FMCW Radar Sensors

Evaluation board user guide

Sensor module / evaluation board assembly

The evaluation system is delivered with the RS3400 series module mounted on the control board as shown in Figure 1. Power is delivered through the 2.5/5.5mm DC connector. Positive voltage, 10 12V, should be applied on the center pin. The control board is protected against reverse voltage. In order to prevent undesired noise, a linear power supply is recommended, but for simple tests, a switched supply should suffice. Communication between the PC and the control board is over a RS232 serial connection. Connect a straight serial line between the female DSUB9 of the control board and the PC. If the PC does not have an RS232 interface, easily installed USB to RS232 adapters are available in most computer stores.

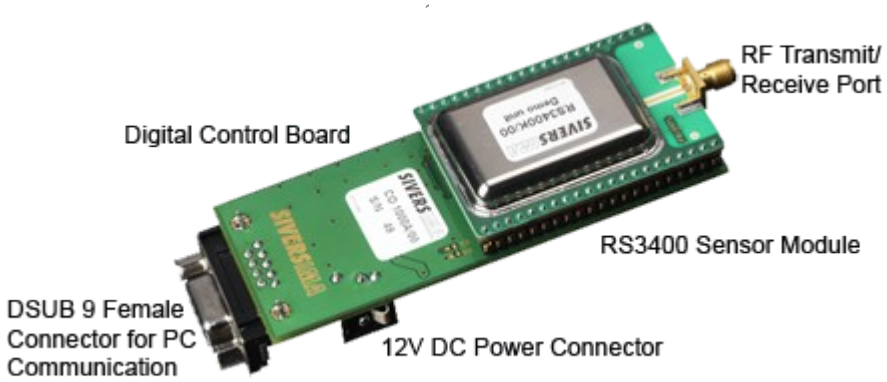

Figure 1. Controller board and radar sensor

In order to communicate with the evaluation board, a terminal emulation program is required. On older Windows systems (XP and older) Hyper Terminal works well. A free-open source alternative which has been found to also work is PuTTY, which is available online. To test the communication with the system, start a terminal window on the PC and configure the communications port where the control board is connected to the PC. The port can usually be identified using Windows device manager, select “Ports (COM & LPT)”. Native ports are generally labeled COM1, COM2, COM3 or COM4. For USB-adapters, the COM-number is usually somewhat higher.

Data subject to change without notice. Rev. A 2011 – 06 - 2011

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The configuration of the port should be as follows:

- Bits per second: 115200
- Data bits: 8
- Parity: None
- Stop bits: 1
- Flow control: None

You may also want to turn on local echo in order to display your input in the terminal. Depending on the terminal emulator you are using, you may also want to enable session logging for retrieving measurement data from the text log file.

Make sure that the terminal program is started, the port configured correctly and the control board is connected to the serial line. Connect power to the control board. A green LED on the control board should light up. If the communication is working, a message should be displayed looking similar to the following:

```
SiversIMA AB

FMCW Eval board initialized

Software version: B RS3400
```

If the message is not displayed, try pressing the RETURN or ENTER key a few times. The character "?" should be displayed. If this is not the case, see the troubleshooting guide at the end of this section. With communication established between the computer and the control board, control of the RS3400 is now possible and measurements can be performed.

Now that communication with the evaluation board has been established, some type of waveguide will need to be attached. This is typically an antenna, but may be another device depending on the application. For ranging purposes, a 15-20dB standard gain horn is recommended. Bearing in mind that the possible sweep bandwidth is up to 750 or 1500 MHz, the antenna needs to have a fairly large bandwidth. It is very important that the antenna is connected using high quality cabling. It must be capable of operating at the frequency of the chosen module; otherwise high reflections and attenuation will occur, impeding the quality of the measurements.

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Trouble shooting guide for communication between the control board and a PC

Symptom	Possible Cause	Solution
The LED of the control board is not lit	Power is not supplied to the control board.	Connect 10-12V on the center pin of the 2.5/5.5mm DC connector
The terminal program or the control board is not responding when the enter key is pressed	The serial cable between the PC and the control board is not properly connected	Check serial cable connection
	The terminal program has not connected to the remote system.	Initiate communication within the terminal. For Hyper terminal, select menu Call and click on Call (alt+C, C)
	The communications port is not configured correctly	From within the terminal program, verify that the correct communications port is selected and that it is configured as described above.
	The cable between the PC and the control board is incorrect.	Try shifting the lines going to the DSUB9 connector pin 2 and 3.

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Example FMCW radar measurement using the CO1000A/00 evaluation board

The following shows a typical measurement sequence and some trivial data manipulation in order to retrieve a distance measurement.

You will need the following items:

- RS3400 series sensor module
- CO100A evaluation board
- 12V power supply
- Serial cable
- USB adapter (if needed)
- Horn antenna
- RF cable or male to male SMA adapter
- Radar target (piece of sheet metal works well)
- Mathematical analysis software capable of fast Fourier transforms

The unit is connected to a standard gain horn antenna using a one meter RF cable. A metal sheet, used as a radar reflector, is positioned at approximately zero, one and two meters away from the horn opening during the three measurements.

Starting the units shows:

SiversIMA AB

FMCW Eval board initialized

Software version: B RS3400

Start by initiating the equipment. Setup the measurement, using defaults for most parameters. Position the radar reflector close to the horn antenna. Send the following commands to initialize the system, enable measurement and set the number of frequency sweeps to one:

```
INIT

SWEEP:MEASURE ON

SWEEP:NUMBERS 1
```

Initiate a measurement sweep:

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```
TRIG:ARM
```

Measurement completes in approximately 85 ms and data can be retrieved by typing:

```
TRACE:DATA ?
```

Depending on what terminal emulator you are using you may need to save the data at this point. If you are using Hyper Terminal, use the capture text command to save all 1501 measurements to a text file named S0.TXT. If you are using a terminal emulator such as PuTTY with session logging verify that your data has been captured by opening the log file. You can extract the data following all measurements.

Position the radar reflector at approximately 1m from the horn. Initiate a new sweep.

```
TRIG:ARM
TRACE:DATA ?
```

If needed, save the data to a file named S1.TXT.

Position reflector at approximately 2m from the horn. Initiate a new sweep.

```
TRIG:ARM
TRACE:DATA ?
```

If needed, save the data to a file named S2.TXT.

If using data from a logged session, open the log file and copy the data to 3 text files, or into a spreadsheet, depending on your mathematical analysis software package.

Using a numerical analysis software package (for example Matlab or Mathematica) the acquired data can be plotted and processed. Plots of the three data files are shown in the following figures. As seen in Figures 3,4, and 5, the data is typically an oscillating signal with an amplitude of approximately 10e3 digital units. The closest echo appears to give the largest amplitude. Performing Fourier transformations on the data sets gives the spectral results shown in Figure 6. With a frequency span of 1500MHz, the resolution of the frequency bins will correspond to a distance of 0.1m (accounting for a two way path). As can be seen in Figure 7, the peaks are separated by approximately 10 bins, which corresponds to a shift in position of the reflecting sheet of 1m. It is also evident that all signals contain an echo positioned approximately at bin 16. This is most likely caused by the connection between the RF cable and the horn antenna. The 16 bins passed from the RF connector

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of the FMCW module and the connector of the horn relates to a one meter RF cable containing a PTFE dielectric, which gives an equivalent length in vacuum of approximately 1.6 meters.

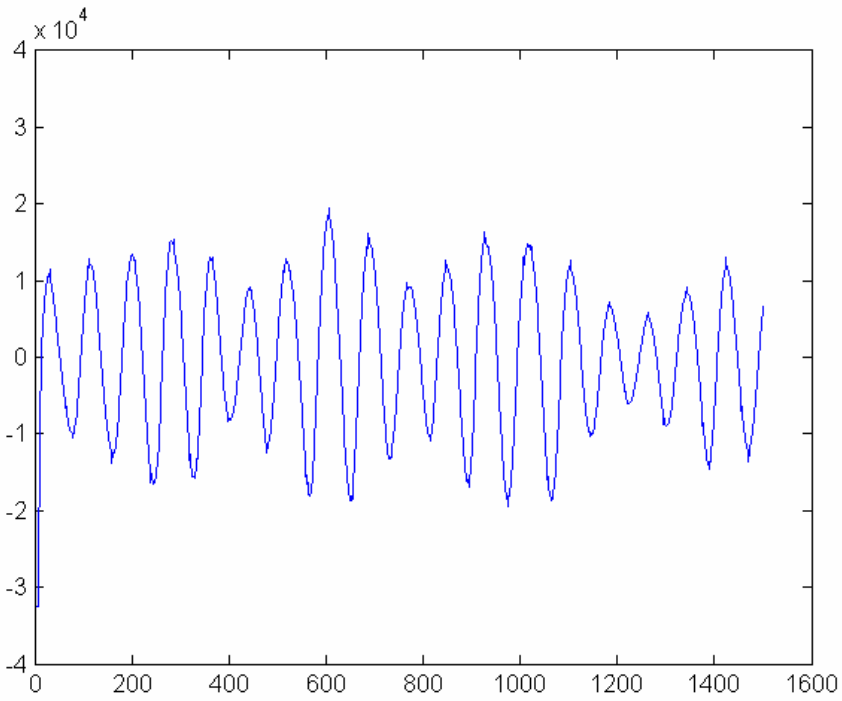

Figure 3. Plot of S0.TXT. Signal corresponds to a very close echo and possible reflections in the measurement equipment.

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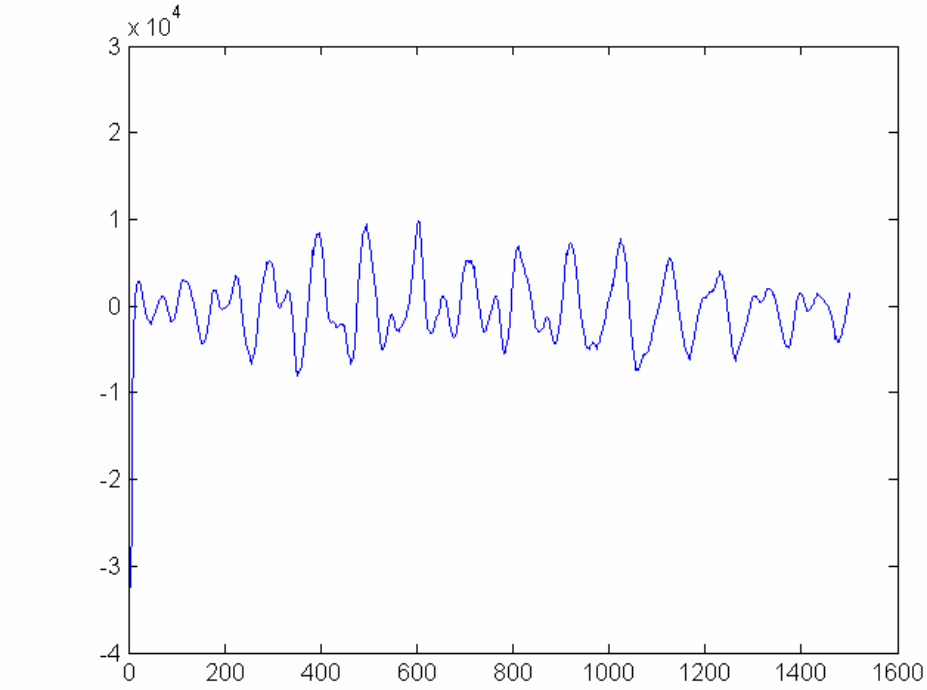

Figure 4. Plot of S1.TXT. Signal corresponds to an echo positioned approximately one meter away from the horn and possible reflections in the measurement equipment.

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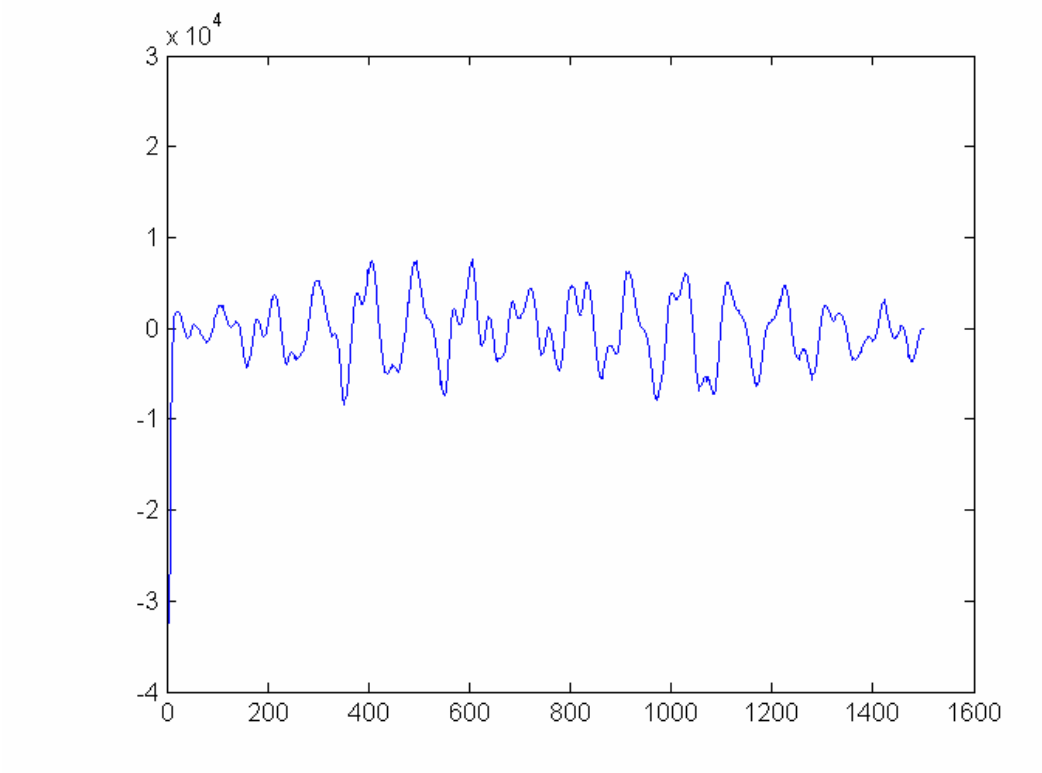

Figure 5. Plot of S2.TXT. Signal corresponds to an echo positioned approximately two meter away from the horn and possible reflections in the measurement equipment.

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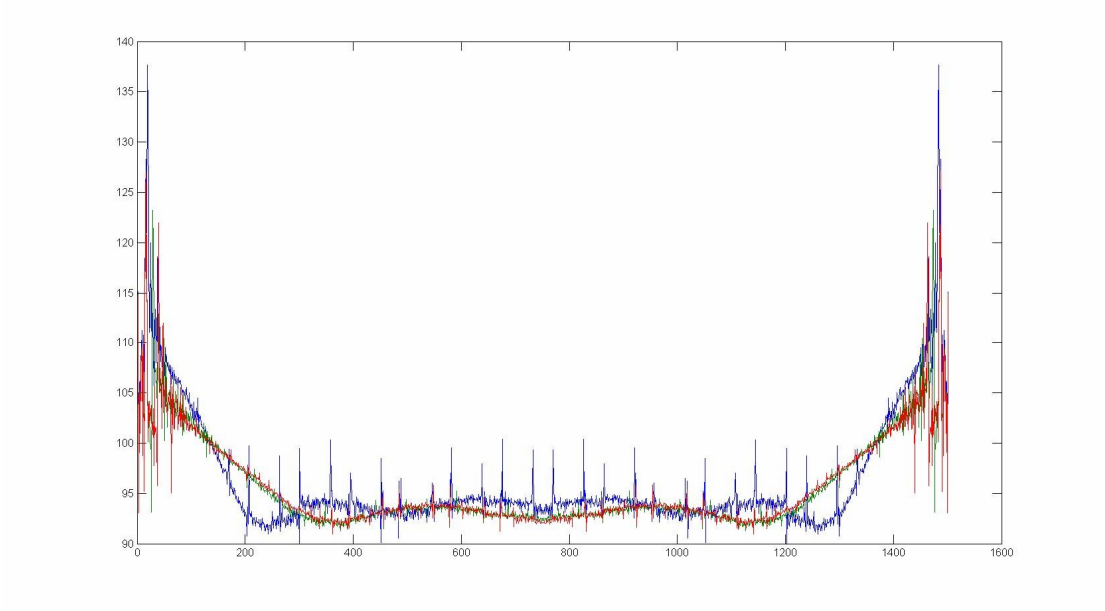

Figure 6. Plot of spectrum (absolute magnitude in dB).

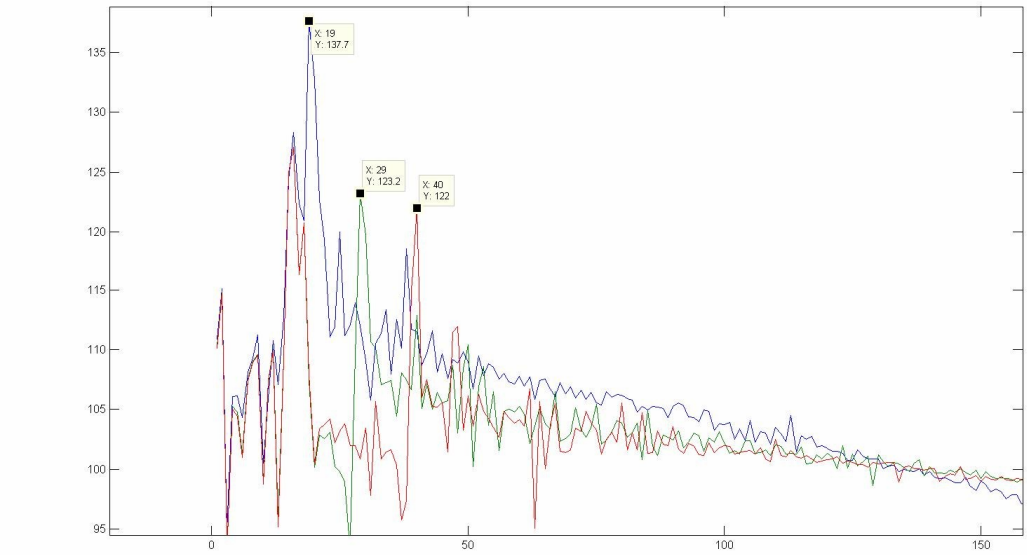

Figure 7. Close up of Figure 6, peaks indicated with markers.

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