

Attn : TEMEX Sales Representatives

December 21st, 2007

Subject: TEMEX digital pulse compression sub-systems advantages

The purpose of this document is to show the key advantages of our digital pulse compression subsystems.

A) TEMEX know-how

TEMEX as a 30 years of experience in RADAR pulse compression sub-systems design.

Pulse compression sub-system :

- ✓ Expander (output is a chirp)
- ✓ Compressor (input is the chirp received by the RADAR antenna, output is a compressed pulse)

High experience in signal processing acquired with SAW devices is still valuable, because the same signal processing theory is used for SAW based and digital based devices.

TEMEX has a long experience in designing electronic products for military market. TEMEX products are designed for use in harsh environments.

Digital based devices are on the way up (thanks to Moore's law)
SAW based devices are on the way down (but still efficient for high bandwidth products)

Moore's law : Computation power of electronic devices doubles every 18 months.

B) CIBM7xx pulse compression unit

This product is available. It is the first digital compressor designed by TEMEX, but TEMEX has already designed many digital expanders.

This product was first dedicated for refurbishing of existing pulse compression RADARs using SAW based pulse compression sub-systems. This is the reason why this product has analog IF (Intermediate frequency) input and output : it may be a "plug and play" replacement of a SAW based pulse compressor (that has also analog IF input and output).

It may be used for :

- ✓ Replacement of an obsolete SAW based pulse compression sub-system (or only compressor)
- ✓ Performance enhancement of a RADAR using a SAW based sub-system (or only compressor).

Even if I/O are analog, the pulse compression process is fully digital, using high performance FPGA. The processing is done in real time, at full speed with a little latency.

CIBM7xx benefits of all the features inherent to digital technology :

- ✓ Theory like performance

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- ✓ BxT (Bandwidth x Time dispersion) product up to 1000, or higher
- ✓ Main lobe without base widening
- ✓ Side lobe level commonly 5dB better than SAW devices
- ✓ Reproducibility
- ✓ Repeatable characteristics from one part to another (no matching, no tuning needed)
- ✓ Stability
- ✓ Stable performances in all operating area (e.g. temperature range) (it is not the case for SAW devices that must be ovenized for high stability)
- ✓ Flexibility (not available on the existing product, needs a customization)
- ✓ Several waveforms (e.g. with different doppler pre-correction) may be stored inside the FPGA, and selected with a simple electric command
- ✓ FPGA software may be updated (e.g. with new waveforms) without hardware change

TEMEX supply a stand alone product (including electronic board, mechanical box, and FPGA program). The FPGA program will be designed by TEMEX upon customer specifications (i.e. RADAR specifications)

TEMEX may customize the CIBM7xx product upon customer request, for example :

- ✓ Add command inputs
- ✓ Different form factor
- ✓ Different power supply value
- ✓ Add trigger input for an expander function

C) TEMEX SuperCOTS

COTS means “Commercial Off The Shelf”

The basic idea is to develop standard products that may fit to several customers needs (needs a standardization effort).

A COTS system is composed by :

- ✓ Hardware products available from several suppliers
- ✓ Existing software
- ✓ Customer customization (specific mechanics, hardware, software, ruggedization,...)
- ✓ Ideally, the last item should be as limited as possible.

COTS was introduced in the US military market in 1990's when US army leaders realized that they pay \$600 for toilet seats and \$400 for hammers! These products were designed with military specifications even though it was not absolutely required. U.S. Secretary of Defense William Perry issued his famous memo declaring that commercial off-the-shelf (COTS) technology should be used whenever possible.

Several COTS standards exist.

- ✓ cPCI (stands for Compact PCI), which is an industrial version of the well known PCI PC bus

- ✓ VME (VERSAmodule Eurocard) and spin off : VME64x, VXS, VPX, VPX-REDI (for harsh environments)

There are many other standards.

The pros and cons of systems based on COTS products are the following :

- 1) Development cost : COTS systems use existing “bricks” (fully tested products). The extra engineering effort is lower than for a custom design.
- 2) Development time : short, for the same reason
- 3) Availability of a complete solution : as COTS systems use existing “bricks”, engineers will not always find the right “bricks” adapted to its application. The problem may be the function, the form factor, the ruggedization level, the consumption.
- 4) Size / Weight / Power optimization : for the same reasons, a COTS based product will not be so optimized as a custom product. Available products may have higher performances than required, which often leads to higher power, size or weight. COTS products always fit to a standard specification that has particular requirements. This leads to extra functions or components (connectors) required for compliance to the standard but with no use for a specific application. The design is often split in several boards which is not the best solution for SWP optimization.
- 5) Life cycle : COTS electronics boards have commonly a 2 years life cycle. **This is a crucial problem for military market that commonly requires a 10 years maintainability period.**
- 6) Production Cost (low quantity) : a custom system with low quantity production has a high production cost (needs for production tools). COTS bricks have a relatively low price, because the development cost is shared by all users.

TEMEX SuperCOTS : the advantages of COTS products without the drawbacks !

- 1) Availability of a complete solution : TEMEX SuperCOTS product is specifically designed for use in RADAR systems (many other COTS products various applications such as target radar systems, communication systems, automatic test equipments, medical systems, ... with a single board!). TEMEX SuperCOTS board is specifically designed for use in harsh environments, which will be compliant for many military RADAR systems. If this product does not fully fill the customer requirement, TEMEX will customize the product.
- 2) Size / Weight / Power optimization : TEMEX SuperCOTS product is specifically designed for use in RADAR systems, so is optimized for this application.
- 3) Life cycle : TEMEX design the complete product, including the hardware. The life cycle of this product will be equivalent to other TEMEX military products (more than 10 years).

D) EXP-2xCOMPR XMC board

TEMEX propose a pulse compression XMC form factor board.

We propose XMC format because :

- ✓ It is adapted to the pulse compression sub systems
- ✓ It may be used as it is for many standards (cPCI, aTCA, VME64, VXS, VPX, VPX-REDI,...) with only a carrier board replacement
- ✓ Digital interface (serial LVDS or PCI express) will be OK to transport digital baseband data.
- ✓ Many mother boards or carrier boards available

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If the customer is interested in this product, we will develop a version of this product fitting their specific requirements.

TEMEX supply a stand alone product (including electronic board, and FPGA program). This is the main difference with competitors' boards.

The FPGA program will be designed by TEMEX upon customer specifications (i.e. RADAR specifications)

As TEMEX design also hardware :

- The maintenance is guaranteed during a long period (high life cycle)
- Customization is possible.
- TEMEX may also propose high ruggedization levels, card cage assembly, (on customer request)

The target applications are :

- **New compression radar design**
- Performance enhancement of existing compression radars
- Refurbishing of existing compression radars

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