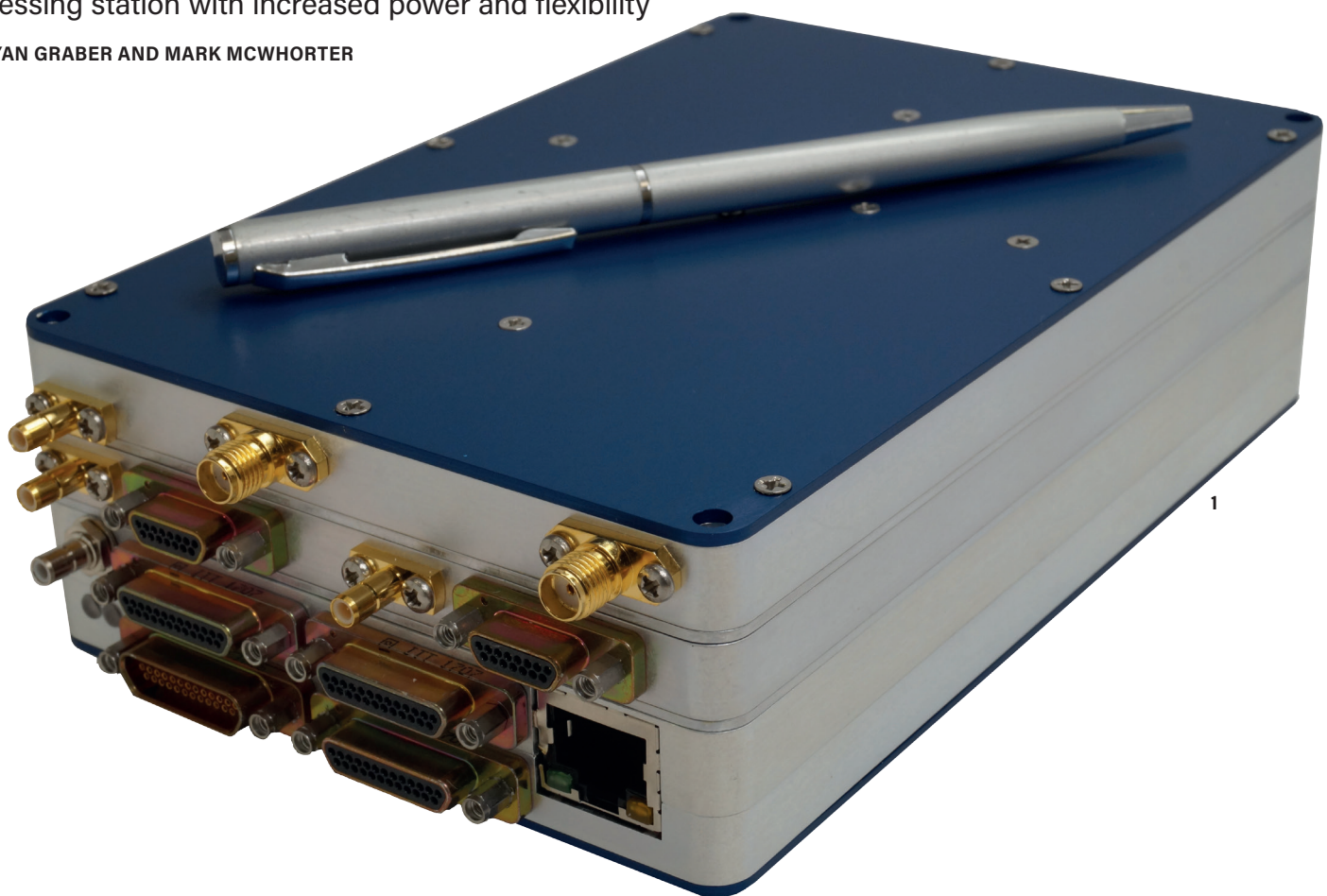# MODULAR TELEMETRY RF, DATA RECEIVING AND PROCESSING ENGINE

Design and technology advancements have led to a greatly reduced footprint and weight for a fourth-generation telemetry processing station with increased power and flexibility

// BRYAN GRABER AND MARK MCWHORTER

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1 // The Lumistar LS-28-DRSM telemetry processing engine

Lumistar has completed engineering development and begun production of a revolutionary modular 'fourth-generation' digital product primarily designed for applications in testing for fixed ground, mobile and airborne flight test applications.

The LS-28-DRSM series includes all the traditional functions of a full rack mount telemetry processing station in the approximate footprint of a handheld 3.5in PC hard drive. Standard capabilities include two independent digi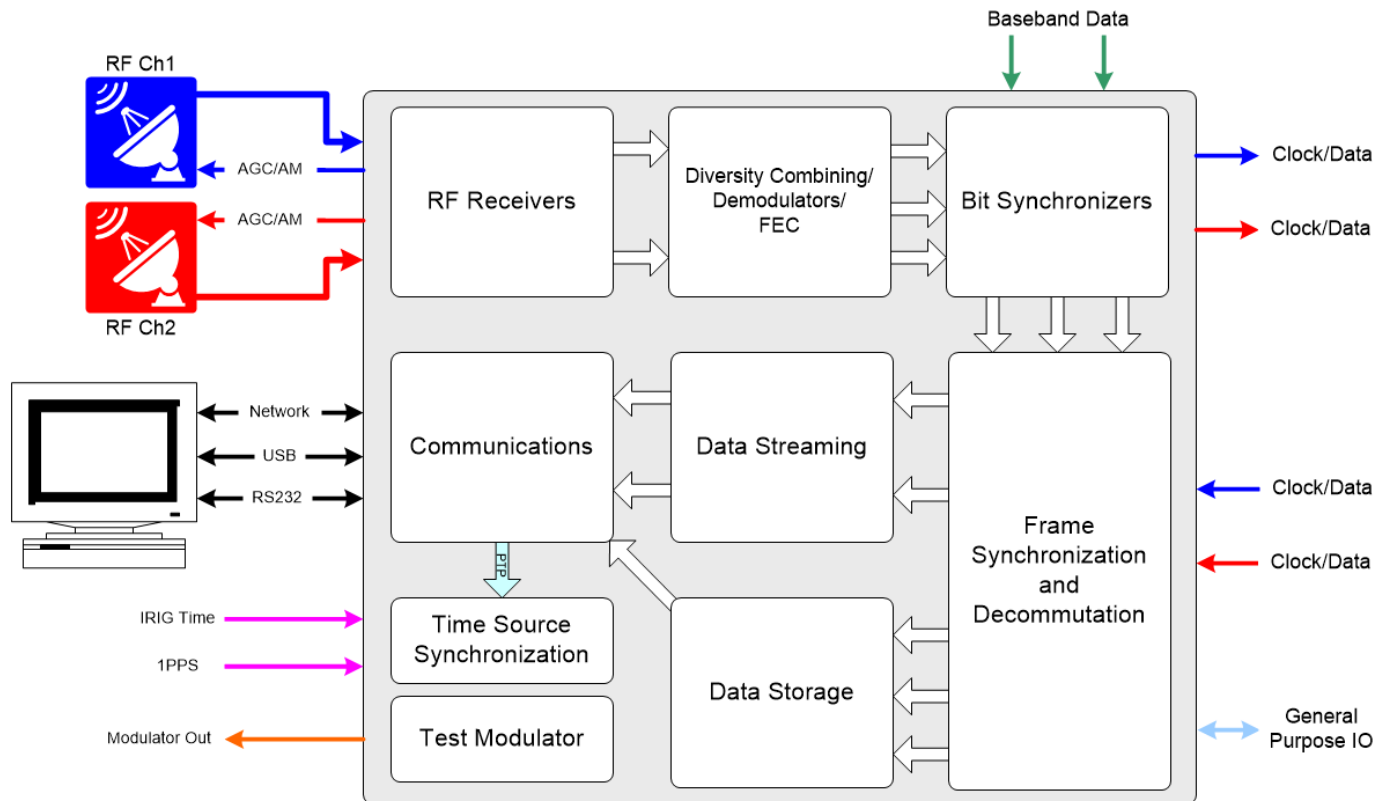tal multi-band RF receiver channels, each supporting multiple digital demodulation formats, bit synchronization, forward error correction, data recording, decommutation, graphical displays, baseband data acquisition, and Ethernet data distribution.

The flexibility of the design architecture allows for adaptability to many other applications, such as remote site spectrum monitoring, command verification receivers, and traditional data acquisition applications, all with minor modifications to the standard device's factory-installed firmware personality.

Some of the primary design objectives of the LS-28-DRSM product line were to reduce the platform size, to provide an 'OS-less' environment by eliminating the use of commercial software operating systems for functional processing, to provide easy and flexible field upgrade/enhancements capabilities, and to provide a network appliance for device control and data transport.

A comparison to the previous generation Lumistar product line of similar capabilities illustrates the scope of the size, weight, and power reduction achieved by

2 // A functional block diagram of the LS-28-DRSM showing some of the standard inputs and outputs

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the design team. Previous generations of equipment required 300w of power, weighed approximately 62 lb (28kg), and were housed in a 4U industrial computer chassis occupying approximately 3,100in³ (50,8000cm³). By contrast, Lumistar's latest fourth-generation product typically consumes 45w, weighs 2 lb (0.9kg), and occupies a volume of 40in³ (655cm³). This is an 85% reduction in power, a 96.8% reduction in weight, and a 98.7% reduction in volume versus its predecessor. The unit is primarily controlled and monitored using a 1000/100/10Mbps Ethernet interface with alternate controls being provided by USB and RS-232. Using available documentation from several sources, the customer can develop their own interface GUI or use the provided Lumistar network application.

Beyond excellent RF performance, at the heart of the modular design is a flexible and extensible multicore DSP Engine that can assume one of 12 'personalities'. The device construction is via four hardware 'slices': RF, IF, signal processing, and a control processing engine. The slices can be configured as a whole set or as a subset to perform targeted functionality.

Operational firmware loads, or 'personalities', are retained internally in the device for quick switching between operational requirements. New firmware personalities and/or control processing revisions are easily updated in the field. There is no need to return the unit for most modifications.

When configured as a traditional range telemetry receiver/combiner, the LS-28-DRSM can handle up to six frequency bands per channel from 70MHz to 7GHz. All standard RF receiver functions are provided, including antenna tracking using AM demodulation and AGC feedback, downconversion, diversity combining, multimode demodulation, bit synchronization, IQ video output, Eb/No

monitoring, and spectral and constellation displays with other data quality indicators.

Various non-standard options include the addition of up to 64GB per channel data recording at the bit level and UDP data broadcasting of the received telemetry. The receiver can be configured to support Multi-symbol PCM/FM, SOQPSK, GMSK, Analog FM Video w/wo NTSC de-emphasis, BPSK, QPSK, OQPSK, AUQPSK, PCM/PM, and Multi-H CPM. Data rates up to 60Mbps are supported. The unit has a very flexible and useful internal data/IF modulator and bit error reader/frame synchronizer lock indicator for use in system loopback tests. Adding an external tunable upconverter makes this feature a very powerful tool itself.

The unit constantly performs maintenance monitoring of various environmental parameters and alerts the user to out-of-boundary conditions. The software logs the user settings and important receiver performance parameters as a function of time at up to a 10Hz rate.

If the user wants to convert from receiver mode to a dual-channel bit synchronizer personality, that change can be commanded via software. The unit will be converted to a dual-channel bit sync while the GUI is transformed for that operational mode. The bit sync function operates to 30Mbps and provides several options for PCM code conversion.

and merits (as well as demerits) in modern telemetry flight testing and space telemetry applications.

REMOTE SPECTRUM MONITORING

When configured for remote spectrum monitoring applications (Figure 2), each LS-28-DRSM RF section can be configured with 12 independent RF channels (six per channel x two channels) from 70MHz to 7GHz. Each channel is sampled in a 50MHz bandwidth at the second IF of the receiver, digitized, packetized, and converted to the VITA-49 standard for transmission across the LAN. This allows for a complete digital reconstruction via software of the RF signature at all remote

sampling sub-channels operating independently: a channel for intermediate frequencies between 1MHz and 100MHz, and a DC-coupled channel covering frequencies up to 30MHz. The intermediate frequency sampling sources include RF and frequency down-converted sources, as well as external sources, and provide AGC if required. The low-frequency input acquisition port contains provisions for signal offset, AGC controls, and software selectable input impedances. Once the desired signal envelop has been established, the signal is digitized at up to 250 millions of samples per second by the intermediate frequency processing channel or up to 125Msps for the low frequency channel. Each sub-channel supports 12-bits of resolution at the ADC. This sampled data can then be further processed in any number of ways, recorded, and/or streamed via the network port based on user requirements.

COMMAND VERIFICATION RECEIVER

The LS-28-DRSM can be configured to provide the functionality of a Command Verification Receiver. This is required for use in Command Destruct applications, where verification of the quality of the transmitted command signals is required. The unit can be configured to receive two channels of UHF command signals, typically between 350-450 MHz. These signals contain up to four low-frequency FM modulated 'tones' in accordance with the IRIG 208 standard. The command receiver will demodulate the tones and provide discrete tone frequency values and deviation as per the standard's requirements. The compliance of the tones is then displayed via software GUI. The software can be configured to provide alerts when the received tones are non-compliant.

Owing to the open-ended architecture of the LS-28-DRSM series product, many more personality applications are conceivable and achievable. \\

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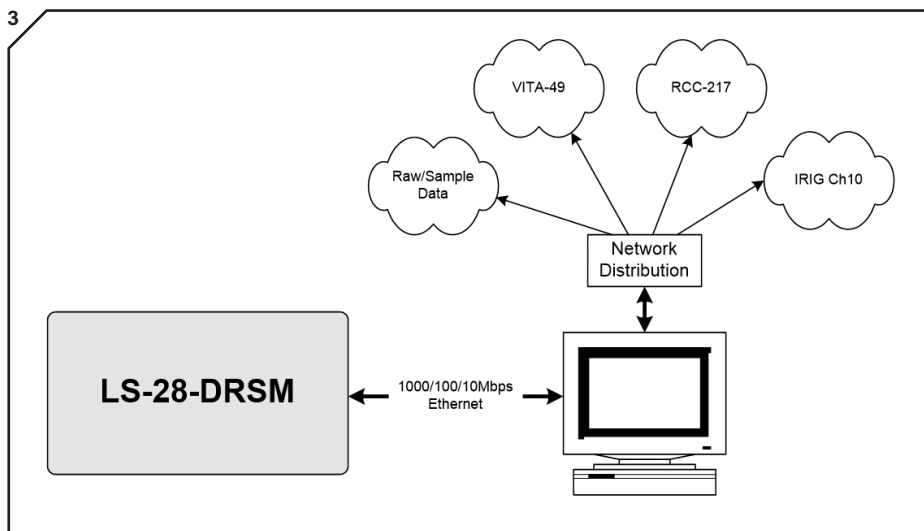
3 **//** The processing engine LS28DRSM can be part of a 'network centric' design

The LS-28-DRSM provides the capability to decommutate data from any input source (RF, IF, baseband). The framed data is then broadcast via UDP packets. These packets can be brought in via the network 'auxiliary input' of the Lumistar Data Processing Software (LDPS) suite of tools for real-time display, archive, playback and simulation of telemetry data.

The LS-28-DRSM is capable of handling many modern coding and digital link enhancement schemes, such as Viterbi, Reed-Solomon, LDPC, Space Time Coding, and Adaptive Equalization. Each of these has its own special niche, applications

sites that require 24/7 spectrum monitoring. Special software for this application will display each site's spectrum real time, archive the spectrum as a function of time, and provide for user-identified alarm conditions when certain preset limits are exceeded.

SIGNAL ACQUISITION NETWORK APPLIANCE

The LS-28-DRSM can be configured in a role as a generic analog-to-digital acquisition unit for RF, IF and low-frequency signals up to 30MHz (Figure 3). Each channel of the module contains two