Phased Array UT Platform for Customizing Dedicated and Automated NDT Applications

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Abstract
Small form factor, excellent signal-to-noise ratio (SNR), fast data throughput and an easy to integrate electronics are just some of the important aspects for automated phased array inspection systems. Furthermore, a software application programming interface (API) is crucial for creating a dedicated and simple software front end. This paper will present how a family of phased array ultrasonic modules can meet the demands of the most unique and innovative industrial and research based phased array applications.

Keywords: Phased Array UT, Ultrasonic Testing, AUT, FMC, Full-Matrix Capture, TFM, Total Focus Method

1. Introduction

As technology improves Phased Array Ultrasound (PAUT) for Non-Destructive Testing (NDT) continues to be challenged by new applications and the growing need to inspect faster and more accurately. PAUT software applications are difficult to standardize due to the various industry needs, materials and part geometry. A large portion of the inspection system is the software driving the acquisition, analysis and automation. It would be difficult to have one locked down software application capable of managing all possible applications. There is a need for the ability to customize the software to fit the need and an open platform hardware capable of supporting 3rd party and custom software, where techniques like Full-Matrix Capture (FMC) and Total Focus Method can be implemented or further investigated.

2. OEMPA

OEMPA, pronounced by reading the letters O-E-M-P-A, is based on an OEM (Original Equipment Manufacturer) concept, and more specifically an OEM Phased Array Module that industrial users (e.g. Systems Integrators or NDT Equipment Manufacturers) can customize or create a solution to fit the exact application that is being targeted. (2) Naturally, the OEM concept fits well with the needs of Researchers that require an open and advanced data acquisition unit with Phased array features.

3. Phased Array Ultrasonic Acquisition

OEMPA is a PC-based phased array ultrasonic acquisition module with the following configurations: 16/16, 32/32, 16/128, 32/128, 64/64, and 128/128.

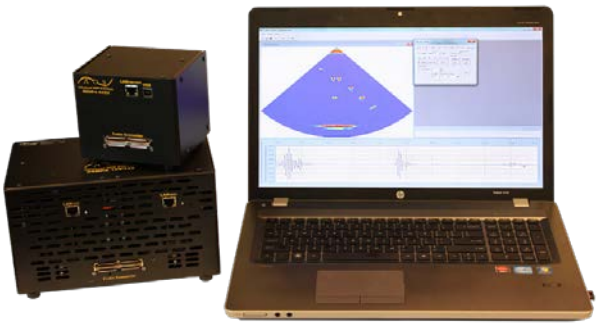

Figure 1: OEMPA 128/128 and OEMPA 64/46 with Data Acquisition Laptop

These options provide an integrator the ability to cover more than one application without over-spending on the number of channels. Integrators can invest on a one-time software interfacing period and be able to easily plug-and-play a different hardware configuration to meet a different application.
There are many advantages to having a PC based scalable hardware platform. In this type of setup the Phased Array Acquisition unit sends digitized acquisition data to the PC via an Ethernet connection using the TCP/IP protocol. Ethernet is an easy way to interface a device with a tablet, laptop or desktop PC and also provides a robust and flexible means for remote control from almost anywhere.

4. OEM Concept

OEMPA can be rebranded and integrated into an end-solution, whether it is a dedicated portable device for a particular niche inspection or large scale automated inspection system. NDT experts that now have the opportunity to offer a solution to their local market that is unique and an improvement based on their experience and know-how. The actual electronic modules as seen below can be provided so that OEMPA can be placed in a unique enclosure more suited for the application. The board on the top houses the pulsing analog circuitry, each of the four boards in the middle contain 16 parallel receive channel and the bottom board manages the data communication and some of the signal processing. This type of board stack creates a complete 64 parallel pulse/receive phased array module.

Figure 3. Bare OEMPA 64/64 Module

5. Small Size for Automation

The form factor plays an important role in integration. The small size allows one to place the acquisition unit closer to the transducer. Traditionally, advanced phased array acquisition units have been large in form factor due to the high channel count. Depending on the application (e.g. tank crawlers, girth weld inspection, sub-sea ROVs… etc.) umbilical cables are in the range of tens of meters long. Not only is the length an issue, but the cables can get thick due to the high channel count of phased array. The reliability of the constant movement and flexing of the cable also becomes an issue causing spares to be needed.

6. Hardware Internals

OEMPA includes many advanced features allowing it to be integrated into automated systems yet still maintain the small form factor, low power, and cost effectiveness. Some features worth mentioning are extremely low noise per channel, Dynamic Depth Focusing (DDF), Distance Amplitude Correction (DAC), up to 2048 cycles and more in some special cases, up to 20kHz Pulse Repeti-tion Frequency (PRF), gates, filtering, and interface echo-tracking. OEMPA has the flexibility to easily create mul-tiple groups of focal laws. This is useful in the scenario of running multiple scans, for example linear scans

Figure 5. Visualization of Timeslot

at different angles and to be able to visualize this on multiple B-scan views coming from the same probe. An-other scenario could be in the case of driving more than one probe from one OEMPA module using a probe split-ter. As seen in the diagram below, a cycle is the identifier of a grouping of parameters for one particular focal law within a Time Slot and the corresponding acquired A-scan. From the perspective of the hardware it is sequenc-ing through cycles, and the software application would be free to assign the data to the desired grouping when creating a B-scan visualization window.

7. References

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