005
RB1, RB2, RB3, RB4	4	Bumpon, rubber, 0.5inch square, black	3M	SJ-5518 (black)
F1, F2	2	Nothing to install — fiducial mark for PCB		
PCB	1	PCB, ASEK37610, Board, EVB, Q_RIFT_DC	Allegro	TED-0003944-R1-PCB

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Table 4: ASEK37610, EVB, Busbar Board Bill of Materials

Designator/PCB Label	Quantity	Description	Manufacturer	Manufacturer Part Number
DUT1	1	IC, TSSOP-8, sensor	Allegro	ACS37610LLUA-10B5
X1	1	LE Straddler Busbar Demo	Allegro	85-0929
C2	1	Capacitor, 0603, mono, C0G, 50 V, 1 nF	AVX	06035A102JAT2A
C1	1	Capacitor, 0603, mono, X7R, 50 V, 100 nF	AVX	06035C104K4T2A
R1	1	Resistor, 0603, 100 mW, thick film, 1%, 10.0 kΩ	Panasonic	ERJ-3EKF1002V
J3	1	Connector header through hole, right angle 8 position 0.100" (2.54mm)	Würth Elektronik	61300821021
FAULT, GND, OUT, PROG, VCC	6	Testpoint, thro, compact, for 62 mil PCB, red	Keystone	5005
PCB	1	PCB, as from TED-0003139 Rev 5 gerber files	Allegro	TED-0003139

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Related Documentation

The ACS37610 product datasheet is available for download on the Allegro website. In addition, several application notes and related information is available. This information is listed in the table below.

Table 5: Related Documentation and Application Notes

Documentation	Summary	Location
ACS37610 Product Datasheet	Product datasheet defining common electrical characteristics and performance characteristics.	ACS37610 Product Page
ACS37610 Purchasing	Purchasing homepage.	ACS37610 Product Page
ACS37610 Gerber Files	Schematic files containing demo board layers.	ACS37610 Product Page
ACS37610 Samples Programmer Software	Programming software for download.	https://registration.allegromicro.com/login
An Effective Method for Characterizing System Bandwidth in Complex Current Sensor Applications	Application note describing methods used by Allegro to measure and quantify system bandwidth.	https://www.allegromicro.com/-/media/files/application-notes/an296169-acs720-bandwidth-testing.pdf
High-Current Measurement with Allegro Current Sensor IC and Ferromagnetic Core: Impact of Eddy Currents	Application note focusing on the effects of alternating current on current measurement.	https://www.allegromicro.com/-/media/files/application-notes/an296162_a1367_current-sensor-eddy-current-core.pdf
ACS37610 Busbar Geometry and Design Techniques (AN296194)	Application note offering guidelines for selecting the optimum combination of ACS37610 and busbar geometry for a given current sensor application and its specific requirements.	https://www.allegromicro.com/-/media/files/application-notes/an296194-acs37610-busbar.pdf?sc_lang=en
Notched Busbar Design Guidelines For Coreless ACS37610 Differential Current Sensor (AN296231, P0110)	Application note focusing on how a busbar should be designed to achieve optimum performance with the ACS37610 coreless current sensor.	https://www.allegromicro.com/-/media/files/application-notes/an296231-acs37610-busbar-notch-guidelines.pdf?sc_lang=en
Overcurrent Fault Detection Using ACS37610 Coreless Current Sensor	Application note explaining how the Overcurrent-Fault (OCF) feature of Allegro ACS37610 device can be used in application to reliably detect overcurrent conditions and how it can be configured to optimize accuracy and cover different application needs.	https://www.allegromicro.com/-/media/files/application-notes/an296241-overcurrent-fault-detection-acs37610.pdf?sc_lang=en
Transient Current Behavior in Applications Using the Allegro Coreless ACS37610 Differential Current Sensor (AN296258, P0207)	Application note explaining how the conductor design can impact the response time of the current measurement for coreless current sensing applications and provides examples of response time to transient current for two types of conductors.	https://www.allegromicro.com/-/media/files/application-notes/an296258-acs37610-transient-current-behavior.pdf?sc_lang=en
Allegro Hall-Effect Sensor ICs	Application note providing a basic understanding of the Hall effect and how Allegro designs and implements Hall technology in packaged semiconductor monolithic integrated circuits.	https://www.allegromicro.com/-/media/files/application-notes/an27701-hall-effect-ic-application-guide.pdf?sc_lang=en
Hall-Effect Current Sensing in Electric and Hybrid Vehicles	Application note providing a greater understanding of hybrid electric vehicles and the contribution of Hall-effect sensing technology.	https://www.allegromicro.com/en/insights-and-innovations/technical-documents/hall-effect-sensor-ic-publications/hall-effect-current-sensing-in-electric-and-hybrid-vehicles
Hall-Effect Current Sensing in Hybrid Electric Vehicle (HEV) Applications	Application note providing a greater understanding of hybrid electric vehicles and the contribution of Hall-effect sensing technology.	https://www.allegromicro.com/-/media/files/application-notes/an29610-hall-effect-current-sensing-in-electric-and-hybrid-vehicles.pdf?sc_lang=en

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Documentation	Summary	Location
Achieving Closed-Loop Accuracy in Open-Loop Current Sensors	Application note regarding current sensor IC solutions that achieve near closed-loop accuracy using open-loop topology.	https://www.allegromicro.com/en/insights-and-innovations/technical-documents/hall-effect-sensor-ic-publications/achieving-closed-loop-accuracy-in-open-loop-current-sensors
Guidelines For Designing a Busbar with Notch for Allegro's Coreless ACS37610/12 Differential Current Sensor	Application note offering guidelines for achieving optimum busbar and notch designs using the Allegro ACS37610/12 coreless current sensor.	https://www.allegromicro.com/-/media/files/application-notes/an296188-acs37612-guidelines-for-designing-a-busbar-web.pdf
PCB Ground Plane Optimization for Coreless Current Sensor Applications	Application note discussing PCB ground plane optimization for Coreless Current Sensor Applications.	https://www.allegromicro.com/en/insights-and-innovations/technical-documents/hall-effect-sensor-ic-publications/an296277-pcb-ground-plane-optimization-for-coreless-current-sensor-applications
Allegro ACS37610/12 Busbar Calculator	GUI designed to aid in busbar design and application.	https://allegromicro.com/busbar/
Allegro ACS37610/12 PCB Design Tool	GUI designed to aid in PCB current sensing design and application.	https://www.allegromicro.com/-/media/files/design-tools/acs37612-pcb-design-tool.zip?sc_lang=en

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Busbar Design Recommendations GUI

For busbar design recommendations, refer to "Guidelines for Designing a Busbar with Notch for Allegro's Coreless AS37612 Differential Current Sensor" (https://www.allegromicro.com/-/media/allegro/allegromicro/files/application-notes/an296188-ACS37610-guidelines-for-designing-a-busbar-web.ashx) along with Allegro's interactive busbar design tool in the ACS37610 Samples Programmer on ACS37610 webpage (https://allegromicro.com/en/products/sense/current-sensor-ics/sip-package-zero-to-thousand-amp-sensor-ics/ACS37610). See Figure 21 below for an illustration of the busbar design GUI.

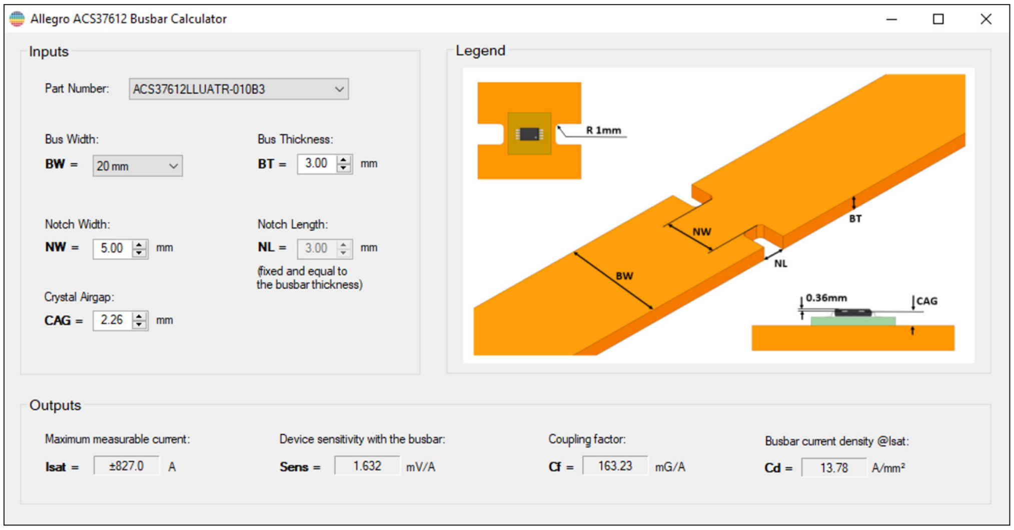

Figure 34: ACS37610 Busbar Calculator GUI

Inputs to the GUI include part number, bus width, bus thickness, notch width, and air gap.

For PCB sensing design recommendations, refer to the Coreless PCB Calculator, located under "Design Support Tools" on the ACS37610 webpage (https://allegromicro.com/en/products/sense/current-sensor-ics/sip-package-zero-to-thousand-amp-sensor-ics/ACS37610). See Figure 22 below for reference.

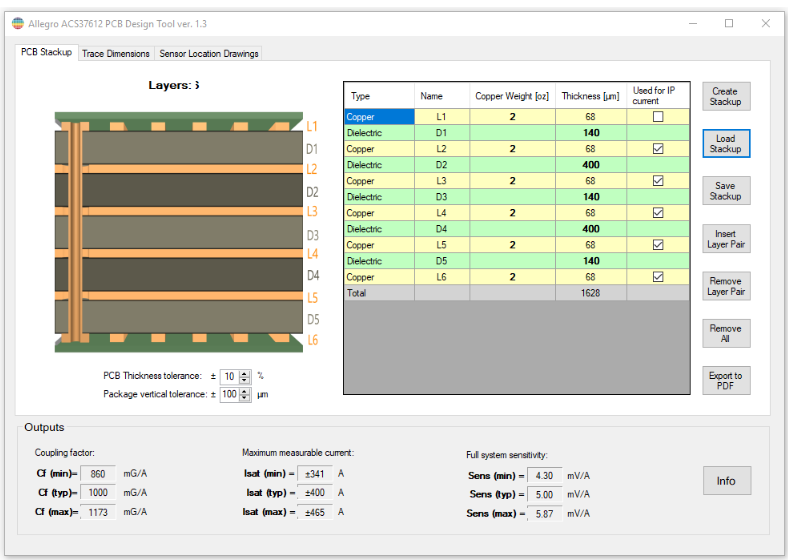

Figure 35: Relationship between Air Gap and Coupling Factor

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Revision History

Number	Date	Description
–	June 12, 2023	Initial release

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