

DAQ on a Stick, Energy Micro Thermocouple

Introduction

The “DAQ on a Stick, Energy Micro Thermocouple” 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 temperature. Figure 1 shows the Data Acquisition on a Stick reference design.

Figure 3 shows a simplified schematic of the thermocouple design. The design uses Intersil’s ISL28134 chopper amplifier, ISL22317 precision Digitally Controlled Potentiometer (DCP), ISL21010 4.096 voltage reference, the ISL26102 24-bit delta sigma converter and Energy Micro’s EFM32LG332F128 microcontroller.

Ordering Information

PART NUMBER	DESCRIPTION
ISLEM-TCSTKEV1Z	Evaluation Board



FIGURE 1. DAQ ON A STICK WITH THERMOCOUPLE

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 operating system before connecting the ISLEM-TCSTKEV1Z 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-thermo-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\IntersilEnergyMicroTCDAQonStick 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-TCSTKEV1Z board into a USB port on the computer and click on the Intersil DAQ shortcut (created in the step above) on the desktop. Figure 2 shows the desktop icon.



FIGURE 2. DESKTOP ICON

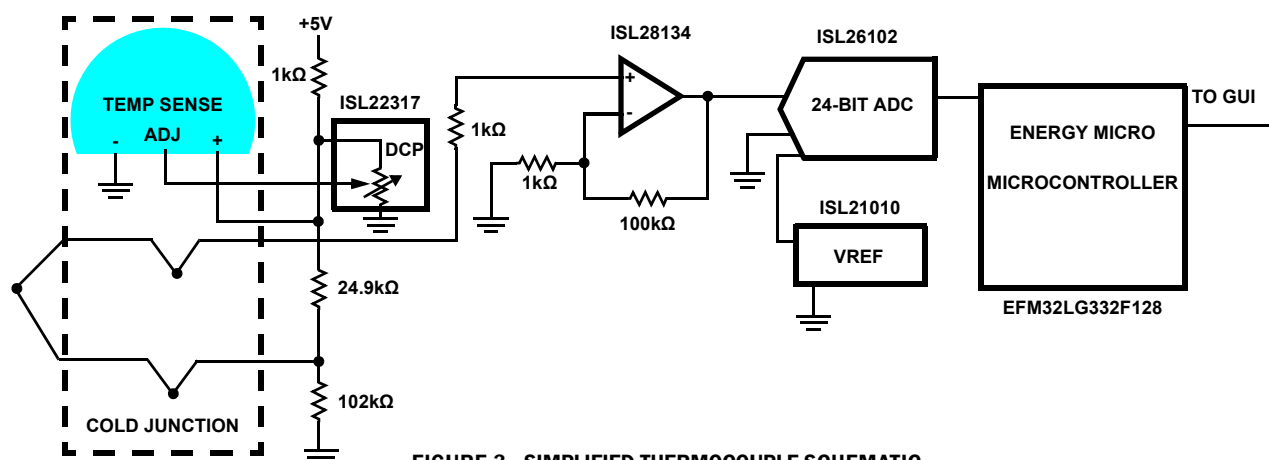


FIGURE 3. SIMPLIFIED THERMOCOUPLE SCHEMATIC

Application Note 1801

The green LED on the DAQ on a Stick board should be on at this time. When the software starts, the DAQ Start-up screen shown in Figure 4 will appear. With the DAQ on a Stick connected, the USB Status indicator will display **Connected 0x2029**. The assigned HID code for this application is 0x2029. This is verification that 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, the user can click on the Instantaneous Temperature button to get a single temperature reading or click the Start button to go to the Measurement display screen, as shown in Figure 5. At this point, the green LED on the board will go off.

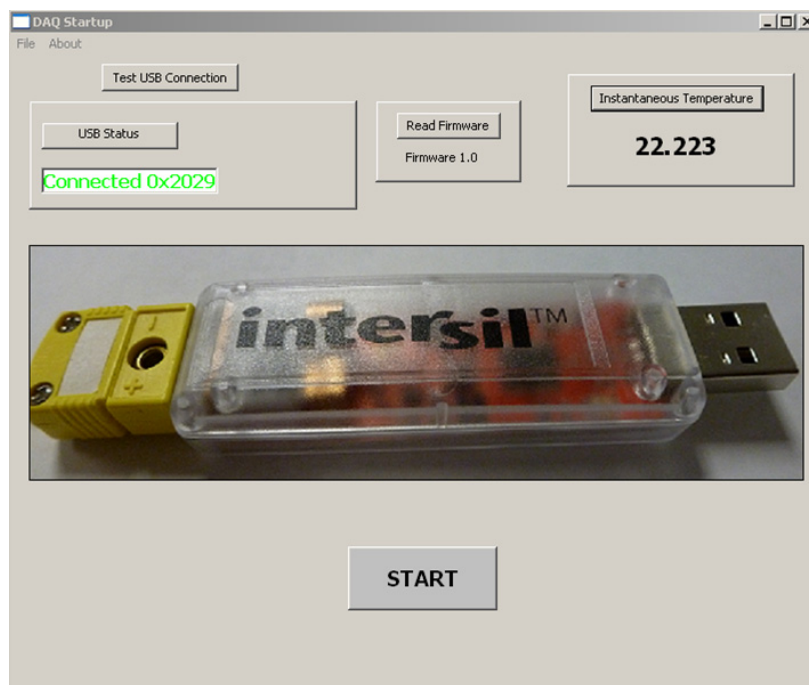


FIGURE 4. GUI START-UP SCREEN

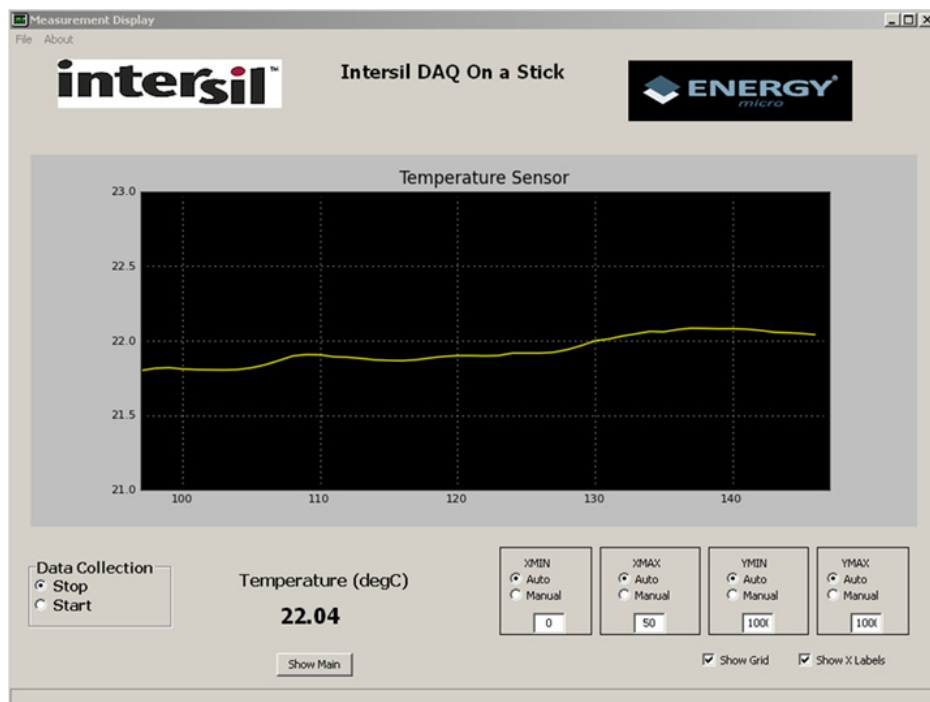


FIGURE 5. GUI MEASUREMENT SCREEN

Figure 5 shows the Measurement Display screen. From this screen, the user can stop and start data collection, adjust the minimum and maximum X and Y axis and go back to the set-up screen by clicking on the Show Main button.

Accuracy of Reference Design

The application circuit is calibrated at +25°C to within ±0.1°C using a Fluke 54II Thermometer. The application accuracy of this design is within the achievable accuracy of the K-type thermocouple for temperatures above 0°C. Table 1 shows the limits of error for the K-type thermocouple.

TABLE 1. LIMITS OF ERROR FOR THERMOCOUPLE

THERMOCOUPLE TYPE	TEMPERATURE RANGE (°C)	LIMITS OF ERROR
K	0 to 1250	+2.2°C or +0.75%
K	-200 to 0	+2.2°C or +2.0%

Table 2 shows the measured accuracy across -40°C to 125°C.

TABLE 2. MEASURED ACCURACY OF DAQ ON A STICK

TEMP RANGE (°C)	MEASURED ERROR (°C)
25 to 125	0.7
0 to 125	0.7
-20 to 25	1.7
-40 to 25	3.5

Design Considerations

Temperature calculation

The temperature displayed on the GUI is calculated using the formula in Equation 1. V_{OUT} is the output voltage of the ISL28134 Chopper amplifier when set for a gain of 100.

$$\text{Temperature} = \frac{(V_{out} - 1.1092)}{4.14 \text{ mV}/^{\circ}\text{C}} \quad (\text{EQ. 1})$$

ISL28134

The ISL28134 is an ideal choice for the input amplifier for a thermocouple design. The ISL28134 uses auto-correction circuitry to provide ultra low offset voltage (2.5µV), and low offset temperature drift (15nV/°C). The very low 1/f noise corner <0.1Hz and low input noise voltage (8nV/√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. The 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 D_1 , resistor R_3 and capacitor C_8 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 ±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.

ISL22317 DCP

The highly precise ISL22317 features a low end-to-end temperature coefficient of ±10ppm/°C and precise resistance selection. It maintains less than ±1% typical variance from the ideal resistance at each wiper position providing 99% accuracy of selected resistance value. This highly accurate DCP eliminates the need for complex algorithms to guarantee precision. The ISL22317 operates from a single supply between 2.7V to 5.5V.

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 ISL22317 Data Sheet “Low Noise, Low Power, I²C™ Bus, 128 Taps DCP” [FN6912](#)
- Energy Micro EFM32LG332F128 [Data Sheet](#).

TABLE 3. BILL OF MATERIALS

PART NUMBER	REF DES	QTY	VALUE	TOTAL	VOLTAGE	POWER	PACKAGE TYPE	JEDEC TYPE	MANUFACTURER	DESCRIPTION
BAT54	D1	1					SINGLE	SOT23	DIODES	30V Schottky Diode
MMSD4148T1	D2, D4	2					SOD123	SOD123	ON-SEMI	Switching Diode
597-3311-407	D3	1					SMD	DIA_LED1206	DIALIGHT	Surface Mount Green LED
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, C17, C18, C22	6	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
H1044-OPEN	C9, C10	2	OPEN	OPEN	OPEN		402	CAP_0402	GENERIC	Multilayer Cap
GRM21BR71C475KA73L	C14	1	4.7μF	10%	16V		805	CAP_0805	MURATA	Ceramic Cap
H1044-00120-50V5	C20, C21	2	12pF	5%	50V		402	CAP_0402	GENERIC	Multilayer Cap
48037-1000	J1	1					MOLEX1	CON_USB_MOLEX_480371000	MOLEX	Right Angle USB A-Type Receptacle
PCC-SMP-K-100-R	J2	1					CON1	CON_PCC-SMP	OMEGA	Type K Thermocouple PCB Connector with Clip
251206102Y1	L1	1	1μH				SMD	SM1210	FAIR-RITE	Ferrite Bead
SMD-30C-PAD	P1-P6	6	DNP	DNP			SMD	SMD-30C-PAD	GENERIC	30 Mil Circular Surface Mount
H2510-00R00-1/16W	R1, R11	2	0	0%		1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
H2510-01000-1/16W1	R2	1	100	1%		1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
H2510-01001-1/16W1	R3, R5, R9, R10	4	1kΩ	1%		1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
H2510-01002-1/16W1	R4	1	10kΩ	1%		1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
H2510-01020-1/16W1	R6	1	102Ω	1%		1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
H2510-02492-1/16W1	R7	1	24.9kΩ	1%		1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
H2510-01003-1/16W1	R8	1	100kΩ	1%		1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
H2511-00150-1/16W1	R12, R14	2	15Ω	1%		1/16W	603	RES_0603	GENERIC	Thick Film Chip Resistor
H2510-04991-1/16W1	R13, R15, R16, R19	4	4.99kΩ	1%		1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor

TABLE 3. BILL OF MATERIALS (Continued)

PART NUMBER	REF DES	QTY	VALUE	TOLAL	VOLTAGE	POWER	PACKAGE TYPE	JEDEC TYPE	MANUFACTURER	DESCRIPTION
H2510-DNP-DNP-1	R20, R21	2	DNP	1%		DNP	402	RES_0402	GENERIC	Thick Film Chip Resistor(Do Not Populate)
MCR03EZPFX3001	R17	1	3k Ω	1%		1/10W	603	RES_0603	ROHM	Metal Film Chip Resistor
H2506-01002-1/10WR1	R18	1	10k Ω	0.10%		1/10W	805	RES_0805	GENERIC	Metal 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	1					SMD	SOT23-5	GENERIC	5 Pin SOT23 Package
LM335Z	U4	1					T092	T092	NATIONAL	PRECESION TEMPERATURE SENSOR
IP4220CZ6	U5	1					SOT457	SOT457	NXP	Dual USB 2.0 Integrated ESD Protection
EFM32LG332F128-QFP64T	U6	1					TQFP	64TQFP-50-RF	GENERIC	64-10x10.5mm Pitch TQFP Package
ISL22317W	U7	1					DFN3X3B	TDFN10_118X118_197_EPB	GENERIC	10 Lead 3X3 0.5 Pitch Thin Dual Flat Package with E-Pad
NX5032GA-48.000M-LN-CD-1	Y1	1					SM	XTAL_NX5032GA	NDK	48.000MHz SM Crystal

ISLEM-TCSTKEV1Z Evaluation Board Layout

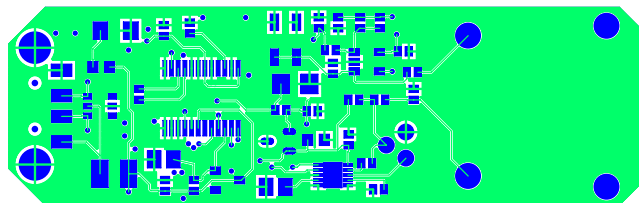


FIGURE 6. TOP LAYER

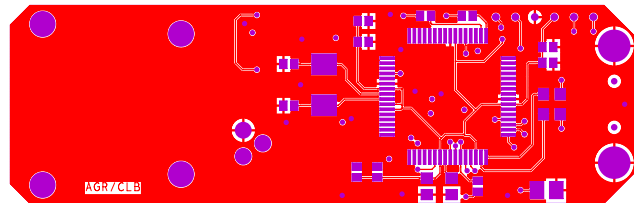
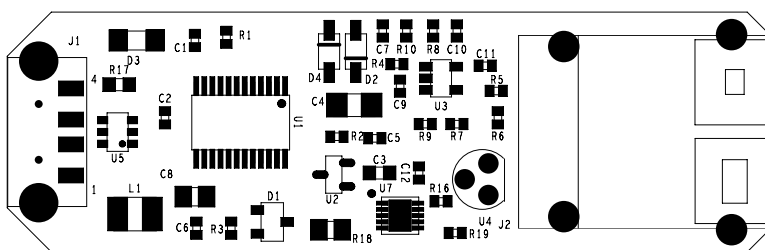
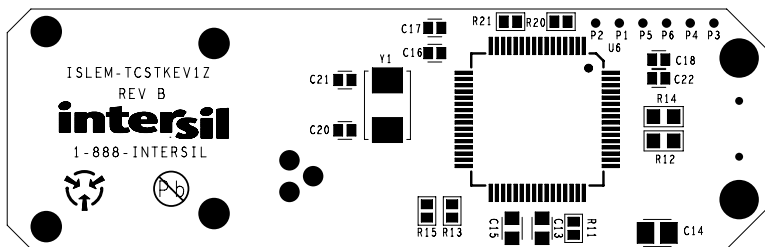


FIGURE 7. BOTTOM LAYER



TOP ASSEMBLY DRAWING



BOTTOM ASSEMBLY DRAWING

FIGURE 8. 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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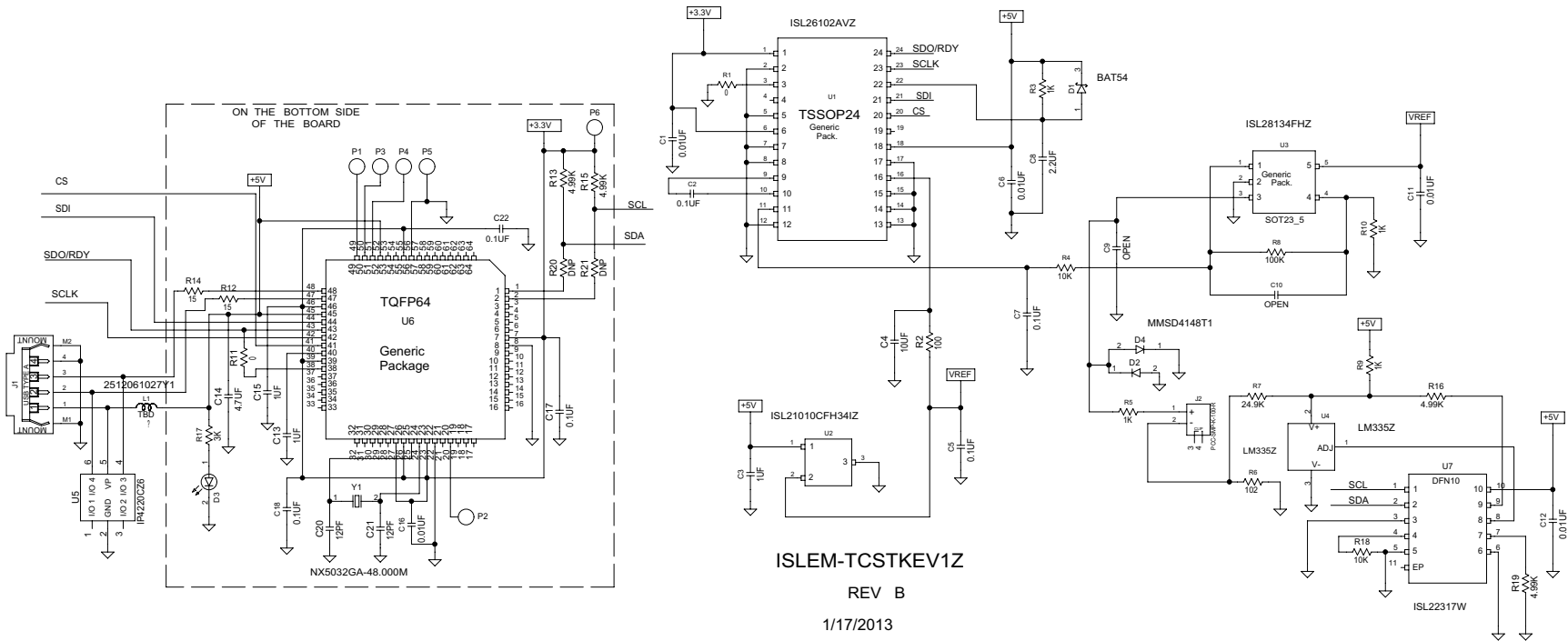


FIGURE 9. ISLEM-TCSTKEV1Z SCHEMATIC

ISLEM-TCSTKEV1Z

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