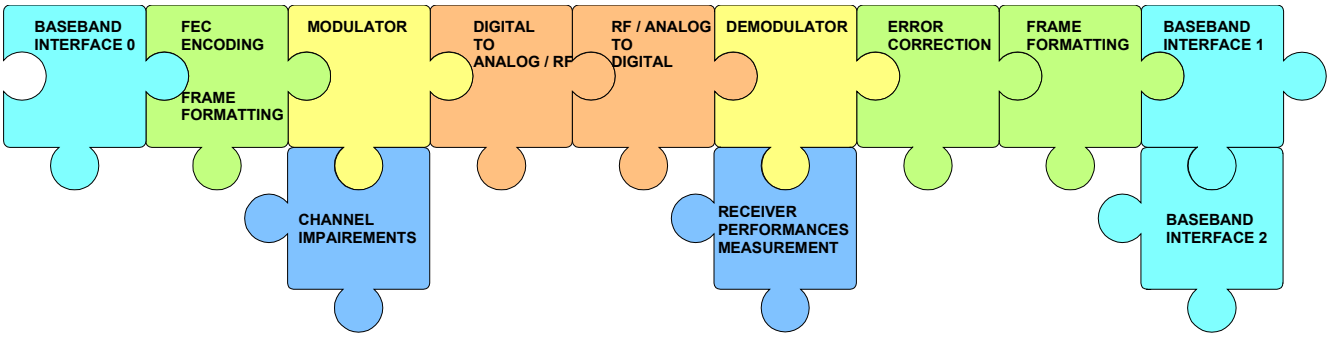
Com Block

Rapid Prototyping Communication Modules



Rapid Prototyping

ComBlock is an innovative approach to developing communication equipment. Low-cost building blocks pre-programmed with essential communication processing functions can be daisy-chained to form complex communication equipment.

The **ComBlock** architecture is aimed at rapid prototyping, developing software-defined radios and building cost-effective low-volume semi-custom equipment.

The layered organization of communication systems is reflected in the **ComBlock** modules available: the **ComBlock** family includes network, digital, analog and radio frequency functions. Technologies span FPGAs, ARM processors, analog and RF, all connecting seamlessly.

ComBlocks can be assembled in a three dimensional structure for maximum volume efficiency.

A single LAN, USB, CardBus or serial connection allows remote monitoring and control of the entire assembly from the ComBlock control center software (included), irrespective of the number of constituent modules.

New FPGA software versions can be downloaded into the modules from the ComBlock control center.

Each module requires a 5V DC supply.

Most modules are in-stock and typically ship within 24 – 48 hours.

3"x3" low-power modem development board

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

In addition to the off-the-shelf pre-programmed modules, users can develop custom applications by using interface compatible FPGA development modules (COM-1800, 1700, 1500, 3011, 1400, 1300, 1200) with large parallel computation capabilities. Multiple FPGA configurations (personalities) can be programmed into the board Flash memory using the supplied ComBlock control center software. The FPGA is configured automatically at power up.

For even larger FPGA projects, several modules can be concatenated.

FPGA modules are best suited for recursive highly-parallel time-critical signal processing such as high-speed modulation or demodulation.

ARM Development Platforms

32-bit ARM processors provide additional sequential computation capabilities in several modules (COM-1700, 1500, 3011, 3505). These modules complement FPGA-based modules by providing flexible, memory-intensive processing.

Path to Production

Project evolution from prototyping to larger production runs is made easy by the availability of reasonably-priced VHDL source code. Price and availability for the most common VHDL IP cores are listed at
www.comblock.com/product_list_IP.html

Modularity

To maximize interoperability among **ComBlocks**, the interfaces are restricted to four main connector types:

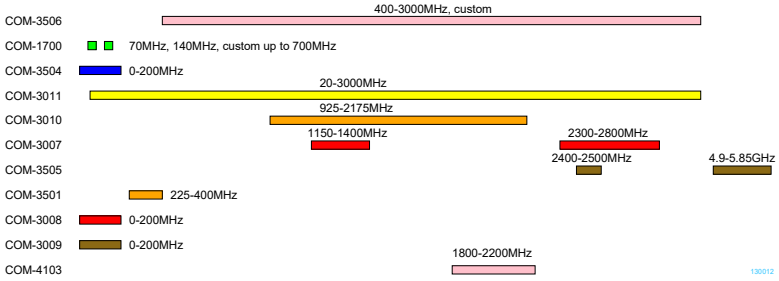
- 98-pin PCI express
- 40-pin headers (standard 2mm, 2 rows * 20 positions)
- SMA
- UMCC (ultra miniature coaxial)

Likewise, for maximum interoperability, baseband signals are generally represented as one of two simple 'natural' interfaces:

- 2 * 10/12/14-bit complex (In-phase and Quadrature) baseband interface, or
- analog baseband (I & Q) interface and gain controls.

These simple 'natural' interfaces maximize the number of possible combinations between RF and digital signal processing modules and facilitate the interface with user-supplied (i.e. non-ComBlock) components.

For example, a digital demodulator can be connected to many interchangeable RF receivers, depending on the frequency band of interest, as illustrated below:



***ComBlock** receivers frequency bands*

ComBlock Family

Analog / IF / RF Front-End

Module	Definition
COM-3506	[400 MHz – 3 GHz] customizable transceiver
COM-1700	Baseband, 70 MHz or 140 MHz receiver. SDR development platform
COM-3505	Dual-ban 2.4/5 GHz 2x2 MIMO transceiver.
COM-3504	Dual Analog <-> Digital conversions, including dual 16-bit 250 MS/s DACs dual 12-bit 150 MS/s ADCs
COM-2001	Dual Digital-to-Analog conversion and anti-aliasing filtering, up to 125 Msamples/s.
COM-2802	Synchronized 8-channel 900 Msamples/s digital to analog conversion.
COM-3010	[925 – 2175 MHz] receiver. LNB compatible.
COM-3011	[20 MHz – 3 GHz] receiver. SDR development platform.
COM-3007	[2.3 – 2.8GHz] receiver. A/D conversion up to 105 Msamples/s.
COM-3008	[0 – 200 MHz] receiver. 10-bit 210 Msamples/s A/D converters, AGC and low phase-noise synthesized sampling clock. Well suited for IF undersampling as well as baseband sampling.
COM-3009	Similar to COM-3008 but with 12-

	bit precision, 105 Msamples/s
COM-3501	1W UHF Transceiver [225-400 MHz] for two-way half-duplex communications

COM-4410	[70 MHz – 2.2GHz] 4-channel quadrature modulators
COM-40xx	Radio-Frequency modulators in-cluding low-phase noise frequency synthesizer, direct I/Q modulation, optional output power measure-ment.
COM-4001	Dual-band 915 MHz and 2.4 GHz modulator
COM-4003	L-band 1500 - 1740 MHz modulator
COM-4005	Cellular band [800 - 1000 MHz] modulator
COM-4006	PCS frequency band [1850 - 2050 MHz] modulator
COM-4008	L-band 850 - 1600 MHz modulator
COM-4101	RF Transmit Redundancy module: Software controlled A/B swith directs RF to one of two paths. 10MHz – 1.5 GHz, 17 dB gain, P_{1dB} = 9.5 dB
COM-4103	L/S-band 10W power amplifier + LNA

Modulators

Module	Definition
COM-1402	PSK/QAM/APSK digital modulator up to 22 MSymbols/s. Includes pseudo-random bit stream generator. USB 2.0 data interface.
COM-1519	Direct-sequence spread-spectrum digital modulator. Up to 60 Mchip/s. Spreading codes: Gold sequences, LFSR sequences, Barker codes, or GPS C/A codes.
COM-1028	FSK/MSK/GFSK/GMSK digital modulator. 2-,4-,8-ary. Programmable data rates (up to 30 Mbit/s), modulation index, BT product (0.3 and 0.5).

Demodulators, Modems

Module	Definition
COM-1518 NEW	Direct Sequence Spread-Spectrum digital demodulator. Up to 60 Mchip/s. Fast parallel acquisition. Maximum processing gain: 33 dB. Spreading factor: 3 to 2047 Maximal code period: 65535
COM-1505 NEW	Integrated PSK modem, including PSK modulation, demodulation, convolutional error correction encoding and decoding, V.35 scrambling, HDLC framing, TCP-IP network interface and USB 2.0 interface
COM-1202	PSK/QAM/APSK digital/analog modulator and demodulator up to 22 MSymbols/s. Includes built-in BER measurement, and pseudo-random bit stream generator. USB 2.0 data interface.
COM-1203	Same as above plus 10/100 Mbits/s LAN/TCP-IP interface.
COM-1027	FSK/MSK/GFSK/GMSK digital demodulator. 2-,4-,8-ary.
COM-1008	Variable decimation: 1:1024. AGC control. Pilot tone detection for frequency calibration. Used as pre-processing for low-data rate demodulators to prevent aliasing.

Error Correction

Module	Definition
COM-1510SOFT	Block error correction codec, 100-250 Mbits/s. Convolutional encoding, Viterbi decoding. K=5,6,7,9. 2 to 5 parity bits GMR-1 3G compatible (IP, VHDL source code)
COM-1209ASOFT	1Gbit/s BCH encoder/decoder. DVB-S2 standard. (IP, VHDL source code)
COM-1509	Error correction codec, 120 Mbits/s. Convolutional encoding, Viterbi decoding. K=5,7,9. V.35 scrambling. HDLC framing. K = 5, rate 1/7 K = 7, rates 1/2, 2/3, 3/4, 5/6, 7/8 K = 9, rates 1/3, 1/2, 2/3
COM-7002	Turbo code encoder / decoder. Includes unique word frame synchronization, interleaving, scrambling and CRC.
COM-1006	Reed-Solomon Encoder DVB standard, Intelsat standard, other commonly used RS codes.

Network / Baseband Interfaces

Module	Definition
COM-5401	4-port 10/100/1000 MBps Ethernet Transceivers for FPGA-based ComBlock modules (COM-1600, COM-1500). 4 RJ-45 ports.
COM-5102	1-port Gigabit Ethernet (10/100/1000) + HDMI video in/out for FPGA-based ComBlock modules (COM-1500). 1 RJ-45 ports, 2 HDMI ports.
COM-5003	TCP-IP / USB Gateway. Connects ComBlock assemblies to a host computer over USB 2.0 or LAN TCP-IP (10Base-T/100Base-Tx). Supports 3 concurrent TCP-IP sockets for high-speed data (2) and monitoring and control (1). Maximum sustained throughput 53 Mbit/s over TCP-IP, 86 Mbit/s over USB 2.0.
COM-5404	IP Router. Typical application: UDP video streaming to/from a synchronous data link.
COM-5101	Signal/Power conditioning interface module. Supports 4 full-duplex RS422 interface signals. Includes
	DC/DC converters for 6-26V supply. All signals conveyed over a single DB25 connector.

Signal Generators, Test Modules

Module	Definition
COM-1524	Real-time digital channel simulator, featuring multipath fading, white Gaussian noise, frequency trans-lation and long propagation delay.
COM-1232	Channel emulator with analog input/output. 64 MSamples/s. Up to 40 paths. Typical applications: Power line channel emulator Wireless channel emulator
COM-1005	Bit Error Rate measurement module.
COM-8001	Arbitrary waveform generator. 256 MB or 1GB SDRAM, Variable sampling rate and precision from 1 to 20 bits and up to 40 Msamples/s.
COM-8002	High-speed data acquisition. 256 MB DRAM, 1 Gbit/s throughput, 50 MHz sampling rate. Variable sample precision from 1 to 20 bits.

Scrambling / Stream Formatting

Module	Definition
COM-1014	Standard Triple Data Encryption Algorithm (TDEA). Can be used for encryption or decryption. Maximum data rate 140 Mbit/s.
COM-1016	Bit Interleaver / Deinterleaver 8 branches, 1024 depth cell. 20 Mbps max.
COM-8003	Signal Diversity Combiner
COM-8004	Signal Diversity Splitter

Connectivity

Module	Definition
COM-9001	Vertical extension connector
COM-9002	Horizontal extension connector
COM-9003	8:1 multiplexing connector
COM-9004	8:1 demultiplexing connector
COM-9105[1]	98-pin to 98-pin connector
COM-9107[1]	98-pin to 40-pin male connector
COM-9108[1]	40-pin female to 98-pin connector
COM-9112[1]	98-pin to 40-pin female connector
COM-9109[1]	98-pin to two 40-pin female connectors (for use with COM-3505)
COM-9113	2 40-pin female to 98-pin male, for connecting two COM-30xx receivers to a FPGA module.
Y03007R4	Card-edge adapter for ARM or Atmel micro programming through JTAG or DB-9 serial

[1] Included with the relevant ComBlock modules. Please let us know your connectivity plans so that we can supply the appropriate module-to-module adapter(s).

User Interface

Module	Definition
COM-6001	LEDs + dual 7-segment display

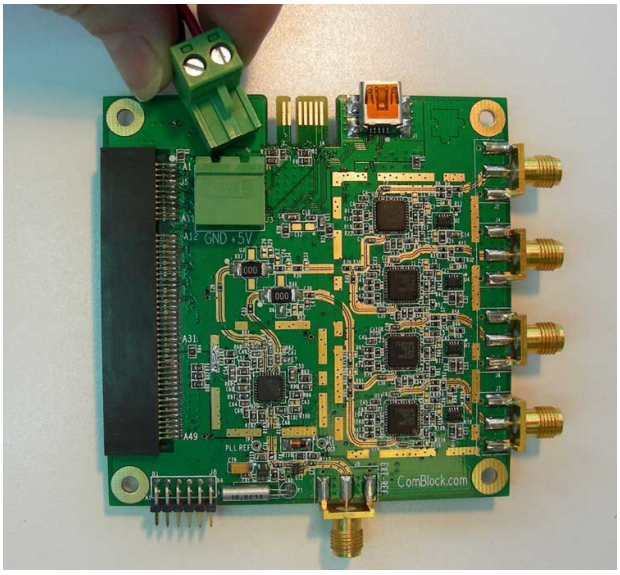
FPGA / ARM Development Platforms

Module	Definition
COM-1800	FPGA + ARM + GbE + DDR3 SODIMM socket Development platform. Based on Xilinx **Artix 7-100T**
COM-1700	FPGA + ARM + GbE + USB2+ NAND + dual ADCs + dual DACs Development platform. Optimized for low-power. Based on Xilinx **Spartan-6 LX45L1**
COM-1500	FPGA + ARM + DDR2 SODIMM socket + USB2+ NAND development platform. Powerful digital signal processing hardware comprising 32-bit ARM processor @120 MHz + **Spartan-6 LX45 or LX150** FPGA+ DDR2 SODIMM socket for large 64-bit wide memory module + 1Gbit NAND flash memory + USB 2.0
COM-3011	[20 MHz – 3 GHz] receiver + FPGA + ARM Software-defined ratio development platform comprising Xilinx **Spartan-6 LX16** FPGA + 32-bit ARM processor @120 MHz + USB 2.0
COM-1200	FPGA development platform, Analog front-end & USB 2.0. Based on the **Spartan-3 XC3S2000**. Analog front-end includes dual high-speed 10-bit ADC, dual high-speed 12-bit DAC and multiple lower speed DACs and ADCs. FPGA configuration remains in non-volatile flash memory and is automatically reloaded at power up. Remote monitoring and control from the ComBlock control center.
COM-1300	FPGA development platform **Spartan-3 XC3S400**. & CardBus / PCMCIA Interface.

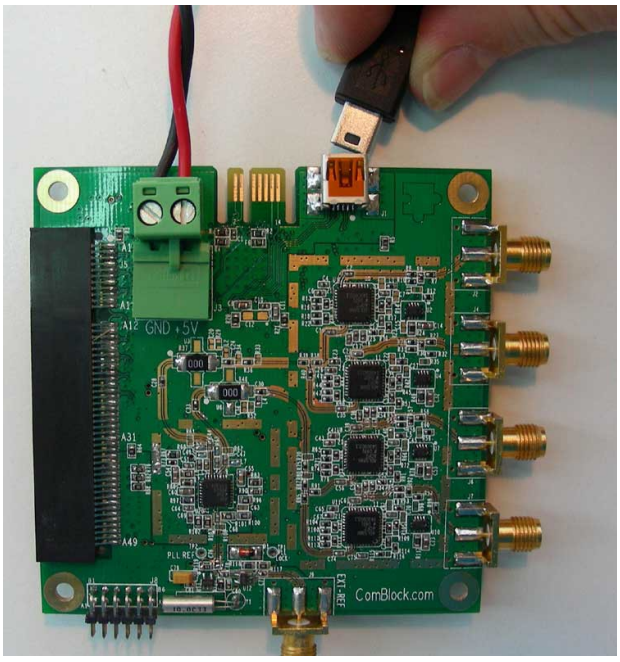
Ease of Assembly

Complex communication systems can be created in three easy steps:

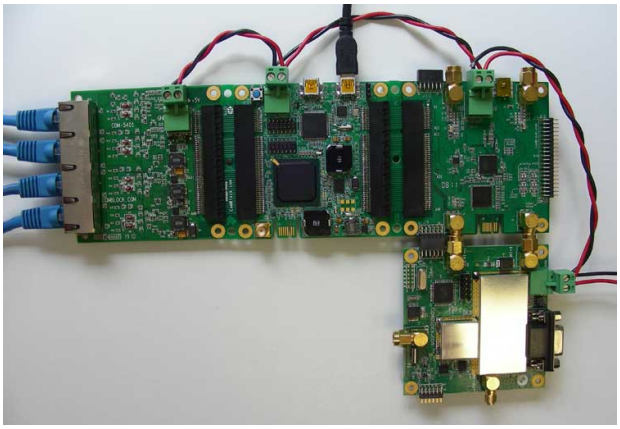
1. Connect +5V DC power to each **ComBlock** module.



2. Connect the monitoring and control link between one of the **ComBlock** modules within the assembly and the host computer. This connection is not mandatory at run-time as each **ComBlock** module retains its configuration.



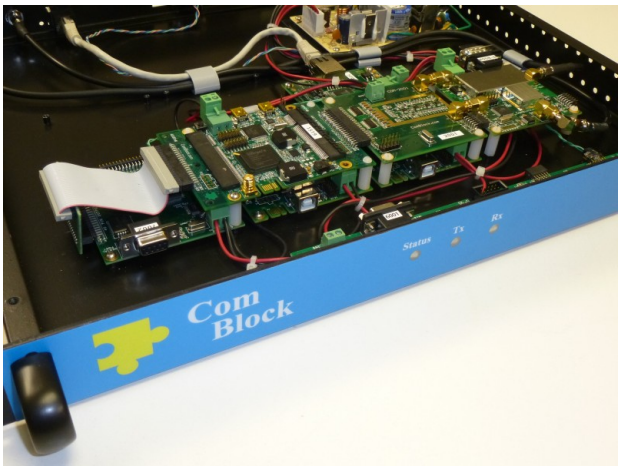
Step 3: Plug in other **ComBlock** modules.

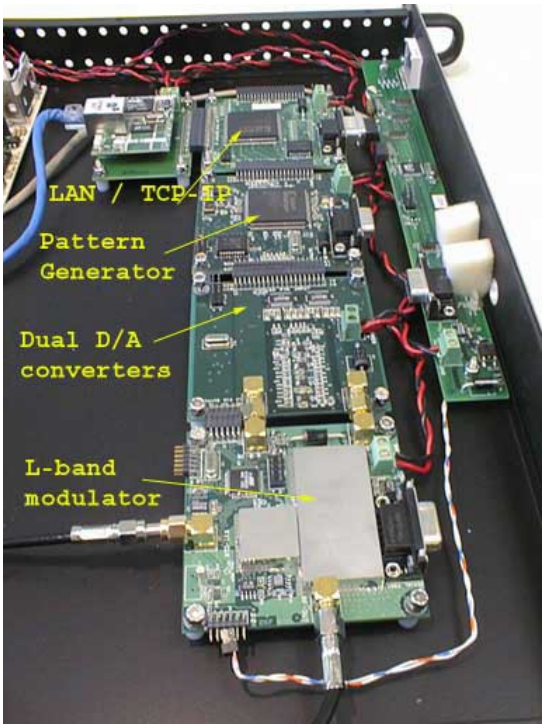


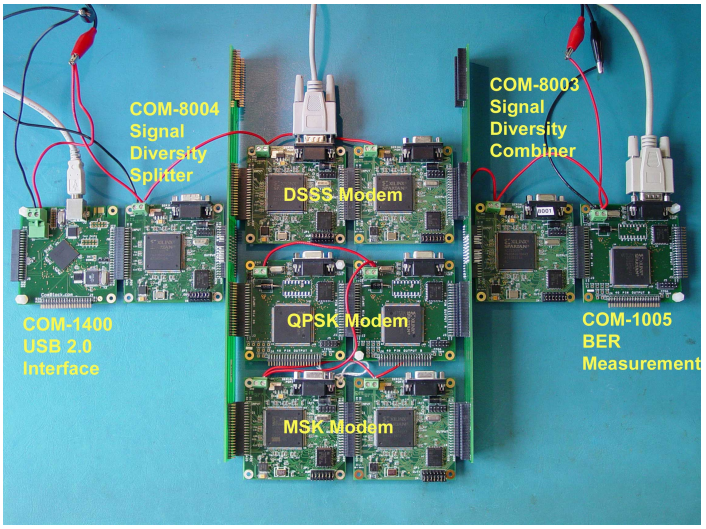
The assembly is now ready to run.

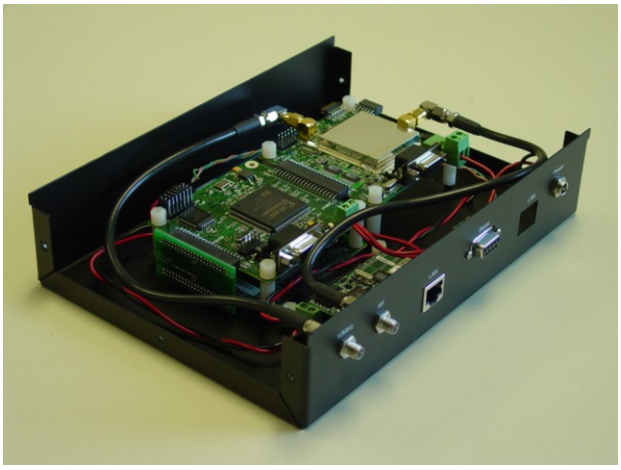
Conformal Assemblies

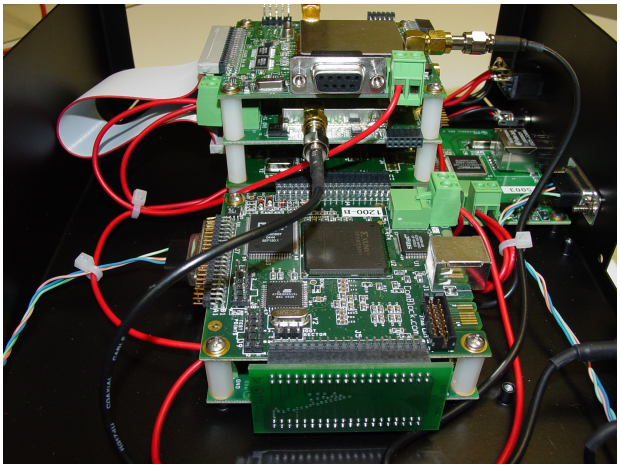
ComBlock modules can be assembled in a variety of two-dimensional or three dimensional shapes to fit within standard size chassis or enclosures.




LAN / TCP-IP
Pattern Generator
Dual D/A converters
L-band modulator


COM-8004 Signal Diversity Splitter
COM-8003 Signal Diversity Combiner
DSSS Modem
QPSK Modem
MSK Modem
COM-1400 USB 2.0 Interface
COM-1005 BER Measurement





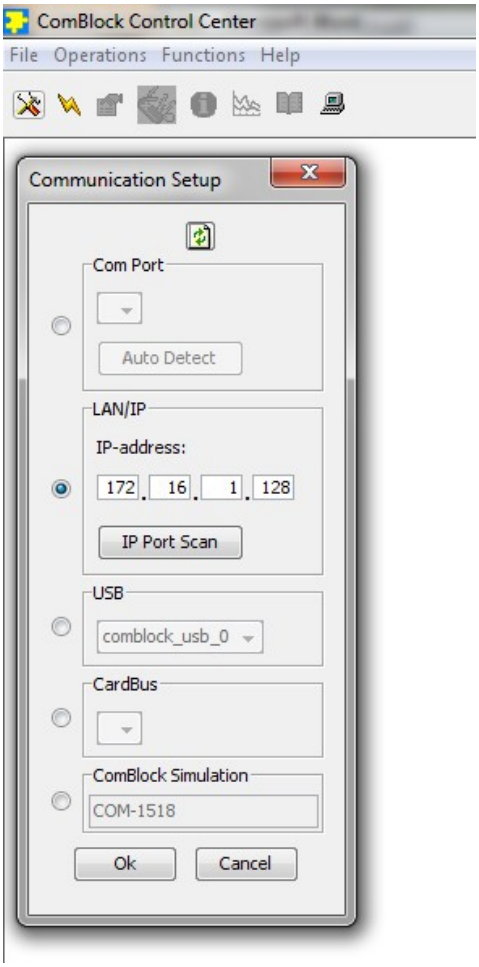
Ease of Operation

ComBlock assemblies can be controlled and monitored over a single connection with a PC. Five connection types are supported by the ComBlock Control Center graphical user interface:

- Network: TCP/IP over a 10/100/1000 Mbps LAN (RJ-45 connector)
- USB 2.0 (high-speed)
- PCMCIA/CardBus
- 115.2 Kbaud/s asynchronous serial link (DB9 connector)
- Simulated connection with a module

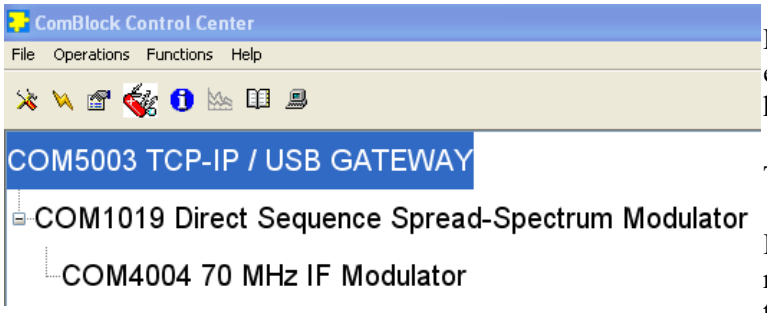
The **ComBlock** Control Center software provides a simple user-friendly method for monitoring and control in four easy steps:

1. Connect with the **ComBlock** assembly.

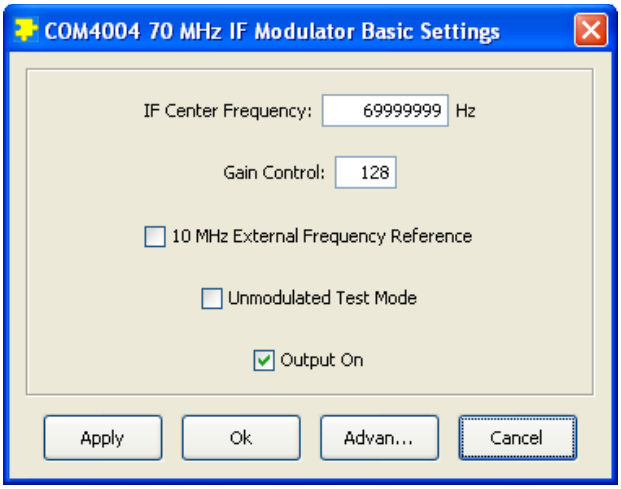


2.

3. Automatically detect the constituent modules of the assembly.



4. Download firmware when new versions are available.
5. Monitor and control each module.



The actual configuration resides in each **ComBlock** in non-volatile memory. It is automatically loaded at power up. Thus, remote configuration is not required once the **ComBlocks** are configured.

Custom monitoring & control applications can also be developed. The messages and protocols for communicating with **ComBlocks** are described in an API document.

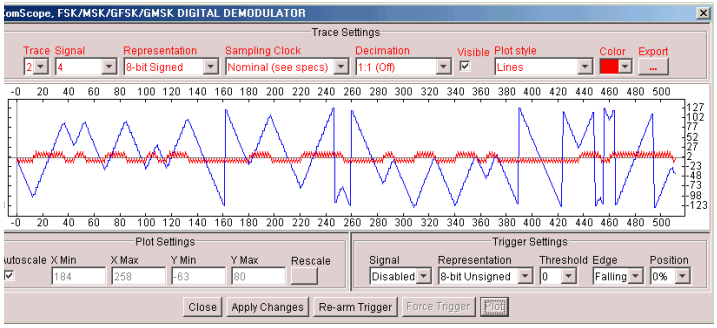
ComScope

Most FPGA-based digital **ComBlock** modules are equipped with the **ComScope** data capture capability to help users visualize otherwise hidden digital signals.

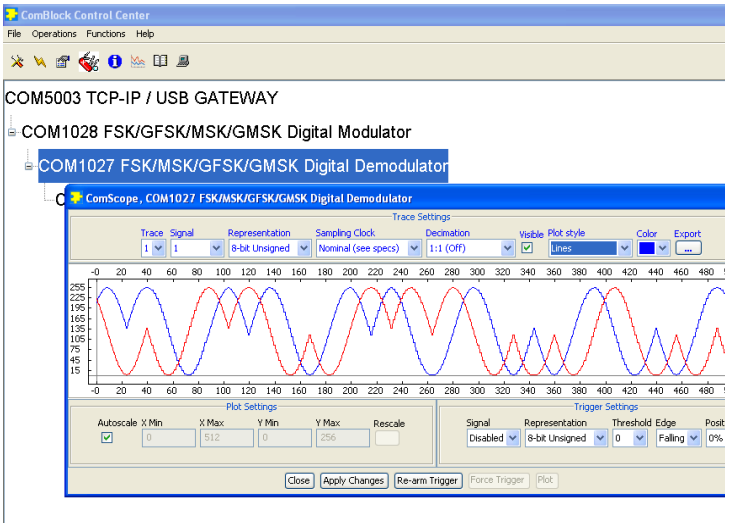
These modules are identified with the  icon.

Internal digital signals, whether binary or digital representation of analog signals, can be stored in real-time into internal memory, then exported to a host computer for plotting, storage and further processing.

The ComScope user manual is available at www.comblock.com/download/comscope.pdf.



ComScope Window Sample: showing GMSK demodulated phase (blue) and reconstructed unfiltered symbols (red).



Multiple Personalities and Dynamic Reconfiguration

FPGA-based digital ComBlock modules are capable of **multiple personalities** and **dynamic reconfiguration**, whereby the FPGA can embody, on demand, one of multiple personalities stored in non-volatile flash memory.

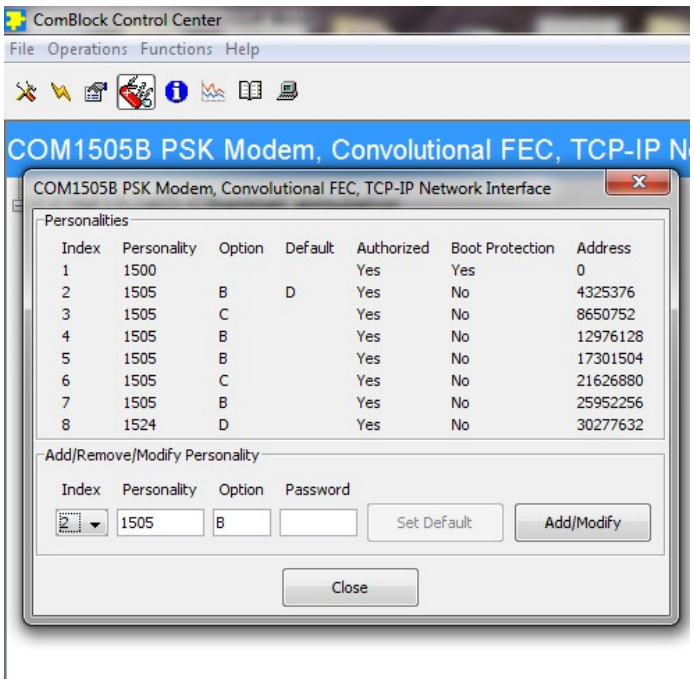
Reconfiguration is ordered by a user over the selected communication link between user and ComBlock assembly: serial, LAN, PCMCIA, or USB, whichever is applicable.

Typical FPGA reconfiguration time is between 0.1 and 4 seconds, depending on the ComBlock, as listed in the specifications.

FPGA configuration data can be programmed into Flash memory one at a time, without affecting the other FPGA configurations already stored within the Flash memory.

Dynamic reconfiguration of the FPGA does not require any special VHDL programming. All ancillary tools are supplied with the ComBlock.

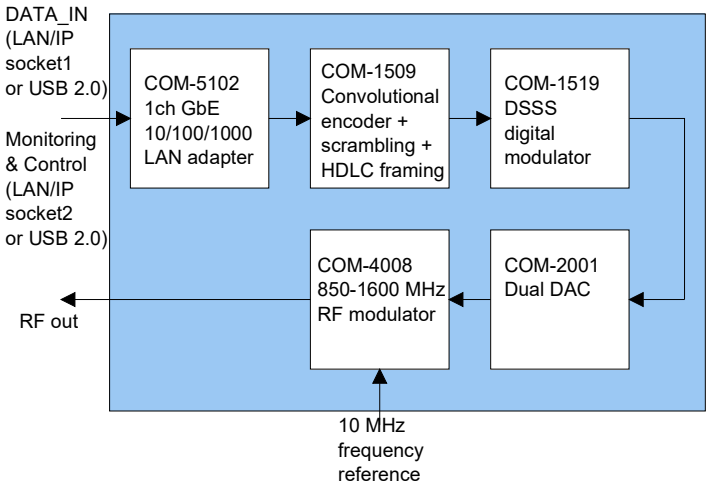
ComBlock hardware platforms supporting the dynamic reconfiguration are identified with the  icon.



User can select the default personality after reset/power-up.

Application Example: Spread-Spectrum L-band Modulator

Using five modules, one can easily assemble a variable data rate spread-spectrum L-band modulator.



The user forwards data to be transmitted over the LAN to a TCP-IP socket, or alternatively through a USB 2.0 connection between PC and COM-1509.

The data to be transmitted is encoded by a convolutional error correction code (COM-1509). The same module can also scramble the data and insert an HDLC-like frame structure prior to convolutional encoding.

The resulting data stream undergoes direct-sequence spread-spectrum (digital) modulation in the COM-1519 module.

The signal is then converted to analog baseband, low-pass filtered to reject spurious spectral lines and out-of-band signals. (COM-2001)

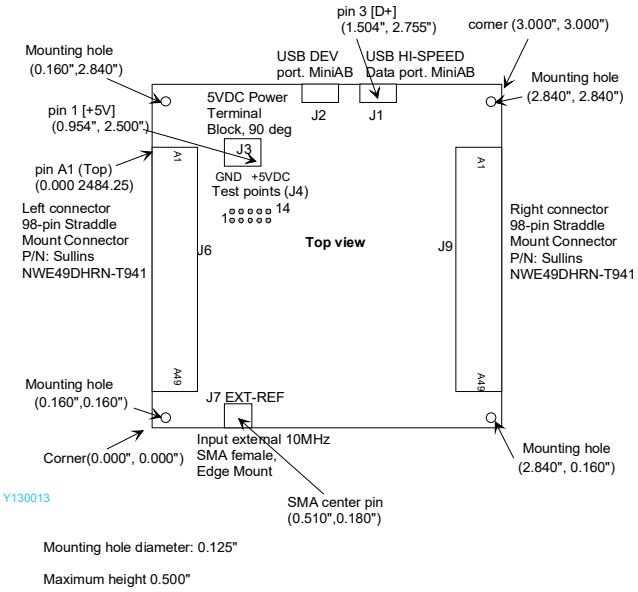
The last module (COM-4008) synthesizes a low-phase noise carrier. High frequency stability can be obtained by locking the carrier frequency to an external ultra-stable 10 MHz reference clock. The carrier frequency is user-selectable over the range 850 MHz to 1.6 GHz.

In order to keep the RF modulated signal at a fixed power level, an accurate RF power measurement is performed in the last stage. The user can control the transmitted power accurately over at least 20 dBs.

Several test modes are included in this assembly, including transmitting a known 2047-bit pseudo-random sequence.

Mechanical Interface Example

COM-15xx module



Ordering Information

MSS • 845 Quince Orchard Boulevard Ste N •
Gaithersburg, Maryland 20878 • U.S.A.
Telephone: +1 240 631-1111
Facsimile: +1 240 631-1676
E-mail: sales@comblock.com
Skype: mss_az, mss_blb
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