ATC Lite

Student Team:
Benjamin Brown, Ian McDowell, Donald Petersen,
Taylor Rieger, Dominic Smith, Karmyn VonEhr
Sponsor: Array of Engineers - **Sponsor Advisor:** Brendan Grimes
Faculty Advisors: Dr. Blake Ashby, Dr. Karl Brakora, Dr. Brian Krug, Professor Scott Zuidema

Background

Array of Engineers (AoE), a company based in Grand Rapids, MI, previously developed an Automated Test Controller (ATC). This Automated Test Controller is a 1U 19-inch standard enclosure rack unit that is designed for desktop testing applications for industries such as medical and defense. While the ATC is a viable product, customers have found the need for a portable version with similar functionality. This would allow them to take the product into the field in order to test the needed equipment.

ATC Enclosure

ATC PCB

The new “ATC Lite” will allow Array of Engineer’s customers to easily test in the field without having to bring the equipment into the office. The addition of a modern graphical user interface (GUI) will allow users to easily verify incoming and outgoing data.

Purpose

The ATC Lite is a variant of AoE’s current product, the ATC. The ATC is a custom data acquisition circuit board, which contains a multitude of analog and digital interfaces, for use in electronic hardware testing automation. The ATC Lite is a scaled version in a new form factor that is more compatible for field use. The ATC Lite includes select digital interfaces that will satisfy the customers needs. These digital interfaces will communicate over multiple protocols including Local Interconnect Network (LIN), Controller Area Network (CAN), Serial Peripheral Interface (SPI), Inter-Integrated Communication (I2C), Recommended Standard 232 (RS-232), and MIL-STD-1553. These communications will be interpretable through a Graphical User Interface (GUI), allowing the user to easily see and test the communications between the ATC Lite and their device. Furthermore, the enclosure has been redesigned to be shock resistant as specified by military standards.

Key Specifications

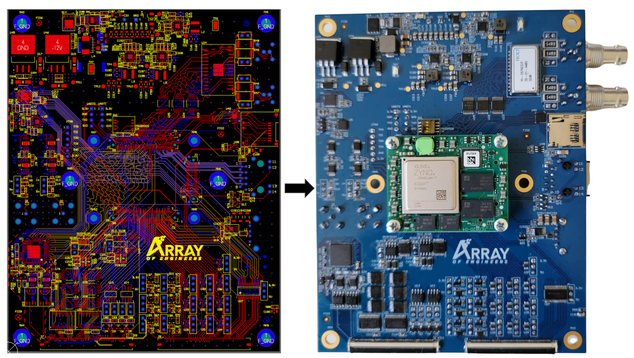
The new version has reduced ADC channels, removed Low Voltage Differential Signaling, removed high speed GTR transceivers, increased GPIO, doubled RS232 communications, added LIN communications and an updated DAC.

•Develop a new variant of the Automated Test Controller (ATC).
•The new design must be scaled down in size and be more compatible for field use.
•Features include:
- 10x Individual GPIOs
- 2x 6-Bit GPIO Banks
- 6x Open-Collector GPOs
- 8x RS-232 Channels
- 2x CAN Channels
- 1x Gigabit Ethernet Channel
- 1x USB Channel
- 1x ADC with 2x Inputs for Differential Measurement
- 2x MIL-STD-1553 Channels
- 2x LIN Channels

•Supported protocols include I2C, SPI, and TTL Serial.
•GUI must be developed for user interface.

PCB

The ATC Lite PCB is functionally an extensive breakout board for the Zynq Ultrascale+ System on Module (SoM). The SoM sits on top of the ATC Lite and contains the Field Programmable Gate Array (FPGA) and processors that run the board. The board is powered by a 12V, 2A power adapter. The input is then regulated to -12V, +/- 5V, 3.3V, and 1.8V rails for the various ICs. The SoM connectors are then routed to each of the listed features in the key specifications. All connectors on the board are connected to the enclosure connectors with internal cables. The schematic and board design was done in Altium Designer.



Enclosure

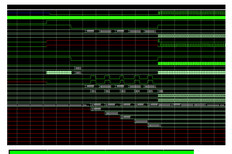
The enclosure is an off-the-shelf product to reduce in-house manufacturing costs of the ATC Lite. The IP-67 rating of the enclosure ensures a dustproof and waterproof system.

All machined holes on the enclosure were sealed with gaskets to maintain its IP rating. Built in heatsink on the aluminum extrusion helps to dissipate generated heat.

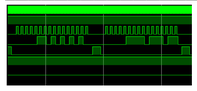
Firmware

Firmware is the hardware description layout for the FPGA module that controls and synchronizes everything on the board. Since the board has new components, these descriptions had to be rewritten from the ground up. The GPIO module was created to allow for a wide range of possible input patterns. This was called the arbitrary function generator.

GPIO: Arbitrary Generator Simulation

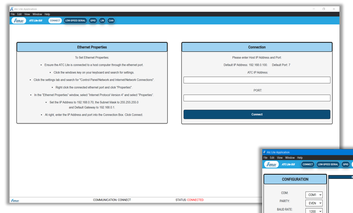


DAC: SPI Simulation



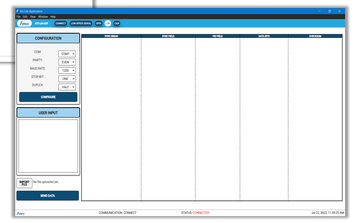
The GPIO module was configured so that different PWM parameters can be selected. The DAC module was created to interface with the new DAC component, with firmware that provides support for SPI, and parallel communication.

GUI



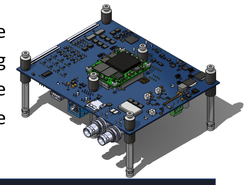
The GUI was developed for simple user interface with the ATC Lite. It is used to configure varying protocols and observe data streams.

The GUI can also be used to configure the GPIO functionality and observe register statuses.

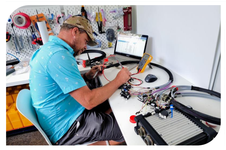


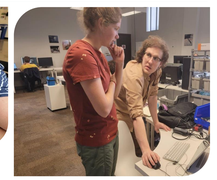
Mounting

Deflections on the PCB board can take place due to shock from the controller being dropped or vibrations. To reduce these affects a dynamic method of mounting the PCB was designed using dampers.

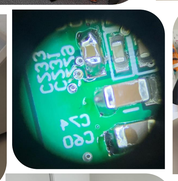


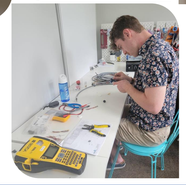
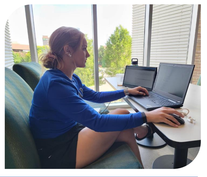
Prototype & Build







Oversights Identified

- The orientation of circular connectors was critical for the breakout board design but was not initially considered.
- Underestimated effort for firmware development and testing.

Future Work

- Finalize LIN communication IP core.
- Find alternate high speed operational amplifiers for DAC and ADC.
- Improve internal cable management.
- Thorough thermal testing of board and enclosure.
- Removal of the additional heatsink from the overall design.