Summary - FMCOMMS2/3 RX Worker

Package Prefix	ocpi.core
Component	rx
Name	fmcomms_2_3_rx
Authoring Model	rcc
Version	1
OpenCPI Release	v1.5 (released 4/2019)
Tested Platforms	Zedboard (xilinx13_3), ML605 (x86_64 CentOS 7)
Slaves	-
ACI "Slaves"	• ad9361_config_proxy.rcc • ad9361_adc_sub.hdl • ad9361_data_sub.hdl

Functionality

This worker is an endpoint proxy used to control a single RX channel of an instance of the FMCOMMS2 or the FMCOMMS3 RF transceiver card. Multiple RX channels on the same FMCOMMS2/3 card are not yet supported. This worker has two paramaterized build configurations: one for FMCOMMS2 (`TYPE_p` parameter property value of 'fmcomms2') and one for FMCOMMS3 (`TYPE_p` parameter property value of 'fmcomms3'). 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 `rx` component spec which this worker is based off of exposes a property set suitable for use 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 special functionality that only some RX interfaces will have.

Worker Implementation Details

This worker controls the filtering, gain, tuning frequency, and the sample rate of the AD9361 on the FMCOMMS2/3 RF transciever card. Each of these are described below in their own section.

Clock Generation

The AD9361 contains multiple PLLs which all use the same external-to-the-AD9361 clock source. This external source can be either:

- a crystal connected to the AD9361 XTALP/N pins (a 40 MHz [nominal] crystal is connected on FMCOMMS2/3), or
- an external clock source connected to the AD9361 XTALN pin (the REF_CLK SMA connector is connected on FMCOMMS2/3).

This worker's `config` property's `reference_clk_rate_Hz` struct member should contain the value of the clock frequency in Hz (whether crystal or external). If the default FMCOMMS2/3 hardware is to be used (i.e. crystal used), the `config` property's `are_using_REF_CLK_SMA` value should be left to its default value (of false). If the FMCOMMS2/3 has an external clock connected, the `config` property's `are_using_REF_CLK_SMA` value must be set to true. Only the default settings (i.e. crystal used) have been verified.

Filtering

In the RF section of the AD9361 receiver, there are no filtering elements.

The AD9361's baseband Rx signal path is composed of two programmable analog low-pass filters, a 12-bit ADC, and four stages of digital decimating filters [1]. The baseband filters are as follows:

- Rx TIA LPF (Transimpedance Amplifier Low-Pass Filter)
  - analog single-pole low-pass filter with a programmable 3dB corner frequency
- Rx BB LPF (BaseBand Low-Pass Filter)
  - analog third-order Butterworth low-pass filter with a programmable 3dB corner frequency
- Rx HB3/DEC3 filter (Half-Band / Decimation)
  - digital filter with multiple selectable tap sets with decimation factors of 1 (bypasses filter), 2, or 3
- Rx HB2 filter (Half-Band)
  - digital filter with multiple selectable tap sets with decimation factors of 1 (bypasses filter) or 2
- Rx HB1 filter (Half-Band)
  - digital filter with multiple selectable tap sets with decimation factors of 1 (bypasses filter) or 2
- PROG RX FIR (***disabled by this worker***)
  - digital filter whose decimation factor is configurable to 1, 2, or 4, and whose taps are customizable with 16-bit values up to 128 taps

Changes to the AD9361 RX sample rate (via the `sample_rate_MHz` property) or the TX sample rate can affect the RX HB digital filter settings. Note that the setting of both the analog and the digital filters will determine the overall effective baseband bandwidth. Values written to the `bb_cutoff_frequency_MHz` property are rounded to the nearest Hz and passed to the No-OS ad9361_set_rx_rf_bandwidth() API call, which attempts to set the overall baseband -3dB bandwidth to *approximately* the requested (rounded to nearest Hz) value. Read requests to the `bb_cutoff_frequency_MHz` property will simply return the value of the No-OS ad9361_get_rx_rf_bandwidth() API call, *which is known to not have floating-point precision as well as to represent a crude approximation of the current nominal value*. Work is expected to be done in the future to modify read requests to return the double floating point-precision nominal value instead of using the No-OS API.

Gain

The AD9361 supports a variety of automatic RX gain control modes as well as a manual mode. Use of the manual mode is enforced by this worker. The AD9361 RX gain is affected by both RF and baseband elements. These elements are controlled by runtime-dynamic gain tables. Because this worker uses the No-OS ad9361_set_rx_rf_gain() / ad9361_get_rx_rf_gain() API calls for controlling/accessing manual gain values, and those API calls allow only for settings overall gain and not baseband or RF gain specifically, this worker currently exposes overall AD9361 RX via the `rf_gain_dB` property. This worker's `bb_gain_dB` property should not be used. Note that because the gain tables are runtime-dynamic, the `rf_gain_min_dB` and `rf_gain_max_dB` are also runtime-dynamic, and their values should be assessed before deciding on a value to write to `rf_gain_dB`.

Tuning

The AD9361 has a mixer for downtuning from RF to baseband. The mixer LO is source by a PLL which is sourced by the external-to-the-AD9361 reference clock, which is a 40 MHz crystal on the FMCOMMS2/3 PCB. This worker's `frequency_MHz` property sets the AD9361 RX center frequency and reads back the nominal value with double floating point precision.

Sample Rate

The AD9361 RX sampling clock is generated by an on-AD9361 PLL which is sourced by the external-to-the-AD9361 reference clock, which is a 40 MHz crystal on the FMCOMMS2/3 PCB. This worker's `sample_rate_MHz` property sets the AD9361 RX sample rate and reads back the nominal value with double floating point precision. Note that the `sample_rate_MHz` property as it currently exists corresponds to the pre-RX FIR complex sample rate, and the FIR is always disabled by this worker.

Source Dependencies

- assets/hdl/cards/fmcomms_2_3_rx.rcc/fmcomms_2_3_rx.cc
- assets/hdl/cards/fmcomms_2_3_rx.rcc/include/ad9361/ad9361_common.h
- assets/hdl/cards/fmcomms_2_3_rx.rcc/include/ad9361/FMCOMMS_2_3/readers_FMCOMMS_2_3.h
- assets/hdl/cards/fmcomms_2_3_rx.rcc/include/ad9361/readers_ad9361_bb_pll.h
- assets/hdl/cards/fmcomms_2_3_rx.rcc/include/ad9361/readers_ad9361_bb_rx_adc.h
- assets/hdl/cards/fmcomms_2_3_rx.rcc/include/ad9361/readers_ad9361_bb_rx_filters_analog.h
- assets/hdl/cards/fmcomms_2_3_rx.rcc/include/ad9361/readers_ad9361_bb_rx_filters_digital.h
- assets/hdl/cards/fmcomms_2_3_rx.rcc/include/ad9361/readers_ad9361_cfg.h
- assets/hdl/cards/fmcomms_2_3_rx.rcc/include/ad9361/readers_ad9361_rf_rx_pll.h
- assets/hdl/cards/fmcomms_2_3_rx.rcc/include/ad9361/readers_ad9361_rf_tx_pll.h
- assets/hdl/cards/fmcomms_2_3_rx.rcc/include/ad9361/readers_ad9361_rx_gain.h
- assets/hdl/cards/fmcomms_2_3_rx.rcc/include/ad9361/writers_ad9361_bb_rx_adc.h
- assets/hdl/cards/fmcomms_2_3_rx.rcc/include/ad9361/writers_ad9361_bb_rx_filters_analog.h
- assets/hdl/cards/fmcomms_2_3_rx.rcc/include/ad9361/writers_ad9361_rf_rx_pll.h
- assets/hdl/cards/fmcomms_2_3_rx.rcc/include/ad9361/writers_ad9361_rx_gain.h
- assets/hdl/cards/fmcomms_2_3_rx.rcc/include/ocpi_component_prop_type_helpers.h
- assets/hdl/cards/fmcomms_2_3_rx.rcc/include/worker_prop_parsers_ad9361_config_proxy.h

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

rx.rcc

Type	Name	Type	Sequence Length	Array Dimensions	Accessibility/ Advanced	Valid Range	Default	Usage
Property	fmcomms_num	UShort	-	-	Parameter	2, 3	3	Valid values are 2 or 3.
Property	TYPE_p	Enum	-	-	Parameter	fmcomms2, fmcomms3	fmcomms_num == 2 ? fmcomms2 : fmcomms3	The purpose of this property is to provide the option for an application XML to specify this property in order to enforce use of a parameterized build for a particular frontend type.
Property	NOT_SUPPORTED_p	Double	-	-	Parameter	-1	-1	This value, when assigned to a frontend property, e.g. rf_gain_dB, indicates that the frontend setting corresponding to said property is not supported by the frontend hardware controlled by this worker.
Property	AD9361_RX_BBBW_NO_OS_MAX_MHZ_p	Double	-	-	Parameter	Standard	28	AD9361_Reference_Manual_UG-570.pdf "BBBW is half the complex bandwidth and coerced between 28 MHz to 0.20 MHz" - for No-OS's enforcement of this fact, see No-OS ad9361_rx_bb_analog_filter_calib
Property	AD9361_RX_BBBW_NO_OS_MIN_MHZ_p	Double	-	-	Parameter	Standard	0.20	AD9361_Reference_Manual_UG-570.pdf "BBBW is half the complex bandwidth and coerced between 28 MHz to 0.20 MHz" - for No-OS's enforcement of this fact, see No-OS ad9361_rx_bb_analog_filter_calib
Property	RF_GAIN_STEP_DB_p	Double	-	-	Parameter	1	1	-
Property	BB_GAIN_MAX_DB_p	Double	-	-	Parameter	NOT_SUPPORTED_p	NOT_SUPPORTED_p	-
Property	BB_GAIN_MIN_DB_p	Double	-	-	Parameter	NOT_SUPPORTED_p	NOT_SUPPORTED_p	-
Property	BB_GAIN_STEP_DB_p	Double	-	-	Parameter	NOT_SUPPORTED_p	NOT_SUPPORTED_p	-
Property	FREQUENCY_MAX_MHZ_p	Double	-	-	Parameter	-1	fmcomms_num == 2 ? 2500 : 6000	-
Property	FREQUENCY_MIN_MHZ_p	Double	-	-	Parameter	-1	fmcomms_num == 2 ? 2400 : 70	-
Property	SAMPLE_RATE_MAX_MHZ_p	Double	-	-	Parameter	-1	61.44	-

Property	SAMPLE_RATE_MIN_MHZ_p	Double	-	-	Parameter	-1	2.08334	Note that the AD9361 precision is double(25/12), and the No-OS implementation's precision is 2.083334, but we set it to 2.08334 to avoid confusion since an OpenCPI bug does not correctly implement the precision for 2.083334 (OpenCPI rounds it to 2.08334)
Property	RF_CUTOFF_FREQUENCY_MAX_DB_p	Double	-	-	Parameter	NOT_SUPPORTED_p	NOT_SUPPORTED_p	-
Property	RF_CUTOFF_FREQUENCY_MIN_DB_p	Double	-	-	Parameter	NOT_SUPPORTED_p	NOT_SUPPORTED_p	-
Property	RF_CUTOFF_FREQUENCY_STEP_DB_p	Double	-	-	Parameter	NOT_SUPPORTED_p	NOT_SUPPORTED_p	-
Property	BB_CUTOFF_FREQUENCY_MAX_DB_p	Double	-	-	Parameter	AD9361_RX_BBBW_NO_OS_MAX_MHZ * 1.4	AD9361_RX_BBBW_NO_OS_MAX_MHZ * 1.4	The maximum configurable cut-off frequency in MHz of the FMCOMMS2/3's AD9361's third-order Butterworth Rx anti-aliasing filter. The Rx filter is normally calibrated to 1.4x the BBBW. For more information, see AD9361_Reference_Manual_UG-570 .pdf p. 9.
Property	BB_CUTOFF_FREQUENCY_MIN_DB_p	Double	-	-	Parameter	AD9361_RX_BBBW_NO_OS_MIN_MHZ * 1.4	AD9361_RX_BBBW_NO_OS_MIN_MHZ * 1.4	The minimum configurable cut-off frequency in MHz of the FMCOMMS2/3's AD9361's third-order Butterworth Rx anti-aliasing filter. The Rx filter is normally calibrated to 1.4x the BBBW. For more information, see AD9361_Reference_Manual_UG-570 .pdf p. 9.

SpecProperty	`rf_gain_dB`	Double	-	-	Volatile, ReadSync, WriteSync	see `rf_gain_min_dB`, `rf_gain_max_dB`	1	The value of the RF gain stage of the receiver. Note that the gain is LO-dependent due to No-OS gain tables. When a write to the property occurs, this property's written value is applied to hardware. When a read of this property occurs, the read value is the (nominal) in-situ value (actual value which is currently assigned in hardware, which may be slightly different than a previously written property value due to rounding that occurs before writing hardware register values and/or No-OS API rounding) with double floating point precision.
SpecProperty	`bb_gain_dB`	Double	-	-	WriteSync	see `bb_gain_min_dB`, `bb_gain_max_dB`	`NOT_SUPPORTED_p`	The value of the baseband gain stage of the receiver. When a write to the property occurs, this property's written value is applied to hardware. When a read of this property occurs, the read value is the (nominal) in-situ value (actual value which is currently assigned in hardware, which may be slightly different than a previously written property value due to rounding that occurs before writing hardware register values and/or No-OS API rounding) with double floating point precision.

SpecProperty	`frequency_MHz`	Double	-	-	Volatile, ReadSync, WriteSync	see `frequency_min_MHz`, `frequency_max_MHz`	2400	The value for the tuned center frequency of the incoming RF samples. When a write to the property occurs, this property's written value is applied to hardware. When a read of this property occurs, the read value is the (nominal) in-situ value (actual value which is currently assigned in hardware, which may be slightly different than a previously written property value due to rounding that occurs before writing hardware register values and/or No-OS API rounding) with double floating point precision.
SpecProperty	`sample_rate_MHz`	Double	-	-	Volatile, ReadSync, WriteSync	see `sample_rate_min_MHz`, `sample_rate_max_MHz`	30.72	Sample rate of the incoming RF samples. When a write to the property occurs, this property's written value is applied to hardware. When a read of this property occurs, the read value is the (nominal) in-situ value (actual value which is currently assigned in hardware, which may be slightly different than a previously written property value due to rounding that occurs before writing hardware register values and/or No-OS API rounding) with double floating point precision.

SpecProperty	rf_cutoff_frequency_MHz	Double	-	-	WriteSync	see rf_cutoff_frequency_min_MHz, rf_cutoff_frequency_max_MHz	NOT_SUPPORTED_p	When a write to the property occurs, this property's written value is applied to hardware. When a read of this property occurs, the read value is the (nominal) in-situ value (actual value which is currently assigned in hardware, which may be slightly different than a previously written property value due to rounding that occurs before writing hardware register values and/or No-OS API rounding) with double floating point precision.
SpecProperty	bb_cutoff_frequency_MHz	Double	-	-	Volatile, ReadSync, WriteSync	see bb_cutoff_frequency_min_MHz, bb_cutoff_frequency_max_MHz	18	The effective cutoff frequency, i.e. half of the bandwidth, for all filtering that is done in the baseband stage of the receiver. The cutoff frequency in MHz of the FMCOMMS2/3's AD3961's third-order Butterworth Rx anti-aliasing filter. The Rx filter is located just before the ADC in the Rx signal path and is normally calibrated to 1.4x the baseband channel bandwidth (BBBW). Note that the BBBW is half the complex bandwidth. For more information, see AD9361_Reference_Manual_UG-570.pdf p. 9.
SpecProperty	rf_gain_max_dB	Double	-	-	ReadSync, WriteSync	LO frequency-dependent	-	Maximum valid value for RF gain
SpecProperty	rf_gain_min_dB	Double	-	-	ReadSync, WriteSync	LO frequency-dependent	-	Minimum valid value for RF gain
SpecProperty	rf_gain_step_dB	Double	-	-	WriteSync	RF_GAIN_STEP_DB_p	RF_GAIN_STEP_DB_p	Minimum granularity for changes in RF gain
SpecProperty	bb_gain_max_dB	Double	-	-	WriteSync	BB_GAIN_MAX_MHZ_p	BB_GAIN_MAX_MHZ_p	Maximum valid value for baseband gain

SpecProperty	bb_gain_min_dB	Double	-	-	WriteSync	BB_GAIN_MIN_MHZ_p	BB_GAIN_MIN_MHZ_p	Minimum valid value for baseband gain
SpecProperty	bb_gain_step_dB	Double	-	-	WriteSync	BB_GAIN_STEP_DB_p	BB_GAIN_STEP_DB_p	Minimum granularity for changes in baseband gain
SpecProperty	frequency_max_MHz	Double	-	-	WriteSync	FREQUENCY_MAX_MHZ_p	FREQUENCY_MAX_MHZ_p	Maximum valid value for frequency
SpecProperty	frequency_min_MHz	Double	-	-	WriteSync	FREQUENCY_MIN_MHZ_p	FREQUENCY_MIN_MHZ_p	Minimum valid value for frequency
SpecProperty	frequency_step_MHz	Double	-	-	ReadSync, WriteSync	LO frequency-dependent	-	Minimum granularity for changes in frequency
SpecProperty	sample_rate_max_MHz	Double	-	-	WriteSync	SAMPLE_RATE_MAX_MHZ_p	SAMPLE_RATE_MAX_MHZ_p	Maximum valid value for sample rate
SpecProperty	sample_rate_min_MHz	Double	-	-	WriteSync	SAMPLE_RATE_MIN_MHZ_p	SAMPLE_RATE_MIN_MHZ_p	Minimum valid value for sample rate
SpecProperty	sample_rate_step_MHz	Double	-	-	ReadSync, WriteSync	Runtime-variable	-	Indicates the precision which will be used to evaluate the value written to this worker's sample_rate_MHz property before that value is applied to hardware. For example if the step is 2, the value written is rounded to the nearest multiple of 2 in order to be applied to hardware. The precision in this case is determined by the precision of the ad9361_config_proxy.rcc worker's rx_sampling_freq property.
SpecProperty	rf_cutoff_frequency_max_MHz	Double	-	-	WriteSync	RF_CUTOFF_FREQUENCY_MAX_MHZ_p	RF_CUTOFF_FREQUENCY_MAX_MHZ_p	Maximum valid value for RF cutoff frequency.
SpecProperty	rf_cutoff_frequency_min_MHz	Double	-	-	WriteSync	RF_CUTOFF_FREQUENCY_MIN_MHZ_p	RF_CUTOFF_FREQUENCY_MIN_MHZ_p	Minimum valid value for RF cutoff frequency.
SpecProperty	rf_cutoff_frequency_step_MHz	Double	-	-	WriteSync	RF_CUTOFF_FREQUENCY_STEP_MHZ_p	RF_CUTOFF_FREQUENCY_STEP_MHZ_p	Minimum granularity for changes in RF cutoff frequency.
SpecProperty	bb_cutoff_frequency_max_MHz	Double	-		WriteSync	BB_CUTOFF_FREQUENCY_MAX_MHZ_p	BB_CUTOFF_FREQUENCY_MAX_MHZ_p	Maximum valid value for baseband cutoff frequency
SpecProperty	bb_cutoff_frequency_min_MHz	Double	-	-	WriteSync	BB_CUTOFF_FREQUENCY_MIN_MHZ_p	BB_CUTOFF_FREQUENCY_MIN_MHZ_p	Minimum valid value for baseband cutoff frequency
SpecProperty	bb_cutoff_frequency_step_MHz	Double	-	-	ReadSync, WriteSync	Runtime-variable	-	Maximum granularity for changes in baseband cutoff frequency

Property	app_inst_name_ad9361_config_proxy	String	-	128	Initial, Readable, WriteSync	Standard	ad9361_config_proxy	Value must match the name of the ad9361_config_proxy application instance.
Property	app_inst_name_ad9361_data_sub	String	-	128	Initial, Readable, WriteSync	Standard	ad9361_data_sub	Value must match the name of the ad9361_data_sub application instance.
Property	app_inst_name_ad9361_adc_sub	String	-	128	Initial, Readable, WriteSync	Standard	ad9361_adc_sub	Value must match the name of the ad9361_adc_sub application instance.
Property	config	Struct (see Table 1)	-	-	Initial, Volatile, ReadSync, WriteSync	Standard	reference_clk_rate_Hz 40e6,duplex_mode FDD,are_using_REF_CLK_SMA false,SMA_channel RX1A	Value must match the name of the ad9361_adc_sub application instance.
Property	LO_source	Enum	-	-	Readable, Writable, WriteSync	internal, external	internal	The value 'external' should only be used if an external-to-the-FMCOMMS2/3 clock drives the TP102 test point on the FMCOMMS2/3 PCB.

Table 1: Structure declaration for rx.rcc config property type.

Type	Name	Type	Sequence Length	Array Dimensions	Accessibility/ Advanced	Valid Range	Default	Usage
Property	reference_clk_rate_Hz	Double	-	-	-	Standard	-	Schematic crystal Y101 frequency.
Property	duplex_mode	Enum	-	-	-	TDD, FDD	-	-
Property	are_using_REF_CLK_SMA	Boolean	-	-	-	Standard	-	-
Property	SMA_channel	Enum	-	-	-	RX1A, RX2A	-	Indicates which SMA connector on the FMCOMMS2/3 PCB that the RX data stream controlled by an instance of this worker corresponds to.

Performance and Resource Utilization

fmcomms_2_3_rx.rcc

Processor Type	Processor Frequency	Run Function Time
TBD	TBD	TBD

Test and Verification

No unit test for this worker exists. However, a hardware-in-the-loop application (which is NOT a unit test) exists for testing purposes (see applications/fmcomms_2_3_rx_test).

References

[1] AD9361 Reference Manual UG-570
AD9361_Reference_Manual_UG-570.pdf