Summary - Matchstiq-Z1 TX

Name	matchstiq_z1_tx
Worker Type	Frontend Interface (Proxy)
Version	v1.3
Release Date	February 2018
Component Library	ocpi.assets.platforms.matchstiq_z1.devices
Workers	matchstiq_z1_tx.rcc
Tested Platforms	Matchstiq-Z1
Slave Worker	Multiple

Functionality

This worker is used to control the TX portion the Matchstiq-Z1 SDR. Each property has a max, min, and step value associated with it. These associated properties are available to be used by application developers for reading back information about the functionality of the interface during runtime if necessary.

This worker implements a common interface that is intended to be used across multiple platforms. All platforms will have the same property interface to allow application to be ported seamlessly to other platforms. It is also intended to be a simple interface that encompasses functionality that all TX interfaces will have but not any specialty functionality that only some TX interfaces will have.

There are two known limitations when using this worker:

1) When used in addition to the RX frontend interface, there must be a 1 MHz offset between the TX and RX center frequencies, due to a limitation with the Lime transceiver device on the Matchstiq-Z1 SDR.

2) Due to a limitation of the framework, this component must appear after the TX control proxies in an application XML.

Worker Implementation Details

This worker controls the filtering, gain, tuning frequency, and the sample rate of the Matchstiq-Z1 transmitter. Each of these are described below in their own section.

Filtering

In the RF section of the transmitter, there are no filtering elements.

The baseband section has a variable low pass filter that is located in the LMS6002D transceiver.

Gain

The RF section only has one device which is a VGA in the LMS6002D transceiver.

The baseband section only has one device which is a VGA in the LMS6002D tranceiver.

Tuning

The LMS6002D transceiver converts the signal from baseband to RF using one mixing phase.

Sample Rate

The sampling clock domain originates from the CLK0 output of a SI5338 clock generator, which is connected directly to the Zynq FPGA. The platform worker outputs this clock to the Lime transceiver. This clock returns as an input to the Zynq FPGA aligned with the ADC data. This means that on the Matchstiq-Z1 platform, the TX and RX sample clocks are connected together so they will need to be the same value unless changes are made to the BSP by the user.

Block Diagrams

Top level

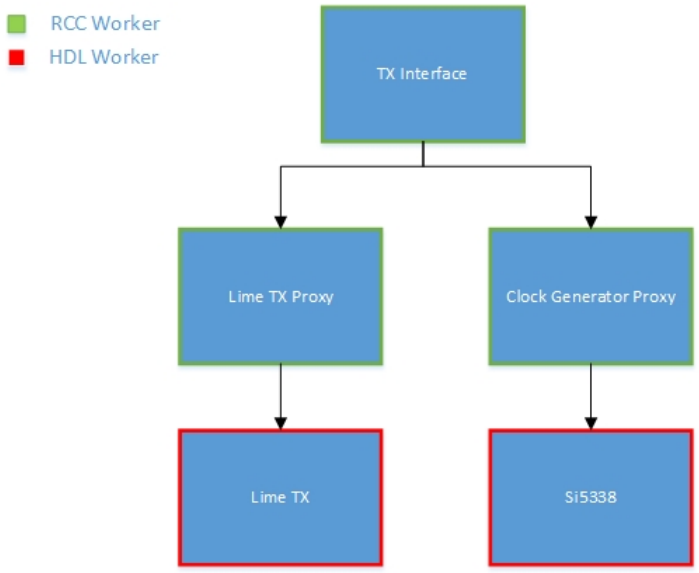

Figure 1: Top Level Block Diagram

TX Hardware

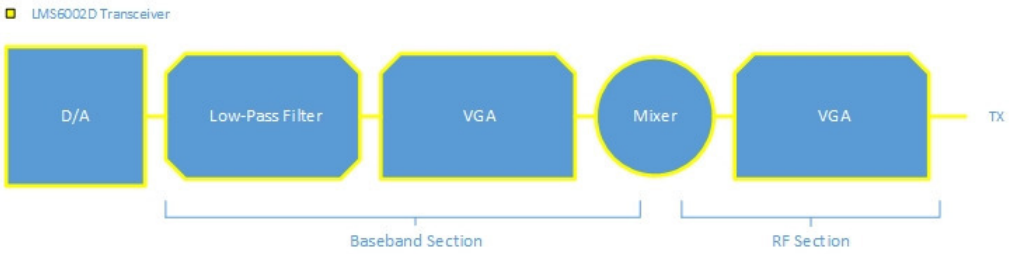

Figure 2: Hardware Block Diagram

Source Dependencies

- ocpi.assets/hdl/platforms/matchstiq_z1/devices/matchstiq_z1_tx.rcc/matchstiq_z1_tx.cc

Component Spec Properties

Name	Type	Sequence Length	Array Dimensions	Accessibility	Valid Range	Default	Usage
rf_gain_dB	double	-	-	Readable, Writable	-	0	The value of the RF gain stage of the transmitter
rf_gain_max_dB	double	-	-	Volatile, Writable	-	0	Maximum valid value for RF gain
rf_gain_min_dB	double	-	-	Volatile, Writable	-	0	Minimum valid value for RF gain
rf_gain_step_dB	double	-	-	Volatile, Writable	-	0	Minimum granularity for changes in RF gain
bb_gain_dB	double	-	-	Readable, Writable	-	0	The value of the baseband gain stage of the transmitter
bb_gain_max_dB	double	-	-	Volatile, Writable	-	0	Maximum valid value for baseband gain
bb_gain_min_dB	double	-	-	Volatile, Writable	-	0	Minimum valid value for baseband gain
bb_gain_step_dB	double	-	-	Volatile, Writable	-	0	Minimum granularity for changes in baseband gain
frequency_MHz	double	-	-	Readable, Writable	-	0	The value for the tuned center frequency of the outgoing RF samples
frequency_max_MHz	double	-	-	Volatile, Writable	-	0	Maximum valid value for frequency
frequency_min_MHz	double	-	-	Volatile, Writable	-	0	Minimum valid value for frequency
frequency_step_MHz	double	-	-	Volatile, Writable	-	0	Minimum granularity for changes in frequency
sample_rate_MHz	double	-	-	Readable, Writable	-	0	Sample rate of the outgoing RF samples
sample_rate_max_MHz	double	-	-	Volatile, Writable	-	0	Maximum valid value for sample rate
sample_rate_min_MHz	double	-	-	Volatile, Writable	-	0	Minimum valid value for sample rate
sample_rate_step_MHz	double	-	-	Volatile, Writable	-	0	Minimum granularity for changes in sample rate
rf_cutoff_frequency_MHz	double	-	-	Readable, Writable	-	0	The effective cutoff frequency, i.e. half of the bandwidth, for all filtering that is done in the RF stage of the transmitter. There is no RF filtering stage on this transmitter.
rf_cutoff_frequency_max_MHz	double	-	-	Volatile, Writable	-	0	Maximum valid value for RF cutoff frequency
rf_cutoff_frequency_min_MHz	double	-	-	Volatile, Writable	-	0	Minimum valid value for RF cutoff frequency
rf_cutoff_frequency_step_MHz	double	-	-	Volatile, Writable	-	0	Minimum granularity for changes in RF cutoff frequency
bb_cutoff_frequency_MHz	double	-	-	Readable, Writable	-	0	The effective cutoff frequency, i.e. half of the bandwidth, for all filtering that is done in the baseband stage of the transmitter.
bb_cutoff_frequency_max_MHz	double	-	-	Volatile, Writable	-	0	Maximum valid value for baseband cutoff frequency
bb_cutoff_frequency_min_MHz	double	-	-	Volatile, Writable	-	0	Minimum valid value for baseband cutoff frequency
bb_cutoff_frequency_step_MHz	double	-	-	Volatile, Writable	-	0	Minimum granularity for changes in baseband cutoff frequency

Worker Properties

matchstiq_z1_tx.rcc

Type	Name	Type	Sequence Length	Array Dimensions	Accessibility/ Advanced	Valid Range	Default	Usage
SpecProperty	rf_gain_dB	-	-	-	WriteSync	0-25	4	The value of the RF gain stage of the transmitter
SpecProperty	rf_gain_max_dB	-	-	-	-	25	25	Maximum valid value for RF gain
SpecProperty	rf_gain_min_dB	-	-	-	-	0	0	Minimum valid value for RF gain
SpecProperty	rf_gain_step_dB	-	-	-	-	1	1	Minimum granularity for changes in RF gain
SpecProperty	bb_gain_dB	-	-	-	WriteSync	-35 - -4	-4	The value of the baseband gain stage of the transmitter
SpecProperty	bb_gain_max_dB	-	-	-	-	-4	-4	Maximum valid value for baseband gain
SpecProperty	bb_gain_min_dB	-	-	-	-	-35	-35	Minimum valid value for baseband gain
SpecProperty	bb_gain_step_dB	-	-	-	-	1	1	Minimum granularity for changes in baseband gain
SpecProperty	frequency_MHz	-	-	-	WriteSync	232.5 - 3720	500	The value for the tuned center frequency of the outgoing RF samples
SpecProperty	frequency_max_MHz	-	-	-	-	3720	3720	Maximum valid value for frequency
SpecProperty	frequency_min_MHz	-	-	-	-	232.5	232.5	Minimum valid value for frequency
SpecProperty	frequency_step_MHz	-	-	-	-	0.1	0.1	Minimum granularity for changes in frequency
SpecProperty	sample_rate_MHz	-	-	-	WriteSync	0.1 - 40	0.1	Sample rate of the outgoing RF samples
SpecProperty	sample_rate_max_MHz	-	-	-	-	40	40	Maximum valid value for sample rate
SpecProperty	sample_rate_min_MHz	-	-	-	-	0.1	0.1	Minimum valid value for sample rate
SpecProperty	sample_rate_step_MHz	-	-	-	-	1	1	Minimum granularity for changes in sample rate
SpecProperty	rf_cutoff_frequency_max_MHz	-	-	-	-	-1	-1	Maximum valid value for RF cutoff frequency
SpecProperty	rf_cutoff_frequency_min_MHz	-	-	-	-	-1	-1	Minimum valid value for RF cutoff frequency
SpecProperty	rf_cutoff_frequency_step_MHz	-	-	-	-	-1	-1	Minimum granularity for changes in RF cutoff frequency
SpecProperty	bb_cutoff_frequency_MHz	-	-	-	WriteSync	0.125-14	10	The effective cutoff frequency, i.e. half of the bandwidth, for all filtering that is done in the baseband stage of the transmitter.
SpecProperty	bb_cutoff_frequency_max_MHz	-	-	-	-	14	14	Maximum valid value for baseband cutoff frequency
SpecProperty	bb_cutoff_frequency_min_MHz	-	-	-	-	0	0	Minimum valid value for baseband cutoff frequency
SpecProperty	bb_cutoff_frequency_step_MHz	-	-	-	-	0.125	0.125	Minimum granularity for changes in baseband cutoff frequency

Performance and Resource Utilization

matchstiq_z1_tx.rcc

Processor Type	Processor Frequency	Run Function Time
TBD	TBD	TBD

Test and Verification

The testbench for this worker is meant to exercise the properties of the worker dynamically while the application is running. Random data is sent out to emulate noise on the spectrum analyzer. The following steps are taken in the testbench:

1) Change the rf_gain_dB settings

2) Change the bb_gain_dB settings

3) Toggle the low-pass filter settings

These steps are repeated at different center frequencies and directions are provided in the testbench for this. The results are inspected visually on a spectrum analyzer.

WARNING: A 10 dB attenuator is recommended between the radio and spectrum analyzer to prevent any equipment from being damaged.

The results should be as follows:

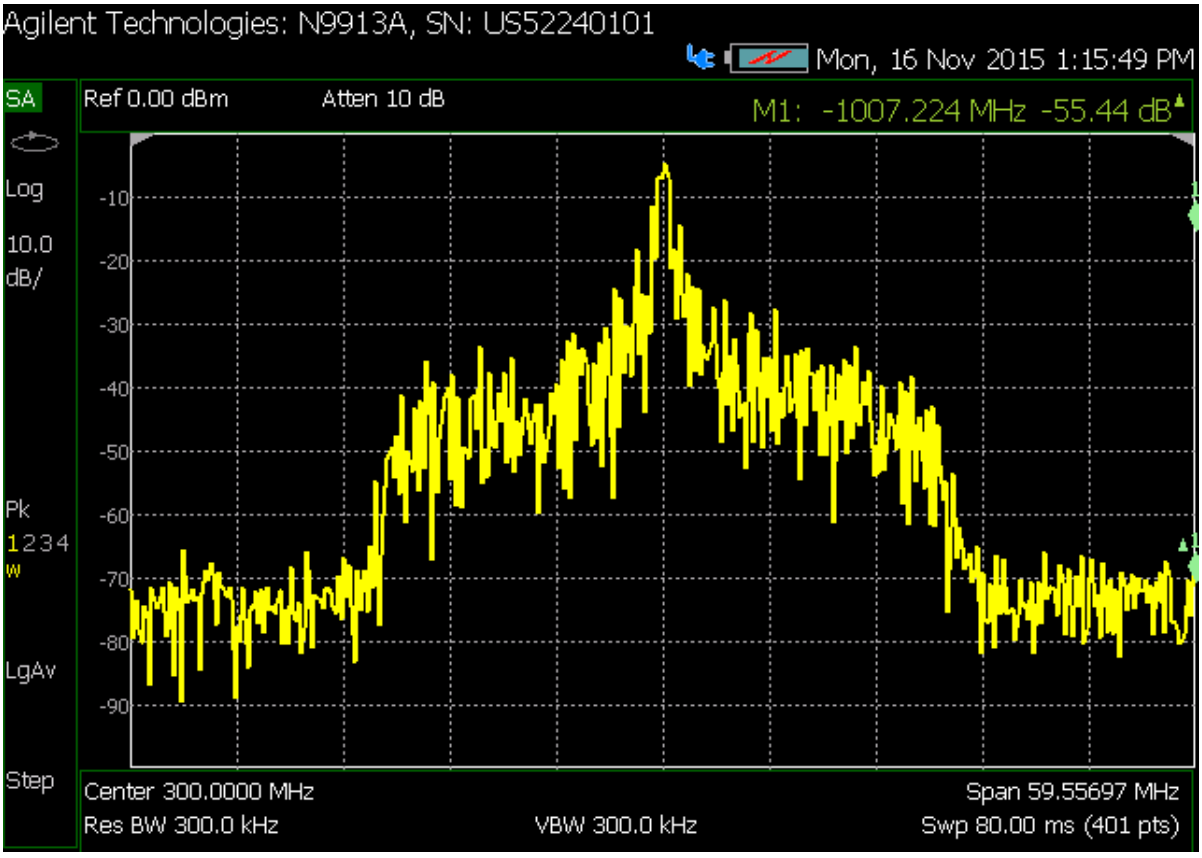

Figure 3: Expected Results: Beginning

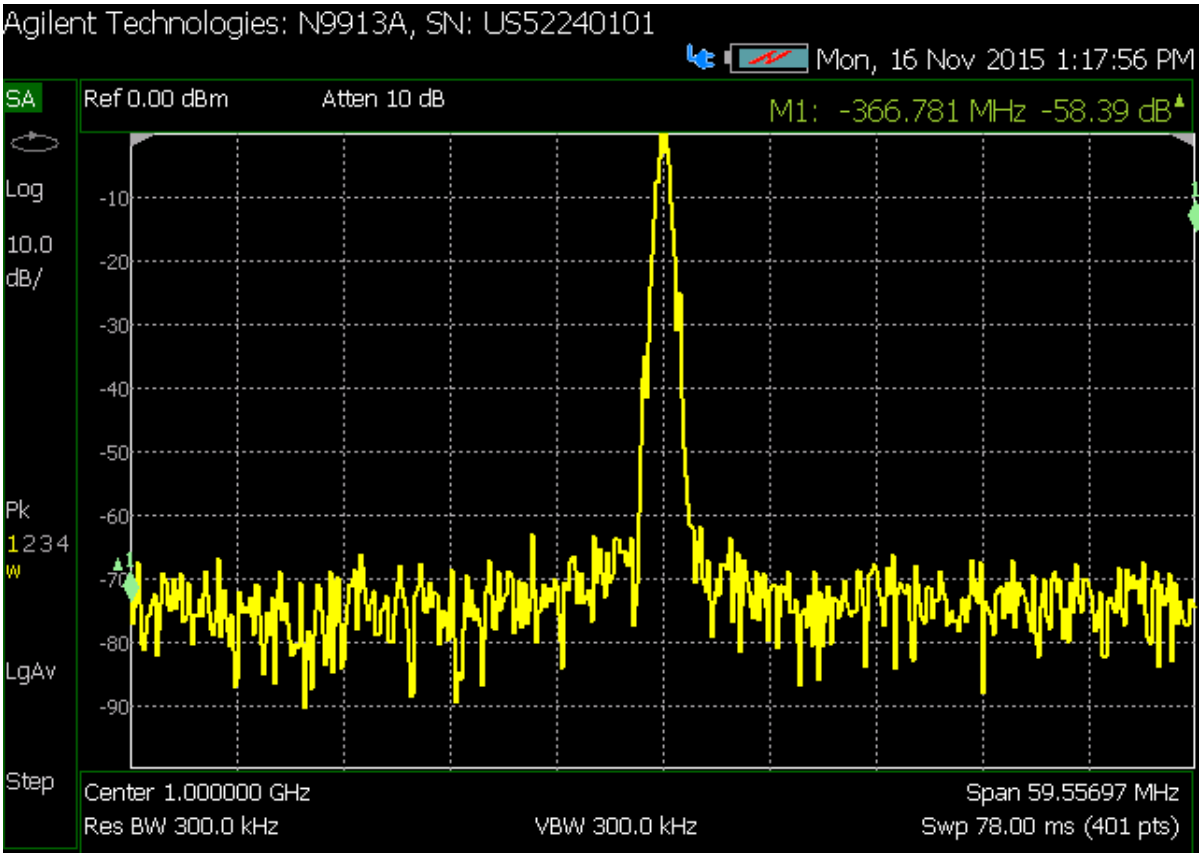

Figure 4: Expected Results: End

The signal should look like a amplitude adjusted version of the first picture throughout except when testing the filtering. In the filtering stage of testing the signal will slowly walk from the second picture back to the first picture.

References

1) LMS6002D Datasheet, www.limemicro.com

2) The Matchstiq-Z1 Software Development Manual (provided by Epiq with the Platform Development Kit)