Summary - Matchstiq-Z1 RX

Name	matchstiq_z1_rx
Worker Type	Frontend Interface (Proxy)
Version	v1.3
Release Date	February 2018
Component Library	ocpi.assets.platforms.matchstiq_z1.devices
Workers	matchstiq_z1_rx.rcc
Tested Platforms	Matchstiq-Z1
Slave Worker	Multiple

Functionality

This worker is used to control the RX 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 applications to be ported seamlessly to other platforms. It is also intended to be a simple interface that encompasses functionality that all RX interfaces will have but not any specialty functionality that only some RX interfaces will have.

There are two known limitations when using this worker:

1) When used in addtion to the TX 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 RX 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 receiver. Each of these are described below in their own section.

Filtering

In the RF section of the receiver, there is an band select filter which is determined automatically by this worker based on the receiver tuning frequency. This functionality can either be turned on or turned off (set to bypass).

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

Gain

In the RF section of the receiver, there are three elements that have adjustable gain: an external LNA, a step attenuator, and LNA in the LMS6002D Transceiver. There is an algorithm to turn one high level gain value into settings for each of the three gain devices in this stage. The external LNA is determined first, then the internal LNA, then finally the attenuator is used to finalize the overall value for this stage.

The baseband section has two VGA devices which are both located in the LMS6002D transceiver.

Tuning

The LMS6002D transceiver converts the signal from RF to baseband 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

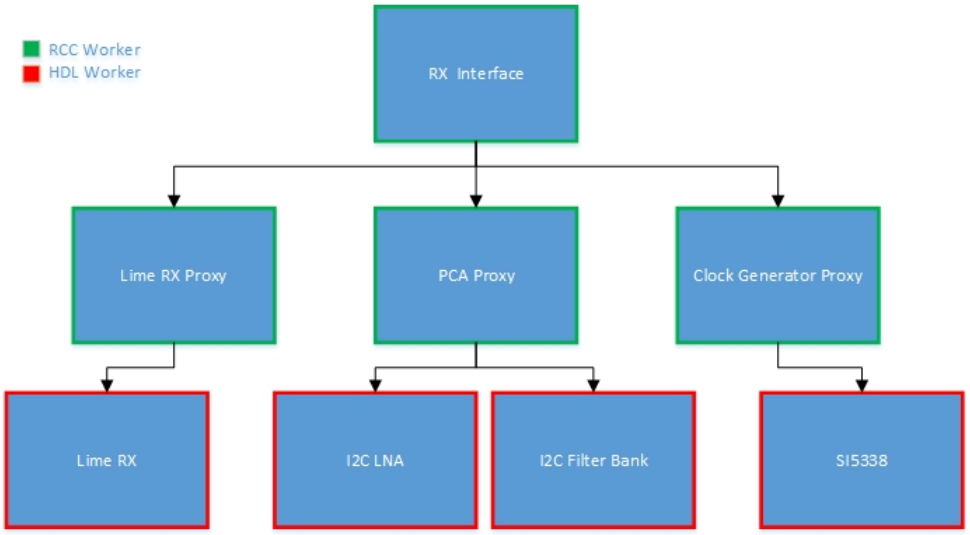

Figure 1: Top Level Block Diagram

RX Hardware

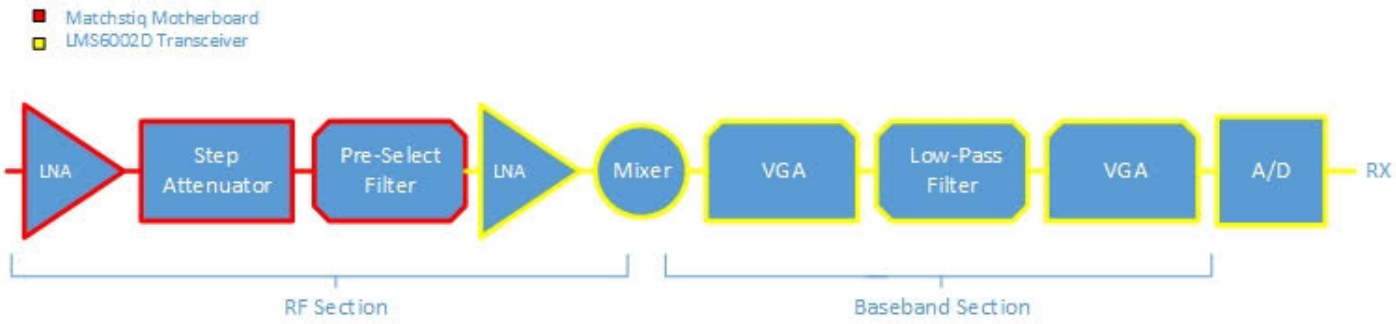

Figure 2: Hardware Block Diagram

Source Dependencies

- ocpi.assets/hdl/platforms/matchstiq_z1/devices/matchstiq_z1_rx.rcc

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 receiver
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 receiver
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 incoming 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 incoming 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 receiver.
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 receiver.
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_rx.rcc

Type	Name	Type	Sequence Length	Array Dimensions	Accessibility/ Advanced	Valid Range	Default	Usage
SpecProperty	rf_gain_dB	-	-	-	WriteSync	-32.5 - 16	0	The value of the RF gain stage of the receiver
SpecProperty	rf_gain_max_dB	-	-	-	-	16	16	Maximum valid value for RF gain
SpecProperty	rf_gain_min_dB	-	-	-	-	-32.5	-32.5	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	5-60	5	The value of the baseband gain stage of the receiver
SpecProperty	bb_gain_max_dB	-	-	-	-	60	60	Maximum valid value for baseband gain
SpecProperty	bb_gain_min_dB	-	-	-	-	5	5	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 incoming 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 incoming 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_MHz	-	-	-	WriteSync	0, 400	400	The effective cutoff frequency, i.e. half of the bandwidth, for all filtering that is done in the RF stage of the receiver. In this case, it is a band select filter that is set to bypass (0) or turned on (400) and changed based on the tuned center frequency.
SpecProperty	rf_cutoff_frequency_max_MHz	-	-	-	-	400	400	Maximum valid value for RF cutoff frequency
SpecProperty	rf_cutoff_frequency_min_MHz	-	-	-	-	0	0	Minimum valid value for RF cutoff frequency
SpecProperty	rf_cutoff_frequency_step_MHz	-	-	-	-	400	400	Minimum granularity for changes in RF cutoff frequency
SpecProperty	bb_cutoff_frequency_MHz	-	-	-	WriteSync	0-14	10	The effective cutoff frequency, i.e. half of the bandwidth, for all filtering that is done in the baseband stage of the receiver.
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_rx.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. The sample rate is set low and not changed so that there is less data to pass to file because of bandwidth issues. The test requires that there be a signal generator capable of generating a sine wave from 300MHz to 3GHz connected to the RX SMB connector of the Matchstiq-Z1 radio and set to -55dB. The following steps are taken in the testbench:

1) Baseband filtering is set from low to high
2) RF gain is set from low to high then set back to zero
3) Baseband gain is set from low to high
4) The center frequency is changed with a corresponding change to a signal generator

While the test application is running, sample data is being written to the output file. It is important to quickly perform the changes prompted by the application to obtain similar results shown in the plot below. The results are then plotted in the time domain and verified manually by inspection. The results should look like the below image:

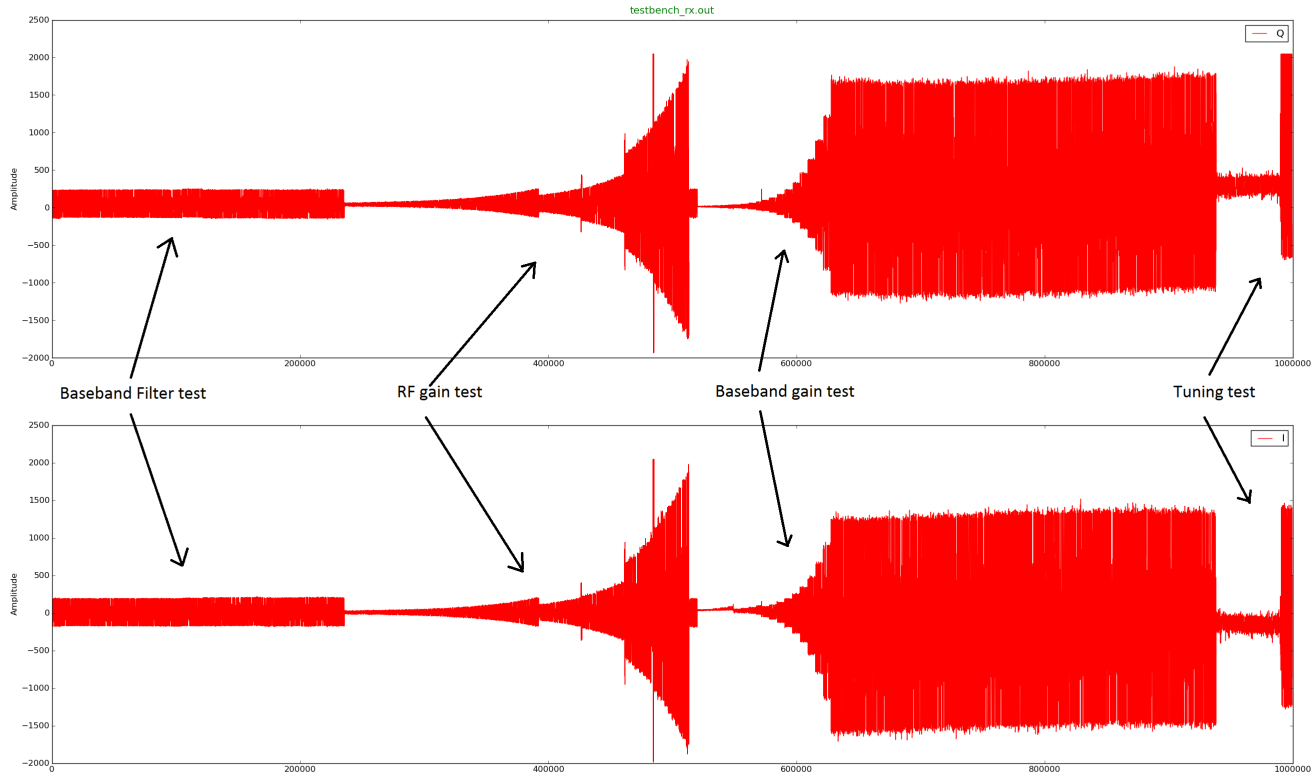

Figure 3: Expected Results

References

1) LMS6002D Datasheet, www.limemicro.com

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