

## Introduction

The "DAQ on a Stick, Atmel Thermocouple" is the first 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 Atmel microprocessor. The complete reference design is conveniently housed in a USB stick form factor. This compact design enables the user to power the application through the USB port and monitor the temperature through the GUI interface on a computer. Figure 1 shows the Data Acquisition on a Stick reference design with the thermocouple attached.

Figure 3 shows a simplified schematic of the thermocouple design. The design uses Intersil's ISL28134 chopper amplifier, ISL21010 4.096 voltage reference, our ISL26132 24-bit delta sigma converter and Atmel's AT90USB162 microcontroller.

## Ordering Information

PART NUMBER	DESCRIPTION
ISLTHERMO-STKEV2Z	Evaluation Board

## Reference Documents

- Intersil ISL28134 Data Sheet, [FN6957](#)
- Intersil ISL21010 Data Sheet, [FN7896](#)
- Intersil ISL26132 Data Sheet, [FN6954](#)
- Atmel A90USB162 Data Sheet, 7707-AVR-11/10



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 Operation System before connecting the ISLTHERMO-STKEV2Z 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 [here](#).

### Loading Software

Click on the Atmel DAQ on a Stick Software link. Follow the on screen instructions to complete the software installation. The installation program places the user interface software in the C:\Program Files\IntersilAtmelDAQonStick 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 IntersilAtmelDAQonStick box then click the finish button.

### Video Clip

A quick video clip is also provided [here](#) or at the above 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 ISLTHERMO-STKEV2Z 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 desk top icon.



FIGURE 2. DESKTOP ICON

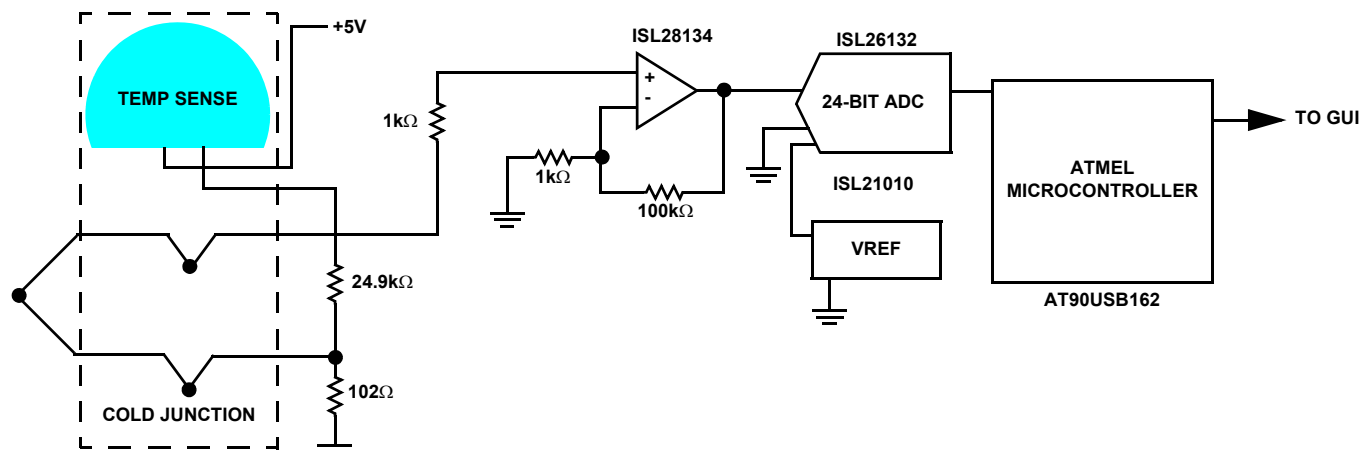


FIGURE 3. ISLTHERMO-STKEV2Z SIMPLIFIED EVALUATION BOARD SCHEMATIC

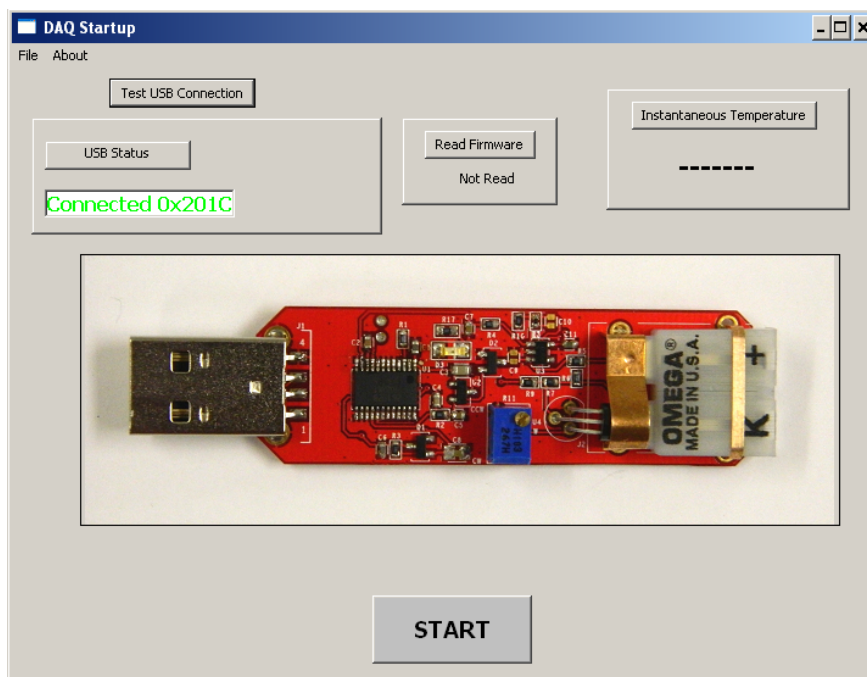


FIGURE 4. GUI START-UP SCREEN

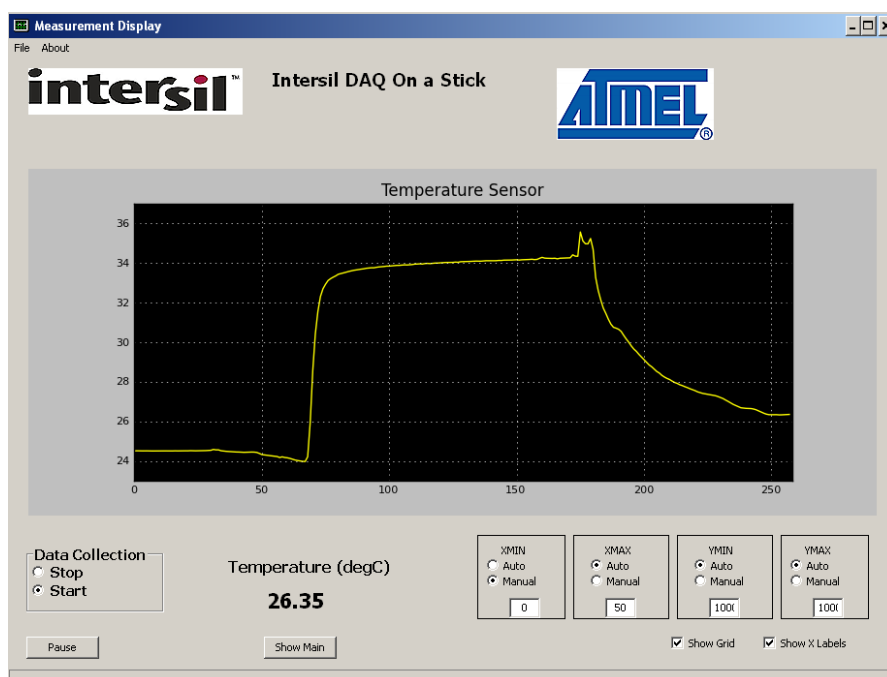


FIGURE 5. GUI MEASUREMENT SCREEN

The green LED on the DAQ on a Stick board should be on at this time. When the software starts, the DAQ Startup screen as shown in Figure 4 will appear. With the DAQ on a Stick connected, the USB Status indicator will display **Connected 0x201C**. The assigned HID code for this application is 0x201C. 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, try disconnecting the DAQ on a Stick or reloading 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 5 shows the Measurement Display screen. From this screen, the user can stop and start data collection, adjust the minimum and maximum X & 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

TEMPERATURE 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.  $V_{OUT}$  in Equation 1 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, rail-to-rail input/output swing and low power consumption.

### ISL26132 24-BIT ADC

The ISL26132 is a complete dual differential analog front end for high resolution measurements and it features a third order modulator providing up to 21.6-bit noise-free performance. 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 ISL26132 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 ±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.

## Bill of Materials

PART NUMBER	REF DES	QTY	VALUE	TOL	VOLTAGE	POWER	PACKAGE TYPE	JEDEC TYPE	MANUFACTURER	DESCRIPTION
C0805C106K8PACTU	C12	1	10 $\mu$ F	10%	10V	-	805	CAP_0805	KEMET	Multilayer Cap
H1044-00103-16V10	C1, C6, C11, C16	4	0.01 $\mu$ F	10%	16V	-	402	CAP_0402	GENERIC	Multilayer Cap
H1044-00104-16V10	C2, C4, C5, C7, C17	5	0.1 $\mu$ F	10%	16V	-	402	CAP_0402	GENERIC	Multilayer Cap
H1044-00220-50V5	C14, C15	2	22pF	5%	50V	-	402	CAP_0402	GENERIC	Multilayer Cap
H1044-OPEN	C9, C10	2	OPEN	OPEN	OPEN	-	402	CAP_0402	GENERIC	Multilayer Cap
H1045-00105-16V20	C3, C13	2	1 $\mu$ F	20%	16V	-	603	CAP_0603	GENERIC	Ceramic Cap
H1046-00225-16V10	C8	1	2.2 $\mu$ F	10%	16V	-	805	CAP_0805	GENERIC	Multilayer Cap
BAT54S	D1, D2	2	-	-	-	-	DUAL-DIODE	SOT23	DIODES	30V 200mA SCHOTTKY BARRIER 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
PCC-SMP-K-100-R	J2	1	-	-	-	-	CON1	CON_PCC-SMP	OMEGA	Type K Thermocouple PCB Connector with Clip
2512061027Y1	L1	1	0.3 $\Omega$	-	-	0.3W	SMD	SM1210	FAIR-RITE PRODUCTS	FERRITTE BEAD
PAD_50	P1, P2	2	-	-	-	-	THOLE	PAD-50	GENERIC	0.050 Pad with 0.031 Plated Thru Hole
SMD-40C-PAD	P3, P4	2	DNP	-	-	-	SMD	SMD-40C-PAD	GENERIC	40 Mil Circular Surface Mount
H2510-00R00-1/16W	R1	1	0	0%	-	1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
H2510-01001-1/16W1	R3, R5, R9, R10	4	1k	1%	-	1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
H2510-01002-1/16W1	R2, R4	2	10k	1%	-	1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
H2510-01003-1/16W1	R8	1	100k	1%	-	1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
H2510-01020-1/16W1	R6	1	102	1%	-	1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
H2510-02492-1/16W1	R7	1	24.9k	1%	-	1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
3262W-1-103	R11	1	10k	10%	-	1/4W	RADIAL	3262W-POT	BOURNS	Trimmer Potentiometer
H2510-04702-1/16W1	R15, R16	2	47k	1%	-	1/16W	402	RES_0402	GENERIC	Thick Film Chip Resistor
H2510-DNP-DNP-1	R13	1	DNP	1%	-	DNP	402	RES_0402	GENERIC	Thick Film Chip Resistor(Do Not Populate)
H2511-022R1-1/16W1	R12, R14	2	22.1	1%	-	1/16W	603	RES_0603	GENERIC	Thick Film Chip Resistor
MCR03EZPF3001	R17	1	3k	1%	-	1/10W	603	RES_0603	ROHM	Metal Film Chip Resistor

## Bill of Materials (Continued)

PART NUMBER	REF DES	QTY	VALUE	TOL	VOLTAGE	POWER	PACKAGE TYPE	JEDEC TYPE	MANUFACTURER	DESCRIPTION
ISL26132AVZ	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
LM335AZ	U4	1	-	-	-	-	T092	T092	NATIONAL	PRECISION TEMPERATURE SENSOR
AT90USB162-16AUR	U5	1	-	-	-	-	LQFP	LQFP32_275X275_315	ATMEL	32 LEAD 7 X 7 LQFP PACKAGE
CMR309T-8.000MABJ-UT	Y1	1	-	-	-	-			DIGI-KEY	CRYSTAL, IT IS MANUALLY PLACED IN THRU HOLES ON BOTTOM OF BOARD
5SRTC-TTK-30-36	Type K	1	-	-	-	-			Omega	Type k 36 inch long

# ISLTHermo-STKEV2Z Evaluation Board Layout

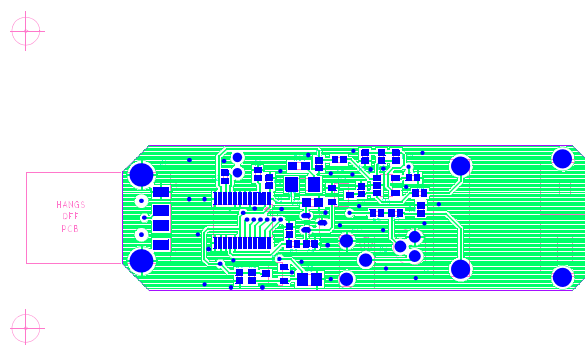


FIGURE 6. TOP LAYER

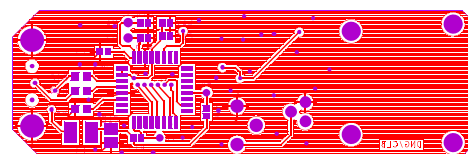


FIGURE 7. BOTTOM LAYER

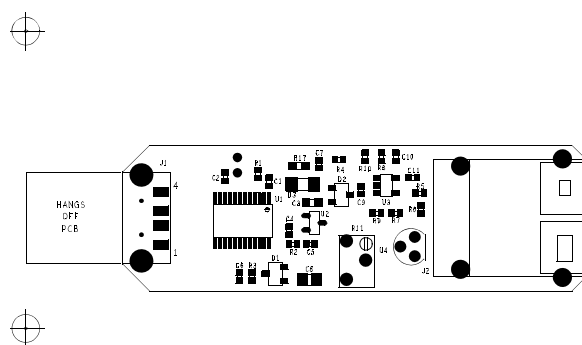


FIGURE 8. ASSEMBLY DRAWING

# ISLTHERMO-STKEV2Z Schematic

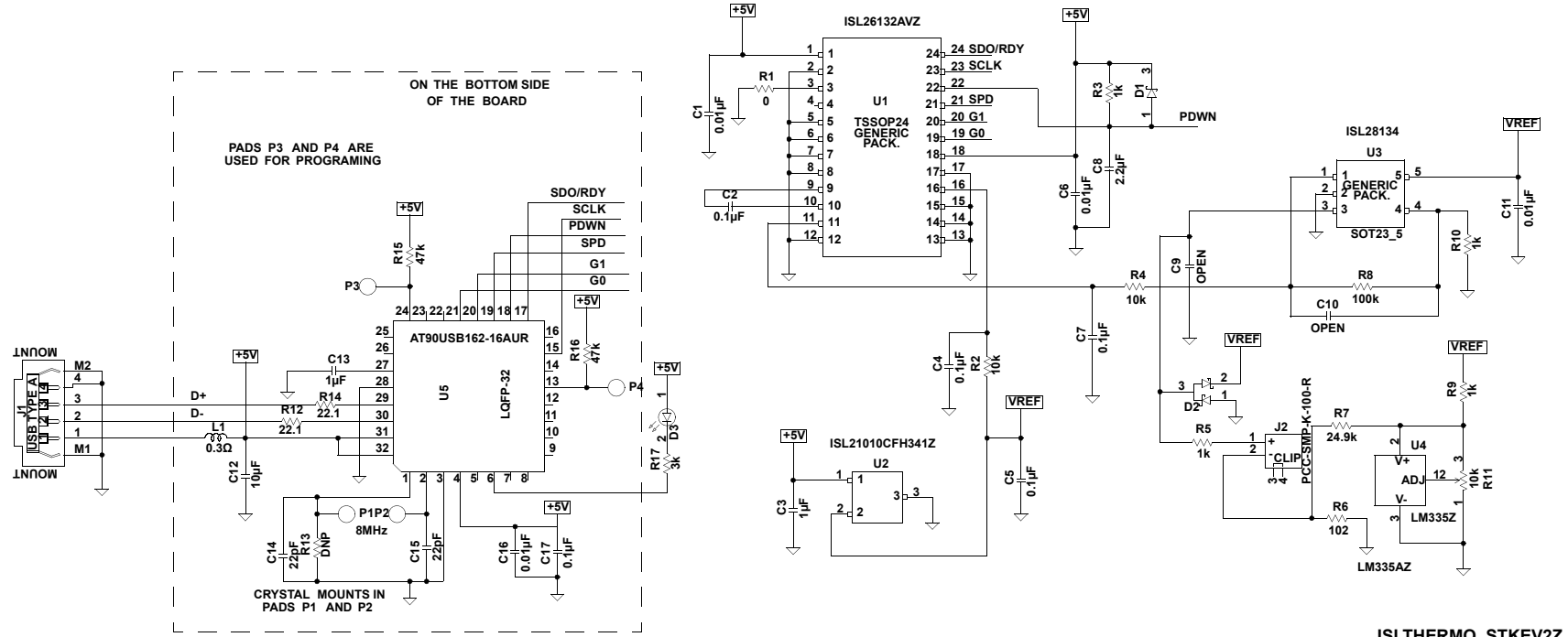


FIGURE 9. ISLTHERMO-STKEV2Z EVALUATION BOARD SCHEMATIC

ISLTHERMO\_STKEV2Z  
REV A  
5/09/2012

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