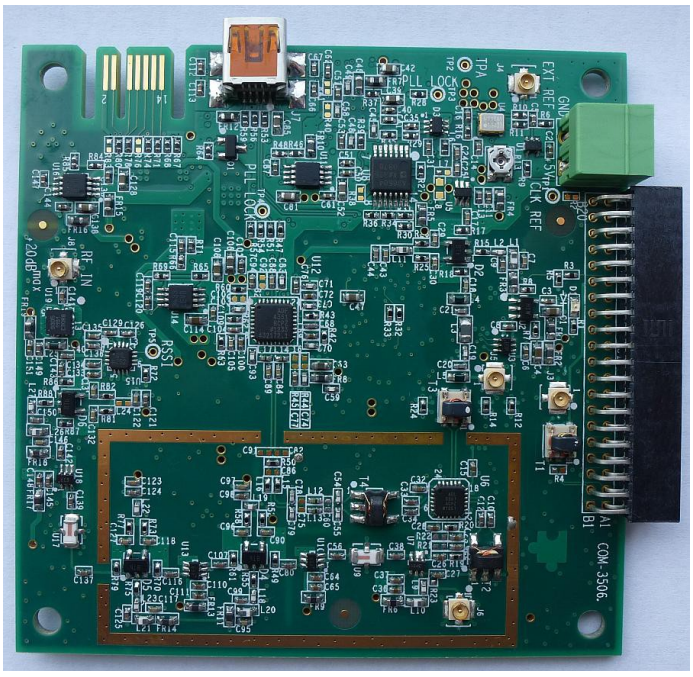
COM-3506 [400MHz - 3GHz] Transceiver

Key Features

- Full or half-duplex transceiver,
- Configurable as wideband (400 MHz – 3 GHz) or, for higher receiver sensitivity and cleaner transmit spectral purity, with application-specific frequency bands. Custom frequency bands at no extra charge.
- RF input level: -90 dBm to -10 dBm.
  2 dB noise figure.
- RF output level: +5 dBm max
- Receiver bandwidth: 28 MHz
  Other bandwidths available upon request.
- Low phase noise (<-90 dBc @ 1KHz) consistent with low data rate applications.
- Internal 2.5ppm TCXO frequency reference (before calibration), or external 10 MHz frequency reference.
- Half-duplex Tx/Rx switch time < 3µs
- Independently tunable center frequency for tx/rx.
- Baseband
  - Modulator input: differential analog signal, 1Vpp complex baseband (In-phase and Quadrature)
  - Receiver output: 140 MHz IF, suitable for IF undersampling.
- RF interfaces: 50 Ohm UMCC connectors for tx output, rx input, external 10 MHz frequency reference.
- USB port for monitoring and control.
- Only single +5V_{DC} supply required.
  Connectorized 3”x 3” module for ease of prototyping

For the latest data sheet, please refer to the **ComBlock** web site: comblock.com/com3506.html.
These specifications are subject to change without notice.

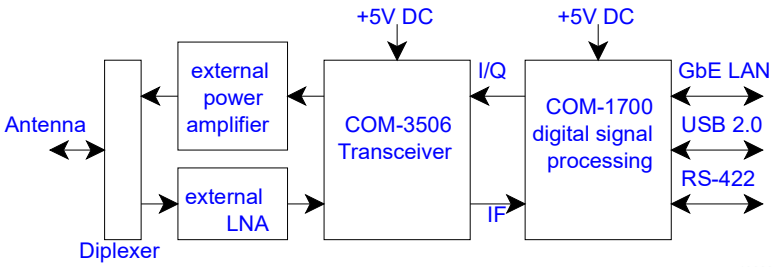
For an up-to-date list of **ComBlock** modules, please refer to comblock.com/product_list.html

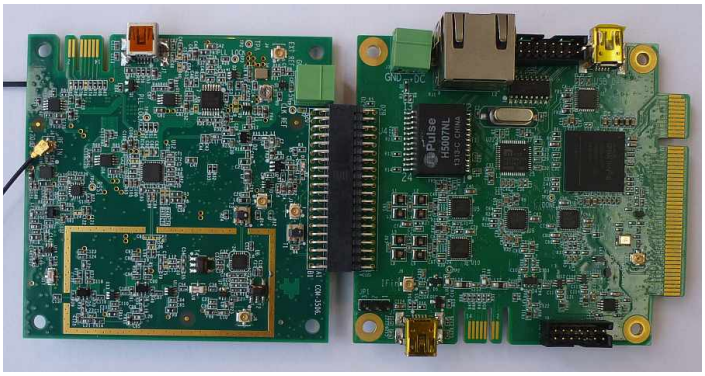


COM-3506 3”x3” Transceiver (shown without shield)

Applications Examples

2-module satellite modem





MSS • 845 Quince Orchard Boulevard Ste N • Gaithersburg, Maryland 20878-1676 • U.S.A.
Telephone: (240) 631-1111 Facsimile: (240) 631-1676 www.ComBlock.com
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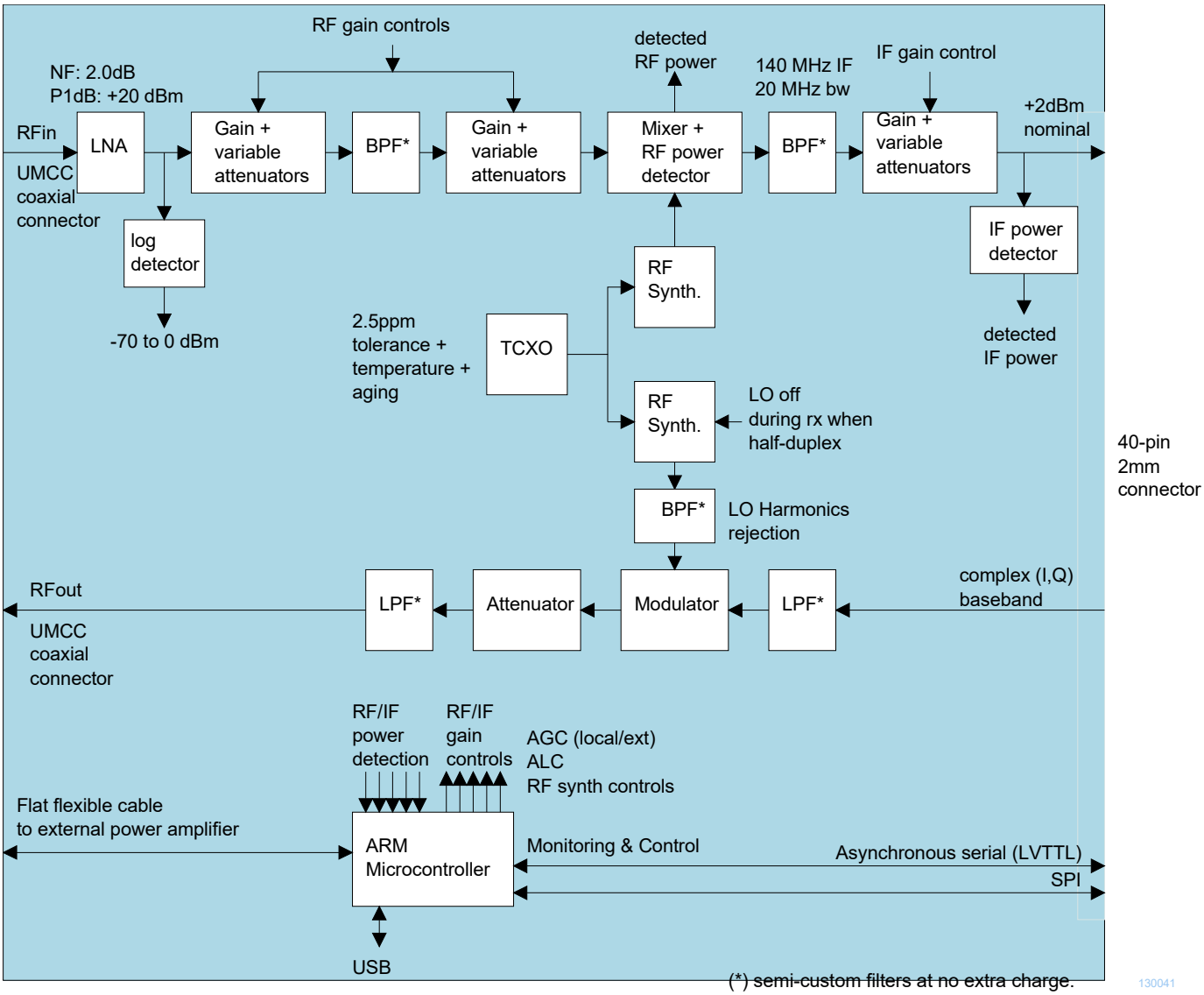
Block Diagram



(*) semi-custom filters at no extra charge.
Let us know the band of operation.

Electrical Interface

Baseband Interface 40-pin J1	Definition
RX_IF_P / RX_IF_N	The received signal is an IF signal with a nominal center frequency of 140 MHz. Output level is +2dBm, for most of the receiver input dynamic range except for the lower input range of [-100 to –80 dBm]. The output is available in two forms: single-ended 50 Ohm coaxial at the J3 UMCC connector, or 100 Ohm differential at the J1 RX_IF_P/N pins. Differential output: 1Vpp maximum differential voltage (0.5Vpp on each signal). 0.9V common-mode voltage. Load minimum differential resistance: 10 KOhm.
TX_I_P / TX_I_N TX_Q_P / TX_Q_N	The transmitter expects a complex (I/Q) baseband input with the following characteristics: 0.5V common mode voltage 100 Ohm differential input pairs (_P for +, _N for -), I for in-phase, Q for quadrature. Full range 2.0Vpp differential (1.0Vpp on each TX*x*_P and TX*x*_N signal). AC-coupled inputs. Input impedance: 60 KOhm.
RX_AGC1	Receiver gain control. Analog input in the range 0 – 3.3V. Range > 90 dB log scale. 0V yield the maximum gain. Meaningful only when selecting the external AGC loop mode. Ignored otherwise.
RX_TXN	Binary Receive/Transmit# selection. ‘0’ = transmit ‘1’ = receive. Ignored when configured for full duplex. In half-duplex, the transmit output is muted when RX_TXN = ‘1’. LVTTL input. Recommended guard time: 3.5us.
TX_ENB	Binary transmit section enable. Active high. ‘1’ = to power the transmit section ‘0’ = to save power in a receive-only configuration. Unlike the fast RX_TXN switch signal, this signal cannot be switched dynamically because of the power supply slow rise time. LVTTL input.
ANALOG_OUT	Multi-purpose analog output signal. The meaning is defined through control register. Range 0 – 3.3V.
TX_GAIN_CTRL1	Transmitter gain control. Analog input in the range 0 – 3.3V. Range: 30 dB Non-linear scale. 3.3V yield the maximum gain.
UMCC coaxial connectors	
RF_IN	Receiver input. 50 Ohm, UMCC (Ultra miniature coaxial connector) Operating range: -100 to -10 dBm Maximum no damage input level: + 20 dBm
RF_OUT	Transmitter output. 50 Ohm, UMCC (Ultra miniature coaxial connector) Transmit level: +5 dBm max
EXT_REF	Optional higher-stability external frequency reference. 10 MHz. Sinewave, clipped sinewave or squarewave. AC-coupled. J4 UMCC connector. 50 Ohm. Minimum level: 2Vpp. Maximum level: 3.3Vpp.
Flat flexible cable connector to power amplifier module	
RX_TXN TX_EN RFOUT_ENB TX_GAIN_CTRL2 PA_MONITORING1	Monitoring and control signals to an external power amplifier/RX-TX switch module.

PA_MONITORING2	

Monitoring & Control	
USB	Mini-USB connector Type AB Full speed / Low Speed
SPI	SPI interface through the 40-pin connector.
Async. Serial	LVTTL-level (NOT RS232!) asynchronous serial, 115.2 Kbaud. Through the 40-pin connector and card edge.
Power	
Power Interface	4.9 – 5.5V_{DC}; 3.81mm Terminal block. Power consumption is 950 mA typ.

Absolute Maximum Ratings

Supply voltage	-25V min, +6.5V max
Baseband input signals	-0.3V min, +3.6V max
External 10 MHz clock	5Vpp max
RF input	+20 dBm

Configuration

An entire ComBlock assembly comprising several ComBlock modules can be monitored and controlled centrally over a single connection with a host computer. Connection types include built-in types:

- USB
- SPI
- Asynchronous serial (LVTTL levels)

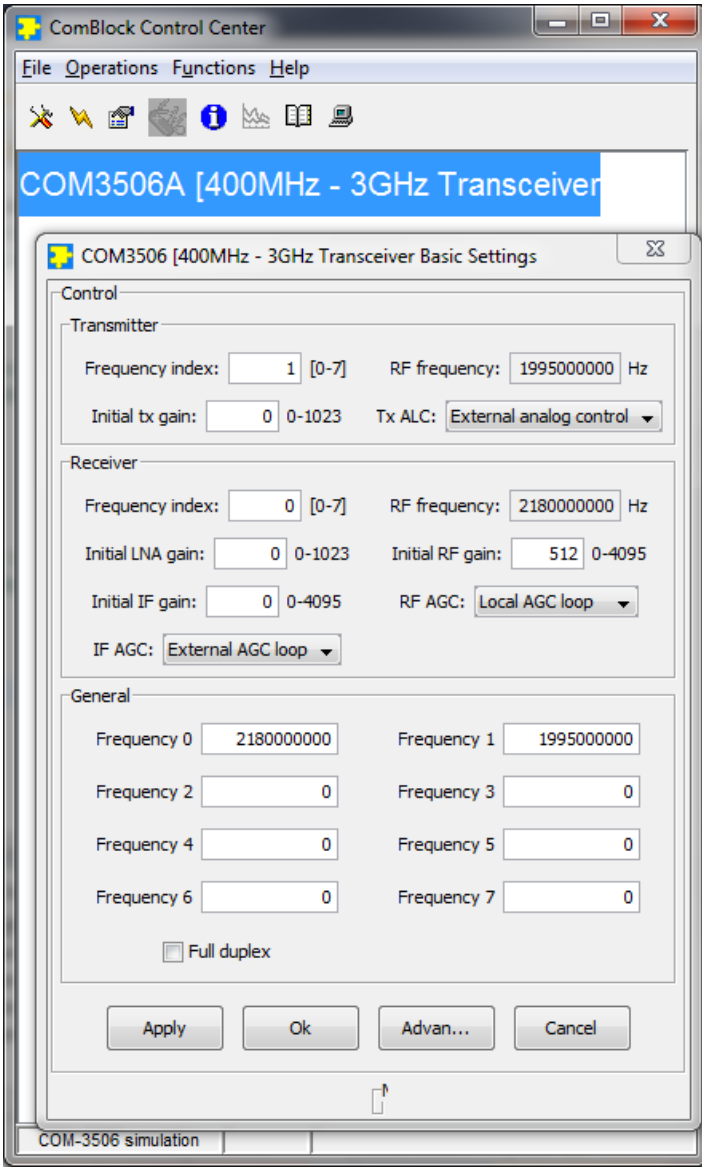
or connections via adjacent ComBlocks:

- USB
- TCP-IP/LAN,
- Asynchronous serial (DB9)
- PC Card (CardBus, PCMCIA).

The module configuration is stored in non-volatile memory.

Configuration (Basic)

The easiest way to configure the COM-3506 is to use the **ComBlock Control Center** software supplied with the module on CD. In the ComBlock Control Center window detect the ComBlock module(s) by clicking the *Detect* button, next click to highlight the COM-3506 module to be configured and click the *Settings* button to display the *Basic Settings* window shown below.



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)

The module configuration parameters are stored in non-volatile memory. 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.

Parameters	Configuration
Receiver center frequency selection	Select the receiver center frequency by pointing to one of eight stored frequencies. Range 0 through 7 REG6(2:0)
Transmitter center frequency selection	Select the transmitter center frequency by pointing to one of eight stored frequencies. Range 0 through 7 The rx/tx frequencies change is enacted upon writing to REG6. REG6(6:4)
Stored frequency f_0	Stored transmitter or receiver frequency f_0. (one of eight stored frequencies) Valid range 400 MHz – 4.2 GHz, expressed in Hz. REG0: bit 7:0 (LSB) REG1: bit 15:8 REG2: bit 23:16 REG3: bit 31:24 (MSB)
Stored frequency f_x	Seven additional stored frequencies x = 1 through 7 Same format as f_0. REG(3+4*x): bits 7:0 (LSB) REG(4+4*x): bits 15:8 REG(5+4*x): bits 23:16 REG(6+4*x): bits 31:24 (MSB)
Receiver initial LNA gain	Initial LNA gain (before the RF AGC takes over). 12-bit. 0 for the minimum gain, 4095 for the maximum gain. The receiver LNA gain change is enacted upon writing to REG41. REG40: bits 7:0 (LSB) REG41(3:0): bits 11:8

Receiver initial RF gain	Initial RF gain (before the RF AGC takes over). 12-bit. 0 for the minimum gain, 4095 for the maximum gain. The receiver RF gain change is enacted upon writing to REG5. REG4: bits 7:0 (LSB) REG5(3:0): bits 11:8
Receiver initial IF gain	Initial IF gain (before the IF AGC takes over). 12-bit. 0 for the minimum gain, 4095 for the maximum gain. The receiver IF gain change is enacted upon writing to REG36. REG35: bits 7:0 (LSB) REG36(3:0): bits 11:8
Transmitter initial gain	Initial transmitter gain (before the ALC takes over). 12-bit. 0 for the minimum gain, 4095 for the maximum gain. The transmitter gain change is enacted upon writing to REG38. REG37: bits 7:0 (LSB) REG38(3:0): bits 11:8
Receiver RF AGC loop	0 = open loop. The RF path gain is fixed by above control registers. 1 = local AGC loop. Out-of-range conditions at the RF mixer and IF power detector are corrected locally, without involving any external module. REG39(1:0)
Receiver IF AGC loop	0 = open loop. IF path gain is fixed by control registers. 1 = local AGC loop. Out-of-range condition at the IF power detector is corrected locally, without involving any external module. 2 = external AGC loop. Follow-on modules (demodulator for example) adjust the receive gain based on the supplied RX_RSSI information and other salient level information such as RX_IF level, possible saturation at the external A/D converter, etc. The gain control signal is RX1_AGC. REG39(3:2)

Transmitter ALC loop	0 = open loop. Transmitter gain is fixed by control registers. 1 = external ALC loop. Follow-on module (modulator for example) sets the transmitted power using the TX_GAIN_CTRL1 pin. REG39(5:4)
Full/Half-Duplex	0 = half duplex 1 = full duplex. In half-duplex mode while RX_TXN = '1', the RF board mutes the RF modulator output, mutes the tx RF synthesizer output, freezes the ALC loop and reduces the tx gain, so as to minimize the leakage from tx to rx. Likewise, when RX_TXN = '0', the rx RF synthesizer output is disabled and the receiver AGC is frozen. REG39(6)
Frequency reference	0 = 19.2 MHz (default, internal TCXO). 1 = 10 MHz (external). Also requires removal of resistor R10. REG42(3:0)
Transmitter Power Down	0 = tx powered down 1 = tx enabled REG43(0)
Rx-only or Tx-only modes	Generally, the transceiver is configured to switch rapidly between transmit and receive mode under control of the external RX_TXN signal. For applications requiring transmit only or receive only mode of operation, the mode can be fixed by this control register. 0 = as controlled by RX_TXN 1 = receive-only. RX_TXN ignored 2 = transmit-only. RX_TXN ignored REG43(5:4)
Analog output selection	Select which analog signal is to be monitored at the multi-purpose pin ANALOG_OUT J1/A16 0= disabled 1 = RSSI (after LNA) 2 = detected power at the RF mixer 3 = detected power at the IF output 4 = LNA_AGC level 5 = RF_AGC level 6 = IF_AGC level 5 = detected power at external power amplifier 6 = temperature REG44(3:0)

Monitoring

Monitoring the status of the COM-3506 is performed by viewing the S*tatus* window in the ComBlock Control Center. All register values are displayed in hexadecimal, but other formats are displayed by hovering over the hex value with the cursor.

Parameters	Monitoring
Power supply check	SREG0(0): power good1 D_+3.3V SREG0(1): power good2 IF1_+3.1V SREG0(2): power good3 RX_+4.75V SREG0(3): power good4 RF1_+3.1V SREG0(4): power good5 A_+4.75V SREG0(5): power good6 MOD_+4.75V SREG0(6): power good7 RX_SYNT_+3.3V SREG0(7): power good8 TX_SYNT_+3.3V SREG1(0): power good9 ATTN_+1.2V Note: the power good flag for the +4.75V internal regulated supplies may toggle because of the low margins when the board is supplied with 5.0V. The power good indicator for these internal supplies is only guaranteed if the input supply voltage is >5.15V. Irrespective of these status registers, this RF board will operate properly at input supply voltages down to 4.9V. Overall valid response: 0x1FF (when input supply is > 5.15V) or 0x1CB
RF synthesizers locked	'1' when locked SREG2(0): rx synthesizer locked SREG2(1): tx synthesizer locked
RSSI	Received signal strength indicator. 12-bit number Practical range –75 to 0 dBm after LNA and first bandpass filter See RF_POWER_DET1 in schematic. SREG3 = LSB SREG4(3:0) = MSB
Received power at RF mixer	Power detection at RF mixer. See RF_POWER_DET2 in schematic. SREG5 = LSB SREG6(3:0) = MSB
IF output power	Power detection at IF after bandpass filter and IF gain control. See IF1_POWER_DET in schematic. SREG7 = LSB SREG8(3:0) = MSB
Board temperature	Thermistor output SREG9 = LSB SREG10(3:0) = MSB
External power amplifier monitoring 2	Monitoring external power amplifier output power (via flat flexible cable) SREG11 = LSB SREG12(3:0) = MSB
External power amplifier monitoring 1	Monitoring external power amplifier temperature (via flat flexible cable) SREG13 = LSB SREG14(3:0) = MSB

Test Points

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

Test Point	Definition
TP1 CLK_REF	19.2 MHz TCXO clock
TP5 RSSI	Received signal strength indicator (measured immediately after LNA) Range: -75dBm(0.58V) to 0 dBm (2.02V)
TP4 RX PLL LOCK	Receiver RF synthesizer lock status. 3.3V when locked.
TP3 TX PLL LOCK	Transmitter RF synthesizer lock status. 3.3V when locked.
TP2 TPA	Multi-purpose analog test point. Represents one of several analog signals as selected using control register REG44
Red LED	Red when one of these conditions occur: α) Tx RF frequency synthesizer is out of lock β) Rx RF frequency synthesizer is out of lock The red LED will turn on briefly at power up as a light check.

Operations

Internal vs External Frequency Reference

An internal VC-TXCO provides a ±2.5ppm temperature-stable 19.2 MHz frequency reference to the RF frequency synthesizers. In addition, small calibration adjustments are possible through the trimming potentiometer R13.

If the internal TCXO stability is not sufficient for the target application, the RF frequency synthesizers can be driven by an external 10 MHz higher-stability frequency reference. The external frequency reference selection requires removal of surface mount resistor R10. Please let us know at the time of order if an external frequency reference is preferred.

RF Frequency Synthesizers

Two independent RF frequency synthesizers are used for tuning the transmitter and receiver respectively over a wide frequency range.

- Receive frequency range: 70 MHz to 4.54 GHz
- Transmit frequency range: 400 MHz to 4.4 GHz.

The tuning step size is 5 KHz or less.

Even though the RF synthesizers are capable of tuning to 4.4 GHz, the COM-3506 transceiver performances are degraded above 3 GHz in terms of sensitivity, noise figure and transmit level. Operation above 3 GHz requires a de-rating of 20 dB (TBC).

Frequency band

For most applications, the frequency band of operation is significantly narrower than the COM-3506 tuning range. Best performance can be achieved by limiting the transceiver bandwidth using band-pass filters. ComBlock will customize the operational frequency band to meet customers' requirements at no extra cost.

Please let us know your application requirements in terms of :

- receiver operational frequency band
- transmitter operational frequency band
- channel bandwidth

In return, we will let you know the closest transceiver capabilities.

Receive Gain Control

The receiver AGC loop is split between this module and an external 'brain' (external AGC loop). This module is the gain actuator while the gain adjustment decision is taken by an external circuit based on various sensors, including the RX_RSSI received level, RX_I/Q level, etc. The gain control signals are RX1_AGC and RX2_AGC for transceiver 1 and 2 respectively.

The receiver AGC loop can also be open while the user defines a fixed receiver gain.

Schematics

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

Performance

Internal Clock Reference

The internal frequency reference performance is as follows:

- temperature stability (-30°C to +75°C): ± 2.5 ppm max
- aging: ±1ppm max/year

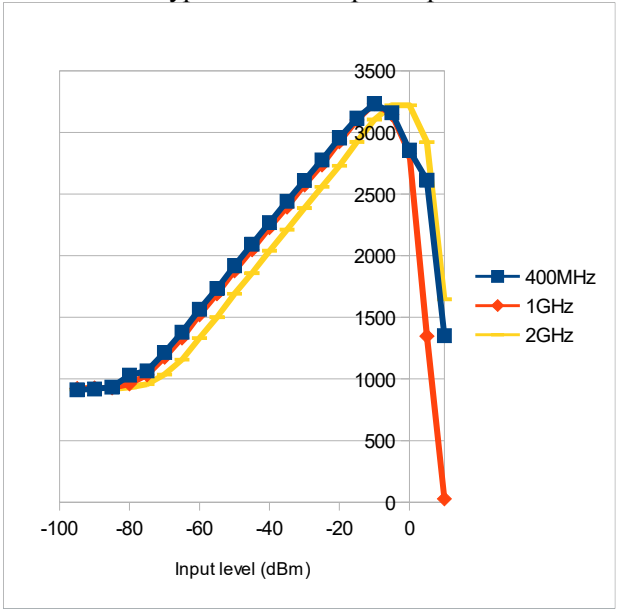
The design includes a trimmer potentiometer R13 to remove fixed known offsets through calibration.

Frequency Synthesizer

Phase noise @2GHz (LO):
-75 dBc/Hz @ 100 Hz from the carrier
-91 dBc/Hz @ 1 KHz from the carrier
-89 dBc/Hz @ 10 KHz from the carrier
-99 dBc/Hz @ 100 KHz frrom the carrier

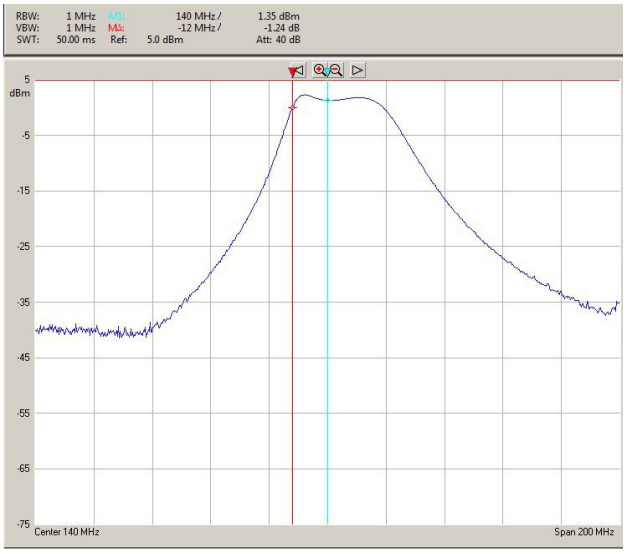
RSSI

The unfiltered RSSI level is measured immediately after the LNA. It is available in analog form as a test point (labeled TP5 RSSI) and in digital form through status registers. The practical range of this receive strength indicator is –70 dBm to 0 dBm (at 2 GHz), or –80 dBm to –10 dBm (below 1 GHz), as shown in the typical RSSI response plot below:

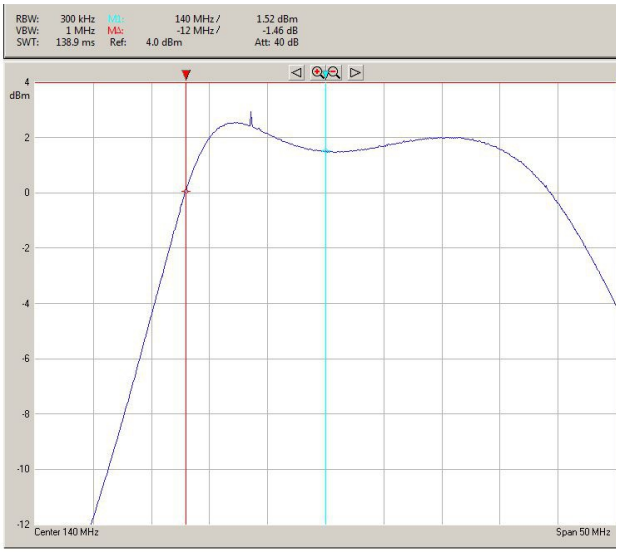


Receiver IF Bandpass filter

28 MHz bandpass centered around 143 MHz

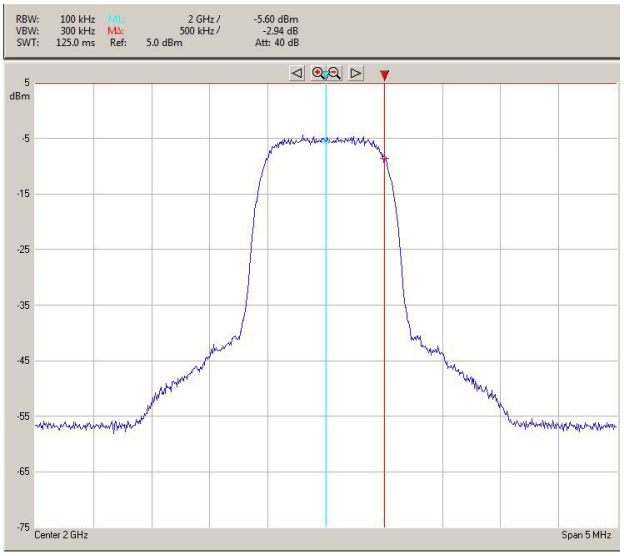


Receiver IF filter response (200 MHz span)

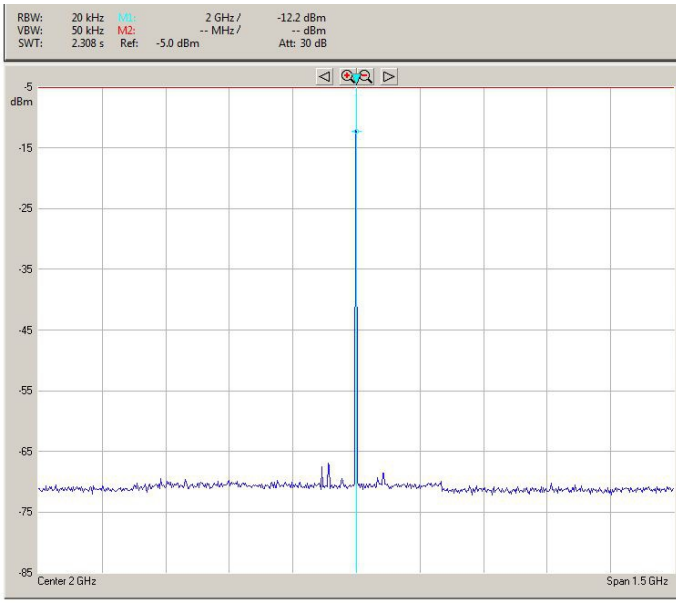


Receiver IF filter response (50 MHz span)

Transmitter spectrum

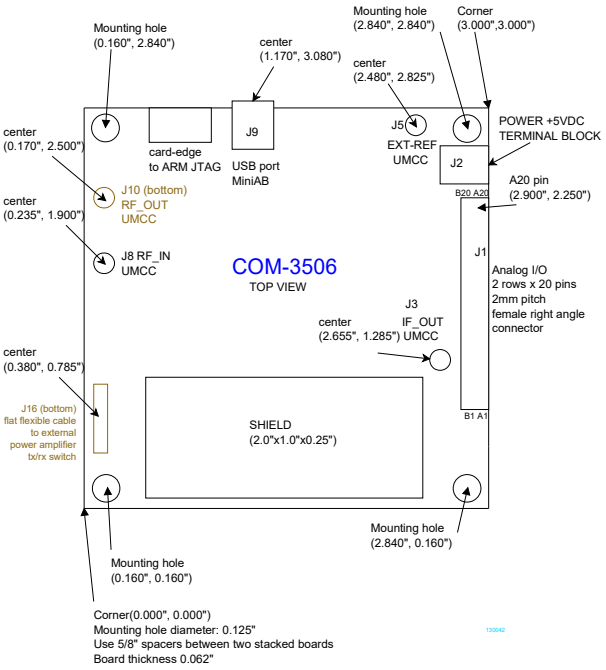


Transmit spectrum example: 1 Msymbols/s QPSK, +4.5dBm output in conjunction with COM-1705 PSK modem.



Spectral spurious lines < -55 dBc

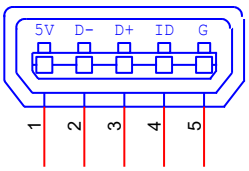
Mechanical Interface



Pinout

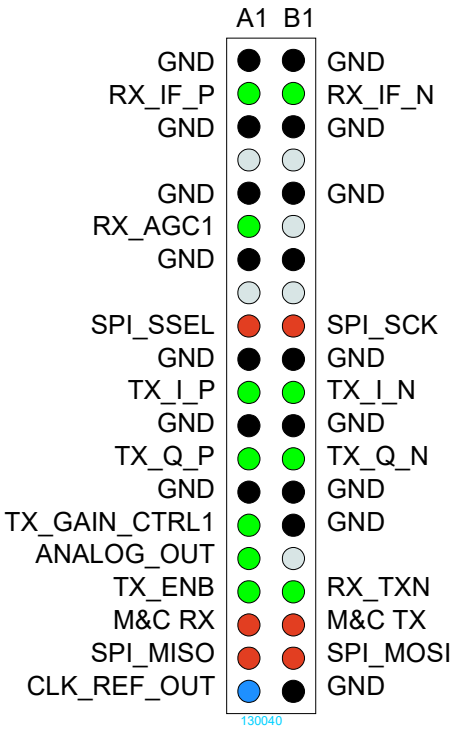
Mini USB Connector, J7

The COM-3506 is a USB device with a mini type AB connector. (G = GND)



Baseband I/O Connector J1

40-pin (2 rows x 20) 2mm right-angle female connector.
Part number: Samtec SQT-120-01-L-D-RA



Flat Flexible Cable Connector, J10

ZIF board-mount connector, 8 positions, 1mm pitch, right angle. Part number TE 84952-8. Mates with 1mm pitch, 0.3mm thickness flat flexible:

I/O Compatibility List

(not an exhaustive list)

I/O
COM-1700-A Low-power compact development Platform FPGA + ARM + DACs + ADCs + VGA + GbE LAN + USB2+ NAND + TCXO + RS422. Option –A.
COM-1705 Low-power compact PSK modem + Viterbi Convolutional FEC + IP router
COM-3504 Dual Analog <-> Digital Conversions

ComBlock Ordering Information

COM-3506 [400MHz - 3GHz] Transceiver

PLEASE SPECIFY AT THE TIME OF ORDER:

1. MAXIMUM TRANSMIT FREQUENCY (for the harmonics rejection filter)
2. RECEIVE FREQUENCY BAND (MIN/MAX)
3. TCXO OR EXTERNAL 10 MHZ FREQUENCY REFERENCE

ECCN: 5A991.b

MSS • 845 Quince Orchard Boulevard Ste N • Gaithersburg, Maryland 20878-1676 • U.S.A.
Telephone: (240) 631-1111
Facsimile: (240) 631-1676
E-mail: sales@comblock.com