# Under water Acoustic Transponder Launch Control Unit Simulator

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**Abstract** Underwater acoustic communication is a technique of sending and receiving message below water. Under water communication is difficult due to their propagation and improper selection of interfacing modules. A detail study of Under Water Acoustic Transponder (UWAT) launch control unit is discussed in this paper. In the present paper the underwater acoustic transponder parameters are simulated by interfacing with DAQ system and MIL-STD protocol. A simulator is developed to measure various parameters precisely such as pressure, presence in terms of weight, and firing arc of the barrel in the launcher. The simulator is designed as user friendly and flexible to operate with minimum training. The simulator provides the online status of the launcher. Apart from the data collection, data can also be stored for future analysis. The control and Data Acquisition of the launcher parameters must be flexible and capable for being configured for multi tasks with in short time.

## 1. Introduction

Under Water Acoustic Transponder Control Unit Simulator (UWAT) is a prototype designed for launching the underwater acoustic transponder. The UWAT launch control parameters like transponder Presence, Barrel Pressure and Firing Arc are obtained from a unit named Weapon Data Controller (WDC) in the form of voltage signal like 24Vdc. These control signals are being conditioned and provided to the Data Acquisition Card (DAQ) as Inter locks.

Using DAQ card, the status of various parameters will be acquired and necessary fire command will be generated after checking all the inter locks through DAQ in a suitable Graphical User Interface (GUI) which is developed by using visual basic software. GUI will enable operations like selection of mode of operation, barrels selection, salvo time setting etc. When a required selection is made, fire command will be generated and transmitted through the output ports of DAQ card to launch the UWAT with a feedback. Detail results of simulations are presented in simulation section.

Through GUI software, DAQ card's isolated digital input port data is read in scanning mode and after satisfying all the interlocks using a suitable GUI, fire command stops scanning mode and starts launching the UWAT of the selected barrels. A fire command followed by reset command is used to reinitiate the process with default settings. The voltage signals of each 24Vdc are signal conditioned and provided to the DAQ input ports. The DAQ output port signals are also amplified to a voltage level of 24Vdc.

The above unit can work as standalone and also work in remote mode in which it receives commands and data from the remote station on MIL-STD communication link.

In real time a soldier can move into hazardous unit. And it is highly required to a soldier to operate his war equipment like filling barrels. A standard cable is needed to make field equipment enable by interfacing with remote system. The cable plays vital role in receiving and transmitting data between remotely operated bus controller and locally connected remote terminal. In the present paper MIL-STD is selected to implement this connection. In the present work the MIL-STD connection is established to generate fire commands to launch acoustic transponder in deep sea.

MIL-STD is a standard bus that defines the electrical and protocol characteristics for a data bus. A data is used to provide a medium for the exchange of data and information between various systems [1].

Main Interfacing components in the present system are,

- MIL-STD
- A bus controller
- A remote Terminal

A. **MIL-STD Bus:** It is used to interface local processing unit and Remote processing unit.

**B. Bus controller (BC)**

- Bus controller initiates all message communications over the bus
- The bus controller is responsible for directing the flow of data on the data bus.
- Only one bus controller may be active at a time.
- The bus controller is the only one allowed to issue commands onto the data bus.
- The commands may be for the transfer of data or the control and management of the bus

**C. Remote terminal (RT)**

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- A remote terminal typically consists of a transceiver, an encoder/decoder, a protocol controller, a buffer or memory, and a subsystem interface.
- It is used to transfer data between the data bus and the subsystem
- It responds to the valid commands received from BC with in a very small, closely defined amount of time.
- If a message doesn't meet the validity requirements defined, then the remote terminal must invalidate the message and discard the data.

## 2. Existing Methods

In channel communication [2] antennas are used to establish communication between source and destination. Antennas are very good communication devices for long distances. But there is chance of unwanted frequency inferences which causes signal distortion. In this method influence of seasonal variations and variation of range between source and destination creates major problems in critical situations [2].

## 3. Hard ware Description

The Block Diagram show in figure 1 indicates various components used in Under water acoustic Transponder (UWAT) Launch Control Unit. UWAT Launcher parameters are the status of the Launcher which are given as input to the USB based discrete input output (DIO) card USB-4750 through a signal conditioning unit. The DIO card accepts discrete data as input and also produces discrete output is connected to PC/Local Processing Unit through USB port.

Launcher status parameters of each 24V dc from UWAT Launcher are provided to DIO card input ports by converting into a voltage level of -5Vdc using Signal Conditioning circuit. The output at DIO card is a voltage of 1V dc is signal conditioned to a voltage level of +24V dc which is fire command to launch UWAT.

The launcher used may contain one or more barrels with UWATs in it. The three different parameters of launcher are UWAT presence in the barrel, barrel pressure whether sufficient to launch and Firing Arc. The first two parameters are obtained individually from each barrel and Firing Arc is the common parameter for all barrels in the launcher. Thus a total of eleven parameters inform the status of UWATs to DAQ card and further it is processed by local processing unit.

A prototype of the launcher is developed to study and observe the parameters of the barrel. In the prototype the sensor parameters are artificially generated by operating relay circuits. These relay operations are controlled manually by switches as input parameters. These parameters are further signal conditioned to provide as inputs to DIO card are processed in the local processing unit.

The local processing unit generates the fire commands which are outputs through the DIO card to fire the UWATs in the barrels of the Launcher. The local processing unit can work as a standalone when interfaced to the remote processing unit using MIL-STD protocol. This remote processing unit controls the local processing unit to receive inputs and generate outputs of the DIO card.

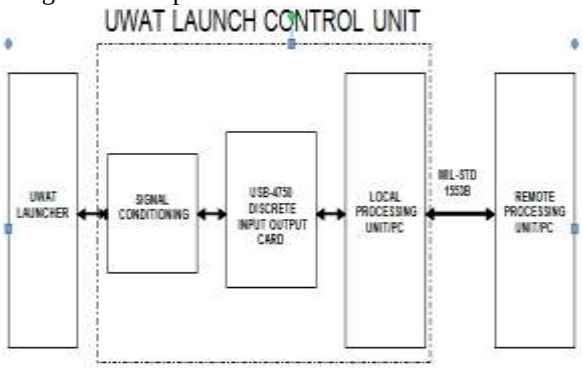


**Figure 1: Block Diagram of UWAT Launch Control Unit**

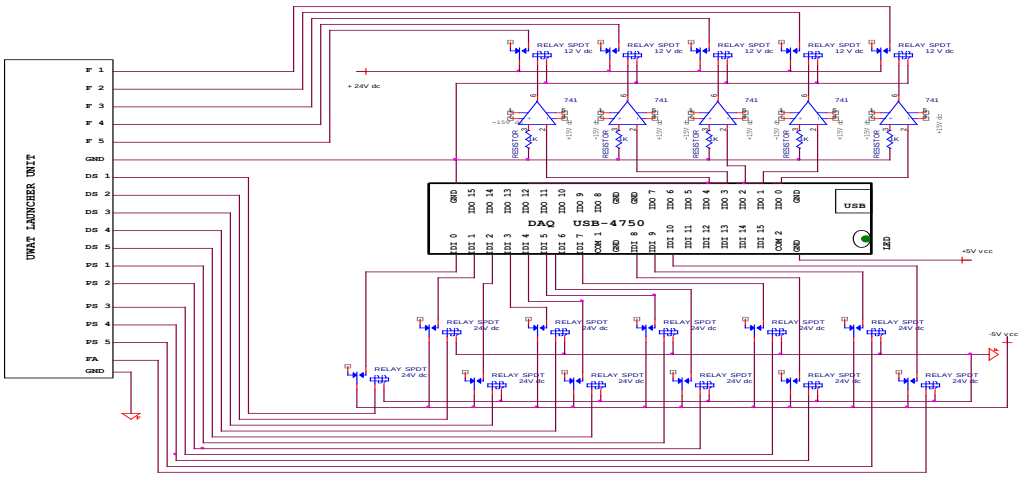

**Figure 2: Schematic diagram of signal conditioning circuit with UWAT Launcher Interfacing**

The signal conditioning circuit shown in figure2 converts 24Vdc into -5V dc using 24V dc SPDT relay, where -5V dc is connected to COM terminal. When relay is activated COM terminal changes from NO (normally open) to NC (normally connect).Thus -5V dc is provided to DIO card. A voltage output of 1V dc from DIO card is converted into 24V dc using 741Op-Amp and a relay. The voltage of 1 Vdc is input to an Operational amplifier 741 connected in open loop which produces a voltage suitable for a 12V dc relay to operate. A 12V dc SPDT relay activated by the output of 741 Op-Amp gives 24V dc output as its COM terminal connected to 24Vdc supply changes from NO to NC.

In the schematic diagram at UWAT Launcher Unit DS1 to DS5 are the inputs received from sensors located at barrel. In the present work the sensor environment is created by SPDT relays which are present in the launcher unit. The relays arranged in the bottom part of the diagram as shown in figure 2 will be tripped once it receives 24V signal from sensors. F1 to F5 are fire commands generated at UWAT launching unit to each barrel which is controlled by relay.

DAQ USB-4750 is a Discrete input and output card (DIO) used to take discrete data as input and provides discrete data as output. Once the relays are tripped due to sensing output, these signals will be given as discrete input to the USB of the local processor. Once the signals are arrived at discrete input then the signals will be displayed on GUI screen to make user understanding about the launcher status. The user can select t the barrels and can send fire commands as discrete output to USB-4750 card. These discrete outputs will activate the corresponding output relays and further send the commands to fire input of the launcher unit. Finally the after the fire command executed the launcher send feedback of the barrel status to USB-4750. This status is displayed in black colour in GUI for a particular barrel position as shown in figure 6.

## 4. Simulation Results

The Local processing unit or a computer contains a Graphical User Interface (GUI) designed for launching the UWAT. The Launcher parameters data, obtained from the input ports of DIO card are represented in GUI in the form of visible color changes. The fire commands are also represented in GUI as shown in below figures. Representation of these parameters in the form of visible colours, makes user easy to understand the launcher status. The parameter conditions are represented simultaneously in color changes as shown in figure 3.

- When No UWAT is present in the barrel, it shows a BLACK COLOR.
- When UWAT is present the barrel, it shows a RED COLOR.
- When a barrel contains the pressure sufficient for UWAT to fire, it shows YELLOW COLOR.
- When Firing Arc of the launcher is OK, it shows GREEN COLOR.

Thus if all the conditions are satisfied simultaneously from the above then UWATs in their respective barrels are ready to fire. Some of the screen shots of the simulations results are presented here. Figure 4 is showing single or Salvo mode selections. Figure 5 is showing that single barrel is selected and it is ready to fire and hence it is shown in blue colour.

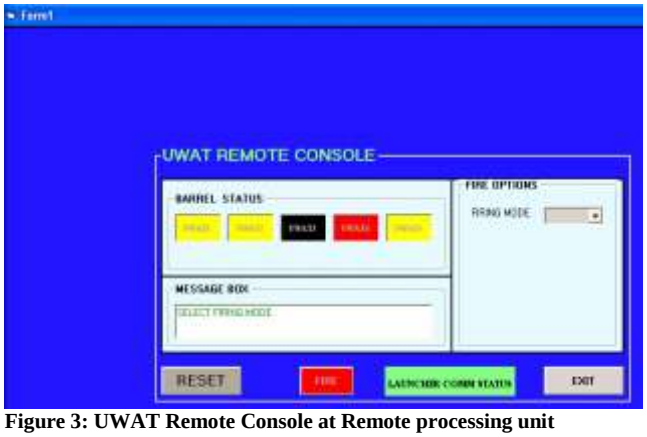


**Figure 3: UWAT Remote Console at Remote processing unit**

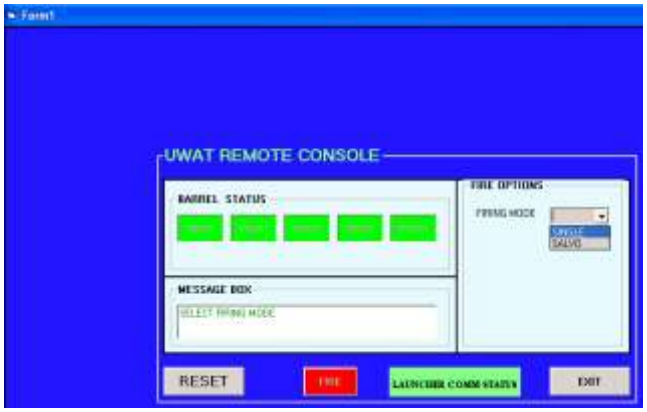


**Figure 4: UWAT remote Console showing selecting firing mode**

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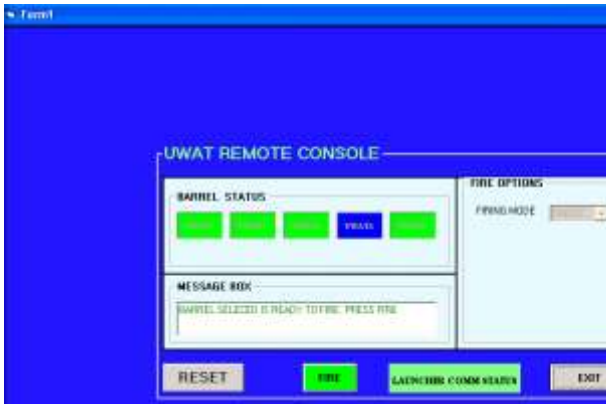


**Figure 5: UWAT Remote Console ready for single UWATfire**

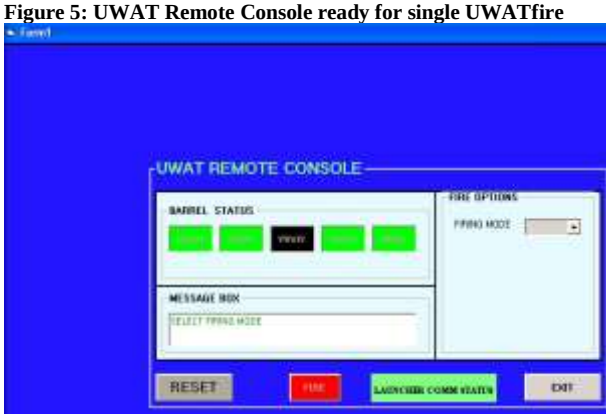


**Figure 6: UWAT Remote Console indicates 3 barrel is fired**

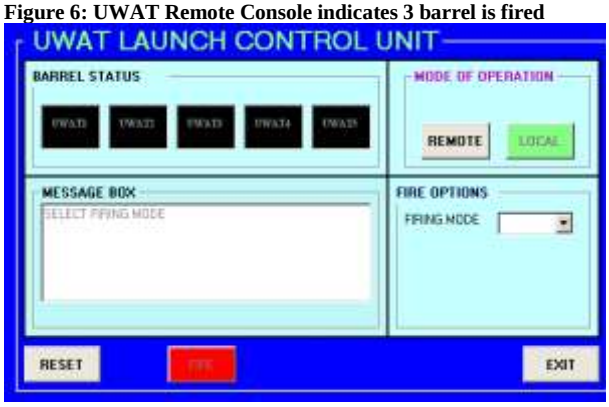


**Figure 7: Image representing in local processing unit when all UWATs fired**

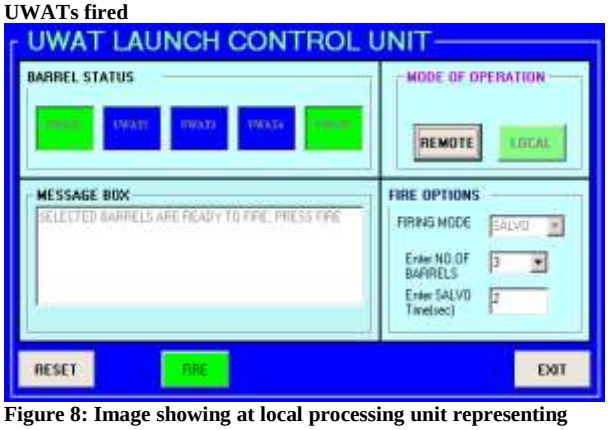


**Figure 8: Image showing at local processing unit representing with 3 barrels selected to fire**

## 5. Conclusion

In the present paper an Under Water Acoustic Transponder (UWAT) launch control unit parameters are simulated using visual basic. The underwater acoustic transponder parameters are simulated by interfacing with DAQ system and MIL-STD protocol. A user friendly GUI application is developed through which simultaneous and individual firing can be achieved by simple software button pressing. The barrel and various physical parameters can be easily identified with small different colour marks on the screen.

## References

[1] A User Manual, "MIL-STD Tutorial" http://www.barrcentral.com/manuals/RS232%20Manual.pdf.

[2] A. Essebbar et al., "Under water acoustic Simulations for communications", IEEE, 1994, pp495-500, doi: 0-7803-2056-5.

[3] S. Ramji et al., Design and testing of Control and positioning system for Underwater Mining Machine, National Institute of Ocean technology, o-933957-35-1, 2007, MTS