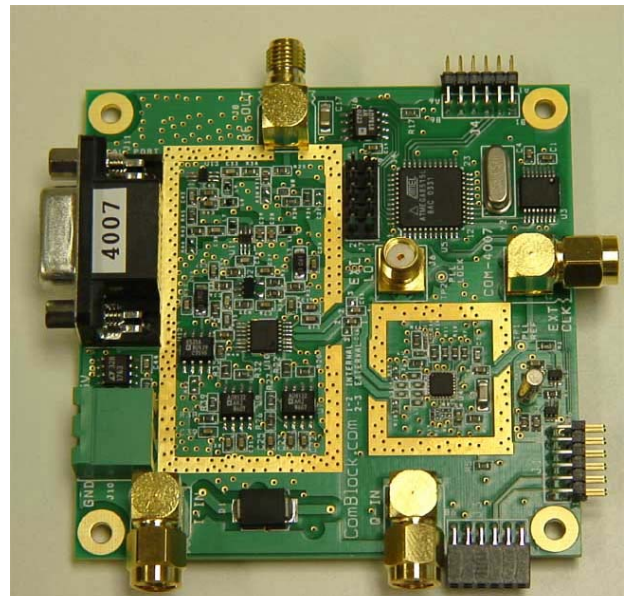
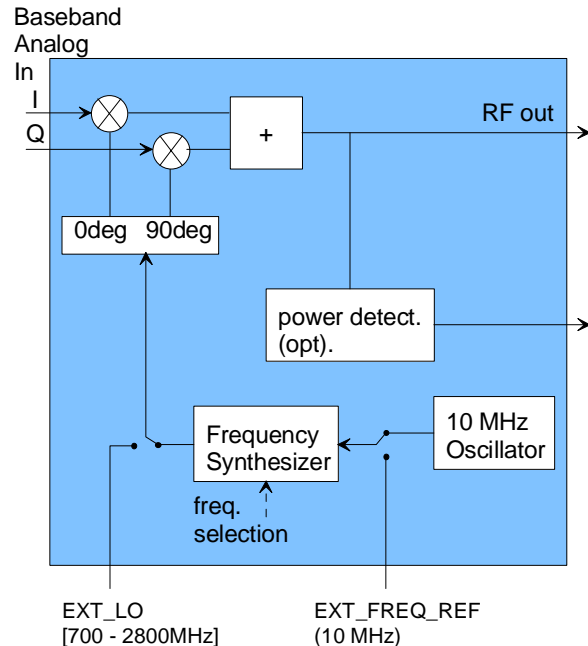


COM-4007 [2.3 – 2.8 GHz] QUADRATURE RF MODULATOR

Key Features

- Quadrature modulator 2.3 – 2.8 GHz¹ center frequency. Designed for use in the 2.3GHz SDARS band, in the 2.4 GHz unlicensed band and in the Multichannel Multipoint Distribution Service (MMDS) band.
- Low-noise frequency synthesizer can be tuned over entire range by steps of 1 MHz, 200 KHz or 100 KHz.
- Optional output power measurement has 0.1 dB resolution.
- 8 preset frequencies for fast (<6ms) local oscillator frequency tuning.
- Automatic selection of internal / external 10 MHz frequency reference for the frequency synthesizer.
- True PLL: multiple COM-4007s can be phase locked onto the same external 10 MHz frequency reference. The LO phase difference among the multiple modules is fixed at power-up.
- Optional operation over extended frequency range [700 MHz – 2.8 GHz] by supplying an externally-generated RF carrier for frequency upconversion via SMA connector.
- Single 5V supply with reverse voltage and overvoltage protection. Connectorized 3" x 3" module for ease of prototyping. SMA connectors.



(shown without shield)

For the latest data sheet, please refer to the **ComBlock** web site: comblock.com/download/com4007.pdf. These specifications are subject to change without notice.

For an up-to-date list of **ComBlock** modules, please refer to www.comblock.com/product_list.htm.

¹ Also able to tune in the 1150-1400 MHz range.

Electrical Interface

Inputs / Outputs

Input Module Interface	Definition
ANALOG_I_IN	Modulated input signal, analog, baseband, real (I) axis. 1Vpp max. Positive DC bias is required so that signal is within the [0.3 – 3.0V] rails. The DC bias is removed internally by a low-pass filter with cutoff bandwidth < 2 Hz. SMA male connector.
ANALOG_Q_IN	Modulated input signal, analog, baseband, imaginary (Q) axis. 1Vpp max. Same electrical characteristics as above.
EXT_REF_CLK	Optional input. External 10 MHz frequency reference for frequency synthesis. Sinewave, clipped sinewave or squarewave. J2 SMA male connector. 50 Ohm. Minimum level: 2Vpp. Maximum level: 3.3Vpp.
EXT_LO	Optional input. Externally generated RF carrier for frequency down-conversion, thus bypassing the internal frequency synthesizer. Enabled or disabled by moving two SMT capacitors soldered on the board. AC coupled, 50 Ohm impedance. Input level: 0 dBm max, -10 dB min.

Analog Output Signals	Definition
RF_OUT	Modulated RF output. 2.3 – 2.8 GHz or 1.15 – 1.4 GHz. Maximum output level: +4 dBm. Impedance: 50 Ohms. SMA female connector
Control Lines	Definition
ENABLE	Low-voltage TTL input control. Used to turn the modulator on/off. Level signal: 3.3V = ON, 0V = OFF. Response time 113 µsec. On/Off rejection > 50 dB. Connector J1 Pin B3. This control signal is enabled only when REG6 bit 1 = '1'. Pulled high by default.

PLL_STROBE	Low-voltage (3.3V / 0V) TTL input control. Used to increment the modulo- N_{freq} frequency pointer (where N_{freq} is defined in Register 35). RF frequency 0 -> RF frequency 1 -> RF frequency 2 -> RF frequency 0 > etc... Rising edge triggered. Minimum pulse width: 10 µsec. Connector J1 Pin A3.
TX_RXN_OUT	Low-voltage (3.3V / 0V) TTL output control to switch the COM-4102 transceiver between transmit (high) and receive (low) modes based on the REG5 bit 2 control register.
Serial Monitoring & Control	DB9 connector. 115 Kbaud/s. 8-bit, no parity, one stop bit. No flow control.
Power Interface	4.75 – 5.25VDC. Terminal block. Power consumption is 300mA max.

Important: digital I/O signals are 0-3.3V LVTTTL. Inputs are NOT 5V tolerant!

Absolute Maximum Ratings

Supply voltage	-60V min, +10V max
12-pin connector digital inputs	-0.5V min, +3.6V max
EXT_REF_CLK, ANALOG_I_IN, ANALOG_Q_IN, EXT_LO	-0.5V min, +3.6V max

Configuration

Complete assemblies can be monitored and controlled centrally over a single asynchronous serial connection or, when available through adjacent ComBlocks, LAN/TCP-IP, USB, or CardBus connection.

The module configuration is stored in non-volatile memory.

The COM-4007 ignores any M&C message received within 6 ms of a transition on the PLL_STROBE and ENABLE signals.

Configuration (Basic)

The easiest way to configure the COM-4007 is to use the ComBlock Control Center software supplied

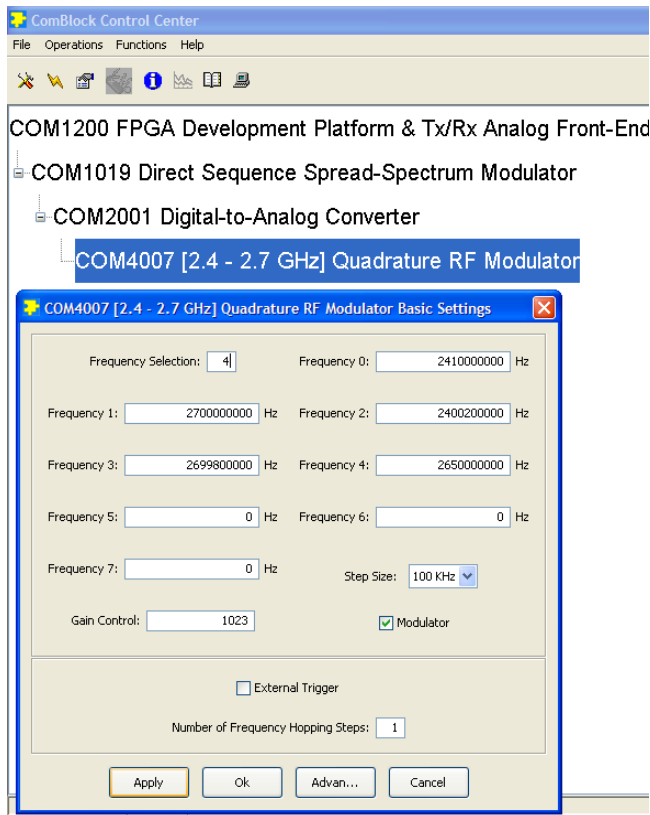
with the module(s). After detecting the ComBlock modules (2nd button from left), highlight the COM-4007 module to be configured. Then press the settings button (3rd button from the left).

Up to eight frequencies can be stored within each module at any given time. The current frequency is selected by an index in the range 0 to 7. Frequencies must be integer multiples of the RF synthesizer step size.

A basic frequency hopping scheme can be enabled by

- (a) enabling the external trigger
- (b) entering the number of frequency hopping steps in the round-robin arrangement.

For example, by specifying 4 steps, the modulator center frequency will follow the following index sequence: 0,1,2,3,0,1,2,3,0,1, etc., the index being incremented at the rising edge of each external PLL_STROBE pulse.



Configuration (Advanced)

Alternatively, users can access the full set of configuration features by specifying 8-bit control registers as listed below. These control registers can be set manually through the ComBlock Control Center or by software using the ComBlock API (see www.comblock.com/download/M&C_reference.pdf)

All control registers are read/write.

Undefined control registers or register bits are for backward software compatibility and/or future use. They are ignored in the current firmware version.

Programmers developing custom applications (using the [ComBlock API](#) instead of the supplied ComBlock control center graphical user interface) should know that frequency changes are enacted upon (re-)writing to the last register (REG35).

Parameters	Configuration
RF frequency 0	Preselected frequency 0. Range 2.3GHz to 2.8GHz and 1.15 to 1.4 GHz, by steps 1 MHz, 200 KHz or 100 KHz, expressed in Hz. REG0: bit 7:0 (LSB) REG1: bit 15:8 REG2: bit 23:16 REG3: bit 31:24 (MSB)
Gain control	10-bit control. Non-linear scale. Zero is lowest power. 1023 is for the maximum output power. Gain control range : 12.5 dB @ 2.3GHz (typ.) 13.1 dB @ 2.4GHz (typ.) 16.1 dB @ 2.7GHz (typ.) 17.5 dB @ 2.8GHz (typ.) REG4: bit 7-0 (LSB) REG5: bit 1-0 (MSB)
External power amplifier control	Digital control for the external COM-4102 power amplifier. Controls TX_RXN_OUT signal. 0 = transmit off, receive on 1 = transmit on, receive off REG5: bit 2
External/Internal RF carrier generation	Enable or disable the RF frequency synthesizer. 0 = internal RF carrier generation. 1 = external. An unmodulated RF signal must be supplied, the frequency of which determines the receiver center frequency. The RF frequency settings are thus ignored. REG5: bit 7
External controls enabled/disabled	Enable or disable the PLL_STROBE and output

	PLL_STROBE and output ENABLE external controls on the J1 connector. 0 = external controls disabled 1 = external controls enabled REG6: bit 1
Modulator on/off	0 = modulator off 1 = modulator on Note: external control ENABLE may override this register. REG6: bit 2
Step size selection	Chose the RF frequency synthesizer step size. The selected RF frequency must be an integer multiple of the step size. 200 KHz is recommended for best overall phase noise performance. 00 = 1 MHz step 01 = 200 KHz step 10 = 100 KHz step 11 = undefined REG6 bits 4-3.
Frequency selection	Use to switch local oscillator frequency among preselected values. Note: the external PLL_STROBE control may override this selection. Range 0 through 7 REG6 bits 7-5.
RF frequency 1	Preselected frequency 1. Same format as RF frequency 0. REG7: bit 7:0 (LSB) REG8: bit 15:8 REG9: bit 23:16 REG10: bit 31:24 (MSB)
RF frequency 2	Preselected frequency 2. Same format as RF frequency 0. REG11: bit 7:0 (LSB) REG12: bit 15:8 REG13: bit 23:16 REG14: bit 31:24 (MSB)
RF frequency 3	Preselected frequency 3. Same format as RF frequency 0. REG15: bit 7:0 (LSB) REG16: bit 15:8 REG17: bit 23:16 REG18: bit 31:24 (MSB)
RF frequency 4	Preselected frequency 4. Same format as RF frequency 0. REG19: bit 7:0 (LSB) REG20: bit 15:8 REG21: bit 23:16 REG22: bit 31:24 (MSB)
RF frequency 5	Preselected frequency 5. Same format as RF frequency 0. REG23: bit 7:0 (LSB) REG24: bit 15:8 REG25: bit 23:16 REG26: bit 31:24 (MSB)

RF frequency 6	Preselected frequency 6. Same format as RF frequency 0. REG27: bit 7:0 (LSB) REG28: bit 15:8 REG29: bit 23:16 REG30: bit 31:24 (MSB)
RF frequency 7	Preselected frequency 7. Same format as RF frequency 0. REG31: bit 7:0 (LSB) REG32: bit 15:8 REG33: bit 23:16 REG34: bit 31:24 (MSB)
Number of RF frequencies Nfreq in the scanning list	Each time a PLL_STROBE pulse is received, the frequency pointer increments modulo Nfreq. Nfreq is in the range 1 – 8. REG35: bit 7:0.

Baseline configurations can be found at www.comblock.com/tsbasic_settings.htm and imported into the ComBlock assembly using the ComBlock Control Center File | Import menu.

Monitoring

Parameters	Monitoring
Power measurement (option -D)	10-bit number. The higher the number, the lower the power. The power measurement linearity is shown below. SREG0 bits 7-0: bit 7-0 (LSB) SREG1 bits 1-0: bits 9-8 (MSB)
Temperature measurement (option -D)	10-bit number. The representation in degrees centigrade is as follows: -103°C + (decimal value/4) SREG2 bits 7-0: bit 7-0 (LSB) SREG3 bits 1-0: bits 9-8 (MSB)
PLL lock status	A persistent '1' indicates that the frequency synthesizer is locked to the frequency reference. SREG4 bit 0.

Test Points

Test points are provided for easy access by an oscilloscope probe.

Test Point	Definition
PLL_REF	Internal / External reference clock Note: do not connect any permanent test cable to this test point as it is likely to cause a significant degradation in phase noise performance.
PLL_LOCK	Frequency synthesizer PLL lock status. Active low: '1' when locked. This information is also available in status register SREG4

Operations

Internal vs External Frequency Reference

An external 10 MHz frequency reference can be used when the user application requires high frequency stability. In this case, simply connect a 10 MHz sine wave, clipped sine wave or square wave to the J2 EXT-CLK SMA connector. Detection is automatic, thus no configuration change is needed. Upon removal of the external 10 MHz frequency reference signal, the COM-4007 reverts to the internal frequency reference.

External RF carrier

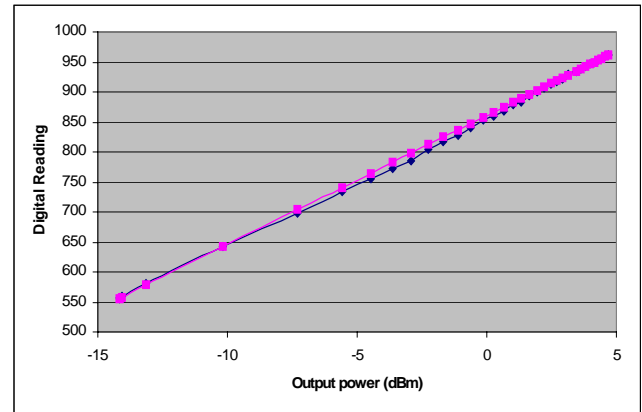
Operation over extended frequency range [700 MHz – 2.8 GHz] is possible by supplying an externally-generated RF carrier for frequency upconversion via the J6 SMA connector. This configuration is not software configurable: the RF carrier path is altered by moving the C15 and C16 capacitors 90 degrees from the 1-2 position to the 2-3 position as shown below:



In order to minimize noise when an external RF carrier is used, it is recommended to switch off the built-in RF frequency synthesizer by software (see control register REG5, bit 7).

Power Measurement (Option -D)

Output power measurement is provided as an option (-D). Output power measured with +/- 0.2 dB accuracy over a range from -30 dBm to the maximum output power. The 10-bit measurement linearity is shown below:



*Power measurement linearity.
Measured (dark blue) vs linear (purple)
Measured at 2.8GHz.*

Schematics

The schematics are available on the ComBlock CD shipped with every module (in the “Hardware schematics” folder).

Performance

Internal Clock Reference

The internal crystal performance is as follows:

- tolerance: [-20 to 0] ppm max @25C
- temperature stability (-10C to +60C): ± 50 ppm max
- aging: ±5ppm/year max (1st year) @25C

Modulation

Quadrature phase error: 1. deg rms. typ
I/Q amplitude balance error: 0.2 dB.typ

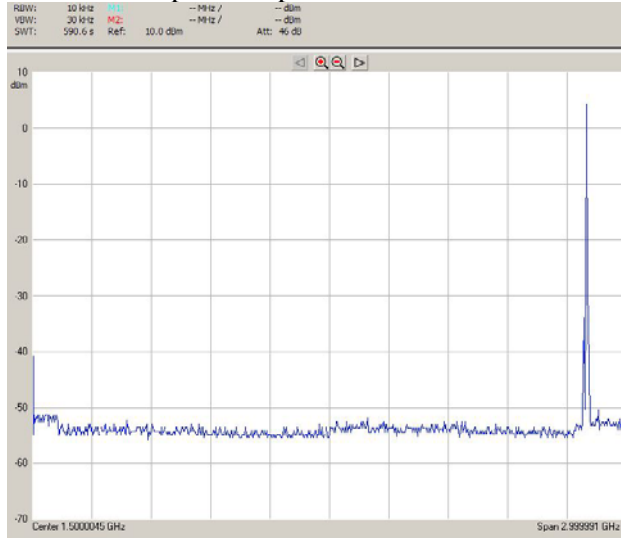
ON/OFF rejection (using modulator on/off command only): 83 dB typ.

LO leakage (at output, maximum tx gain):
-30 dBm @ 2.7 GHz, typ.
-28 dBm @ 2.4 GHz, typ.

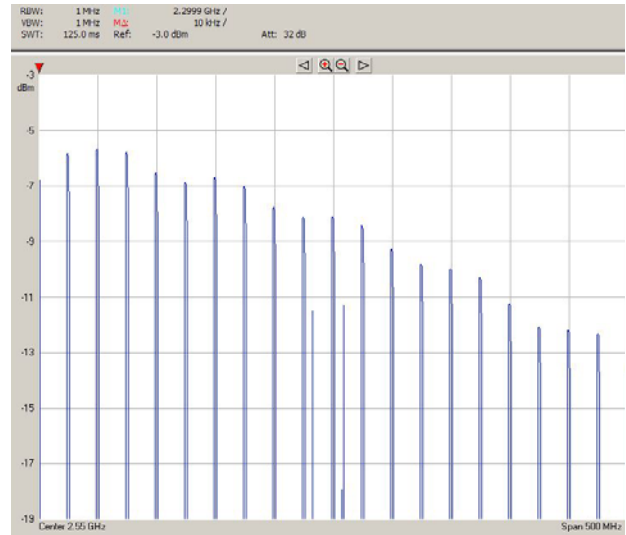
Sideband suppression:
-39 dBc @ 2.7 GHz, typ.
-40 dBc @ 2.4 GHz, typ.

Modulation bandwidth:
+/-100 MHz (200 MHz total) for 600mVpp input signal and +/-0.3 dB gain flatness.

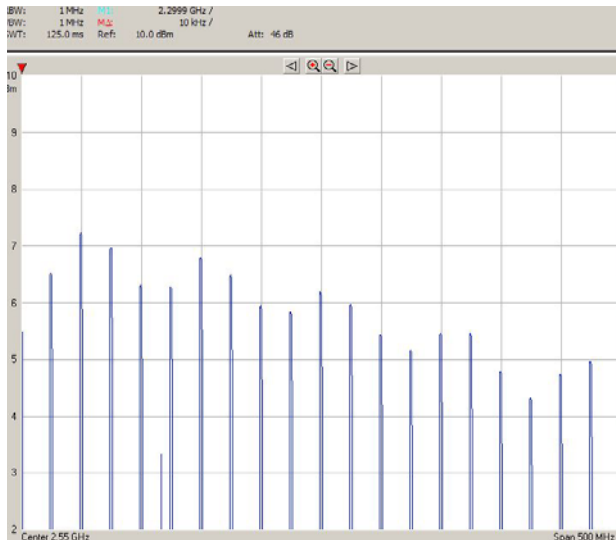
Out-of-band spurious spectral lines: < -60 dBc



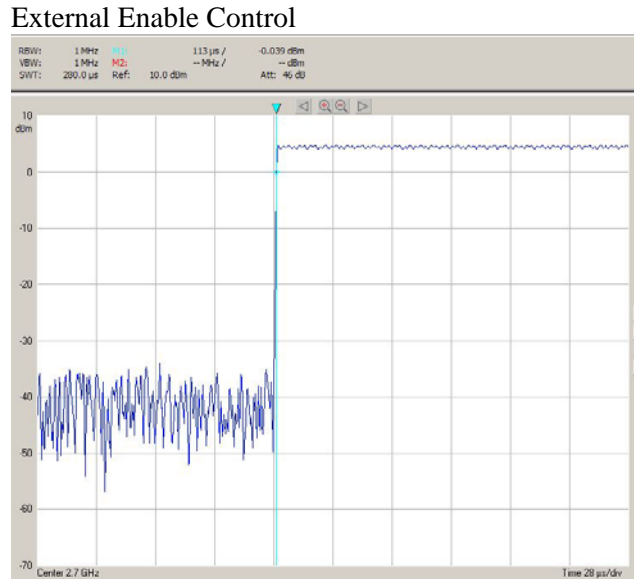
Output spectrum 0 – 3GHz. 10 KHz resolution bandwidth. 2.8 GHz modulated output.



Minimum output power vs tuning frequency. 1Vpp baseband input. Gain settings 0.



Maximum output power vs tuning frequency. 1Vpp baseband input. Gain settings 1023



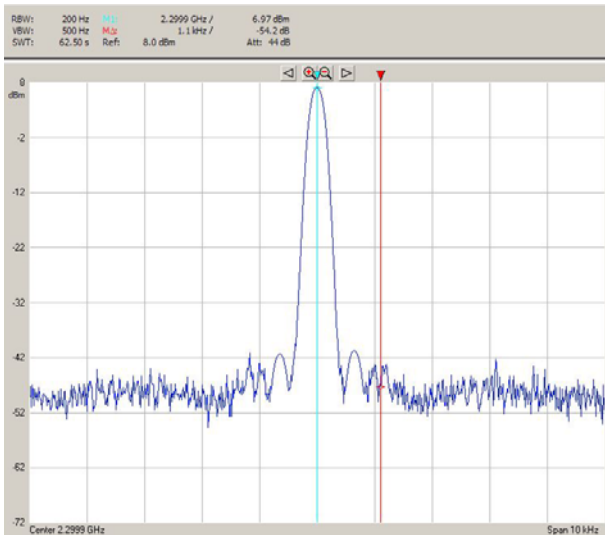
External enable control. Rise time = 113 us On/Off attenuation > 50 dB

Frequency Synthesizer

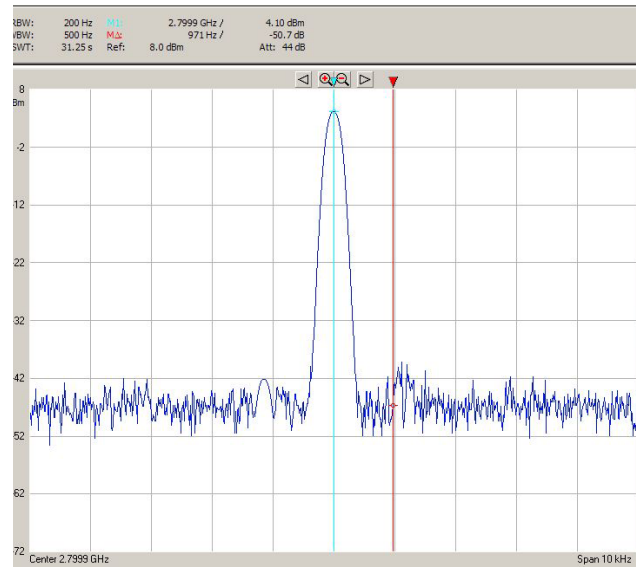
LO frequency switching time: <6 ms

Phase noise (200 KHz step size, internal frequency reference and most external frequency references)

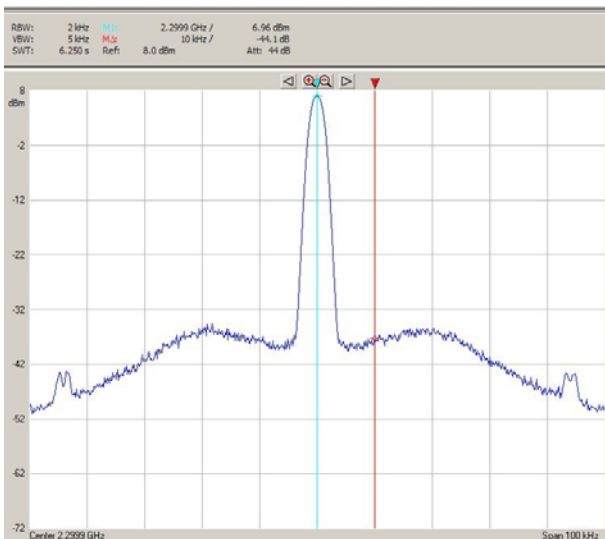
- < -77 dBc @ 1 KHz
- < -77 dBc @ 10 KHz
- < -100 dBc @ 100 KHz



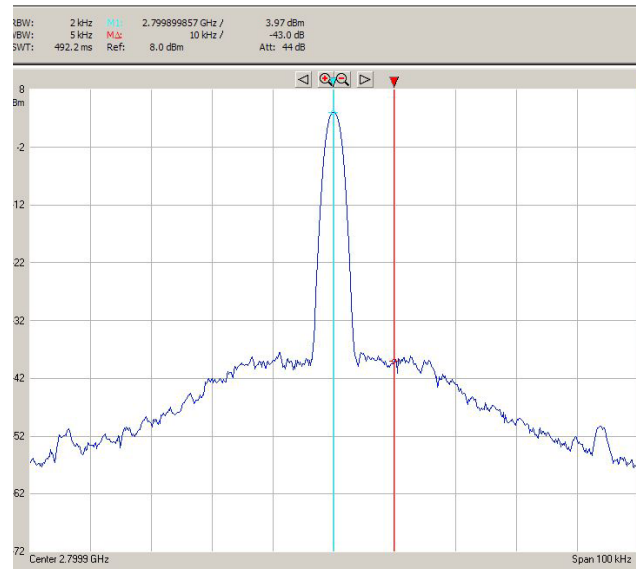
Phase noise @ 2.3 GHz, 200 KHz RF synthesizer step size, maximum output power, internal frequency reference. 10 KHz span, 200 Hz resolution bandwidth.



Phase noise @ 2.8 GHz, 200 KHz RF synthesizer step size, maximum output power, internal frequency reference. 10 KHz span, 200 Hz resolution bandwidth.



Phase noise @ 2.3 GHz, 200 KHz RF synthesizer step size, maximum output power, internal frequency reference. 100 KHz span, 2kHz resolution bandwidth.



Phase noise @ 2.8 GHz, 200 KHz RF synthesizer step size, maximum output power, internal frequency reference. 100 KHz span, 2kHz resolution bandwidth.

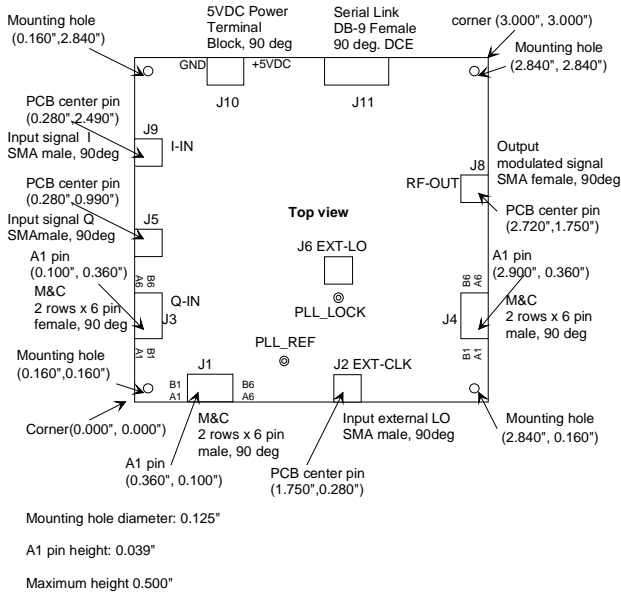
The phase noise performance are similar when using the internal frequency reference or most external frequency reference signals.

Harmonics

2nd harmonics level when using the 1150-1400 frequency range:
1.150GHz, 2nd harmonics: -18.7 dBc

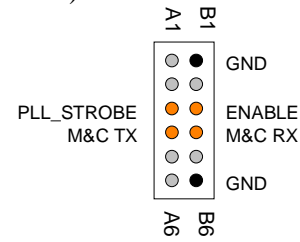
1.400GHz, 2nd harmonics: -20.8 dBc

Mechanical Interface



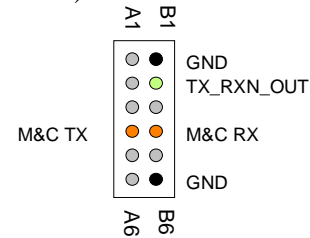
Output Connector J1

12-pin (2 rows x 6) 2mm male connector.



Output Connector J4

12-pin (2 rows x 6) 2mm male connector.

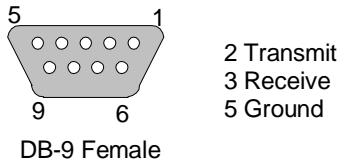


This connector is to forward monitoring and control signals to subsequent analog modules.

Pinout

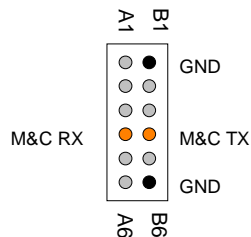
Serial Link J11

The DB-9 connector is wired as data circuit terminating equipment (DCE). Connection to a PC is over a straight-through cable. No null modem or gender changer is required.



Input Connector J3

12-pin (2 rows x 6) 2mm female connector.



This module is designed for direct connection to the COM-2001 baseband digital-to-analog conversion module.

I/O Compatibility List

(not an exhaustive list)

Input	Output
COM-2001 Dual D/A converter (baseband)	COM-3007 [2.3 – 2.8GHz] receiver (back to back with RF attenuation in-between)

Configuration Management

This specification is to be used in conjunction with Atmel microcontroller software revision 4.

ComBlock Ordering Information

COM-4007-C [2.3 – 2.8 GHz] QUADRATURE MODULATOR

COM-4007-D [2.3 – 2.8 GHz] QUADRATURE MODULATOR W/ OUTPUT POWER MEASUREMENT.

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