**Data Acquisition Device Design Direction Study**

**Decision**

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| **Chosen Option** |  |
| **Rationale** |  |
| **Date** |  |
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**Background**

The test site’s data acquisition (DAQ) system currently uses a LabJack T7 as the main DAQ device. The T7 controls components such as valves, heating blankets, and pumps using relays, and acquires data from current-output and voltage-output sensors. However, relay coils and sensor outputs are not directly connected to the T7; instead, custom printed circuit boards (PCBs) for relays and sensor output signal conditioning are used. The relay board has low-side relay drivers that are controlled by digital input/output (IO) pins on the T7. The sensor board has instrumentation amplifiers and current-sense amplifiers to convert differential voltage-output and current-output sensor signals to single-ended analog voltages that are sampled by the T7.

For the DAQ device being designed by the McGill Rocket Team (MRT), we can design a replacement device for the T7 (with extra features), which is general-purpose and does not have application-specific circuitry, or we can design a device which unites the T7, relay board, and sensor boards’ capabilities into a single board. This study compares the two options.

**Comparison**

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|  | **Option 1: T7 Replacement with Extra Features** | **Option 2: Single Unified Board** |
| **Block Diagram** | Diagram  Description automatically generated | Diagram  Description automatically generated |
| **Description** | Device replaces the T7. Relay board and sensor board are still required, though more features can be added to the DAQ device to reduce the complexity of the relay and sensor boards. | Device replaces most of the current test site DAQ system. No need for relay board and sensor board.  Note: the “relays” on the unified board may mean only the relay drivers, with external relays driven by the unified board. |
| **Pros** | * Lower design complexity, simpler hardware * More general-purpose, so may be used in more applications * Changes to relay circuit and sensor signal conditioning circuits do not require re-ordering the T7 replacement board * External circuits interfacing with the device are more flexible * Easier to debug and test than the single unified board | * Single hardware solution which satisfies most of the test site DAQ system requirements * Reduced likelihood of wiring problems, as a lot of the wiring between sensor board, relay board, and T7 replacement is a part of the PCB   + Note: wiring problems have been a major problem at the test site * Easier to disassemble and reassemble for transport between the test site and competition * Application-specific: we can anticipate DAQ system requirements for the short term and control component selection so that new features work with the device |
| **Cons** | * Will likely require custom external add-on boards for signal conditioning / relay control in different applications | * Less flexible than option 1 because changes to one part of the board would require re-ordering the entire board * Application-specific: we can anticipate DAQ system requirements for the short term, but long-term anticipations may be wrong and require changes to the device design |
| **Cost**  **(Excluding shipping and PCB components)** | * PCBA cost lower than option 2 * Estimate of total system cost   + PCB\*: $50.44   + Sensor board: $5.18   + Relay board: $10.84   + Power board: $5.18   + **Total: $71.64** * Note: shipping will be more expensive * Other expenses:   + More wiring   + More connectors (can be expensive!) between boards   \*: T7 board dimensions are 6 in x 2.6 in. Cost calculated assuming device PCB is 6 in x 2.6 in, 4-layer board from JLCPCB. | * PCBA cost higher than option 1 * Estimate of total system cost   + PCB\*: $57.29   + Power board: $5.18   + **Total: $62.47** * Note: shipping will be less expensive * Other expenses:   + Less wiring   + Fewer connectors   \*: T7 board dimensions are 6 in x 2.6 in. Cost calculated assuming device PCB is 6 in x 5.2 in, 4-layer board from JLCPCB. |
| **Power Consumption / Efficiency** |  |  |
| **Noise** | * More wires, so expect more noise to couple into system | * Fewer wires. Noise will likely be primarily on the board, which can be mitigated by careful layout |
| **“Performance”** | Expected to be similar to option 2 | Expected to be similar to option 1 |
| **Additional Considerations** | * This device will not be mass-produced on the MRT. Cost difference is not a critical factor unless there is a significant difference. * Wiring has been one of the biggest problems at the test site. Reducing wiring complexity is a big goal. More wiring means more opportunities for mistakes, more points of failure. * Assembly and disassembly are important, as MRT would like to use the same system at the test site for competition purposes, where there are stronger time constraints and mental pressure. | |