AstroNova®

# Portable Waveform Generator

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## PROJECT MOTIVATION:

AstroNova is committed to supplying their clients with the most innovative test and measurement equipment. To demonstrate the capability of such equipment, a handheld Waveform Generator was created; however recently the design has become obsolete due to rapid growth in the capabilities. Since there is no similar device on the market, AstroNova commissioned a Portable Waveform Generator to be designed. This waveform generator will be able to demonstrate the full capability of the data acquisition systems. In addition, this product will be of interest to future stakeholders due to its uniqueness. The design process was chosen to ease the transition from an in-house product, to a product sold on the market.

## ANTICIPATED BEST OUTCOME:

Team AstroNova will develop a new portable waveform generator that can be used as a direct replacement for the older model. The last waveform generator was updated eleven years ago. Our new and improved WaveGen will feature a sleek updated design along with an easy to operate user interface. We plan to have a PC application that will allow the user to program arbitrary waveforms into onboard memory to be recalled later. In addition, the PC application will provide more control over the WaveGen. The updates and improvements to the product will offer new capabilities that will make it even more useful than the last.

## IMPLICATIONS FOR COMPANY AND INDUSTRY:

The portable waveform generator will allow AstroNova to showcase their test and measurement equipment at trade shows in a way that was not previously envisioned. The key feature of the product is the ability to generate, store and output custom waveforms. This feature allows AstroNova associates to tailor the waveform output to suit the intended audience, maximizing relevancy and boosting sales potential. It is this versatility, as well as a low unit price that set the waveform generator apart as a possible innovative market product after some refinement. Furthermore, WaveGen will serve as a powerful hardware troubleshooting instrument for field technicians and engineering personnel alike due to its frequency range and resolution.

## PROJECT OUTCOME:

The Anticipated Best Outcome was achieved: A replacement Portable Waveform Generator with an updated design and a PC Application.

### KEY ACCOMPLISHMENTS:

**Hardware:** The major components of the WG800 were to provide the functional specifications previously outlined. These components consist of a display, an output connector, DACs, Op-Amps, a FPGA, a Serial Peripheral Interface (SPI) flash memory, push buttons, a power switch, a USB port, a power connector, a JTAG connector, a battery pack, a voltage reference, DC-DC converters, and LDO regulators. After the components were chosen, a schematic was generated. This schematic was reviewed by the team and was sent to a PCB fabrication house where revision A of the board was fabricated. All functionality of the PCB was tested and verified.

**Internal Design and Implementation:** The hardware to support pulse and arbitrary wave generation was added and modified for minimal size. The previous methodology put heavy emphasis on the use of large Xilinx IPs for both sinusoid and arbitrary waveforms. This was discovered to be an inefficient usage of device resources, so custom designs were written to generate user-specified waveforms. A channel-centric approach to the design was adopted to increase the speed of the design. On-chip memory was a concern, as we were unsure that all the predefined waveforms would fit on the limited space that we had. The bigger memory issue was the size of the Microblaze (MB), which grows proportionally to the complexity of the C code programmed onto it. This was necessary, but limits the set of usable header files for the code.

**Embedded Software:** Software development was completed for the MicroBlaze using C. The user interface consists of a startup screen, main menu, bank menu, options menu, host control, and low battery warning. The user can navigate through the menus and control the device. The software also includes the interpretation of host commands and queries from a PC. These commands include fine frequency adjustment, fine amplitude adjustment, bank control, waveform ID adjustment, phase control, voltage offset control, high voltage control, low voltage control and status requests. The MB software also creates triangle and sawtooth waveforms. The algorithms contain parameters to adjust the amplitude and voltage offset. Lastly, the MB uses the onboard memory that is used to configure the FPGA to store data. The MB software is a success.

**PC Application:** This application is based on a Windows Form Application, and is being completed using Microsoft Visual Studios using visual C#. The PC application is responsible for fine tuning of parameters. The front includes a master frequency and amplitude input. Beneath these inputs, each channel and current wave is listed. The “Restore Defaults” button will return all banks to default settings as specified in the documentation. The ‘Parameters’ button will only activate if Bank D is selected. This function opens up a table of all 8 channels with their parameters. This provides an easy way for the user to check and confirm all values. In order to connect, the user must specify the communication port. The PC App is near completion, with room for future development.

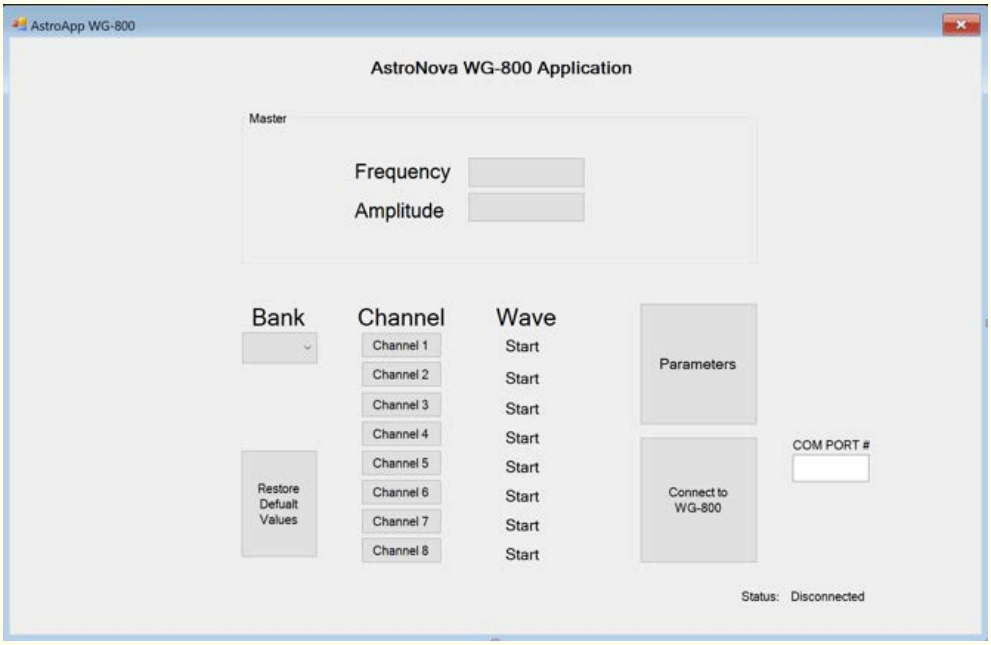


**Fig.1:** PC Application: Final User Interface

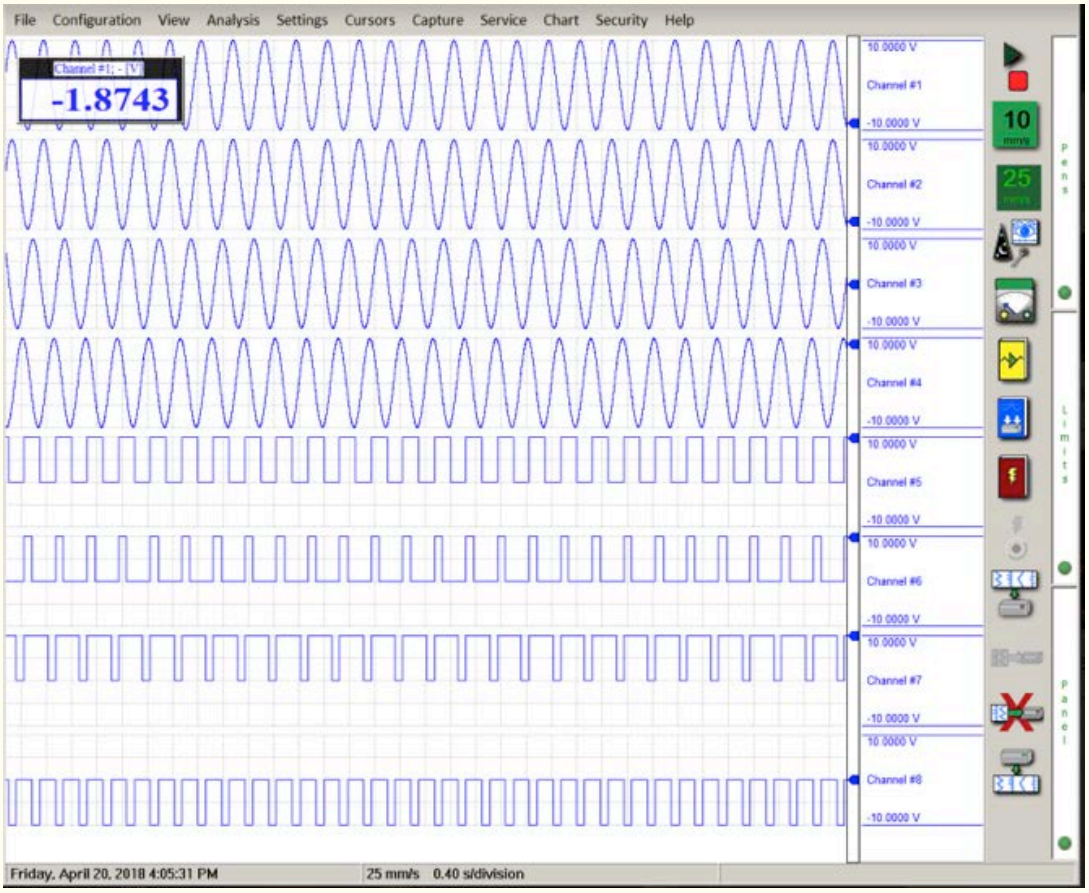


**Fig. 2:** Functional Output of the WG-800 (Sine and Square waveforms)

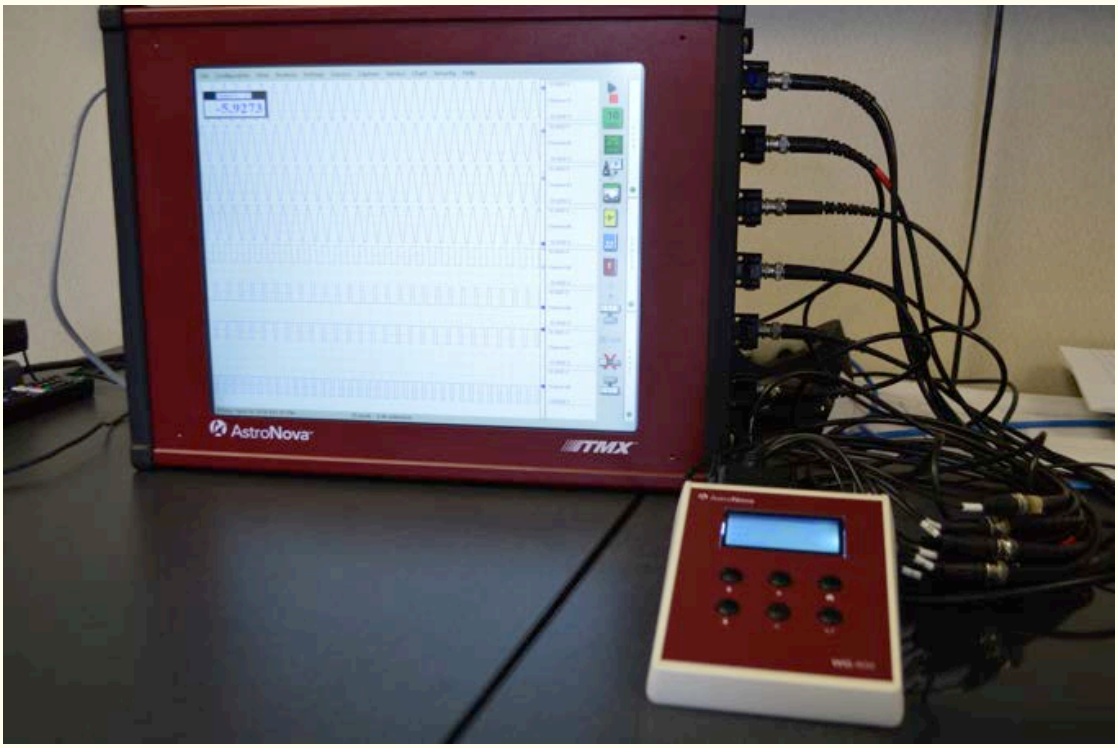


**Fig.3:** Practical application of  WG-800 with capabilities of AstroNova's TMX

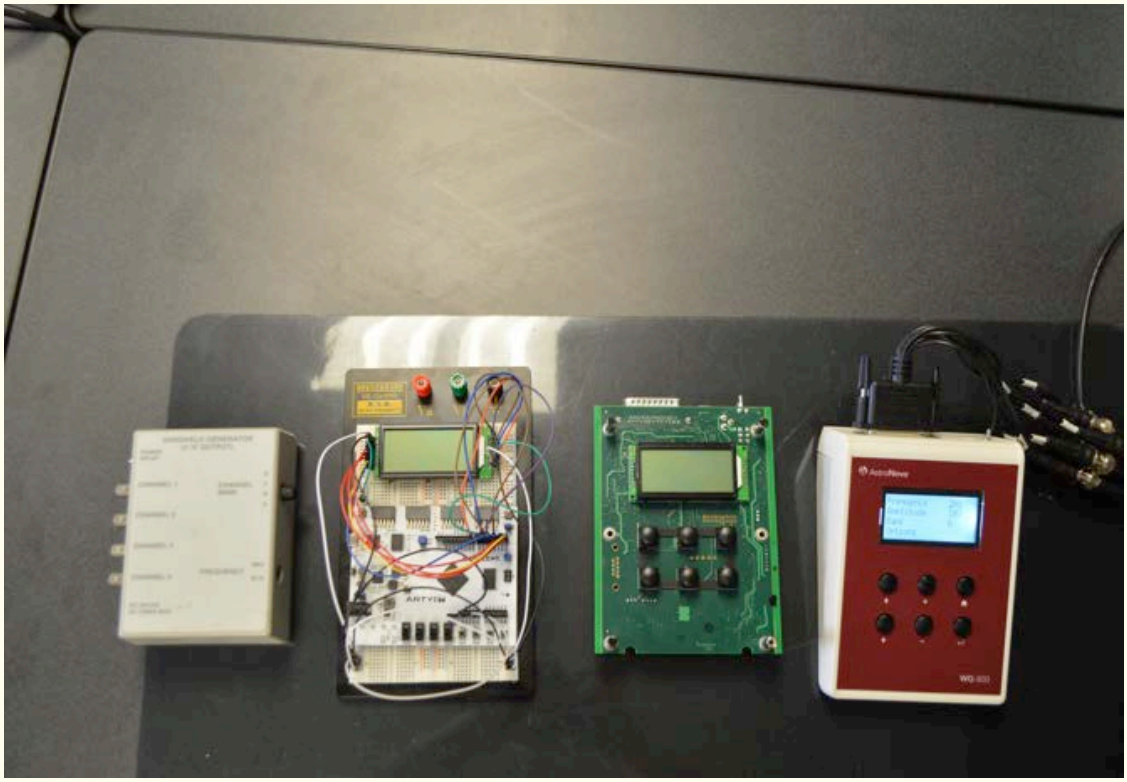

**Fig.4:** The progression of the Portable Waveform Generator