

# DAQ on a Stick, Energy Micro Strain Gauge

## Introduction

The “DAQ on a Stick, Energy Micro Strain Gauge” is one of a series of reference designs highlighting Intersil’s precision products with different microcontrollers. This reference design is a self contained demo showing a complete signal chain solution using Intersil parts and an Energy Micro microcontroller. The complete reference design is conveniently housed in a USB stick form factor. This compact design draws power through the USB port and uses a Graphical User Interface (GUI) to display the real time voltage readings from a bridge strain gauge or a user supplied sensor. Figure 1 shows the Data Acquisition (DAQ) on a Stick connected to an external foil strain gauge.

Figure 2 shows a simplified schematic of the Strain Gauge design. The design uses Intersil’s ISL28134 chopper amplifier, ISL22316 Digitally Controlled Potentiometer (DCP), ISL43741 differential mux, ISL21010 4.096 voltage reference, the ISL26102 24-bit delta sigma converter and Energy Micro’s EFM32LG332F128 microcontroller.



FIGURE 1. DAQ ON A STICK WITH STRAIN GAUGE

## Ordering Information

PART NUMBER	DESCRIPTION
ISLEM-BDGSTKEV1Z	Evaluation Board

## Getting Started

### Installation of the Graphical User Interface (GUI) Software and USB Drivers

The GUI Software and USB drivers have to be installed on a PC running Windows NT/2000/XP/Vista/Win7/Win8 operating system before connecting the ISLEM-BDGSTKEV1Z evaluation board to the USB port.

The software and a quick video on the operation of this application demo can be downloaded or viewed from the Intersil website at <http://www.intersil.com/en/tools/reference-designs/emicro-strain-gauge-reference-design.html>.

### Loading Software

Click on the Energy Micro DAQ on a Stick Software link to load the executable. Follow the on screen instructions to complete the software installation. The installation program places the user interface software in the C:\Program Files\IntersilEnergyMicroSGDAQonStick directory. To create a shortcut on your desktop, check the “Create A Desktop Icon” box during the software installation. Launch the application by checking the “Launch Intersil Energy Micro DAQ on Stick” box, then click the “Finish” button.

### Video Clip

A quick video clip is also provided at the above web link. This video will walk the user through the operation and use of the GUI.

### Running the Evaluation Software

After software has been installed, plug the ISLEM-BDGSTKEV1Z board into a USB port on the computer and click on the Intersil DAQ shortcut (created in the step above) on the desktop. Figure 3 shows the desk top icon.

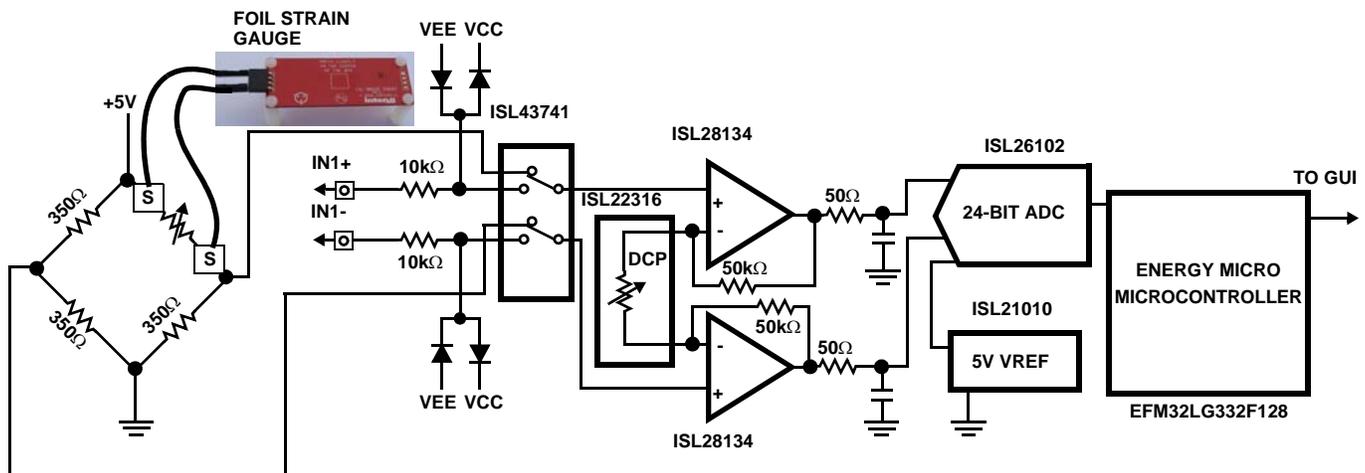


FIGURE 2. SIMPLIFIED STRAIN GAUGE SCHEMATIC

# Application Note 1820



FIGURE 3. DESKTOP ICON

The green LED on the DAQ on a Stick board should be on at this time. When the software starts, the DAQ Startup screen shown in Figure 5 will appear. With the DAQ on a Stick connected, the USB Status indicator will display “Connected 0x202A”. The assigned HID code for this application is 0x202A. This is verification the software is communicating with the board.

If the DAQ on a Stick is not connected, or a problem exists with the demo, the message will read “HID Device Not Found”. If this occurs, click on the “Test USB Connection” button to see if this enables the connection. If not, try disconnecting and re-connecting the device or restarting the software.

From the DAQ Start-up Screen (Figure 5), the user can click on the Instantaneous Voltage button to get a single voltage reading, select the sensor input they want to measure and adjust the gain of the amplifier, or click the Start button to go to the Measurement Display screen, as shown in Figure 6. At this point the green LED on the board will go off.

## Connecting the Sensor

The ISLEM-BDGSTKEV1Z reference design gives the user the option to measure the strain on a foil gauge (supplied with the evaluation board) or connect their own sensor and monitor the voltage reading on the GUI screen. The user will select the “Supplied with the Demo” sensor or “Customer Supplied” sensor by clicking the appropriate radial button at the bottom left side of the GUI (reference Figure 5).

Figure 4 shows the external connector inputs, which are used to connect the sensor to the circuit shown in Figure 2.

## Supplied with Demo Sensor

If the User selects the “Sensor Supplied with Demo” option, the default gain value of the amplifier is 110 V/V and the Gain Selection box is inoperative and grayed out.

1. To connect the foil gauge supplied with the evaluation board, plug the wires into the “S” ports shown in Figure 4 (either top row or bottom row, the columns are connected). Note: a resistor has no polarity and therefore which wire is connected to a specific “S” input doesn’t matter.
2. Connect the opposite end of the wires to the far edges of the foil gauge board as shown in Figure 5.

## Customer Supplied Sensor

1. To connect a “Customer Supplied” sensor, plug the wires into the IN+ and IN- ports shown in Figure 4, then select the “Customer Supplied” option, as shown in Figure 5. This will cause the ISL43741 differential mux to switch the inputs. Once the customer supplied option is selected, the user will have the option of changing the amplifiers’ gain for the best measurement by clicking on the radial buttons in the Gain Selection Box located on the DAQ Startup GUI.
2. The DAQ on a Stick also provides a 5V supply and Ground connection for possible use by the customer’s sensor network.

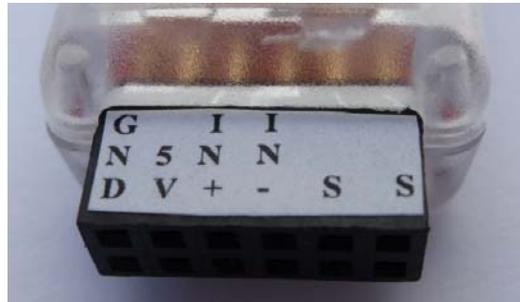


FIGURE 4. SENSOR CONNECTOR

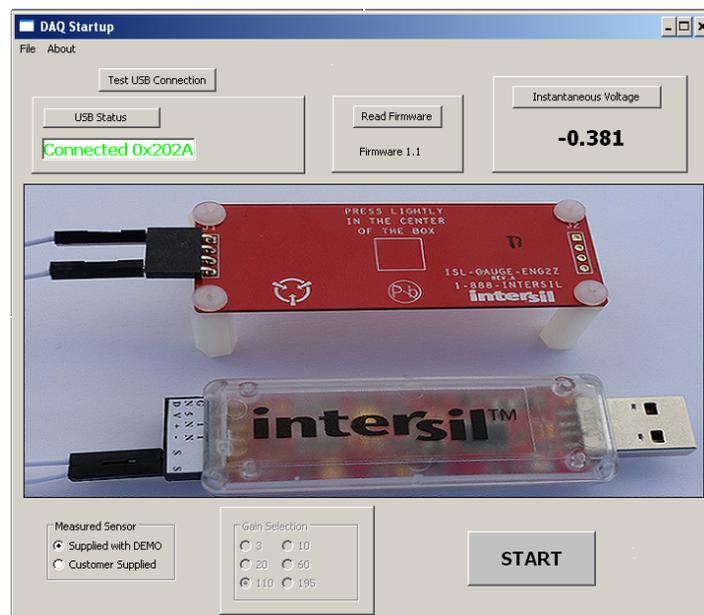


FIGURE 5. GUI START-UP SCREEN

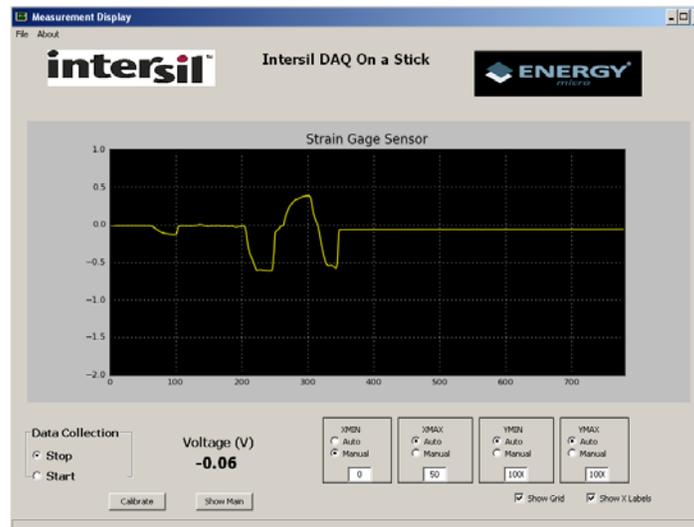


FIGURE 6. GUI MEASUREMENT SCREEN

Once the sensor to be measured is selected on the Setup screen, click on the START Button to proceed to the measurement screen. Figure 6 shows the Measurement Display screen. The Calibrate button located at the bottom left of the screen enables the User to zero out the strain measurement. This is required because the deflection of the strain gauge board does not always return to the same point after being flexed. By calibrating this error out, the user can get an accurate reading for the force being applied during any single event. Also from this screen, the user can stop and start data collection and adjust the minimum and maximum X & Y axis. The User, if using a Customer Supplied sensor, can go back to the set-up screen to change the value of the gain by clicking on the Show Main button at the bottom of the measurement screen. The User can then return to the measure screen by clicking on the START button.

## Design Considerations

### ISL28134

The ISL28134 is an ideal choice for the input amplifier for a strain gauge design. The ISL28134 uses auto-correction circuitry to provide ultra low offset voltage (2.5 $\mu$ V), and low offset temperature drift (15nV/ $^{\circ}$ C). The very low 1/f noise corner <0.1Hz and low input noise voltage (8nV/ $\sqrt{\text{Hz}}$  @ 100Hz) of the amplifier makes it ideal for low frequency precision applications requiring very high gain and low noise. Other attributes of the ISL28134 are the wide gain bandwidth and rail-to-rail input/output swing.

### ISL26102 24-bit ADC

The ISL26102 is a complete analog front-end with dual differential multiplexed inputs for high resolution measurements. ISL26102 features a third order modulator providing up to 21.4-bit noise-free performance (10Sps). The 24-bit delta-sigma analog-to-digital converter includes a very low-noise amplifier with programmable gain. Although this application demo uses an input buffer amplifier (ISL28134), the high input impedance of the ISL26102 allows direct connection of sensors, such as load cell bridges to ensure the specified measurement accuracy without a buffer amplifier.

In order to initiate a correct power-up reset, diode D1, resistor R3 and capacitor C8 implement a simple RC delay to ensure the PDWN transitions from low to high after both power supplies have settled to specified levels.

### ISL21010 (4.096V)

The ISL21010CFH341 is a precision 4.096V, low dropout micropower bandgap voltage reference. It provides a  $\pm 0.2\%$  accurate reference. The ISL21010 provides up to 25mA output current sourcing with low 150mV dropout voltage. The low supply current and low dropout voltage combined with high accuracy make the ISL21010 ideal for precision low powered applications.

### ISL22316 DCP

The ISL22316 is a low noise, low power I<sup>2</sup>C™ bus, 128 tap DCP. The DCP can be used as a three-terminal potentiometer or as a two-terminal variable resistor in a wide variety of applications including control, parameter adjustments, and signal processing.

### ISL43741 Diff 4 to 1 Multiplexer

The ISL43741 is a precision, bidirectional, differential 4-channel multiplexer/demultiplexer. The mux is designed to operate from a single +2V to +12V supply or from  $\pm 2$ V to  $\pm 6$ V supplies. The ISL43741 has low charge injection with 1pC (Max) at  $V_S = \pm 5$ V.

## Reference Documents

- Intersil ISL28134 Data Sheet “5V Ultra Low Noise, Zero Drift Rail-to-Rail Precision Op Amp,” [FN6957](#)
- Intersil ISL21010 Data Sheet “Micropower Voltage Reference,” [FN7896](#)
- Intersil ISL26102 Data Sheet “Low-Noise 24-bit Delta Sigma ADC,” [FN7608](#)
- Intersil ISL43741 Data Sheet “Low-Voltage, Single and Dual Supply, 8 to 1 Multiplexer and Differential 4 to 1 Multiplexer,” [FN6053](#)
- Intersil ISL22316 Data Sheet “Low Noise, Low Power I<sup>2</sup>C® Bus, 128 Taps,” [FN6186](#)
- Energy Micro EFM32LG332F128 [Data Sheet](#)

# Bill of Materials

PART NUMBER	REF DES	QTY	VALUE	TOL.	VOLTAGE	POWER	PACKAGE TYPE	JEDEC TYPE	MANUFACTURER	DESCRIPTION
H1044-00103-16V10	C1, C6, C11, C12, C16	5	0.01µF	10%	16V		402	CAP_0402	GENERIC	Multilayer Cap
H1044-00104-16V10	C2, C5, C7, C9, C17, C18, C22	7	0.1µF	10%	16V		402	CAP_0402	GENERIC	Multilayer Cap
H1045-00105-16V20	C3, C13, C15	3	1µF	20%	16V		603	CAP_0603	GENERIC	Ceramic Cap
H1065-00106-16V10	C4	1	10µF	10%	16V		1206	CAP_1206	GENERIC	Multilayer Cap
H1046-00225-16V10	C8	1	2.2µF	10%	16V		805	CAP_0805	GENERIC	Multilayer Cap
H1045-00103-25V10	C10, C24, C25, C26	4	0.01µF	10%	25V		603	CAP_0603	GENERIC	Multilayer Cap
GRM21BR71C475KA73L	C14	1	4.7µF	10%	16V		805	CAP_0805	MURATA	Ceramic Cap
H1045-OPEN	C19, C23	2	OPEN	5%	OPEN		603	CAP_0603	GENERIC	Multilayer Cap
H1044-00120-50V5	C20, C21	2	12pF	5%	50V		402	CAP_0402	GENERIC	Multilayer Cap
BAT54	D1	1					SINGLE	SOT23	DIODES	30V Schottky Diode
MMSD4148T1	D2, D4-D6	4					SOD123	SOD123	ON-Semi	Switching Diode
597-3311-407	D3	1					SMD	DIA_LED1206	Dialight	Surface Mount Green LED
48037-1000	J1	1					MOLEX1	CON_USB_MOLEX_480371000	MOLEX	Right Angle USB A-Type Receptacle
PPPC062LJBN-RC	J2	1					DIP	CONN12	SULLINS	12 Pin Header 2.54mm x 2.54mm (0.100) Connector RA
251206102Y1	L1	1	1µH	TBD		TBD	SMD	SM1210	FAIR-RITE	Ferrite Bead
SMD-30C-PAD	P1-P6	6	DNP	DNP		DNP	SMD	SMD-30C-PAD	GENERIC	30 Mil Circular Surface Mount
H2510-00R00-1/16W	R1, R6, R11	3	0Ω	0%		1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
H2510-01000-1/16W1	R2	1	100Ω	1%		1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
H2510-01001-1/16W1	R3	1	1kΩ	1%		1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
H2510-049R9-1/16W1	R4, R5	2	49.9Ω	1%		1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
H2510-04992-1/16W1	R7, R8	2	49.9kΩ	1%		1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
H2510-DNP-DNP-1	R9, R20, R21	3	DNP	1%		DNP	402	RES_0402	GENERIC	Thick Film Chip Resistor (Do Not Populate)
H2511-00150-1/16W1	R12, R14	2	15	1%		1/16W	603	RES_0603	GENERIC	Thick Film Chip Resistor

## Bill of Materials (Continued)

PART NUMBER	REF DES	QTY	VALUE	TOL	VOLTAGE	POWER	PACKAGE TYPE	JEDEC TYPE	MANUFACTURER	DESCRIPTION
H2510-04991-1/16W1	R13, R15	2	4.99k $\Omega$	1%		1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
H2512-02490-1/10WR1	R16, R22, R25	3	249 $\Omega$	0.1%		1/10W	805	RES_0805	GENERIC	Thick Film Chip Resistor
MCR03EZPFX3001	R17	1	3k $\Omega$	1%		1/10W	603	RES_0603	ROHM	Metal Film Chip Resistor
H2512-01000-1/10WR1	R18, R23, R26	3	100 $\Omega$	0.1%		1/10W	805	RES_0805	GENERIC	Thick Film Chip Resistor
H2512-00010-1/10WR1	R19, R24, R27	3	1 $\Omega$	0.1%		1/10W	805	RES_0805	GENERIC	Thick Film Chip Resistor
H2510-01002-1/16W1	R28, R29	2	10k $\Omega$	1%		1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
ISL26102AVZ	U1	1					TSSOP	TSSOP24_173_256	INTERSIL	24 Pin 173 Mil TSSOP Package
ISL21010CFH341Z	U2	1					SOT	SOT23-3	GENERIC	3 Pin SOT23-3 PACKAGE
ISL28134FHZ	U3, U4	2					SMD	SOT23-5	GENERIC	5 Pin SOT23 Package
ISL43741IRZ	U5	1					QFN	QFN20_157X157_197_EP	INTERSIL	20 Lead Quad Flat Package (Pb-free)
ISL22316UFRT	U6	1					DFN3X3B	TDFN10_118X118_197_EPB	GENERIC	10 Lead 3 X 3.5 Pitch Thin Dual Flat Package with E-Pad
EFM32LG332F128-QFP64T	U7	1					TQFP	64TQFP-50-RF	GENERIC	64-10x10 0.5mm Pitch TQFP Package
IP4220CZ6	U8	1					SOT457	SOT457	NXP	Dual USB 2.0 Integrated ESD Protection
NX5032GA-48.000M-LN-CD-1	Y1	1					SM	XTAL_NX5032GA	NDK	48.000MHz SM Crystal

# ISLEM-BDGSTKEV1Z Evaluation Board Layout

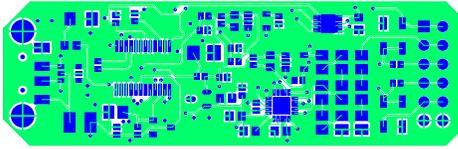


FIGURE 7. TOP LAYER

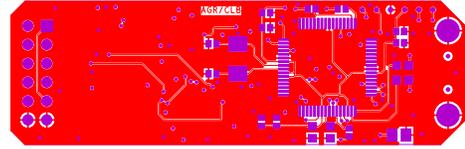
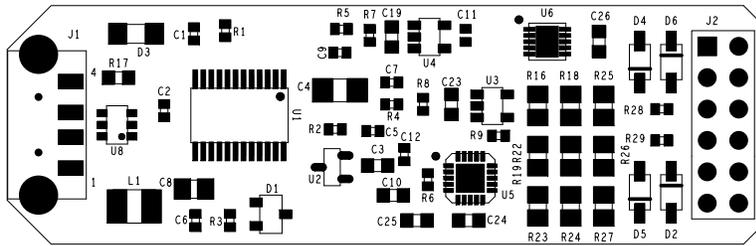
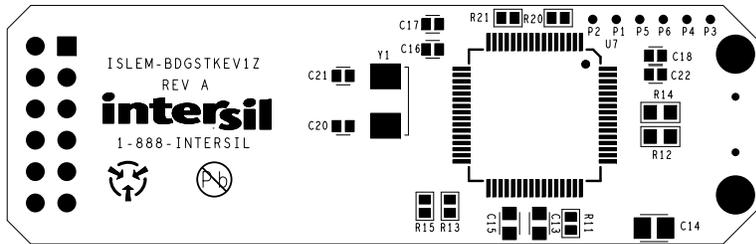


FIGURE 8. BOTTOM LAYER



TOP ASSEMBLY DRAWING



BOTTOM ASSEMBLY DRAWING

FIGURE 9. ASSEMBLY DRAWING

Intersil Corporation reserves the right to make changes in circuit design, software and/or specifications at any time without notice. Accordingly, the reader is cautioned to verify that the Application Note or Technical Brief is current before proceeding.

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# ISLEM-BDGSTKEV1Z Schematic

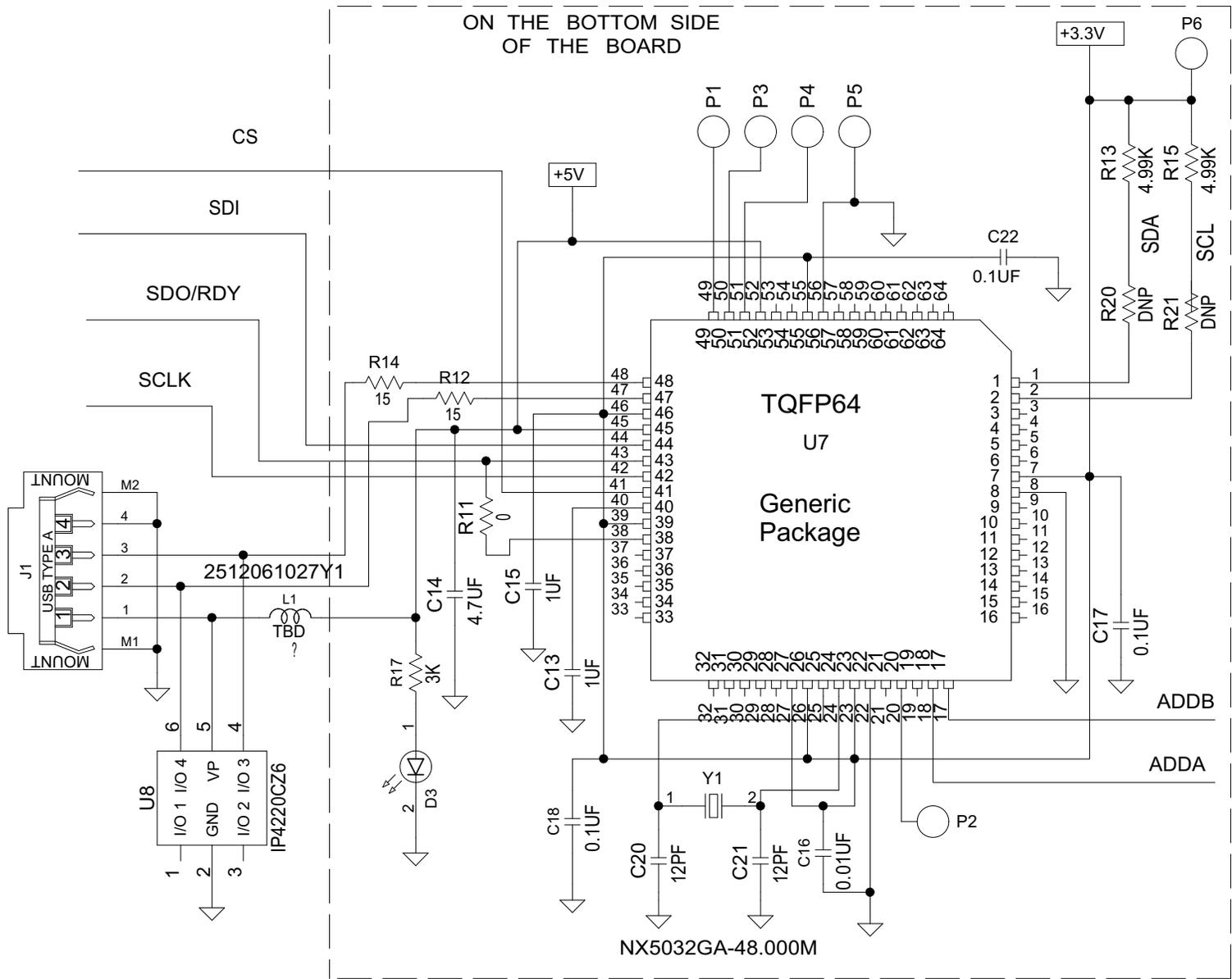
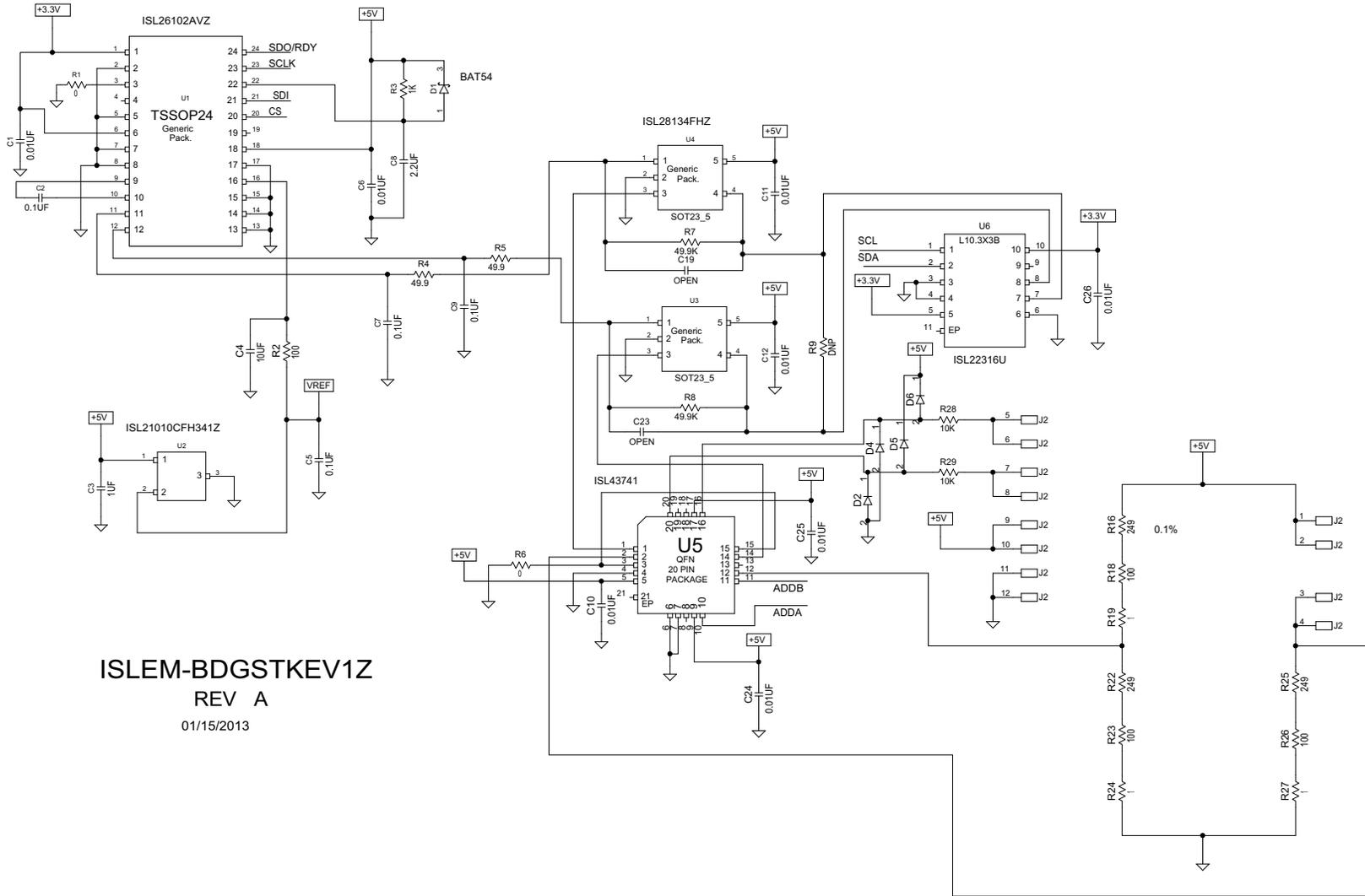


FIGURE 10. ISLEM-BDGSTKEV1Z EVALUATION BOARD SCHEMATIC

# ISLEM-BDGSTKEV1Z Schematic (Continued)



ISLEM-BDGSTKEV1Z  
REV A  
01/15/2013

FIGURE 11. ISLEM-BDGSTKEV1Z EVALUATION BOARD SCHEMATIC