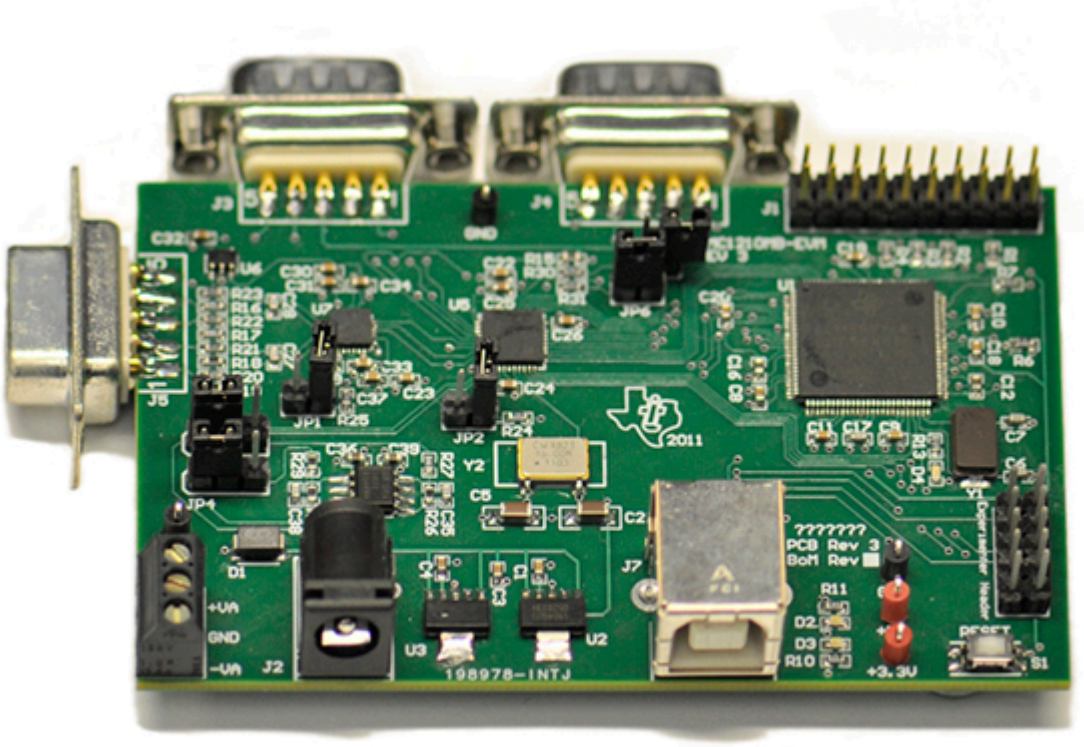
AMC1210MB-EVM



This user's guide describes the characteristics, operation, and use of the AMC1210MB-EVM as part of an evaluation system when used with Texas Instruments delta-sigma (ΔΣ) modulator evaluation modules (EVMs) in resolver or current-shunt applications. A schematic diagram and bill of materials are included in this document.

The following related documents are available for download through the Texas Instruments web site at http://www.ti.com.

EVM-Related Device Data Sheets

Device	Literature Number	Device	Literature Number
AMC1210	SBAS372D	LM3S3748	SPMS085F
ADS1205	SBAS312B	REG104	SBVS025G
TPD2E001	SLLS684E	OPA1632	SBOS286B
OPA353	SBOS103	AMC1203EVM	SBAU170
AMC1204EVM	SBAU178	ADS1209EVM	SBAU167

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Contents

1 EVM Overview 3
2 Hardware Interfaces 3
3 Software 6
4 Schematics and Layout 13

List of Figures

1 AMC1210EVM Software Installation 6
2 NI-VISA AMC1210MB-EVM Driver Installation 7
3 NI-VISA AMC1210MB-EVM Automatic Installation 7
4 NI-VISA AMC1210MB-EVM Driver Installing 8
5 NI-VISA AMC1210MB-EVM Driver Installation Complete 8
6 NI-VISA AMC1210MB-EVM Driver Verification 9
7 AMC1210MB-EVM Software Current Shunt Mode GUI 9
8 AMC1210MB-EVM Software Toolbar 10
9 Save Data Interface 10
10 AMC1210MB-EVM Software Current Shunt Data GUI 10
11 AMC1210MB-EVM Software Resolver Settings GUI 11
12 AMC1210MB-EVM Software Resolver Demo GUI: Position Data 12
13 AMC1210MB-EVM Software Resolver Demo GUI: Raw Data 12
14 AMC1210MB-EVM PCB Silkscreen (Top Image) 14
15 AMC1210MB-EVM PCB Silkscreen (Bottom Image) 14
16 Assembly Configuration 15
17 Schematic Page 1 16
18 Schematic Page 2 17

List of Tables

1 AMC1210MB-EVM Modulator Interface Pinout 3
2 AMC1210MB-EVM Resolver Interface Pinout 4
3 AMC1210MB-EVM Test Point Interface 4
4 AMC1210MB-EVM JP1 and JP2 Interface 5
5 Terminal Block J6 Pinout 5
6 LM3S3748 JTAG Connector 5
7 Bill of Materials 13

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1 EVM Overview

1.1 Features

AMC1210MB-EVM:

- Full-featured evaluation board for the AMC1210 quad digital filter for second-order delta-sigma modulators
- Contains all support circuitry needed for the AMC1210
- Onboard clocking for built-in ADS1205
- Stellaris® LM3S3748 ARM® processor and parallel interface to AMC1210
- JTAG header for reprogramming the LM3S3748 and experimentation
- D-connectors for connecting ΔΣ modulator EVMs
- Easy-to-use evaluation software for computers with Microsoft® Windows® XP operating systems
- Data collection and register access to AMC1210
- Open source firmware and software to customize evaluation

The AMC1210MB-EVM can be connected to a personal or lab computer using an available USB port. This manual shows how to use the AMC1210MB-EVM with the PC software available for download from the product folder at www.ti.com.

This manual covers the operation of the AMC1210MB-EVM. Throughout this document, the abbreviation *EVM* and the term *evaluation module* are synonymous with the AMC1210MB-EVM.

2 Hardware Interfaces

2.1 Modulator Interface Pinout

The AMC1210MB-EVM has two, male-type, nine-pin DSUB connectors at J3 and J4 for connecting TI ΔΣ modulator EVMs. Each connector supports single-channel and dual-channel ΔΣ modulator evaluation fixtures. The AMC1210MB-EVM supports using one dual-channel modulator or two single-channel modulator EVMs configured to use different channels of the DB9 connectors. Table 1 summarizes the AMC1210MB-EVM modulator interface pinout.

Table 1. AMC1210MB-EVM Modulator Interface Pinout

Pin	Signal
1	GND
2	Floating
3	3.3 V
4	5 V
5	GND
6	AMC1210 CLK1
7	AMC1210 CLK2
8	AMC1210 IN2
9	AMC1210 IN1

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2.2 Resolver Interface Pinout

The AMC1210MB-EVM is designed for easy interfacing to resolver applications. Connector J5 is a nine-pin, female-type DSUB connector for connection to a standard resolver. To hold the floating resolver inputs to a predefined common-mode level, a 2.5-V offset is added to the resolver inputs. The AMC1210MB-EVM resolver interface pinout is detailed in Table 2.

Table 2. AMC1210MB-EVM Resolver Interface Pinout

Pin	Signal
1	Positive sine-wave input
2	Negative sine-wave input
3	Positive cosine-wave input
4	Negative cosine-wave input
5	Floating
6	Positive carrier-wave output
7	Negative carrier-wave output
8	Floating
9	GND

2.3 Test Points

The AMC1210MB-EVM provides test points for easy access to onboard supplies for extended evaluation or experimentation. Table 3 describes each test point.

Table 3. AMC1210MB-EVM Test Point Interface

Test Point	Signal
TP1	+3.3V
TP2	GND
TP3	GND
TP4	+5V
TP5	GND
TP6	+VA
TP7	GND
TP8	–VA

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2.4 Jumpers

JP1 and JP2 are available to configure the resolver carrier signal driver. The carrier signal may either be driven directly by the AMC1210 or through the OPA1632 operational amplifier. The purpose of the OPA1632 is to provide the ability to filter the carrier signal and continue to be capable of sourcing 85 mA on the carrier. This interface is shown in Table 4.

Table 4. AMC1210MB-EVM JP1 and JP2 Interface

Jumper		Description
JP1	JP2	
1-2 closed	1-2 closed	PWM carrier signal is driven by the OPA1632
2-3 closed	2-3 closed	PWM carrier signal is driven directly from the AMC1210

2.5 Power Supplies

The AMC1210MB-EVM requires 5-V and 3.3-V power supplies for proper operation. Using the test-point descriptions from Table 3, apply 5 V to TP4 (+5V), and 3 V to TP1 (+3.3V). Both supplies must be referenced to GND at TP2, TP3, TP5, or TP7. Alternatively, a 6-V to 7-V power supply can be connected through barrel jack J2 (2.5 mm, center positive, 500 mA). If the OPA1632 is in use (JP1 and JP2 in the 2-3 position; refer to Table 4), the positive and negative supply rails must be provided at terminal block J6 or TP6 and TP8. Terminal block J6 connections are described in Table 5.

Table 5. Terminal Block J6 Pinout

Pin	Description
1	OPA1632 positive supply
2	GND
3	OPA1632 negative supply

2.6 LM3S3748 JTAG Connector

For embedded software investigations with the AMC1210MB-EVM, a 20-pin JTAG connector is provided at J1. The Stellaris LM3S811 Evaluation Board is a low-cost Stellaris evaluation board that can function as an in-circuit debugger for the LM3S3748 on the AMC1210MB-EVM. The JTAG connector key should face the inside of the board, or the pins should align as described in Table 6.

Table 6. LM3S3748 JTAG Connector

Pin	Signal
2, 4, 6, 8, 10, 12, 14, 16, 18, 20	GND
3, 11, 15, 17, 19	Floating
1	3.3 V or XVCC
5	TDI
7	TMS
9	TCK
13	TDO

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3 Software

The program for evaluating the AMC1210MB-EVM is the AMC1210EVM software. This program uses the NI-VISA™ client to communicate with the hardware through a USB port. The program currently runs only on PCs with the Microsoft Windows XP operating system. Windows Vista and Windows 7 are ***not*** supported.

3.1 Installation

Follow these procedures to install the AMC1210MB-EVM software.

Step 1. Install the AMC1210MB-EVM software and LabVIEW™ RunTime Engine software. The screen shown in Figure 1 appears as you start this process.

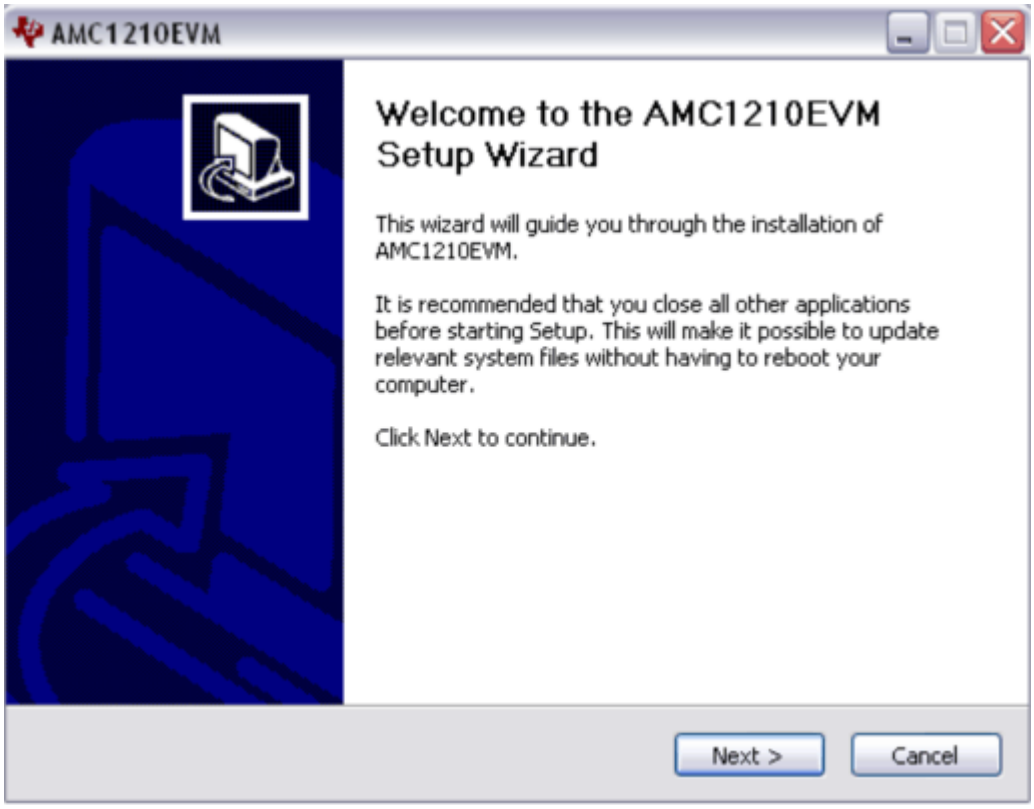


Figure 1. AMC1210EVM Software Installation

Step 2. After the AMC1210EVM software is installed, apply power to the EVM and connect the EVM to an available PC USB port. The computer should recognize new hardware and begin installing the driver. Accept the default settings.

Figure 2 through Figure 5 show the driver installation sequence.

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Figure 2. NI-VISA AMC1210MB-EVM Driver Installation

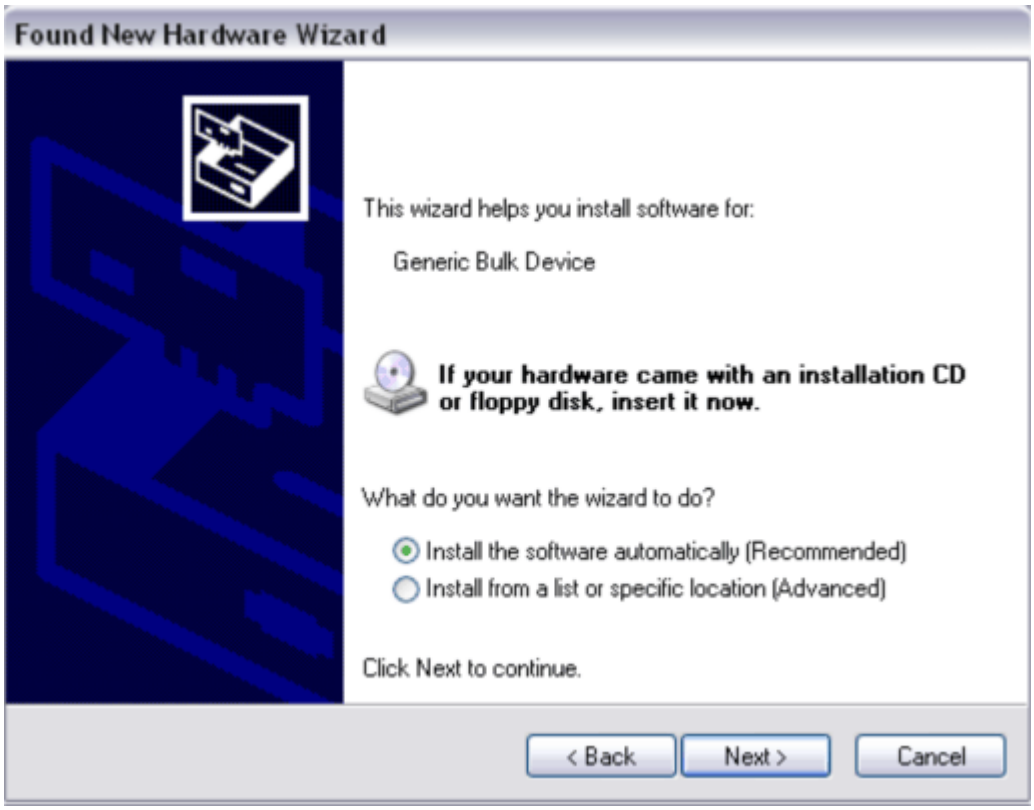


Figure 3. NI-VISA AMC1210MB-EVM Automatic Installation

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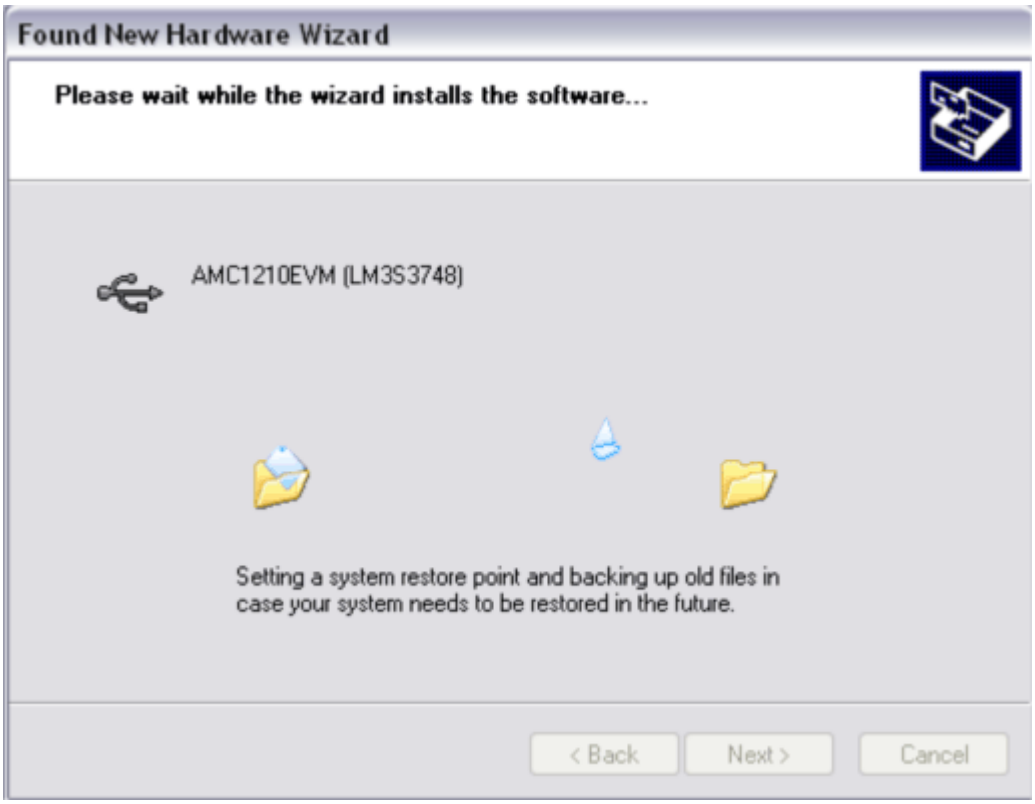


Figure 4. NI-VISA AMC1210MB-EVM Driver Installing

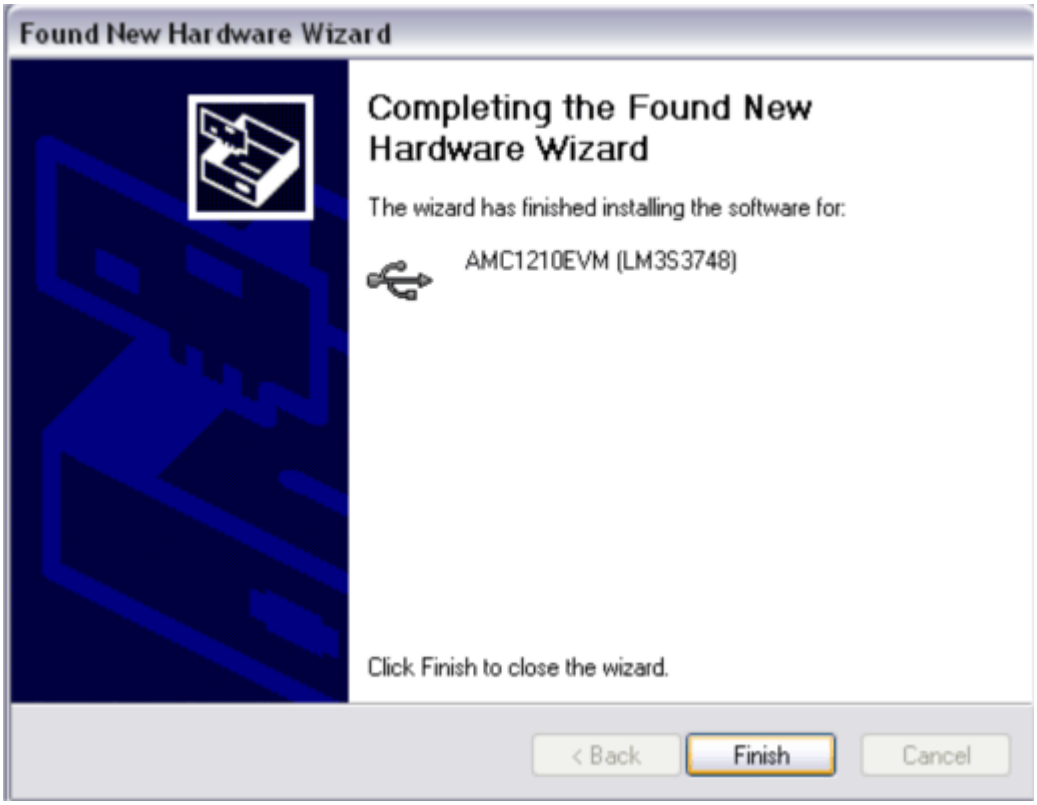


Figure 5. NI-VISA AMC1210MB-EVM Driver Installation Complete

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Step 3. Verify that installation is completed correctly by opening the Windows Device Manager and locating the driver, as shown in Figure 6.



Figure 6. NI-VISA AMC1210MB-EVM Driver Verification

3.2 Using the AMC1210MB-EVM Evaluation Software

The AMC1210MB-EVM evaluation software provides two modes of operation: Resolver Demo and Current Shunt. Each mode of operation provides a separate GUI and features for evaluating the AMC1210. By default, the software launches in Current Shunt Mode. Figure 7 shows the Current Shunt Mode GUI.

NOTE: Neither mode of operation allows for the AMC1210 Control Register or Clock Divider Register to be modified. These registers contain functionally critical features of the device that must remain in control of the AMC1210MB-EVM software.

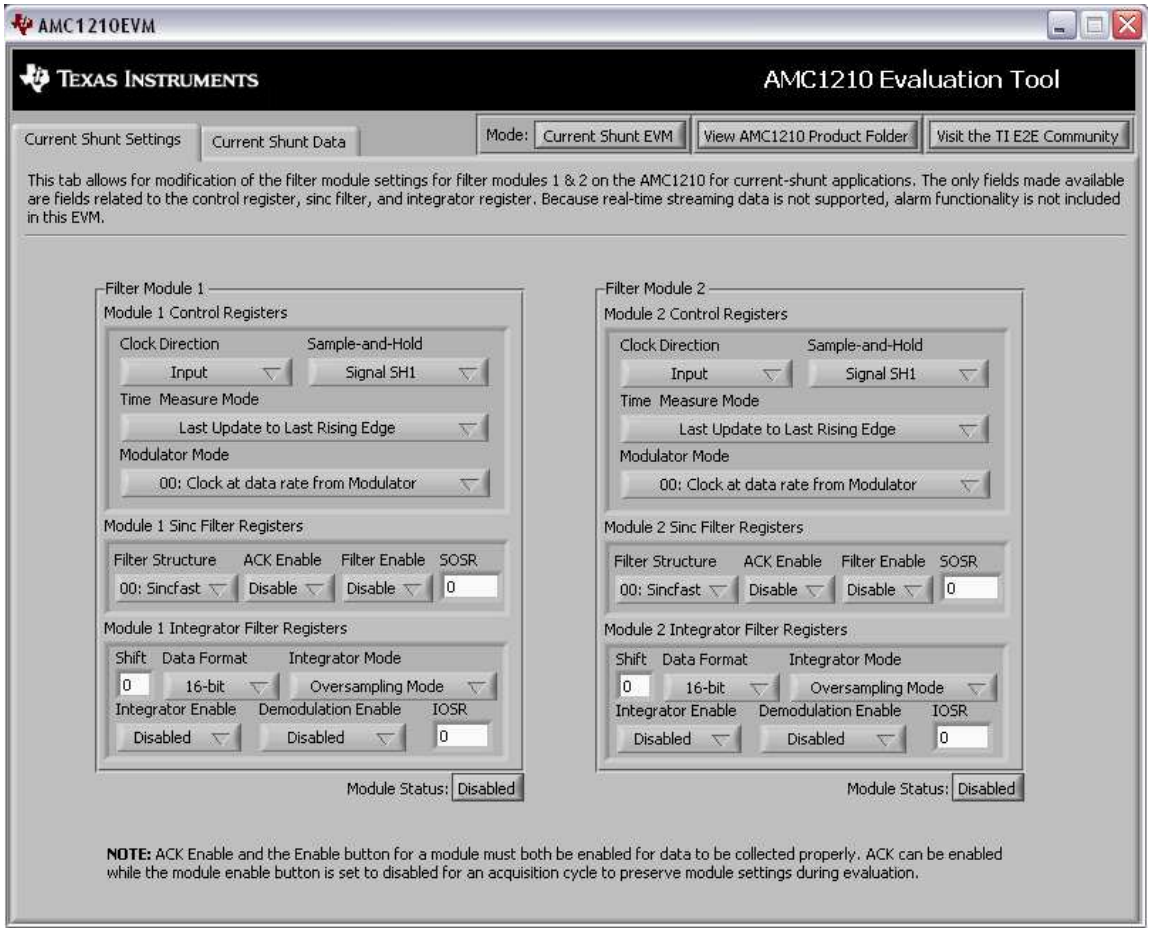


Figure 7. AMC1210MB-EVM Software Current Shunt Mode GUI

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The toolbar shown in Figure 8 is present, regardless of the mode of operation of the AMC1210MB-EVM software. The left-most button is used to switch between Current-Shunt Mode and Resolver Demo Mode. The remaining buttons are provided for convenience to quickly access information about the device or visit the TI E2E community for support or device queries.



Figure 8. AMC1210MB-EVM Software Toolbar

The AMC1210MB-EVM software includes a feature that saves any collected data from either the Resolver or Current Shunt Data tabs to export collected data to another analysis tool. Figure 9 shows the save data interface. To save collected data, click the folder icon to browse the file system, or type a path where the exported data will be saved to a text file. Once the data is collected, click the *Save Data* button to export the data.



Figure 9. Save Data Interface

With the software in Current Shunt Mode, there are two tabs available: *Current Shunt Settings* (refer to Figure 7), and *Current Shunt Data*, as shown in Figure 10. The *Current Shunt Settings* tab makes the control, sinc filter, and integrator filter register settings available for filter modules 1 and 2 on the AMC1210. Alarm registers and interrupts are not supported by the AMC1210MB-EVM evaluation software.

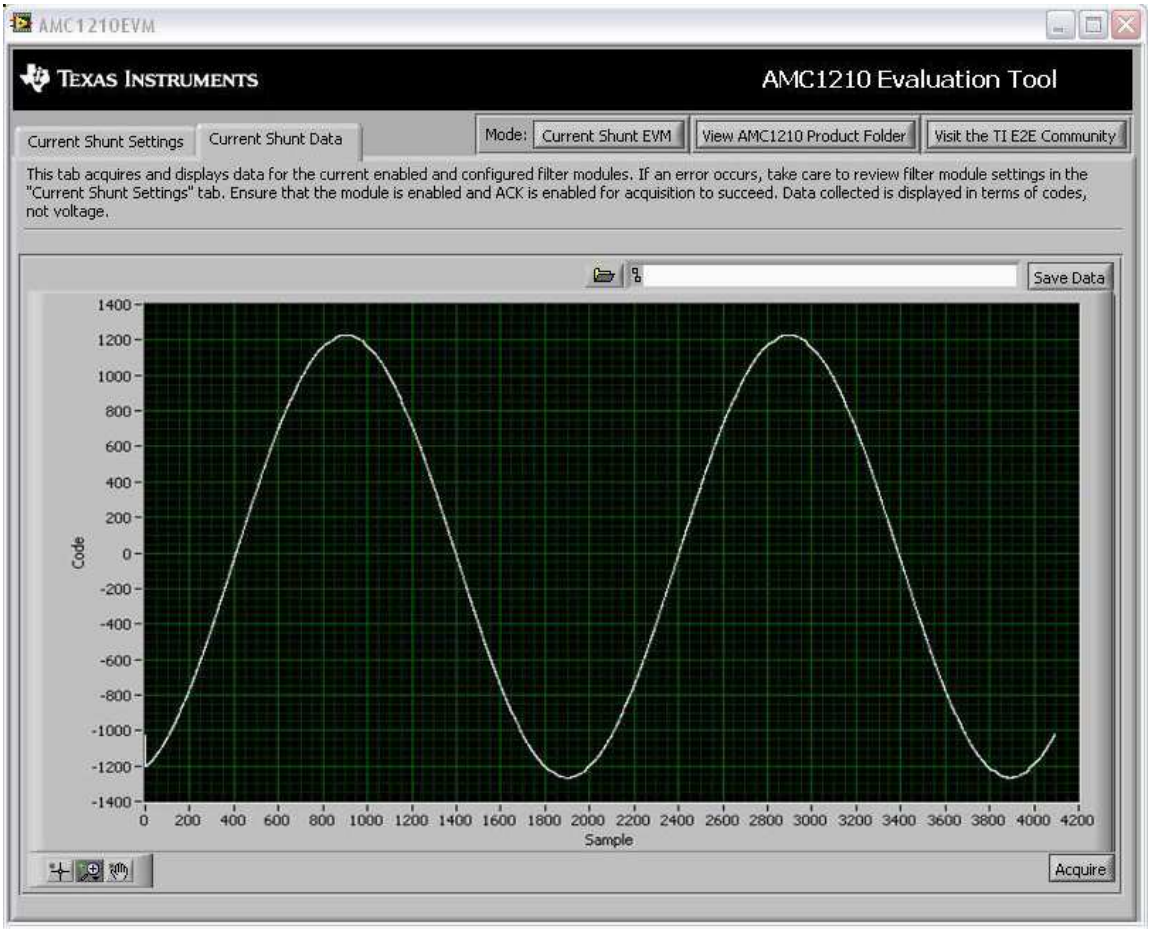


Figure 10. AMC1210MB-EVM Software Current Shunt Data GUI

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Each filter module also has an enable or disable control located below the register configuration indicators. Only enabled filter modules data are displayed in the *Current Shunt Data* tab. Figure 10 shows an sample set of collected data in the *Current Shunt Data* tab, with module 1 enabled and module 2 disabled.

The *Current Shunt Data* tab displays collected data in terms of raw codes instead of voltage because a variety of delta-sigma modulators may be connected to the AMC1210. A basic toolbar is provided in the lower left corner of this tab (in Figure 10) to examine the collected data.

With software in Resolver Demo Mode, there are two tabs available: *Resolver Settings* (shown in Figure 11), and *Resolver Demo* (see Figure 12). None of the AMC1210 registers are made available for modification in Resolver Demo Mode. This mode of operation is only intended to serve as a demonstration. The *Resolver Settings* tab displays all of the relevant device register configurations used in this demo and provides a convenient link to a TI application report concerning using the AMC1210 in Resolver Motor Control applications.

The *Resolver Demo* tab displays the collected resolver data. The software provides two methods of examining the data: post-processing resolver position data, or pre-processing raw sine and cosine data. Refer to Figure 12 for a sample set of position data and Figure 13 for the same data in raw data format.

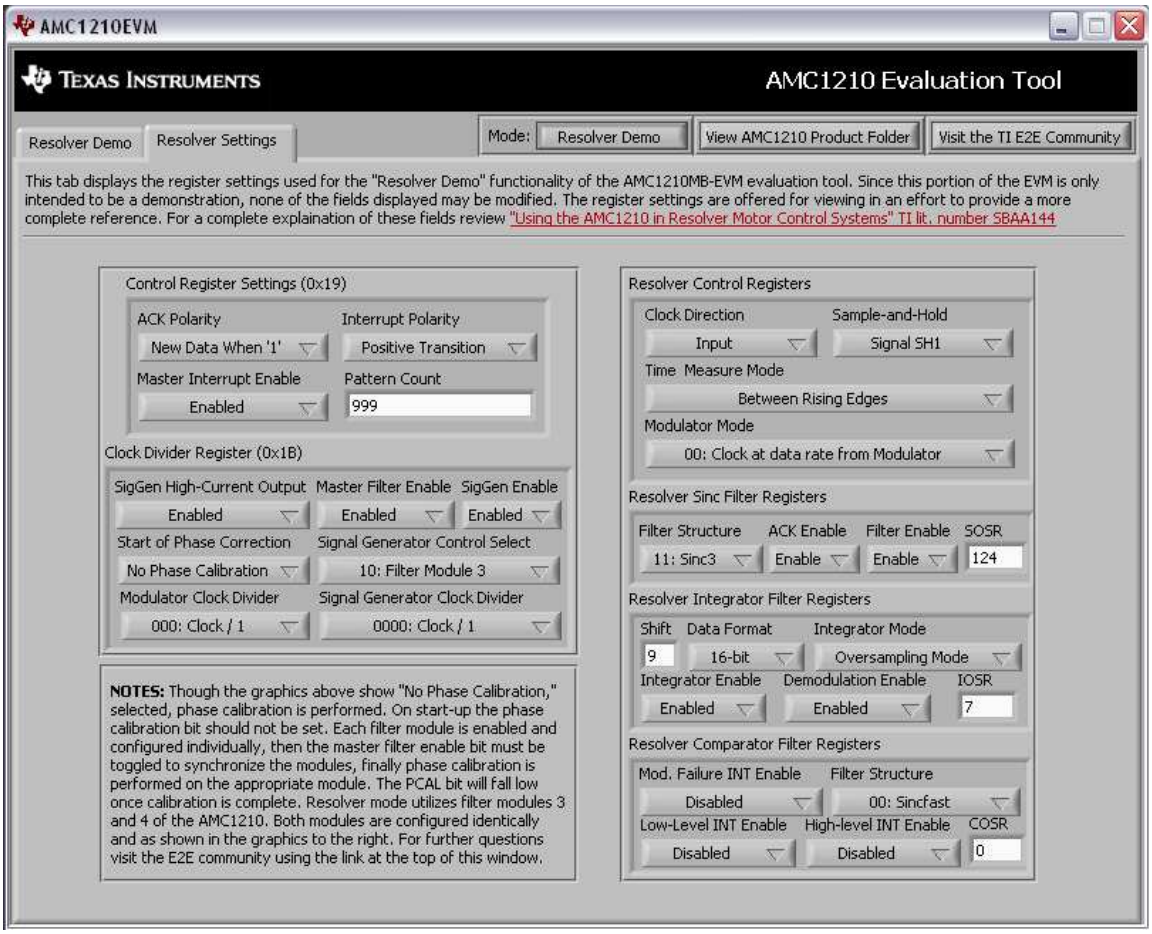


Figure 11. AMC1210MB-EVM Software Resolver Settings GUI

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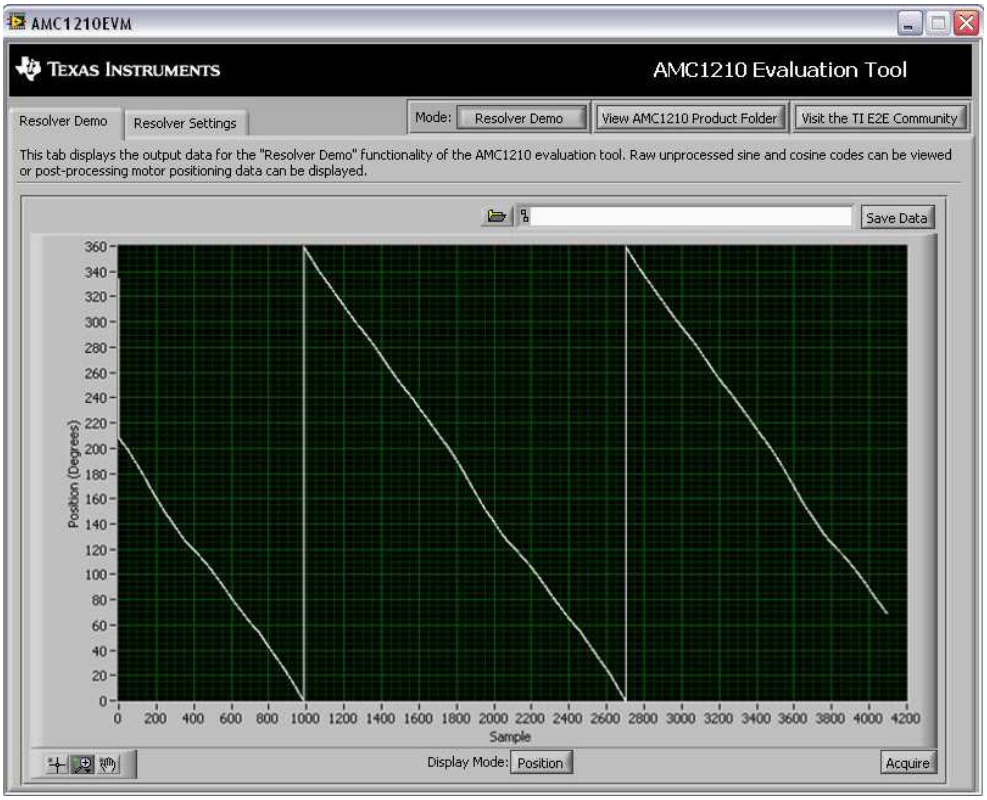


Figure 12. AMC1210MB-EVM Software Resolver Demo GUI: Position Data

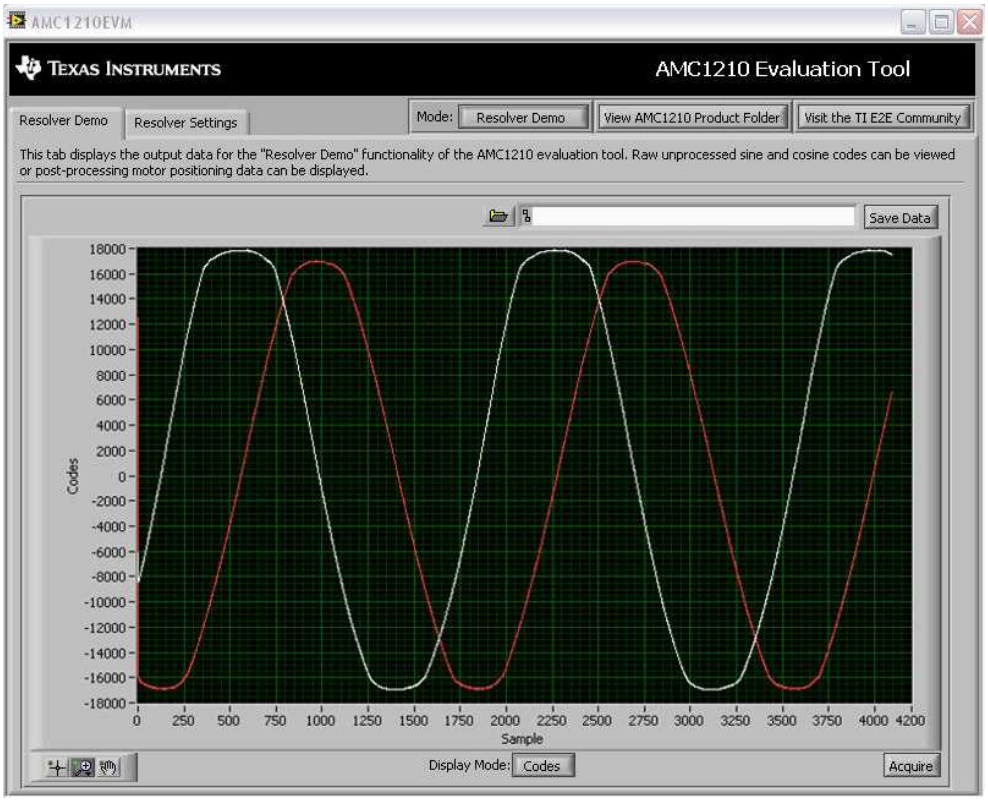


Figure 13. AMC1210MB-EVM Software Resolver Demo GUI: Raw Data

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4 Schematics and Layout

Schematics for the AMC1210MB-EVM are appended to this user's guide. The bill of materials for the evaluation board is provided in Table 7.

NOTE: All components should be compliant with the European Union Restriction on Use of Hazardous Substances (RoHS) Directive. Some part numbers may be either leaded or RoHS. Verify that purchased components are RoHS-compliant. (For more information about TI's position on RoHS compliance, see the Quality and Eco-Info information on the TI web site.)

Table 7. Bill of Materials

Item	Quantity	Designator	Description	Manufacturer	Part Number
1	1	NA	Printed wiring baord	TI	6526789
2	21	C1, C3, C4, C10, C11, C13, C16-C20, C21, C22, C23, C26-C31, C34	CAP CER 0.1UF 25V 10% X7R 0603	Murata	GRM188R71E104KA01D
3	2	C2, C5	CAP CER 10UF 10V X5R 10% 1206	TDK	C3216X5R1A106K
4	2	C6, C7	CAP CER 10PF 50V 5% C0G 0603	Murata	GRM1885C1H100JA01D
5	3	C8, C9, C15	CAP CER 10000PF 50V 10% X7R 0603	Murata	GRM188R71H103KA01D
6	4	C12, C14, C33, C36	CAP CER 1.0UF 10V 10% X5R 0603	Murata	GRM188R61A105KA61D
7	2	C24, C25	CAP CER 22PF 50V 5% C0G 0603	Murata	GRM1885C1H220JA01D
8	2	C32, C35	CAP CER 1000PF 50V 10% X7R 0603	Murata	GRM188R71H102KA01D
9	1	D1	DIODE TVS 6.5V 400W UNI 5% SMD	Bourns	SMAJ6.5A
10	3	D2, D3, D4	LED 565NM GRN DIFF 0603 SMD	Lumex	SML-LX0603GW-TR
11	1	J1	CONN HEADER 20POS .100" DL GOLD	Samtec	TSW-110-07-L-D
12	1	J2	CONN POWER JACK 2.1MM PCB CIRC	CUI	PJ-102A
13	2	J3, J4	CONN DB9 MALE SOLDER CUP TIN	Norcomp	172-E09-102R011
14	1	J5	CONN DB9 FEMALE SOLDER CUP TIN	Norcomp	172-E09-202R001
15	1	J6	TERMINAL BLOCK 3.5MM 3POS PCB	On Shore	ED555/3DS
16	1	J7	USB RCPT B-TYPE R/A FULL BACK	FCI	61729-0011BLF
17	2	JP1, JP2	CONN HEADER 3POS .100" SNGL TIN	Samtec	TSW-103-07-T-S
18	4	R1, R2, R3, R4	RES 27.4 OHM 1/10W 1% 0603 SMD	Yageo	RC0603FR-0727R4L
19	1	R5	RES 4.70K OHM 1/10W 1% 0603 SMD	Yageo	RC0603FR-074K7L
20	1	R6	RES 9.10K OHM 1/10W 1% 0603 SMD	Yageo	RC0603FR-079K1L
21	2	R7, R9	RES 330 OHM 1/10W 1% 0603 SMD	Yageo	RC0603FR-07330RL
22	1	R8	RES 499 OHM 1/10W 1% 0603 SMD	Yageo	RC0603FR-07499RL
23	6	R10, R11, R12, R13, R19, R21	RES 2.00K OHM 1/10W 1% 0603 SMD	Yageo	RC0603FR-072KL
24	4	R14, R15, R16, R17	RES 20.0 OHM 1/10W 1% 0603 SMD	Yageo	RC0603FR-0720RL
25	2	R18, R20	RES 5.10K OHM 1/10W 1% 0603 SMD	Yageo	RC0603FR-075K1L
26	1	R22	RES 10.0K OHM 1/10W 1% 0603 SMD	Yageo	RC0603FR-0710KL
27	1	S1	SWITCH LT 4.7MMX3.5MM 100GF SMD	Panasonic	EVQ-P2002M
28	4	TP1, TP4, TP6, TP8	TEST POINT PC MINI .040"D RED	Keystone	5000
29	4	TP2, TP3, TP5, TP7	TEST POINT PC MINI .040"D BLACK	Keystone	5001
30	1	U1	IC ARM CORTEX MCU 128K 100-LQFP	TI	LM3S3748-IQC50-A0
31	1	U2	IC LDO REG 3.3V 1A SOT223-6	TI	REG104GA-3.3
32	1	U3	IC LDO REG 5.0V 1A SOT223-6	TI	REG104GA-5
33	1	U4	IC ESD-PROT ARRAY 2CH SOT-5	TI	TPD2E001DRLR
34	1	U5	IC QUAD FILTER FOR D-S MOD 40QFN	TI	AMC1210IRHA
35	1	U6	IC OPAMP GP R-R 44MHZ SOT23-5	TI	OPA353NA/250
36	1	U7	IC MODULATOR D-S 2CH 16BIT 24QFN	TI	ADS1205IRGET
37	1	U8	IC AMP AUDIO MONO AB DIFF 8SOIC	TI	OPA1632D
38	1	Y1	CRYSTAL 8.000000 MHZ 8PF SMD	NDK	NX8045GB-8.000000MHZ
39	1	Y2	OSC 32.0000MHZ 3.3V +-50PPM SMD	Connor-Winfield	CWX823-032.0M

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Table 7. Bill of Materials (continued)

Item	Quantity	Designator	Description	Manufacturer	Part Number
40	2	N/A	0.100 Shunt - Black Shunts	3M	969102-0000-DA
41	4	N/A	BUMPON HEMISPHERE .44X.20 BLACK	3M	SJ-5003 (BLACK)

4.1 PCB Layout

Figure 14 and Figure 15 illustrate the silkscreen images for the AMC1210MB-EVM.

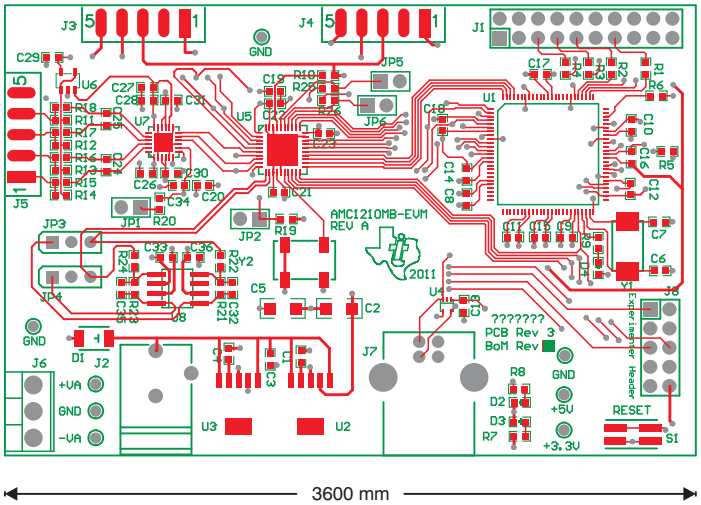


Figure 14. AMC1210MB-EVM PCB Silkscreen (Top Image)

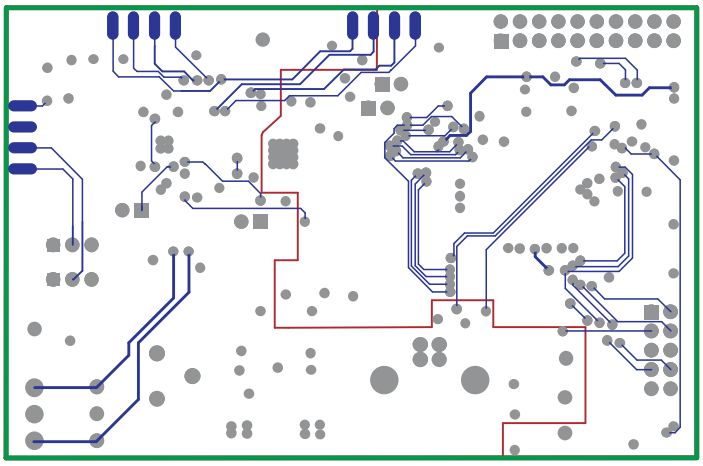


Figure 15. AMC1210MB-EVM PCB Silkscreen (Bottom Image)

4.2 Assembly and Schematics

Figure 16 shows an assembly configuration. Figure 17 and Figure 18 provide two schematics for the AMC1210MB-EVM.

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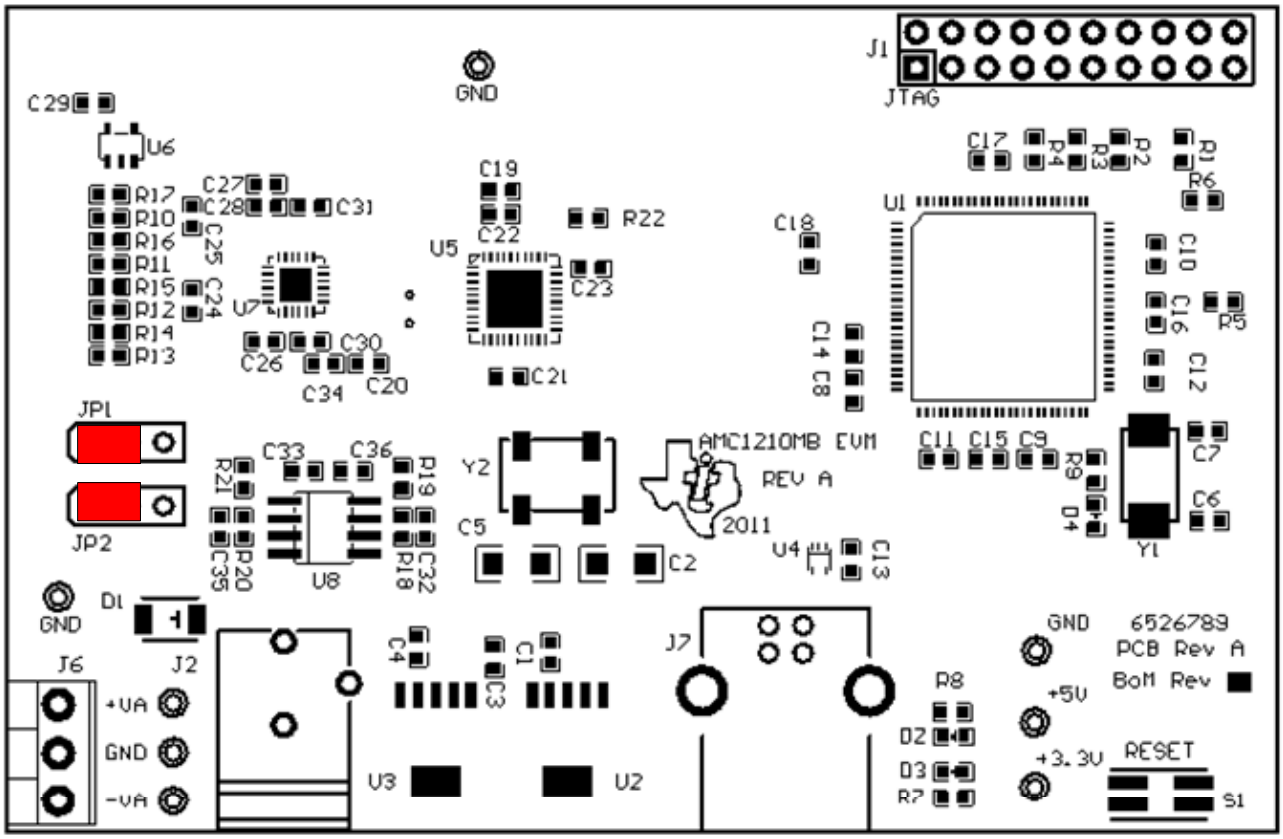


Figure 16. Assembly Configuration

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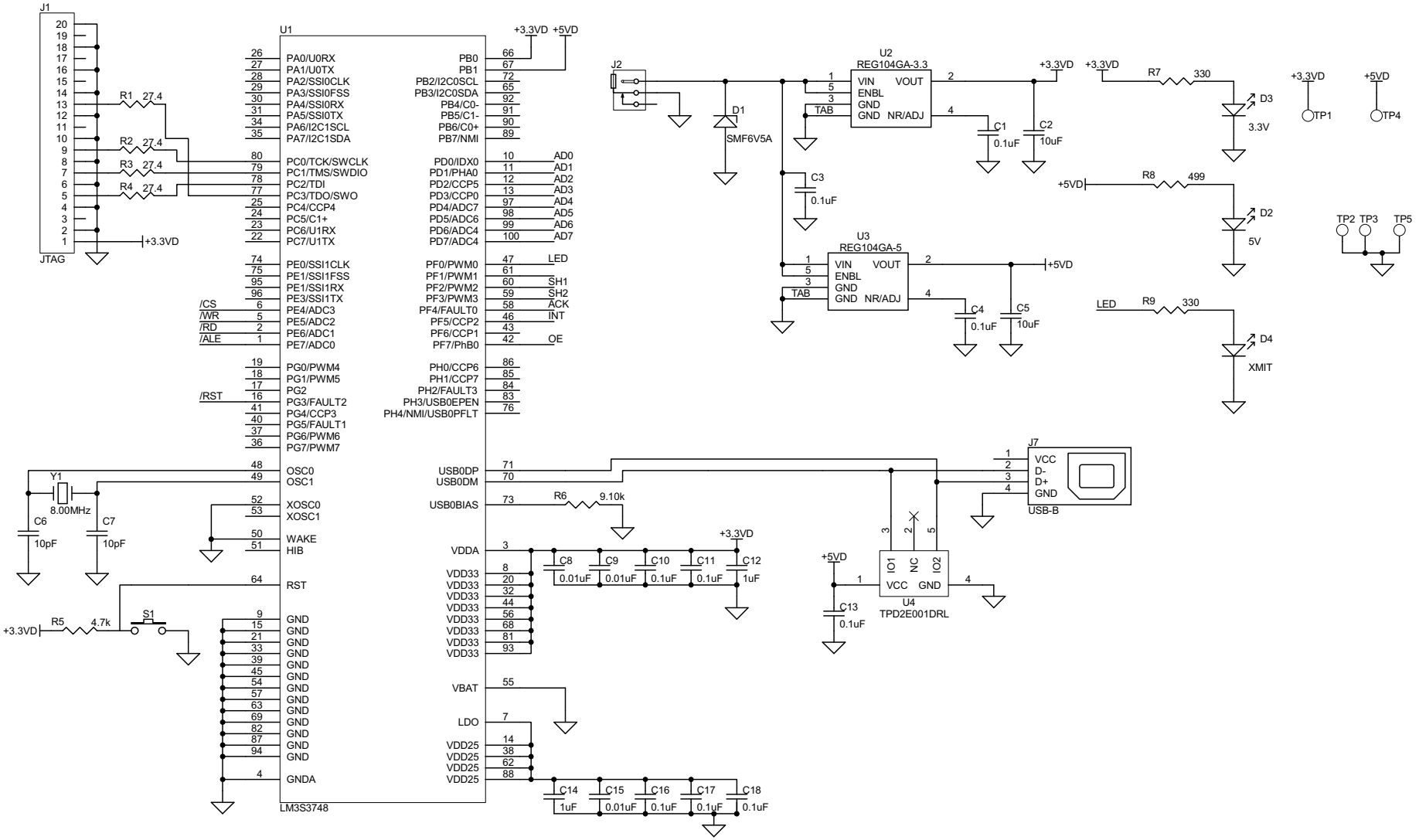


Figure 17. Schematic Page 1

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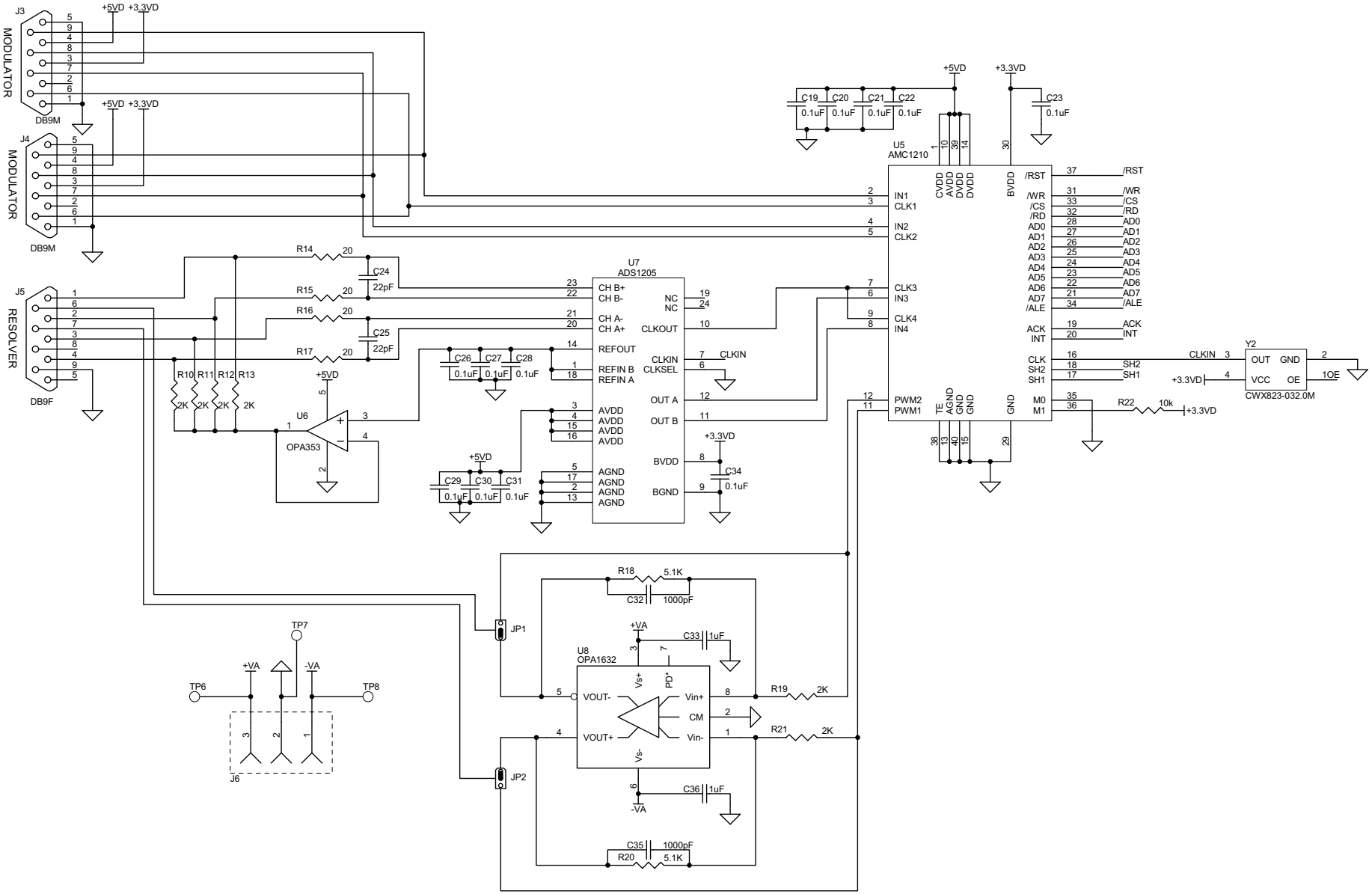


Figure 18. Schematic Page 2

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Revision History

Changes from Original (February 2012) to A Revision	Page
• Changed front page image	1
• Changed *Power Supplies* section regarding the power supply	5

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

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1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

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   2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

3 *Regulatory Notices:*

   3.1 *United States*

      3.1.1 *Notice applicable to EVMs not FCC-Approved:*

      This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

      3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

      CAUTION

      This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

      Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

      FCC Interference Statement for Class A EVM devices

      NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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2. 実験局の免許を取得後ご使用いただく。
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西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

   6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY WRITTEN DESIGN MATERIALS PROVIDED WITH THE EVM (AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

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8. *Limitations on Damages and Liability:*

   8.1 *General Limitations*. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS ANDCONDITIONS OR THE USE OF THE EVMS PROVIDED HEREUNDER, REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN ONE YEAR AFTER THE RELATED CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY WARRANTY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS AND CONDITIONS, OR ANY USE OF ANY TI EVM PROVIDED HEREUNDER, EXCEED THE TOTAL AMOUNT PAID TO TI FOR THE PARTICULAR UNITS SOLD UNDER THESE TERMS AND CONDITIONS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM AGAINST THE PARTICULAR UNITS SOLD TO USER UNDER THESE TERMS AND CONDITIONS SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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