DS100BR210EVK User's Guide
SMA Evaluation Kit

User's Guide

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DS100BR210EVK User Guide SMA Evaluation Kit

The DS100BR210EVK – SMA evaluation kit provides a complete high bandwidth platform to evaluate the signal integrity and signal conditioning features of the Texas Instruments signal conditioning products – with Equalization and De-emphasis.

SMA edge launch connectors are used as the input and the output connections for this evaluation board. Commercially available adaptor boards can be purchased to facilitate connection to cables or backplane interconnects.

Topic **Page**

1 Features

- Two Channel Repeater up to 10.3 Gbps Rate
  - DS100BR210: 2x Unidirectional Channels
- Low 65 mW/channel Power Consumption, with Option to Power Down Unused Channels
- Advanced Signal Conditioning Features
  - 4 Stage Equalization
  - Transmit De-Emphasis
  - Transmit VOD Control
  - < 0.3 UI of Residual DJ at 10 Gbps
- Fully Programmable via Pin Selection or SMBus Interface
- Selectable Single Supply Operation
- >4-kV HBM ESD Rating
- 3.3-V LVCMOS Input Tolerant for SMBus Interface
- Flow–Thru Pinout Package: 24-Pin LLP (4 mm x 4 mm)
- Industrial –40 to 85°C Operating Temperature Range

2 Applications

- High-Speed Active Copper Cable Modules and FR4 Backplanes in Communication Systems
- 10GE, FC, SAS, SATA 3/6 Gbps (with OOB detection), Infiniband, CPRI, RXAUI, and many others

3 Ordering Information

Table 1. DS100BR210EVK Ordering Information

DEVICE	QUANTITY
DS100BR210SQ/NOPB	2000
DS100BR210SQE/NOPB	250
SMA Evaluation Kit: DS100BR210EVK/NOPB	

4 Evaluation Board

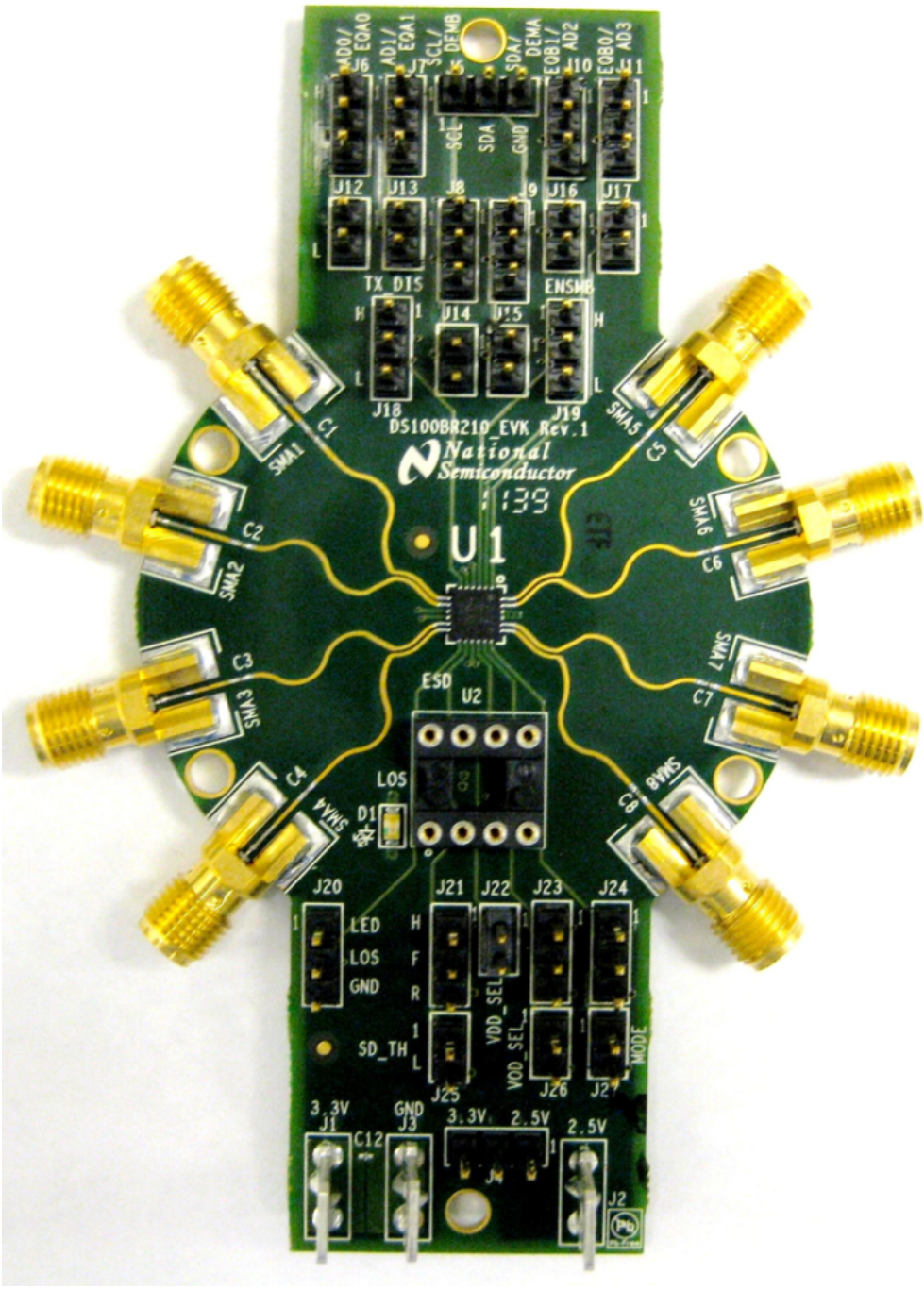

Figure 1. DS100BR210EVK Evaluation Board

5 Setup

The DS100BR210EVK – SMA evaluation kit can be used in three different modes:

1. **Pin Control** (provides access to selected signal integrity settings)
2. **SMBus Mode** (full access to signal integrity and control settings)
3. **EEPROM Mode** (full access to signal integrity and control settings)

The EEPROM mode is a convenient method of programming one or more DS100BRxxx devices on system power-up when a SMBus master (microcontroller or similar) is unavailable in the design.

5.1 DS100BR210 Pin Control

Uses the external control pins on the DS100BR210 to configure the signal integrity and control settings of the device. In this mode only a subset of the equalization and de-emphasis levels are available. Due to the limited number of control pins, a limited bandwidth 4-level input scheme has been implemented across the control pin interface. This allows for improved EQ, DE, and VOD control with fewer physical pins.

The 4 levels are defined as:

1. **Low:** 1 KΩ to GND
2. **Resistor:** 20 KΩ to GND
3. **Float:** No External Connection
4. **High:** 1 KΩ to VDD

The EVK interfaces to this 4-level IO using the setup below. Only one shunt connection is required to access any of the 4 levels. This methodology minimizes the risk of improper connections that could damage the board or board power supply.

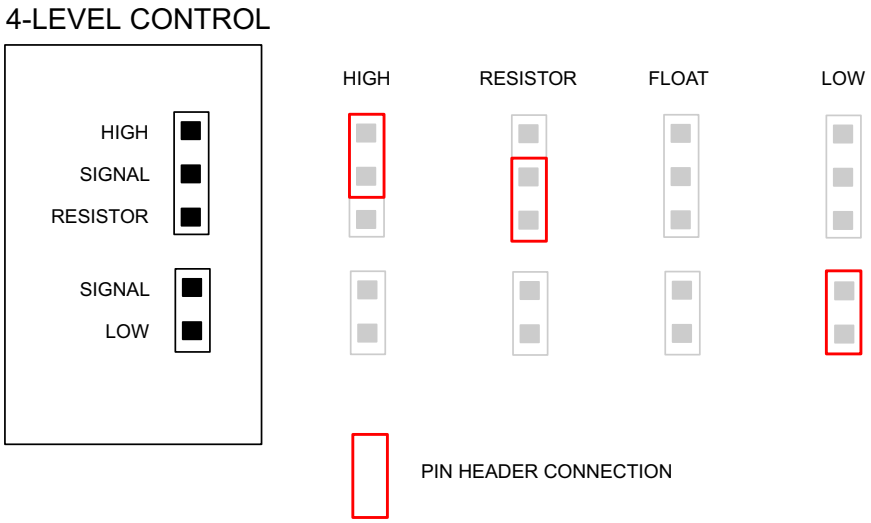

Figure 2. 4-Level IO Control on EVK

The DS100BR210EVK is shipped ready to use in pin control configuration. As delivered, the EVK will have the following installed jumpers.

1. J4 – 3.3V operation: Use the J1 and J3 connectors to supply 3.3-V power to the EVK.
2. J18 – TX-DIS = LOW: Device is enabled.
3. J19 – ENSMB = LOW: Pin Control configuration mode.
4. J20 – LED – LOS: The LOS output is connected to the onboard LED. The LED will glow green in the presence of a valid signal on CH A input.
5. J22 – VDD_SEL = LOW: Use DS100BR210 internal regulator to convert 3.3-V supply to proper internal supply level of 2.5 V. Note: The 2.5-V level may be observed on the device VDD pins.
6. VOD_SEL = Float: Default output amplitude settings for CH A and CH B.

5.2 SMBus Mode

The SMBus can also be used to control the DS100BR210 devices. This method has the advantage of independent control and finer signal conditioning granularity.

Table 2. Typical DS100BR210 Register Writes

Register Address	Function	Description
Register 0x0F	CHA EQ	Write EQ setting for bits [7:0] = 0001 1101'b
Register 0x11	CHA DEM	Write DE setting for bits [2:0] = 000'b
Register 0x25	CHA VOD	Write VOD setting for bits [4:2] = 101'b
Register 0x06	Register Enable	Write bit [3] = 1'b to enable SMBus Slave Mode register slave control

5.3 EEPROM Mode

A serial EEPROM may also be used to configure one or more DS100BR210 devices. This configuration mode is accessed by setting the ENSMB 4-level input to FLOAT. For additional information, please see the device datasheet.

6 Expected Results

This evaluation board has been designed to evaluate the cable and FR4 signal conditioning performance of the DS100BR210. Adding additional cables or adaptor boards into the signal path will have some impact on the optimal settings, but keeping the adaptor boards small and using short high-quality SMA cables will minimize this effect.

6.1 Cable Performance

When used in a full active cable application, it is generally expected that the DS100BR210 driving the cable will use a VOD setting of 1000 mVpp or greater and no output De-Emphasis (DE). The DS100BR210 receiving the signal will utilize a Continuous Time Linear Equalizer (CTLE) to recover the attenuated signal and redrive it into the local system.

SETUP1: PRBS7 Generator → DS100BR210 (A) → 10-m 30AWG cable → DS100BR210 (B) → Scope

DS100BR210 (A) Transmit Settings

1. Output Voltage Amplitude = 1000 mVpp or greater
2. De-Emphasis = 0 dB
3. EQ = 00 (Bypass)

DS100BR210 (B) Receive Settings

1. Output Voltage Amplitude = 700 mVpp or greater
2. De-Emphasis = 0 dB
3. EQ = 2F'h (Default)

Additional documentation and device performance is available in the device datasheet.

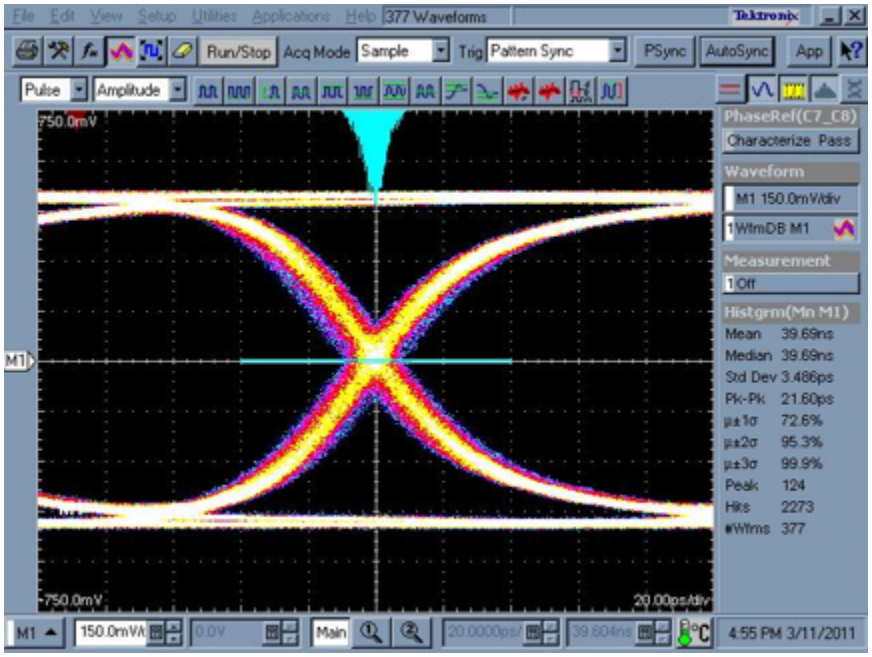

Figure 3. 6 Gbps Eye Diagram at SCOPE in SETUP1

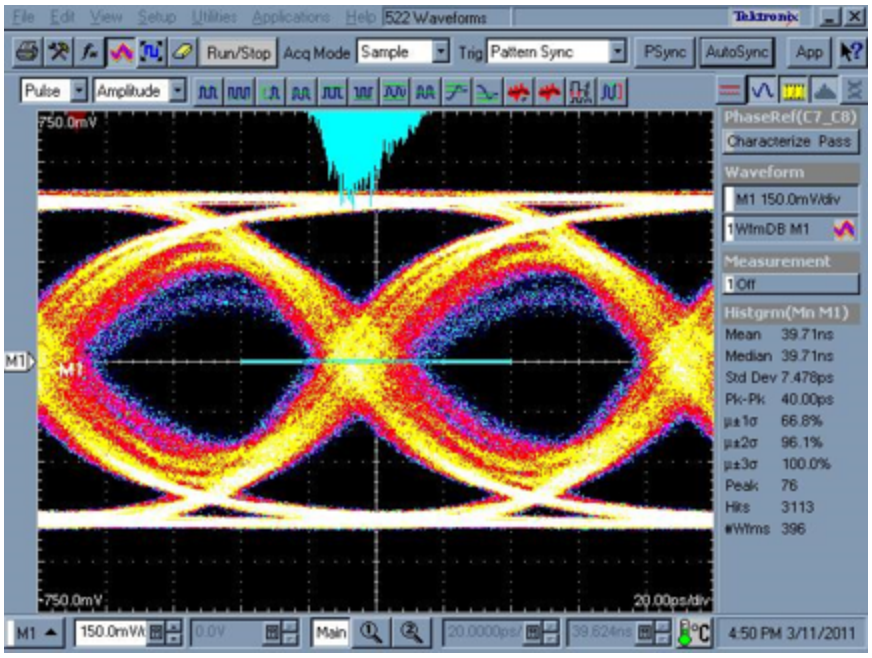

Figure 4. 10.3125 Gbps Eye Diagram at SCOPE in SETUP1

Data Source: MATH1	Data Rate: 10.3125 Gbps	Filter: None
SSC: Off	Pattern: 127 bits	Channel: None
Phase Reference: 10.3125 GHz	Sample Count: 52.70 k	Equalizer: None

Jitter (Decision Threshold: 2.87 mV)			**Noise** (Sampling Phase: 0 UI)		
Random Jitter			**Random Noise**		
RJ (RMS)	=	1.28 ps	RN (RMS)	=	2.17 mV
RJ(h) (RMS)	=	1.27 ps	RN(v) (RMS)	=	2.16 mV
RJ(v) (RMS)	=	177.69 fs	RN(h) (RMS)	=	279.32 uV
Deterministic Jitter			**Deterministic Noise**		
DJ	=	30.26 ps	DN	=	424.41 m
DDJ	=	28.10 ps	DDN	=	414.39 m
DCD	=	466.71 fs	DDN(level 1)	=	340.70 m
DDPWS	=	23.65 ps	DDN(level 0)	=	283.59 m
PJ	=	821.85 fs	PN	=	9.97 mV
PJ(h)	=	0 s	PN(v)	=	9.97 mV
PJ(v)	=	821.85 fs	PN(h)	=	0 V
Total Jitter @ BER			**Total Noise @ BER**		
TJ (1E-12)	=	47.18 ps	TN (1E-12)	=	457.60 m
Eye Opening (1E-12)	=	49.79 ps	Eye Opening (1E-12)	=	332.20 m
			Eye Amplitude	=	789.80 m
Dual Dirac			**SSC Modulation**		
RJ(d-d)	=	1.50 ps	Magnitude	=	0 ppm
DJ(d-d)	=	25.62 ps	Frequency	=	0 Hz

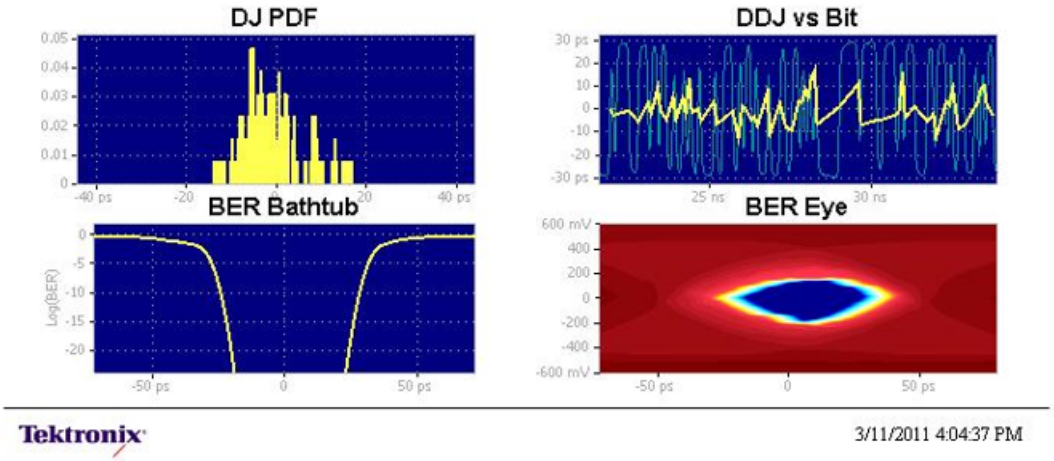

Figure 5. Jitter Analysis:
Breakdown into DJ, RJ, and TJ for 10.3125 Gbps Case

6.2 FR4 Performance

The output de-emphasis of the DS100BR210 allows for flexible placement options on the receive system board. Even at 10.3125 Gbps, a clean eye can be achieved nearly 20” away without resorting to expensive board materials or special board stackups.

SETUP2: PRBS7 Generator → DS100BR210 (A) → 15” FR4 (4-mil trace width) → Scope

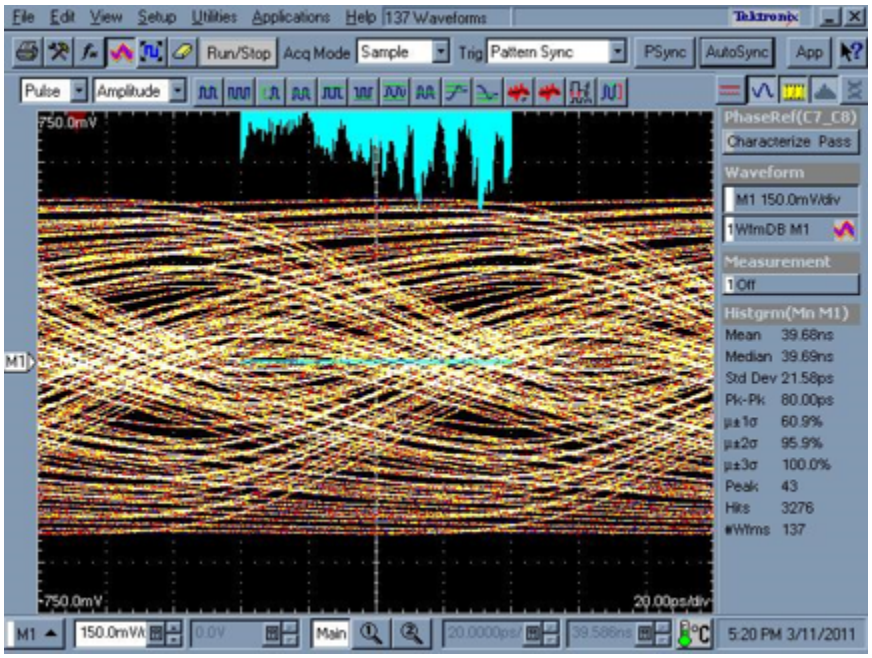

Figure 6. 10.3125 Gbps Eye Diagram at SCOPE in SETUP2 (DE Setting = 000'b)

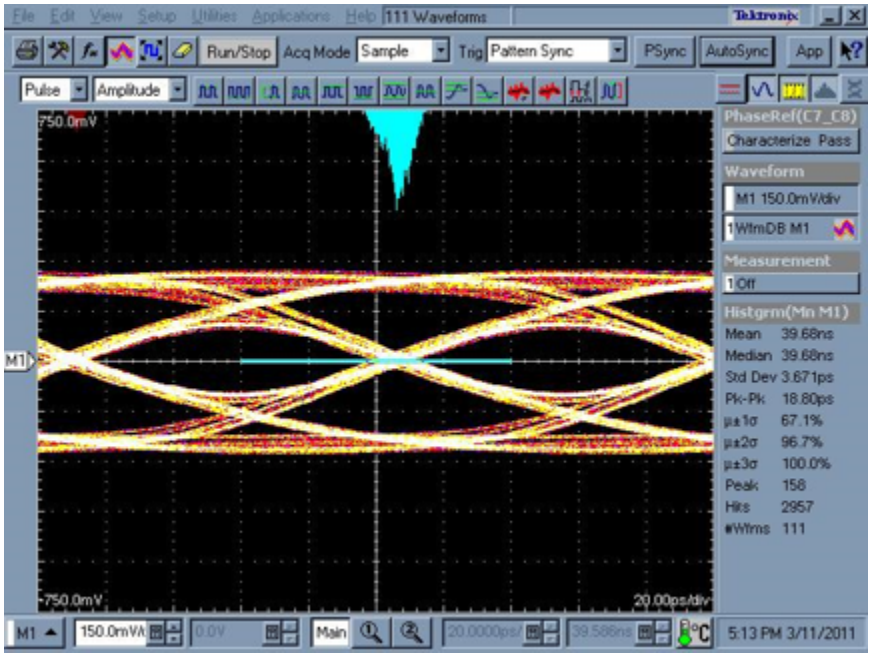

Figure 7. 10.3125 Gbps Eye Diagram at SCOPE in SETUP2 (DE Setting = 110'b)

7 Schematic

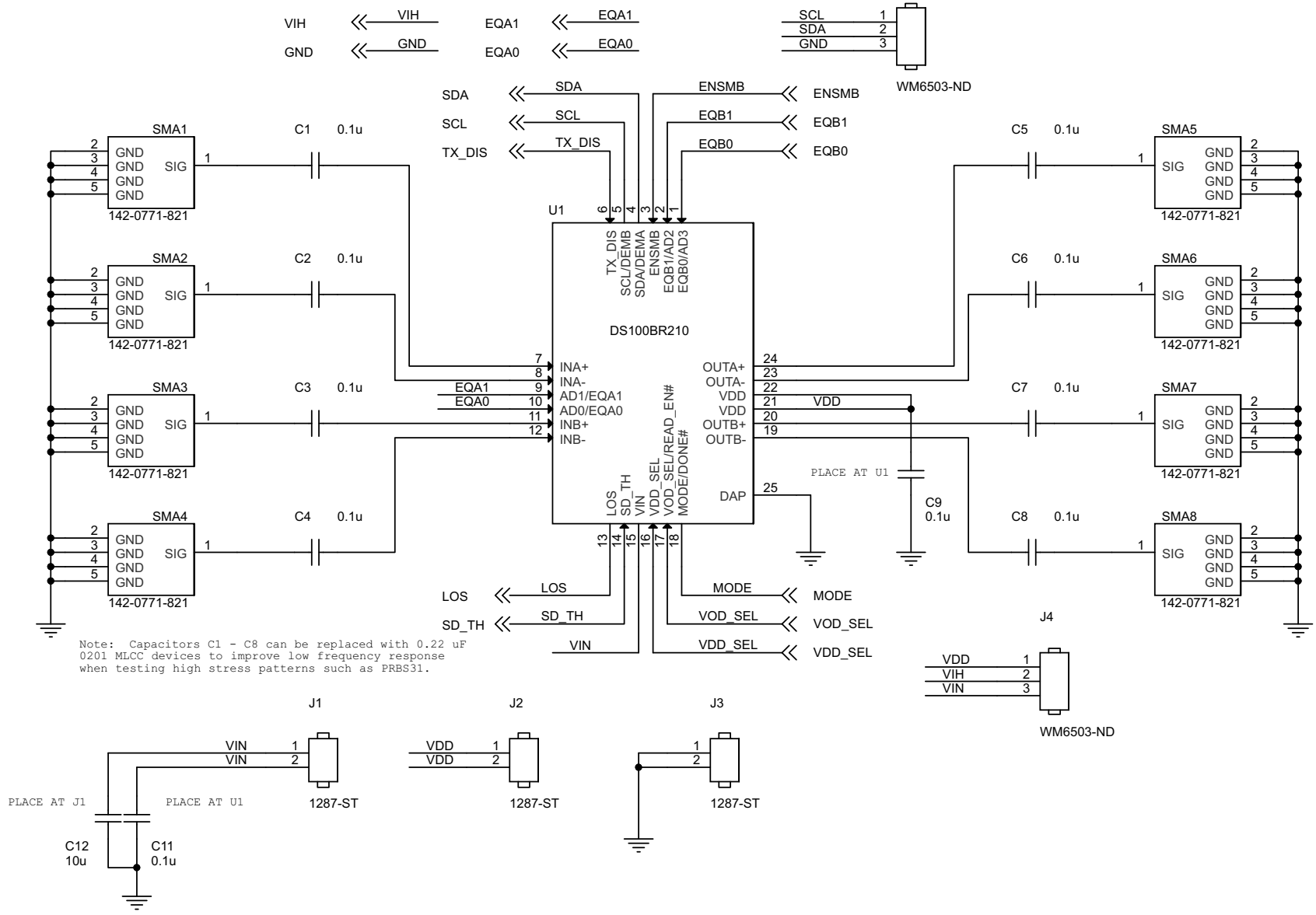

Figure 8. DS100BR210EVK Schematic Page 1

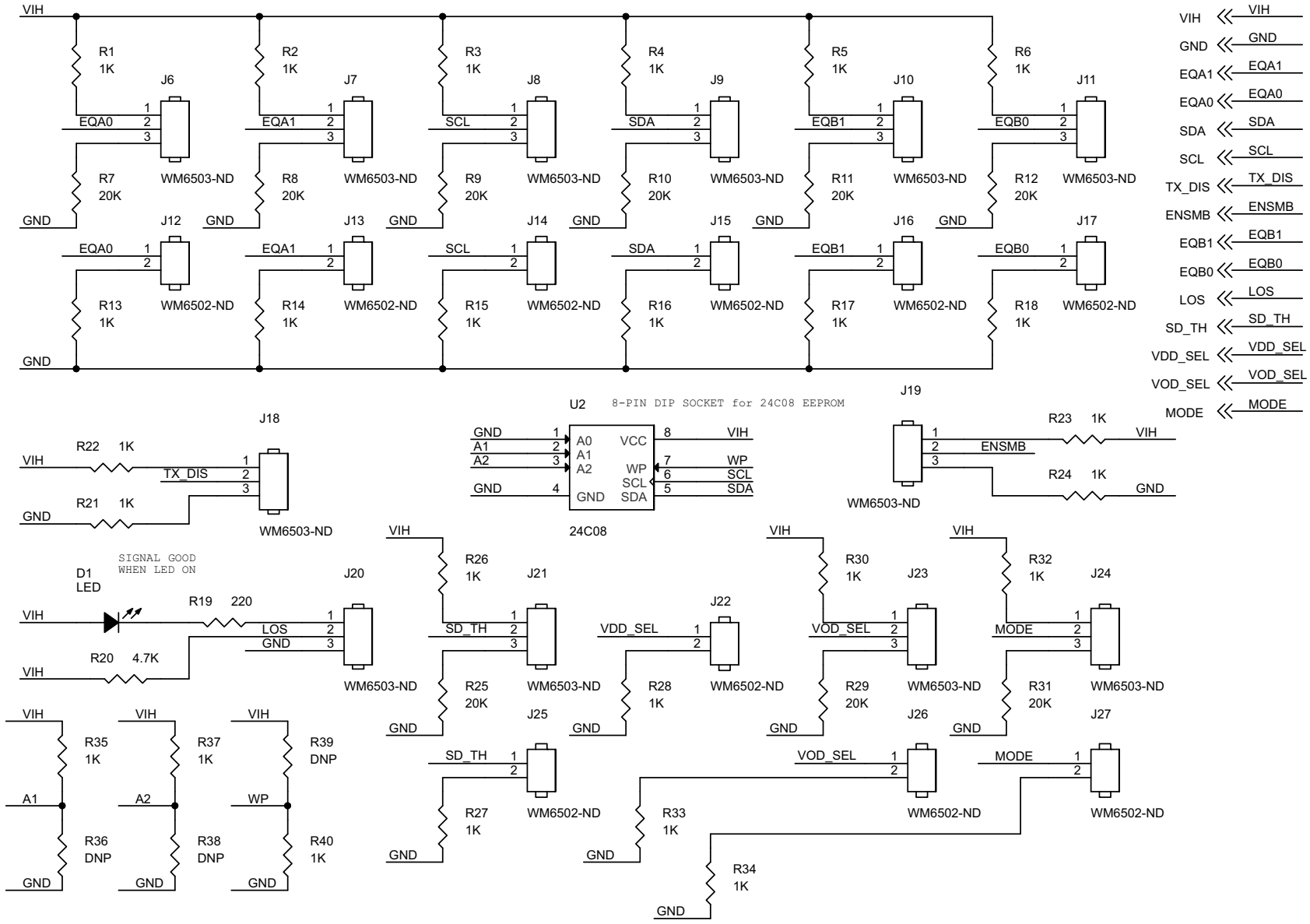

Figure 9. DS100BR210EVK Schematic Page 2

8 Bill of Materials

Item	Quantity	Reference	Digikey PN	Manufacture PN	Descriptions
1	10	C1,C2,C3,C4,C5, C6,C7, C8,C9,C11	445-1796-1-ND	C0603X5R0J104K	CAP CERAMIC .1UF 6.3 V X5R 0201
2	1	C12	511-1502-1-ND	TCTAL1C226M8R	CAP TANT 22UF 16 V 20% SMD 1206
3	1	D1	160-1409-1-ND	LTST-C139KGKT	LED GREEN 0603 SMD
4	10	SMA1,SMA2,SMA3, SMA4, SMA5,SMA6, SMA7,SMA8, SMA9, SMA10,SMA11,SMA12	J807-ND	142-0771-821	CONN JACK SMA 50 Ω PC MOUNT
5	14	J4,J5,J6,J7, J8,J9,J10, J11,J18,J19, J20,J21,J23, J24	WM6503-ND	22-28-4033	CONN HEADER 3POS .100 VERT GOLD
6	10	J12,J13,J14, J15,J16,J17, J22,J25,J26,J27	WM6502-ND	22-28-4023	CONN HEADER 2POS .100 VERT GOLD
7	26	R1,R2,R3,R4, R5,R6,R13, R14, R15,R16,R17,R18, R21, R22,R23,R24, R26,R27,R28, R30, R32,R33,R34,R35, R37, R40	RHM1.0KJCT-ND	MCR01MZPJ102	RES 1.0K Ω 1/16W 5% 0402 SMD
8	9	R7,R8,R9, R10,R11,R12, R25, R29,R31	RHM20.0KLCT-ND	MCR01MZPF2002	RES 20.0K Ω 1/16W 1% 0402 SMD
9	1	R19	RHM220JCT-ND	MCR01MZPJ221	RES 220 Ω 1/16W 5% 0402 SMD
10	1	R20	RHM4.7KJCT-ND	MCR01MZPJ472	RES 4.7K Ω 1/16W 5% 0402 SMD
11	1	R41,R42	RHM0.0JCT-ND	MCR01MZPJ472	RES 0.0 Ω 1/16W 5% 0402 SMD
12	1	U1	NA	TEXAS INSTRUMENTS	DS100BR210SQE/NOPB (24LLP - 4x4mm)
13	1	U2	ED90197-ND	115-43-308-41-001000	IC SOCKET 8PIN DIP
14	3	R36,R38,R39	DNP	DNP	DNP

Revision History

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

Changes from Original (April 2014) to A Revision	Page
• Deleted "Demo Kit Contents" section	3
• Changed sections referencing "DS100BR111A" to "DS100BR210"	3
• Changed description for Reg 0x0F recommendation in Table 2 due to typo	6
• Changed Reg 0x23 to Reg 0x25 in Table 2 due to typo	6
• Changed description for Reg 0x06 in Table 2 due to register map update	6
• Changed mV to mVpp to clarify differential amplitude	7
• Changed schematic to correct DS100BR210 pin mapping typo	11
• Changed IC BOM component from NSC DS100BR111 to Texas Instruments DS100BR210	13

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   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

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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

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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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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.

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