SENSOR INTEGRATION INTERFACES TO INTERNAL AND EXTERNAL ON BOARD NAVY

F Deliu, N Badara, P Burlacu and O Cristea

1 Electrical and Electronic Department, Naval Academy “Mircea cel Bătrân”, Constanta

Email: florentiu.deliu@anmb.ro

Abstract. Care processes before requiring a dedicated processing hard and soft structures, a custom application can now perform with great efficiency and a constant quality system that acquires business data. This paper studies two directions. The first direction refers to classical data acquisition systems. Data acquisition is a branch of engineering dealing with the collection of information from a number of digital and/or analogue sources, the conversion of such data into a digital form, processing, storing and transmitting data, for example to a computer (alpha display numeric) or to a printer. The second direction refers to programmable logic controller (PLC), which is a data acquisition system, but with a specific structure and application. The two directions are closely related to the type of sensors found on a military ship. These sensors can be classified into two classes, special and common. Special sensors are closely related to weapons, observation and navigation systems, and common ones can measure parameters such as temperature, pressure or other parameters specific to the engine room. For the first case there is an example of a radar sensor interfacing and for the second example a control center for measuring and controlling the main engine parameters.

1. Introduction.
The area of common sensor spread across aboard ships is high, so we will relate this class of sensors to PLC’s, as the acquisition rate and the type of signals acquired make them different from the class of special sensors that are connected to the classical acquisition systems.

2. Application with data acquisition system.
Class special sensors is complex, and the question arises: what can help a data acquisition system these sensors? To answer this question will be analyzed one particular type of sensor and radar.

The parameters of these sensors are:
- directivity characteristic,
- the speed of rotation in azimuth and elevation,
- operating frequency,
- power in pulse,
- duration of the impulse,
- location coordinates on board the ship in relation to the ship's reference plane.

A first application that can be achieved is a DAS (Data Acquisition System) with radar extraction function.

The input parameters supplied by the special sensors are:
- the video signal at the receiver output,
- impulse commissioning,
- the position pulses of the antenna.

SAD executes:
- extracting from the video signal of the target signal,
- Conversion of target information in format, ETHERNET, NMEA, or other format compatible with network transmission.
Acquisition rate for DAS must be at least 1Gs / s (sampling per second).

The technical limitations in making a radar extractor are numerous, but they are related to the speed of calculation and the type of devices chosen. In recent years, there have been emerging acquisition systems on the market, we can not call them acquisition boards, whose speed and programming capabilities make it possible to build a radar extractor. These are the acquisition systems that include FPGAs that offer programming and simulation environments. One of these systems is delivered by National Instruments, namely the NI CompactRIO-Performance product with FPGA mode, Spartan included, and the LabVIEW programming environment with Real Time Compact RIO and FPGA modules. The programming environment allows the realization of the functional diagram, simulation and programming in VHDL of the FPGA. Each functional block contains the program lines in the VHDL. In the figure below is a block diagram of a radar extractor, simulated with the LabVIEW programming environment with Real Time Compact RIO and FPGA.

The simulation was conducted in the electrical engineering department and the results were published in a research report. The results confirm the hypothesis that the LabVIEW programming environment with Real Time Compact RIO and FPGA configuration can successfully perform an extraction radar.

A convincing example is the results obtained by the University of Krakow. They worked with the National Instrument’s, NI PXIe-5673 and NI PXIe-5663 hard drives and built a continuous-emission radar with programming in LabVIEW. In other words, they built the entire data acquisition
system with the same hard data set from Real Time Compact RIO and FPGA, which they added to the free slots NI PXIe-5673 and NI PXIe-5663, programmed with the LabVIEW programming.

![Signal generation](image1)

**Figure 3. Signal generation**

![Signal acquisition](image2)

**Figure 4. Signal acquisition**

![Radar demonstration](image3)

**Figure 5. Radar demonstration**

Using the same NI CompactRIO-Performance with the included Spartan FPGA and LabVIEW programming environment, and plugging into NI PXIe 5654 and NI PXIe 5667 free slots, a radio-electronic counter-system with a net performance superior to those onboard the naval ships can perform both radioelectronic research and radio-electronic jamming.

3. PLC and COMMON SENSORS

Common sensors require another type of approach and the difference in systems they work in is obvious. Reason for connecting these sensors to PLCs. It should be noted that the cost price and the
acquisition rate are much lower and the PLCs are imposed on the market with professional solutions. Some observations about what a PLC is?

![Figure 6. Block diagram of a PLC](image)

We should not be surprised that a data acquisition system is also called Programmable Automatic.

A Programmable or Abbreviated PLC is a device that performs logical operations according to a program, that is, according to a list of instructions or commands. These instructions are performed one by one in a specific order. Unlike conventionally configured control systems with electrical connections between system components but which can process multiple connections simultaneously, a Programming Automation can execute the serial instructions one after the other, that is, sequentially. This means that logical operations always require more instructions.

Today, however, Programmable Automata can do much more, such as analogue processing and arithmetic operations, as well as closed-loop control and network operations. In principle, Programmable Devices can be programmed according to requirements. The user creates a program using a programming platform, in a special programming language, through which the Programming Machine performs the appropriate control function for that process.

![Figure 7. Programmable automatic machines](image)
The above figure represents a way of interfacing PLCs for a measurement and control center. The models produced by Siemens, S7-300CPU, S7-200CPU or ABB models are used onboard ships in connection with the whole range of common sensors. Prices range from hundreds of euros to the order of thousands of euros. Programming is very simple. One such example is presented below. The first and second sections represent the definition of the inputs, so the input with the address 0.0, that is, the bank 0, the input 0 is the Boolean input and the S1 label is assigned, the other variables are declared the same. The second section declares the output variables as the bank 2 the input 0 is a Boolean variable with the H1 label. In the third section are defined inter-program variables. The following are execution sections for example Subnet 1, the intermediate variable F1 is assigned a Boolean value (S2 or S4 and S3). The ease of programming is noticeable.

```
(* Operatii complexe folosind variabile intermediare *)
VAR.S
(* Variabile de intrare *)
S1 AT %IX0.0 : BOOL;
S2 AT %IX0.1 : BOOL;
S3 AT %IX0.2 : BOOL;
S4 AT %IX0.3 : BOOL;
S5 AT %IX0.4 : BOOL;
(* Variabile de iesire *)
H1 AT %Q2.0 : BOOL;
(* Variabile intermediare *)
F1 : BOOL; (* Flag from 1st sub-net*)
F2 : BOOL; (* Variabila din sub-retau 2*)
F3 : BOOL; (* Variabila din sub-retau 3*)
END_VAR
```
4. Conclusion.

It can be said that these data acquisition systems together with PLC have begun to occupy a large percentage in automated naval systems as well as in naval power systems. That is why the paper wants to be an incentive for students and specialists to use these systems in complex applications.

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