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SmartBrick

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SmartBrick portfolio

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SUMMARY:

This document presents the overall SmartBrick concept and lists the available modules, standard bases, adapters and ancillaries, along with their technical specifications. Products under development are also briefly described.

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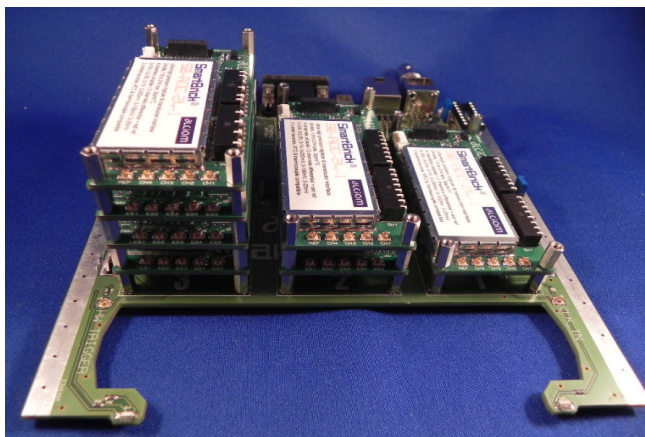
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1 Introduction

The **SmartBrick** product line from ALCIOM is a collection of high performance configurable analog and mixed-signal OEM modules. These modules are freely daisy-chainable and stackable, and allows to build plug'n play compact and efficient smart instrumentation and acquisition systems.



The **SmartBrick** modules are driven by a host system (microcontroller, DSP or PC, either embedded or remote) through the patented and ultra-flexible **SmartBus** interface, compatible with SPI, USB, UART or I2C links. Software libraries provides an easy interface with any user-developed application in virtually any language : Labview, C, C++, Python, C#, Visual Basic, Mathlab/Scilab, etc.

Currently ALCIOM doesn't commercialize the **SmartBrick** technology as end-user products : These modules and bases are used as solid-rock building blocks for the development of custom mixed signal projects required by our customers. Based on project's requirements and time-scale, ALCIOM can propose either of the following solutions :

- **“Lego-style” test-benches or functional demonstrators :** ALCIOM can very quickly design an RF or mixed-signal product through stackup and interconnection of available **SmartBrick** modules with one of the existing standard bases. Some host-side custom software could be developed if needed.
- **Semi-custom modules and demonstrators :** If the project requires specific hardware features, ALCIOM can design them as a new semi-custom **SmartBrick**-compatible module. Such a development is significantly eased thanks by using one of the available designs as a starting point. The semi-custom module can then be paired with any number of existing modules or bases for a fast-delivery complete system.
- **SmartBrick-inside :** One or several **SmartBrick** modules can be used as macro-components in a custom hardware design. Similarly to the System-on-Module approach, this solution can drastically reduce the time-to-market and technological risks when a specific high-end feature is required. As an example a SB-CW4000 could be easily integrated in a product which requires a synthesized wideband RF source.
- **Know-how reuse :** Lastly, for mass-production projects or when constraints avoid the use of standalone **SmartBrick** modules, ALCIOM can reuse the knowledge and design of existing modules as the starting point for a custom design. This could range from limited reuse to full schematic cut and paste.

The **SmartBrick** project is a living project : Convinced that modularity and reuse is the best solution for an optimal time to market, ALCIOM invests up to 20% of its R&D resources into this program year over year. This project is also funded by BPI-France as ALCIOM is a certified SRC (Société de Recherche sous Contrat).

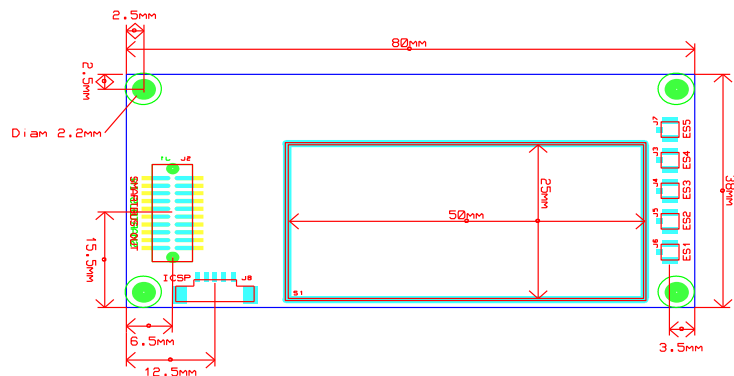
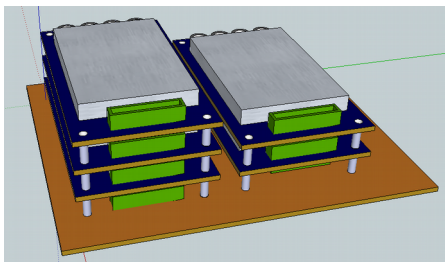
In order to provide to our customers a good view on **SmartBrick** capabilities, this document lists the available and planned **SmartBrick** modules, standard bases, adaptation boards and ancillaries, along with their key technical specifications.

2 Technical overview

The overall architecture and protocols of the **SmartBrick** solution is detailed in the document AL/RL/1048/004 (**SmartBus** specification), available from ALCIOM. This chapter presents the key aspects of this solution.

2.1 Mechanical design

Each **SmartBrick** module is physically a standardized compact 80x38mm high quality printed circuit board, using four to eight conducting layers depending on module complexity. Modules can be stacked, with a standardized 8,2mm spacing (plus 1,6mm PCB thickness). Mechanical fixing is done through four 2mm screws and spacers, insuring high vibration immunity.



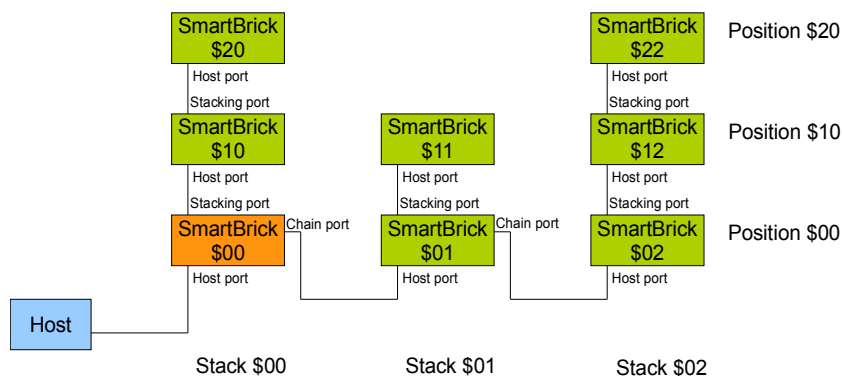
On the bottom side, each module has a **SmartBus** host and daisy chain connector. This connector allows to interconnect the module to its controlling host and allows also to link other modules stacks through a daisy chaining. On the top side each module has a mating **SmartBus** stacking connector, which allows to stack several modules transparently. The top side has also a shielded enclosure which includes all sensitive mixed signal electronics.

Analog and fast signals interconnection between modules and from modules to the application are done through subminiature UFL connectors. ALCIOM can provide standard mating UFL to SMA or UFL to DB15 adaptors.

Please request document AL/RL/1048/001 (**SmartBrick** mechanical specification) for more detailed informations.

2.2 System topology and addressing

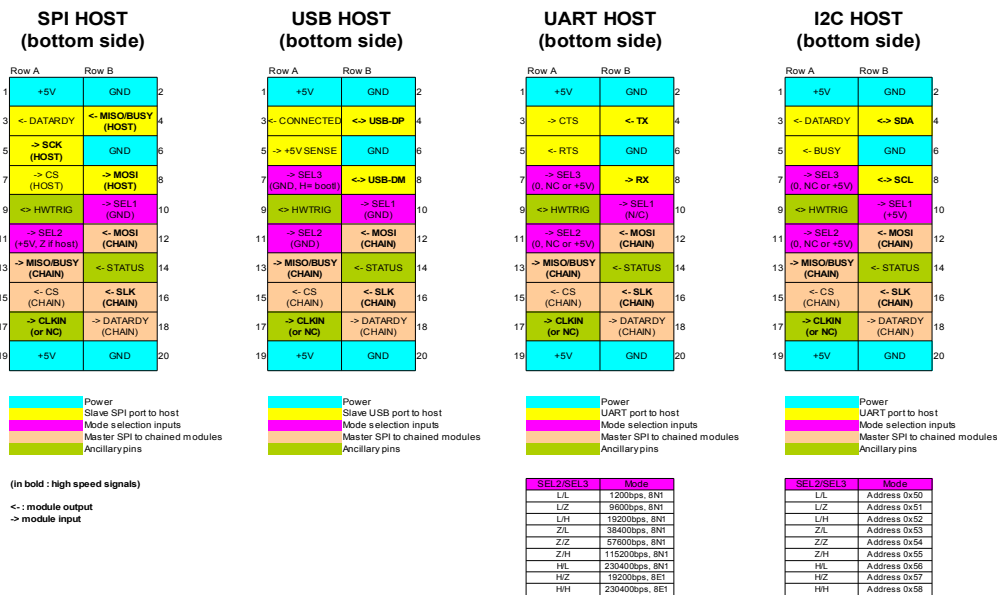
A **SmartBrick** system can hosts up to 128 modules (16 daisy-chained stacks of up to 8 modules each). The system is self-configured : Each module gets a unique address based on its position in the network. The message routing through the stacking and daisy-chaining links is automatically managed by the **SmartBrick** embedded software : The host can send commands and get answers from any of the modules transparently.



2.3 SmartBus interface

Each SmartBrick module is controlled through ALCIOM's patented SmartBus interface. This interface allows simultaneously to use compact connectors (2x10 header, 1,27mm pitch) and provides a very flexible interface. It includes :

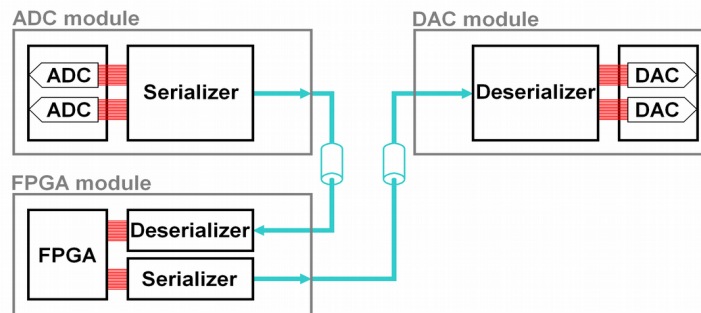
- Ultra-flexible host interface : USB full speed, I2C (9 selectable addresses), UART (9 selectable speed and formats, binary or ASCII mode) as well as SPI are all supported !
- Daisy-chaining and stacking interfaces (through a 8Mbps SPI interface), with automatic protocol conversion between host-side and inter-module physical interfaces
- 5V power distribution, up to 200mA per module (500mA with up to 4 modules per stack)
- Clock distribution : Each module includes its on-board clock reference, but is automatically synchronized on an external clock input if the module or baseboard below it provides a clock reference
- Dedicated inter-modules hardware trigger line, allowing precise synchronization of real-time events



Please request document AL/RL/1048/004 (SmartBus specification) for more detailed informations.

2.4 SmartBrick FastLink

In addition to the module chaining and stacking SPI data interface, some SmartBrick modules and baseboards can be interfaced through dedicated SB-FastLink data connections. These links, physically carried on 50-ohm UFL module to module jumpers, provides up to 2,262Gbps of bandwidth through a 78MHz times 29 bit GMSL (Gigabit Multimedia Serial Link) architecture. The FastLink concept is particularly well suited to software defined radio architectures as well as high-performance instrumentations.

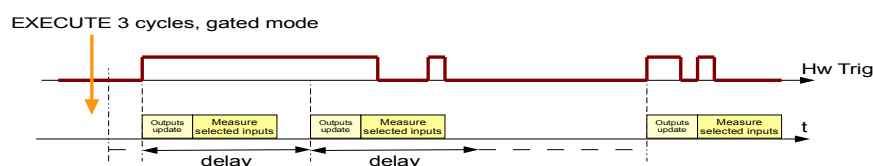


Please request document AL/LT/1410/001 (SmartBus FastLink specification) for more detailed informations.

2.5 Host processor software layers

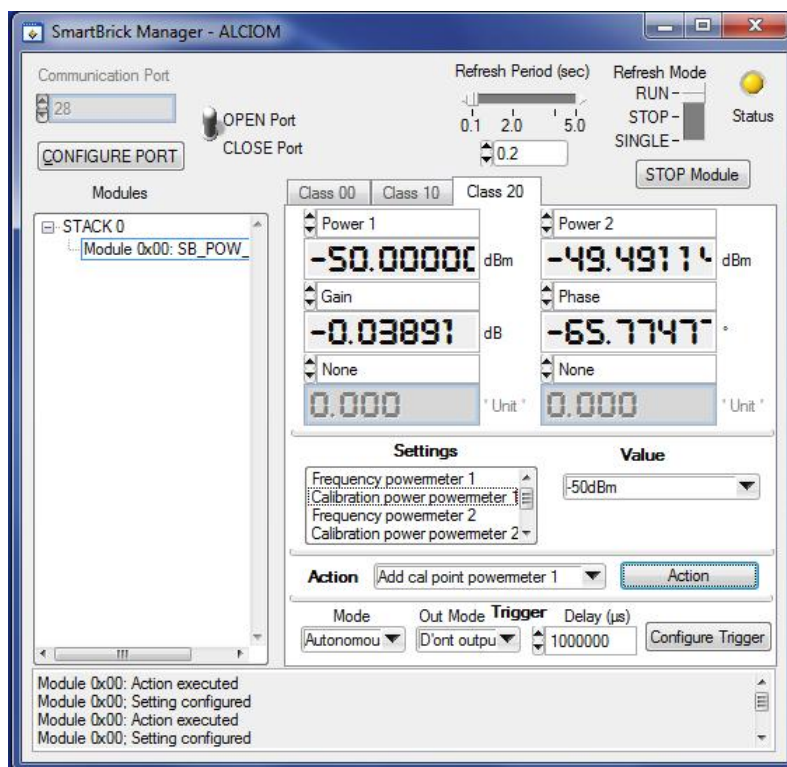
The **SmartBrick** system also defines a standardized software interface on the host side. The **SmartBus** protocol is structured as several independent protocol layers, following the OSI 7-layers protocol model (cf **SmartBus** Specification, AL/RL/1048/004). At the application level, each module “understands” standardized messages from one of several of the following defined classes :

- Class 00 (generic and mandatory commands) : Address assignation, module identification and plug and play mechanisms, status request, diagnostic, etc
- Class 10 (low level control) : Direct access to the module hardware resources for investigation or specific applications
- Class 20 (generic I/O control) : This class is designed to be a flexible way to manage virtually any measurement or generator module through a consistent command set. It is supported by all modules which measure or generate discrete values of physical entities. It includes abstractions like “channels”, “settings”, “actions”, as well as a flexible triggering structure.



- Class 30 (generic message control) : This class is devoted to modules which manages structured messages, like RF or dedicated bus transceivers.

All these classes are designed to provide a full plug'N play experience : The supplied **SmartBrick** Manager PC-based application discovers automatically the modules connected to the host and dynamically built the associated user interface.



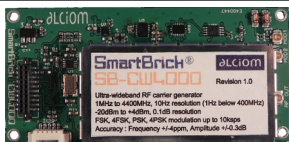
For PC-based Windows or Linux applications, a DLL supplied by ALCIOM allows to easily develop a custom application and to access to **SmartBrick** resources. For other environments, a fully document ASCII or binary protocol through a virtual COM port is supported.

3 Available products

The following pages present the modules already developed and validated by ALCIOM. Each of these modules includes a SmartBus full chainable/stackable interface and clock control. Don't hesitate to contact us for any custom variant.

3.1 Smartbrick modules

3.1.1 SB-CW4000

	Description	Ultra-wideband CW RF generator module The SB-CW4000 module can be used as a flexible frequency source for any instrumentation or RF architecture : local oscillator, excitation source, etc.
	Features	• One 50-ohm CW output • Low phase noise • Fully synthesized architecture • On-board low noise TCXO or external clock input • 2FSK/4FSK/2PSK/4PSK modulation inputs
	Specifications	• Output frequency : 1MHz to 4400MHz • Output frequency resolution : 10Hz (1Hz below 400MHz) • Frequency precision (internal TCXO) : +/-1.5ppm at 25°C, +/-4ppm from -30 to +85°C • Output power : -20 to +4dBm in 0.1dB steps • Output power precision : +/-0.5dB • Phase noise at 2GHz : -100dBc/Hz inband, -160dBc/Hz at 100Mhz • Harmonics : <-20dBc • RMS jitter <180ps typical

3.1.2 SB-CW13G

	Description	Ultra-wideband CW microwave generator module The SB-CW13G module can be used as a flexible frequency source for any instrumentation or RF architecture : local oscillator, excitation source, etc.
	Features	• One 50-ohm CW output • Low phase noise • Fully synthesized architecture • On-board low noise TCXO or external clock input
	Specifications	• Output frequency : 10MHz to 7GHz (up to 13GHz with reduced amplitude range) • Output frequency resolution : 100Hz • Frequency precision (internal TCXO) : +/-1.5ppm at 25°C, +/-4ppm from -30 to +85°C • Output power : -35 to -16dBm in 1dB steps up to 7GHz tbc • Output power precision : +/-1dB • Phase noise : tbc • Harmonics : <-20dBc tbc

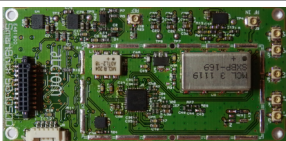
3.1.3 SB-POW4000

	Description	Dual channel RF milli-wattmeter plus gain/phase detector The SB-POW4000 module can be used as a measurement instrument or as part of an automatic level or phase control loop.
	Features	- Two independent high-performance true RMS RF powermeters - One independent phase and amplitude difference detector - Simultaneous sampling on both power channels or phase/amplitude channels
	Specifications	- Two RF power-meter inputs : 50MHz to 4GHz -50 to +10dBm, resolution 0.05dB - Accuracy +/-0.5dB (after frequency calibration) - True RMS measurement, waveform / modulation independent - Measurement ripple < +/-0.1dB, stability over temp +/-0.3dB - One RF gain/phase detector 10MHz to 2.7GHz - Input levels 0 to -60dBm - Delta level measurement from -30 to +30dB, resolution 0.05dB - Delta phase measurement from 0 to 180°, resolution 0.5° - Non linearity and stability over temp <+/-1.5dB and <+/-3°

3.1.4 SB-LNA4000

	Description	Ultra-low noise LNA module The SB-LNA4000 is typically used as a front-end in receiver applications
	Features	- One 50-ohm output, one 50-ohm output - Ultra-low noise - Full band or on-board low-pass or bandpass filter (Minicircuit SXBP series), as required by the application
	Specifications	- Working frequency : 50MHz to 4000MHz - Without filter : - Noise figure : 0.8dB at 2GHz typical, <1.2dB over full band - Gain : 22dB at 500MHz, 13dB typical at 2000MHz - P1dB : 23dBm at 1900MHz - With on-board band-pass filter : - Depending on selected filter, example with SXBP-169+ : 165 to 174MHz, gain 20dB, noise figure 2.5dB typical

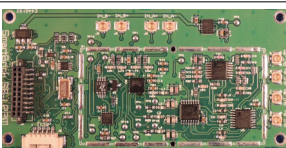
3.1.5 SB-IQ500

	Description	50MHz to 525MHz IQ downconverter module The SB-IQ500 is a basic block for high-performance software-defined receivers
	Features	• One 50-ohm input, differential I/Q outputs • On-board synthesized local oscillator • High I/Q matching for improved image rejection
	Specifications	• Local oscillator frequency : 50MHz to 525MHz (25KHz steps) • Optional external local oscillator input • Optional input bandpass filter (SXBP series) • Conversion gain : 15dB • Phase accuracy between outputs : +/- 0.5° • Amplitude accuracy between outputs : +/-0.1dB • 3dB bandwidth : 2MHz or 100MHz, selectable on order • P1dB : +12dBm at 140Mhz • IP3 : +28dBm at 140MHz • Noise figure : 5dB • LO to RF leakage : -70dBm typical • Output common mode voltage : 1.6V typical

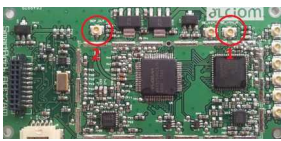
3.1.6 SB-CPL332

	Description	Wideband 6 to 1 resistive splitter/combiner The SB-CPL332 can be used to combine several RF signals efficiently
	Features	• Two stages architecture : two 3:1 splitters and two 2:1 splitters • Could be used as a splitter or as a resistive RF combiner
	Specifications	• 20MHz to 1GHz • Typical path loss 8,4dB +/-0.2dB at 169MHz, max 11dB at 1GHz • Return loss >20dB • Max power handling : 1W

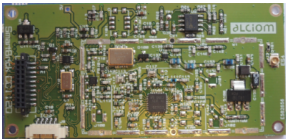
3.1.7 SB-LP2M

	Description	DC to 2.5MHz dual channel matched low pass filter module The SB-LP2M module is typically used before an analog to digital conversion. Its high matching performances are especially useful for I/Q signals.
	Features	• Two differential 50-ohm inputs + two differential 50-ohm outputs • Software configurable filter corner frequency and gain
	Specifications	• Corner frequency setting : 25KHz to 2.5MHz, 5% accuracy • Gain : 0/6/12/24dB (+/-0.5dB) • 9th order linear phase response • 0 to 3V rail-to-rail input and outputs • Low noise : -145dBm/Hz (input referred) • Low distortion : -75dBc at 200KHz • Spurious responses lower than -40dBc up to 10MHz • Matching better than 0,1dB & 5° channel to channel

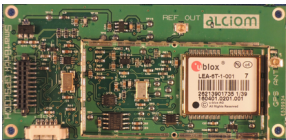
3.1.8 SB-ADC78M

	Description	High-speed 2 x 14 bits ADC input module The SB-ADC78M module is optimized for wide-band IQ data capture in particular for SDR applications
	Features	• 2 channels 14-bits ADC converter • Up to 78Msps • SB-FastLink compatible serialized output interface • On-board sampling clock generator
	Specifications	• Dual 50-ohm inputs, simultaneous sampling • On-board low noise TCXO or external clock input • 1Vpp inputs, differential or single-ended • 60dBFS SNR typical • Up to 2.2Gbps output data rate • Conversion clock selectable from 10Msps to 78Msps • 700MHz input bandwidth • 1ps typical RMS jitter

3.1.9 SB-CC1120

	Description	High performance VHF/UHF general purpose transceiver The SB-CC1120 can be used as part of a test bench or as a generic-purpose wireless link system. The module is currently optimized for the 169MHz band but could be adapted for 433/868MHz ISM bands easily.
	Features	• Built around a high performance CC1120 transceiver (Texas Instruments) • On-board SAW filter and high performance LNA • On-board TX power amplifier
	Specifications	• 164 to 192MHz • Frequency accuracy +/-1,5ppm, +/-4ppm over temperature • +12 to +22dBm output power • Typical sensitivity -120dBm native, -118dBm with SAW filter for improved blocking performances (2400bps, FSK, BER=1%) • FSK/GFSK/ASK/4FSK.4GFSK/MSK/GMSK • Configurable bit rate and deviation • Manual or automatic CRC processing • Flexible triggering scheme (RX/TX after event, timed, RX after TX) • 2KB RX and TX FIFO's + Time-stamping

3.1.10 SB-GPSLOCK

	Description	GPS disciplined reference oscillator The SB-GPSLOCK can provide an ultra-stable frequency reference to either a stack of SmartBrick modules or to any third party equipments
	Features	• GPS locked 10MHz or 12MHz VCTXO oscillator (order selectable)
	Specifications	• External active GPS antenna input • Lock in the presence of even only one satellite • Locked mode : Absolute accuracy better than 10ppb after 1 hour • Free running mode : +/-2.5ppm from -30 to +75°C +/-1ppm/year • 3V3 CMOS clock output (external connector and/or Smartbus clock delivery through stacking connector)

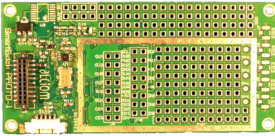
3.1.11 SB-ADC24

	Description	Ultra-high precision quad-channel 24-bit ADC input module The SN-ADC24 module can be used for any general purpose high resolution DC measurement, including strength gauges, polarisations, temperatures, etc.
	Features	• Full high precision 24-bits ADC converter • 4 unipolar input / 2 differential input channels • Selectable 10/40Kohm or 1Mohm input impedance • Internal high precision voltage reference or external reference • Dual RTD input compatible (integrated precision current sources and precision reference resistor) • Dual thermocouple input compatible • Simultaneous 50Hz/60Hz rejection (at rates lower than 10sps)
	Specifications	• Voltage range (unipolar) : 0-10V, 0-2.5V, 0-1V, 0-250mV, 0-100mV, 0-25mV • Voltage range (bipolar) : 0-2.5V, 0-1V, 0-250mV, 0-100mV, 0-25mV, common mode range : 0,3V to 3,0V • Data rate : 214sps to 1.66sps • ENOB : 21.5 bits (5V, 1.6sps) to 16 bits (25mV, 214sps) • Absolute accuracy : +/-0.1% +/-10ppm/°C • Integral non linearity < +/-15ppm of full scale • Total noise <15µV rms • Typical offset error <10nV (25mV scale) • Typical gain error : 7ppm (5V) to 100ppm (25mV) • Typical CMRR >110dB • Voltage reference stability : 3ppm/°C • Reference resistor for RTD modes : 100 ohm/0.01% • Dual current sources : 100µA/1000µA +/-2.5%, matching 0.2%

3.1.12 SB-DAC16

	Description	High precision 16-bit quad-channel DAC output module The SB-DAC16 module can be used to generate up to four software-configurable reference voltages (setpoints, bias levels, etc)
	Features	• 4 independent unipolar DC output channels • Overcurrent protection and detection
	Specifications	• Selectable output range 0/5V, 0/8V or -4/+8V for each output • Typical settling time : 10µs • Absolute precision : +/-0.1% +/-3ppm/°C (with >2Kohm load) • Differential non-linearity : +/-1 LSB • Integral non-linearity : +/-16 LSB • Offset error : +/-6mV +/-4ppm FSR/°C • Output voltage drift over time : +/-15ppm FSR/1000h • DC Output impedance : 0.5 ohm (20mA max output current)

3.1.13 SB-PROTO

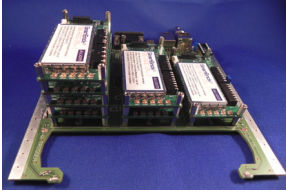
	Description	Universal SmartBrick prototyping experimental module
	Features	• 1 SPI master interface with 4 separate CS control lines • 1 I2C master interface • 5 ancillary 10-bits ADC inputs • 8 digital I/O lines, individually configurable as inputs or outputs • 2 PWM outputs • 16 Ko non volatile configuration memory • +5V, +8V, -8V and +3V3 power sources • Large prototyping area • 5 free UFL I/O connectors
	Specifications	• SPI bus speed : 8MHz, 4MHz, 2MHz • I2C bus speed : 400KHz or 100KHz • ADC precision : +/-1%, ratiometric to the +3V3 power supply • PWM frequency/resolution : 125KHz (5 bits) to 7.3Hz (16 bits)

3.2 Bases and adapters

3.2.1 SB-XS

	Description	Single-module USB base The SB-XS base module can accept one SmartBrick module and provides USB connectivity to a host PC.
	Features	• One SmartBus host socket • One USB slave port to host PC, providing power to the module • Up to four SMA input/output connectors • Bicolor power/active status LED
	Specifications	• Accept any single SmartBrick module • Dye-cast aluminium frame

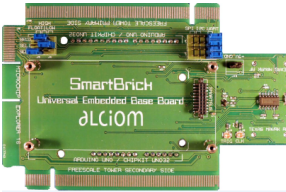
3.2.2 SB-XL

 	Description	Flexible base for up to 15 modules The SB-XL supports complex SmartBrick stacks, with local or remote PC.
	Features	• Three SmartBus host sockets, accepting up to five stacked modules per socket, total 15 modules • Ultra-flexible fully insulated host interface, supporting USB, RS232 and Ethernet, plus SPI and I2C non-insulated host interfaces • On-board low phase noise 12MHz phase-locked VCTXO and 10MHz TCXO reference, external 10MHz input/output • Optional on-board ultra-high stability 10MHz OCXO • Up to twelve SMA input/output connectors • Up to two DB15 connectors with seven I/O signals per connector • Bicolor power/active status LED plus external clock status LED
	Specifications	• Accept up to any 15 SmartBrick modules • Dye-cast aluminium frame • Supplied with an external 110V/220V to 6V/4A power supply

3.2.3 SB-ZYNQ

	Description	Flexible base for up to 10 modules, with integrated ZYNQ processor and SB-FastLink interfaces The SB-ZYNQ supports complex SmartBrick stacks, with local or remote PC or with n-board high-performance processing.
	Features	• Two SmartBus host sockets, accepting up to five stacked modules per socket, total 10 modules • ZYNQ processor with Gigabi-Ethernet interface • One SB-FastLink receiver channel and one SB-FastLink transmitter channel • Fully insulated host interface, supporting USB, RS232, plus SPI and I2C non-insulated host interfaces • On-board low phase noise 12MHz phase-locked VCTXO and 10MHz TCXO reference, external 10MHz input/output • Optional on-board ultra-high stability 10MHz OCXO • Up to twelve SMA input/output connectors • Up to two DB15 connectors with seven I/O signals per connector • Bicolor power/active status LED plus external clock status LED
	Specifications	• Accept up to any 10 SmartBrick modules • Based on MicroZed board with custom FastLink interface • On-board Xilinx XC7Z010 Zynq SoC (dual core Cortex A9, up to 1GHz, 512KB L2 cache, 28K Artix-7 logic cells, 80 DSP slices, up to 100GMACs) • 1GB DDR3 + 128Mb flash + 4GB microSD • Linux based • Dye-cast aluminium frame • Supplied with an external 110V/220V to 6V/4A power supply

3.2.4 SB-UEBB

	Description	Universal embedded base board The SB-UEBB base board is designed to build SmartBrick based demonstrators using a microcontroller evaluation board as a host.
	Features	• Allows to connect a SmartBrick stack to either of the following microcontroller evaluation kits : • Arduino compatible bases • Microchip Explorer-16 compatible bases • Freescale Tower compatible bases • Texas Instruments MAVRK compatible bases • Link through UART, SPI or I2C depending on the board.
	Specifications	• Supports up to 5 modules depending on available power • Configurable UART/SPI/I2C interface

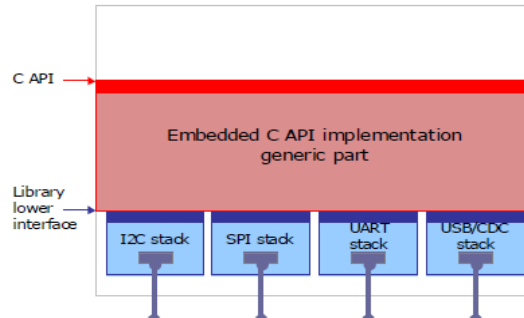
3.2.5 **SB-ADP-PXI**

	Description	Compact-PCI / PXI support board for SmartBricks The SB-ADP-PXI base board allows to integrate up to 9 SmartBricks modules in a PXI or compact-PCI slot
	Features	• Compact PCI / PXI compatible form factor • Allows to easily connect up to three stacks of up to three SmartBricks modules, and control them through the cPXI/PXI bus • On-board USB host interface • On-board low phase noise 12MHz phase-locked VCTXO and 10MHz TCXO reference, external 10MHz input/output from PXI bus or front panel • Optional on-board ultra-high stability 10MHz OCXO • Hardware trigger line interconnected to PXI bus triggers
	Specifications	• Accept up to any 9 SmartBrick modules • Compatible with hybrid PXI slots • Aluminium front panel • Accept up to 9 SMA inputs

3.3 Host side software

3.3.1 Smartbrick host API

ALCIOM provides a full source-code host side API which allows to easily drive a stack of **SmartBricks** modules from any microcontroller. Demonstration code supports an UART interface but could be easily adapted for other physical layers. High level API functions are provided for class 00, 10 and 20 messages.

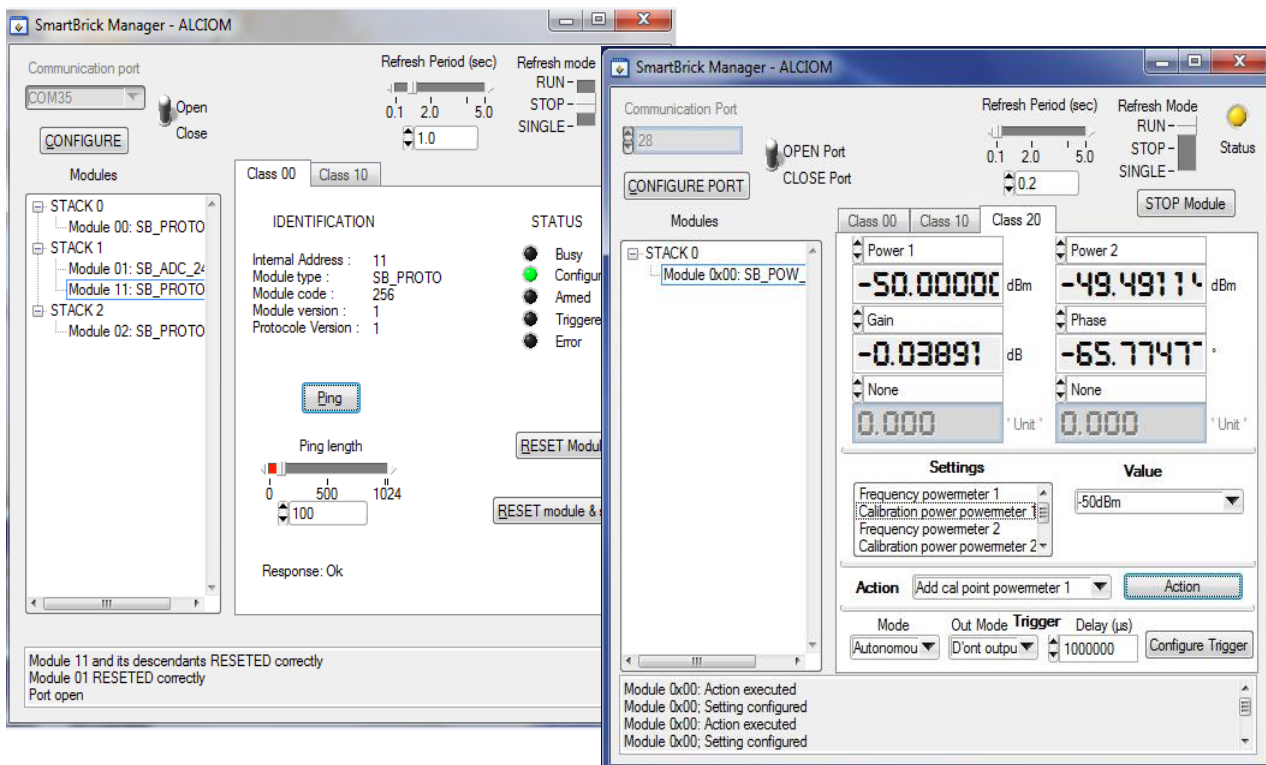


3.3.2 Smartbrick DLL

For PC developments, ALCIOM provides a DLL either under Microsoft Windows and Linux environments. This DLL allows to access to all host API functions from virtually any development environment (VC++, C#, Python, Labview, Labwindows, etc).

3.3.3 SmartBrick Manager

ALCIOM provides also the SmartBrick Manager Windows-based application. This application allows to automatically discover the connected module and to interactively manage each of them. The user interface is fully plug'n play and dynamically configured based on the module's descriptors.



4 Products in development

This chapter presents new **SmartBrick** modules or related products that are either under development or under study by ALCIOM. Of course these preliminary informations are provided without any warranty at this time.

4.1 Custom products

All **SmartBrick** modules share the same hardware and firmware base. This allows ALCIOM to implement very fast development cycles for new modules requirements. Don't hesitate to contact us for custom requirements...

4.2 New bases and adapters

4.2.1 SB-ADP-PCle

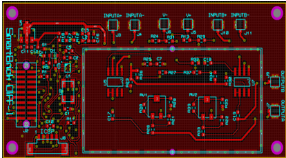
	Description	PCI-Express support board for SmartBricks
	Features	- One PCI-Express compatible SmartBus support board - Allows to easily connect up to three stacks of SmartBricks , and control them through a PCI-express bus

4.3 New Smartbrick modules

4.3.1 SB-DAC78M

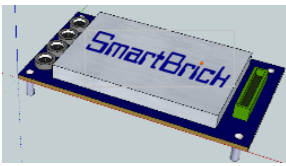
	Description	High speed dual channel arbitrary signal generator module The SB-DAC78M will be a FastLink compliant module. It will be a key high performance building block for I/Q transmitters.
	Features	FastLink high speed serialized digital input, up to 2.2Gb/s - Dual 50-ohm ioutput - Clocked by the FastLink transmitter
	Specifications	14 bit dual channel high speed DAC - Sampling speed up to 78Msps per channel - SFDR : 84dBc at 5MHz - IMD3 : 79dBc at 15.1/16.1MHz

4.3.2 SB-DIFF1

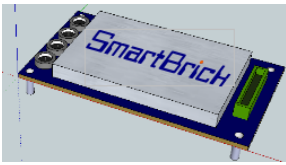
	Description	Differential to unipolar amplifier
	Features	Two independent differential to unipolar amplifiers
	Specifications	- External positive and negative voltage sources (8V minimum) - CMRR : 74dB min - Gain 1 - Adjustable offset - Small signal bandwidth : 3MHz typical

4.3.3 SB-DDS350

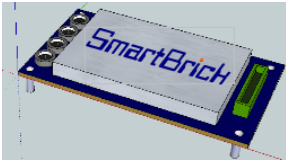
	Description	Direct digital synthesis generator
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	Features	- High purity 50 ohm sine output up to 350MHz - Three mode select logic inputs for up to 8 states real-time FSK/ASK/PSK/QAM modulation - External wideband analog AM, FM and PM modulation input, 14 bits resolution - Programmable AM, FM and PM internal modulation - Programmable amplitude, phase and frequency sweeps - Selectable CMOS-compatible square wave output up to 100MHz - On-board low noise TCXO or external clock input
	Specifications	1Gsps DDS with 14 bits amplitude resolution - Output frequency : 0 to 350MHz - Output frequency resolution : 0.25Hz - Analog modulation bandwidth : 50MHz - Frequency precision (internal TCXO) : +/-1.5ppm at 25°C, +/-4ppm from -30 to +85°C - Output power : -20 to +10dBm in 0.1dB steps - Output power precision : +/-0.5dB - Phase noise at 250MHz < -125dBc/Hz at 1KHz offset

4.3.4 SB-DDS200

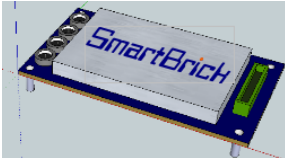
	Description	Quad Direct digital synthesis generator
	Features	- Four high purity 50 ohm synchronized sine output up to 200MHz - One input modulation pin for real-time FSK/ASK/PSK modulation - Programmable amplitude, phase and frequency sweeps - On-board low noise TCXO or external clock input
	Specifications	- Four independent outputs 500Msps DDS with 10 bits amplitude resolution - Output frequency : 0 to 200MHz - Output frequency resolution : 1Hz - Frequency precision (internal TCXO) : +/-1.5ppm at 25°C, +/-4ppm from -30 to +85°C - Output power : -5 to +3dBm in 0.1dB steps - Output power precision : +/-0.5dB - Phase noise at 100MHz < -130dBc/Hz at 1KHz offset

4.3.5 SB-PGA4000

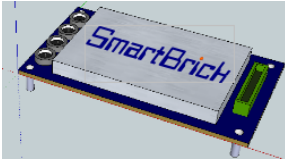
	Description	Programmable dual-channel wide-band RF amplifier
	Features	- Two independent, chainable, wide-band RF power amplifiers - Integrated measurement coupler and RF RMS power meter on channel 1 - Selectable automatic levelling
	Specifications	100MHz to 4GHz - Gain from <-11dB to >+15dB (+30dB with two chained amplifiers) - Gain steps : 0.5dB - Gain stability with temperature +/-0.5dB - Gain accuracy : +/-0.5dB (after frequency calibration) - P1dB > +17dBm - OIP3 >+28dBm - RF power meter : -50 to +10dBm, resolution 0.05dB - Accuracy +/-0.5dB (after frequency calibration) - True RMS measurement, waveform / modulation independent

		- Measurement ripple < +/-0,1dB - Stability over temperature +/-0.3dB - Levelling response time < 1ms
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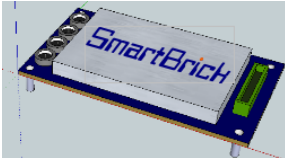
4.3.6 SB-CNV6000

	Description	Dual wide-band upconverter/downconverter
	Features	- Dual RF mixers - On-board synthesized local oscillator - No on-board band-pass filters - On-board low noise TCXO or external clock input
	Specifications	- Input frequencies : 30MHz to 6000MHz - Local oscillator : 85 to 4200MHz - Step size 1.5Hz - Output frequencies : 30MHz to 4500Mhz - Gain : -4dB typical - Integrated phase noise <0.5° RMS - IIP3 : +23dBm

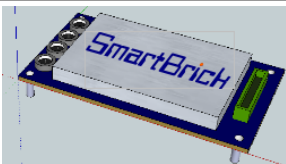
4.3.7 SB-LPF50

	Description	Dual programmable IF low pass filter and amplifier
	Features	- Two independently configurable programmable preamplifiers - Two independently configurable programmable low pass filters
	Specifications	- Amplifier gain : 0 to 50dB - Amplifier resolution : 0.5dB - Gain accuracy : +/-1dB - Filter cut-off frequency : 3,5MHz to 50MHz - Filter cut-off accuracy : +/-2.5% - Filter cut-off frequency temperature stability : +/-0.03%/°C - Selectable direct path : 100Mhz bandwidth 6th order Butterworth amplitude and phase response - Output IP3 : +30dBm - Noise figure (max gain) : 6dB typical - Channels balance : 0.05dB & 0.6° typical - Isolation : 70dB typical

4.3.8 SB-BPF3900

	Description	Programmable RF band-pass filter
	Features	- High accuracy MEMS-based RF band-pass filter - Continuously tunable center frequency - Adjustable bandwidth
	Specifications	- Central frequency tunable from 1GHz to 3.9GHz - Tuning resolution : 10MHz - Tuning accuracy : +/-2% 3dB filter bandwidth : 11% typical 3dB bandwidth adjustment : +/-3% typical 20dB filter bandwidth : 33% - Insertion loss : 12dB typical - Wide-band rejection >30dB - Reentry frequency : >9GHz

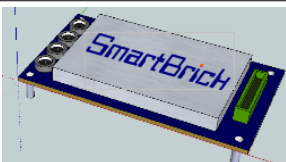
4.3.9 **SB-MUX4000**

	Description	SP4T RF multiplexer
	Features	High performance non-reflective 4 to 1 switch
	Specifications	- Pass-band : DC to 4GHz - Insertion loss : 1dB typical at 2GHz (1.5dB at 4GHz) - Isolation : 40dB typical at 1GHz (25dB at 4GHz) - P1dB > +25dBm - Return loss, on state : 18dB typical up to 2.5Ghz, 12dB above - Return loss, off state : 12dB typical

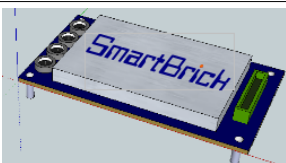
4.3.10 **SB-CPL3000**

	Description	Measurement reflection bridge
	Features	Dual wide band directional coupler
	Specifications	30MHz to 3GHz - Independent forward and reflected couplers - Main path loss <4dB - Coupling : 20dB +/-1dB - Directivity > 15dB - VSWR <1.2:1 - Max power handling : 1W

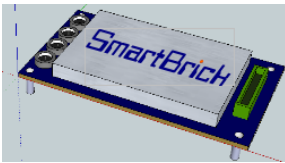
4.3.11 **SB-ARB100**

	Description	Dual channel high performance arbitrary waveform generator
	Features	- Two independent waveform generators 500Msps, 16 bits resolution ! - On-board 100Ksamples memory - Advanced triggering features - On-board low noise TCXO or external clock input
	Specifications	- Resolution : 16 bits per channel - Up to 500Msps per channel - Selectable x2/x8 interpolation - Integrated digital complex mixed and NCO - Integral non linearity : +/-4LSB - Gain error : 0.7% FSR

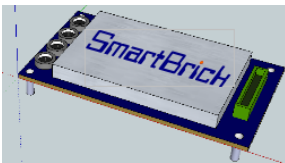
4.3.12 **SB-DEL10**

	Description	Programmable digital delay line
	Features	- Digitally configurable delay generator - LVTTL inputs/outputs
	Specifications	- Delay 2.2ns to 12ns - Delay resolution : 10ps - Input frequency : DC to 150MHz - Accuracy : +/-3% at ambient temperature - Temperature stability : +/-5%. Optional firmware-based temperature compensation

4.3.13 **SB-INE9**

	Description	Inertial measurement unit
	Features	• 3D magnetometer • 3D accelerometer • 3D gyrometer • Optional on-board Kalman-filter processing engine
	Specifications	• Maximum sampling rate : 50Hz • Magnetometer : ◦ Range : +/-1mT ◦ Sensitivity : 0.1μT ◦ Temperature stability : +/-0.1%/°C ◦ Hysteresis : 2% • Accelerometer : ◦ Range : +/-2g, +/-4g, +/-8g ◦ Sensitivity : 15mg • Gyrometer : ◦ Range : +/-400°/s , +/-1600°/s ◦ Sensitivity : 1°/s

4.3.14 **SB-TDAN**

	Description	Time difference analyzer module
	Features	• 2 channels time analyzer with 10ps bins
	Specifications	• 2 LVTTTL inputs or differential LVPECL inputs • Measurement range 0 to 10%μs • Minimum pulse width 1.5ns • Trigger to rising or falling edge • 500KHz continuous rate mode (20MHz in LVPECL mode)

5 Ancillaries

5.1 Wiring

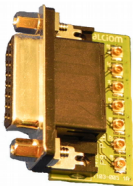
5.1.1 UFL-SMA-KIT

	Description	Set of two SMA to UFL front-panel cables
	Contents	- Two (2) SMA female to UFL female 10cm front-panel cables - Usable with SB-XS, SB-XL, SB-ADP-PXI, etc

5.1.2 UFL-JUMPERS-KIT

	Description	Set of five UFL to UFL jumpers
	Contents	- Five UFL female to UFL female 15cm jumper cables - Usable for internal connections between SmartBrick ports

5.1.3 UFL-DB15-ADAPTER

	Description	One DB15 to UFL adapter
	Contents	- One DB15 female to 7 x UFL male adapter - Usable with SB-XL base when DB15 external I/Os are needed

5.2 Add-ons

5.2.1 OCXO-KIT

	Description	Ultra-high precision 10MHZ OCXO reference
	Contents	- One 10MHz OCXO oscillator - Absolute precision : +/-1ppm - Frequency change vs temperature : <+/-0.25ppm - Aging (1st year) : <+/-0.7ppm - Jitter : 3ps rms (10Hz to 20MHz) - Warmup time : 5 minutes - Pluggable on SB-XL and SB-ADP-PXI when high performance are required and no external precision clock is available. Nota : As an alternative a SB-GPSLOCK module can be used if GPS sky visibility is possible