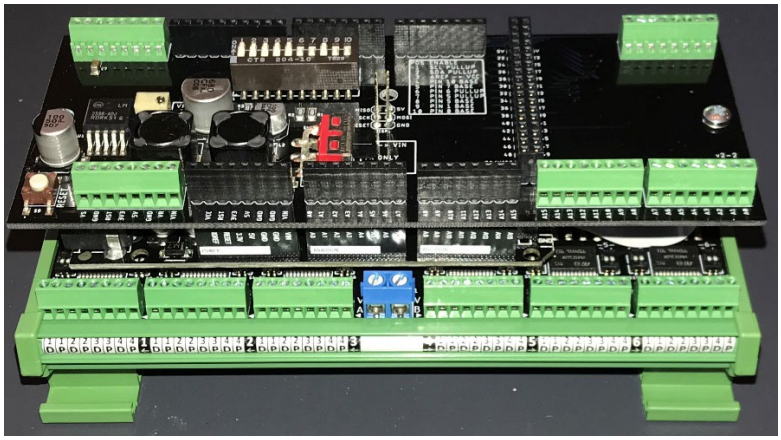
BRUCONTROL

Process Automation Made Personal

Model UM-1
MEGA UniShield
(Base board v2-1 & Riser board v2-2. Updated April 3, 2021)



Description

This is a shield for MEGA format interfaces such as the Arduino MEGA, Arduino Due, Adafruit Grand Central, or other MEGA format compatible interface microcontrollers. It is a stacked design, containing a “Base” board for I/O and a “Riser” board for the interface. These are connected by ribbon cable, allowing for “native” communication or auxiliary shields to be used on top. The Riser board contains a 3-amp DC:DC power supply (DDPS) to reduce the need for multiple power supplies on the control panel. The DDPS can be powered with 12 or 24 VDC and its output is adjustable from 3 to 12 VDC. Its output can be switched to either supply the interface via its VIN pin (for example 7 - 9 VDC), supply the 5V pin directly (thereby bypassing the interface's 5 V regulator to prevent overheating it), or to supply an on-board terminal, creating a discrete DC converter which can be used for other devices such as flow-meters, RTD-amplifiers, etc.

The Base board contains 48 high-current outputs which are split into four banks, enabling each bank to be powered by different sources (e.g. 5, 12, 24 VDC). The current outputs limits are: 2.5 amps per output, 5 amps per driver (4 outputs each), 12 amps per bank (4 banks). This will eliminate the need for electro-mechanical relays to switch low-current DC. Therefore, contactors, valves, relays, DC pumps can be powered directly. This should reduce panel space and simplify wiring, reducing panel size and overall cost. PWM functions at up to 1000 Hz, enabling a DC pump or other PWM capable component to be driven without any additional

hardware. The output drivers are fault tolerant - for example: will not be damaged by an accidental short-circuit.

⚠ Note: While the output drivers include a degree of fault tolerance, the interface micro-controller does not. Therefore, special attention must be paid to keep all connections to the interface within limits.

Each I/O terminal set includes a high-current driver output and a "direct" pin, allowing for devices to be connected directly to the interface pin. Fly-back diodes are included on driver outputs to damp inductive loads such as solenoids and relays to reduce potential electrical noise. Output drivers are enabled by default, but switches are included for each to disable them.

The UniShield includes on-board pull-up resistors for I2C and 1-wire, so external devices such as 1-wire temperature sensors can be easily wired. It also contains terminals for power, analog inputs, SPI, I2C, AREF, grounds, and includes an extra reset button. The unit is mounted in a DIN carrier (a metal enclosure is pending for protection and EMI shielding).

The UniShield comes assembled in a DIN rail carrier with either an Arduino MEGA-2560 compatible interface or an Adafruit Grand Central M4. A basic version without interface is available. Ethernet or Wi-Fi shields are also available options. The assembly is 92 x 87 x 58 mm (L x W x H).

Specifications

Digital Input/Output (I/O) terminals: 48
High Current Driver Outputs: 48
Terminals per Digital I/O: 2 (Direct Pin, Driver Output)
Analog Input Terminals: 16
Driver Output Banks: 4 (VA: lower left side of shield, VB: lower right side of shield, VC: upper left side of shield, VD: upper right side of shield)
Driver Output Voltage Range: 5 – 24 VDC
Driver Output current maximums:

- 3 A per individual output
- 5 A per driver terminal group (4 outputs per driver)
- 12 A per bank (VA – VD)

VA – VD Power Terminals wire size: 14 – 22 AWG
I/O Terminals wire size: 20 – 30 AWG
DC:DC Power Supply: Input: 9 – 24 VDC, output: 3 – 12 VDC @ 3 amp
Additional terminals: Ground x 11, VS, RST, 3v3, 5V, VR, VIN, VCC, AREF, I2C x 2, SPI x 3
Assembly dimensions: 152 x 87 x 65 mm (6 x 3 $^{7}/_{16}$ x 2 $^{9}/_{16}$ inches)

Models

The following MEGA UniShield models are available:

MODEL	INTERFACE	COMMUNICATIONS SHIELD
UM-1-M	MEGA 2560 compatible	None
UM-1-G	AdaFruit Grand Central	None
UM-1-MW	MEGA 2560 compatible	Wi-Fi (WINC1500) w/antenna and antenna cable
UM-1-GW	AdaFruit Grand Central	Wi-Fi (WINC1500) w/antenna and antenna cable
UM-1-ME	MEGA 2560 compatible	Ethernet (W5500)
UM-1-GE	AdaFruit Grand Central	Ethernet (W5500)

Product Notes

The MEGA UniShield will accommodate any Arduino MEGA footprint compatible microcontroller board, however the system builder should select one which meets the design criteria and for BruControl applications where applicable firmware exists. As of this Product Note's writing, those models include the Arduino MEGA 2560 and compatible variants, the Arduino Due, and the Adafruit Grand Central M4. Interfaces may be changed simply by plugging/unplugging the desired microcontroller boards to the underside of the Riser board.

Standard Arduino compatible shields may be stacked on top of the Riser board, such as Wi-Fi or Ethernet shields. UniShields which use interfaces with radios (Wi-Fi and/or Bluetooth, either integrated or via shield) with onboard antennas should be mounted in plastic enclosures to ensure adequate signal strength and communication externally. If mounting in a metal enclosure, models with external antennas should be used (all pre-assembled UniShield models with Wi-Fi offered by BruControl above include external antennas).

⚠ Note: For UniShields with Wi-FI shields and external antennas, never power the UniShield or connect its Interface Microcontroller to USB without first connecting the external antenna cable and antenna to the shields uFL connector.

Base Board

The MEGA UniShield Base board contains four banks of I/O terminals. Each bank is powered by one power terminal: VA, VB, VC, or VD. VA and VB are tied to the 2-position blue screw terminal at the bottom center of the board. VC and VD are tied to the 2-position blue screw terminal at the bottom center of the board. Banks are arranged as follows, with position determined when the printed text is oriented upright (readable) on the Base board:

BANK / POWER TERMINAL	TERMINAL NUMBERS (oriented by printed text)
VA	1, 2, 3 (lower left)
VB	4, 5, 6 (lower right)
VC	7, 8, 9 (upper left)
VD	10, 11, 12 (upper right)

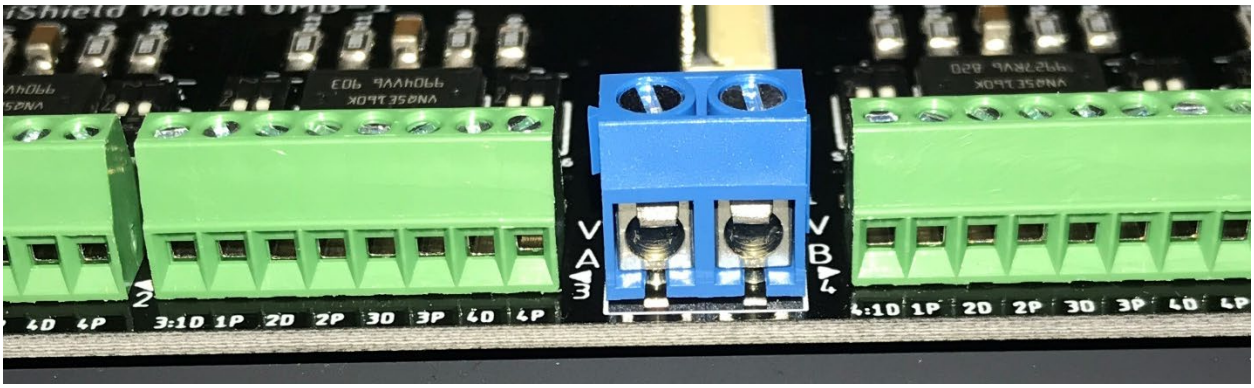


Figure 1: Power Terminals VA and VB

Each set of I/O terminals contains 8 pins. Those are divided into 4 pairs, with each pair are types: “direct pin” (P) and “driver output” (D). These are labeled in terminal:direct|driver format. For example: 2:3D, which indicates the driver output third I/O on the second terminal. When looking into the I/O terminals, they are always in order Driver|Pin when looking from left to right.

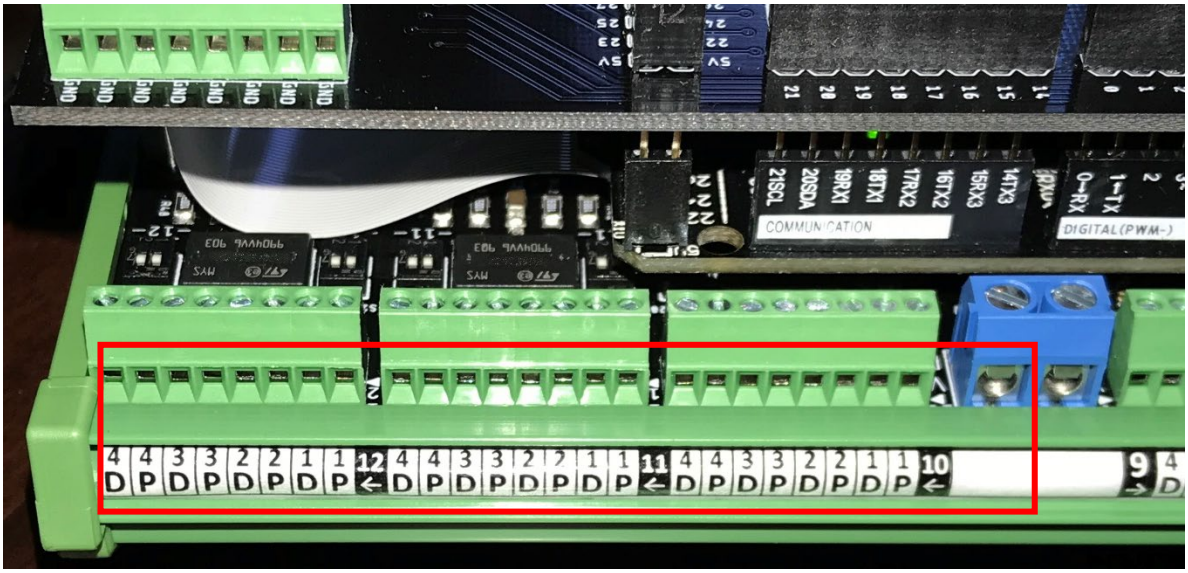


Figure 2: I/O Terminals 10, 11, 12 powered by Bank VD

P pins connect directly to the associated interface pin. These can be used for low-current outputs, inputs, 1-wire sensors, etc. just as if the wiring were being directly connected to the interface microcontroller at its pin/port location. When used as an output, the current limitations for that particular interface pin must be followed (e.g. 10 mA).

⚠ Under no circumstance may a P pin receive any voltage that is higher than the interface's Vcc (operating voltage). This is 5VDC for Arduino MEGA's and 3.3VDC for Adafruit Grand Central. <u>If this limit is exceeded, irreparable damage will occur to both the interface and the base board's drivers</u>.

The D pins are driven by the high-current driver chips on the board. These are automotive grade and contain protection circuitry to handle overtemperature, overcurrent, and other fault situations. The D pins will output the matching voltage associated with its VA, VB, VC, or VD bank power input when ON, therefore only Active-High configurations can be implemented (do not use Active Low settings in BruControl Device Elements).

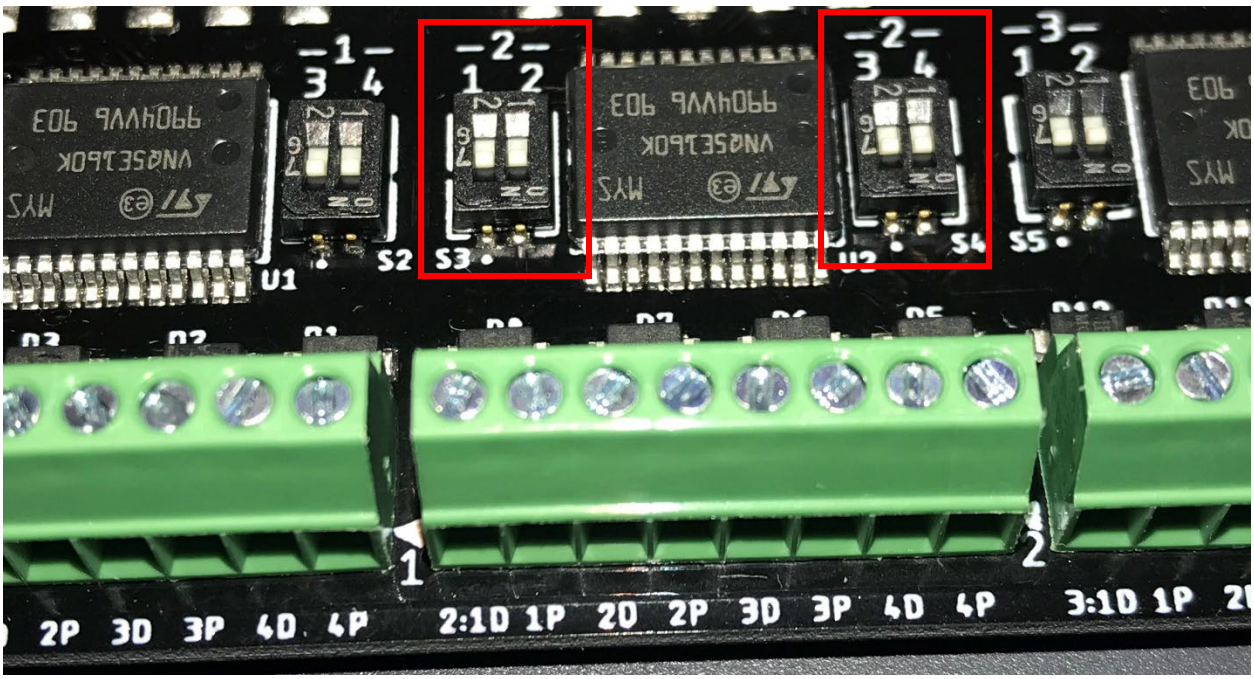


Figure 3: Terminal 2 with Driver Connect Switches for 1, 2, 3, and 4 terminals

On either side of the driver chips are pairs of miniature slide switches. These switches connect the respective P pin to the driver chip input, thereby switching the driver output (D pin) in accordance with the P pin. These are defaulted in the ON position, but the user may opt to switch them OFF in cases where the driver output will not be used or where complete removal of the driver from the circuit is desired. The P pins are connected to the driver input, which is also connected to ground via a 100k ohm resistor, so this should not normally be needed, but the option exists should the P I/O pin not work as expected. Turning these switches OFF only

disable the driver output terminal (D pin) – they have no effect on the P pin. The switch location is aligned with the I/O terminal block it affects and are labeled. The switch is in the ON position when the switch is pointed toward the I/O terminals, also labeled ON on the switch body. These switches are delicate and should be gently switched with an appropriate flat blade screwdriver. All switches are shipped ON as their default state.

Figure 4 below depicts how the interface, slide switch, drivers, P and D pins are interconnected.

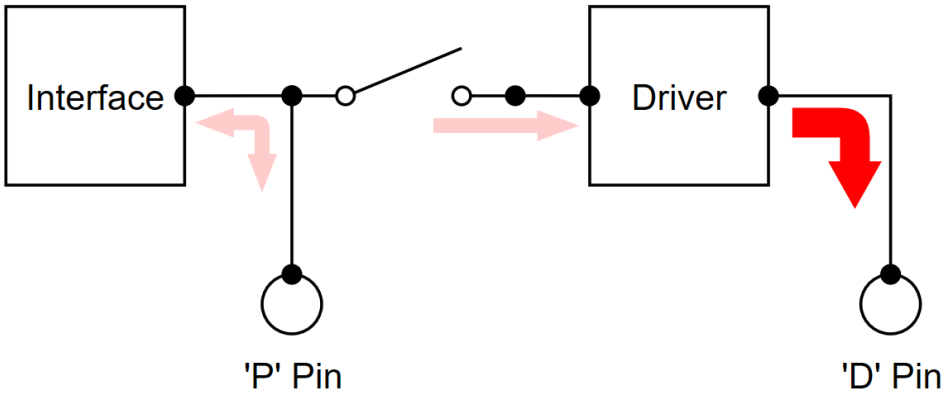


Figure 4: P and D pin connections

⚠ Because both P and D pins are connected to the same microcontroller pin/port, they must never be tied together or used concurrently. This can create an overcurrent situation which will cause irreparable damage the both the UniShield's interface and base board drivers. Wire to either the D pin (for high current outputs from the UniShield) OR the P pin (for low voltage inputs to the UniShield) – but not both! As noted above, never apply any voltage higher than the interface's Vcc to the P pins (e.g. 5V for the Arduino MEGA).

Riser Board

The MEGA UniShield Riser board contains terminals for system integration, a Reset button, a DC:DC Power Supply, a Power Supply Switch and adjustment for power configuration, and a configuration switch set. It also contains Arduino MEGA format headers and pins to mount a compatible interface microcontroller underneath and native format shields on top.

On the lower right of the Riser board are 16 Analog Input terminals.

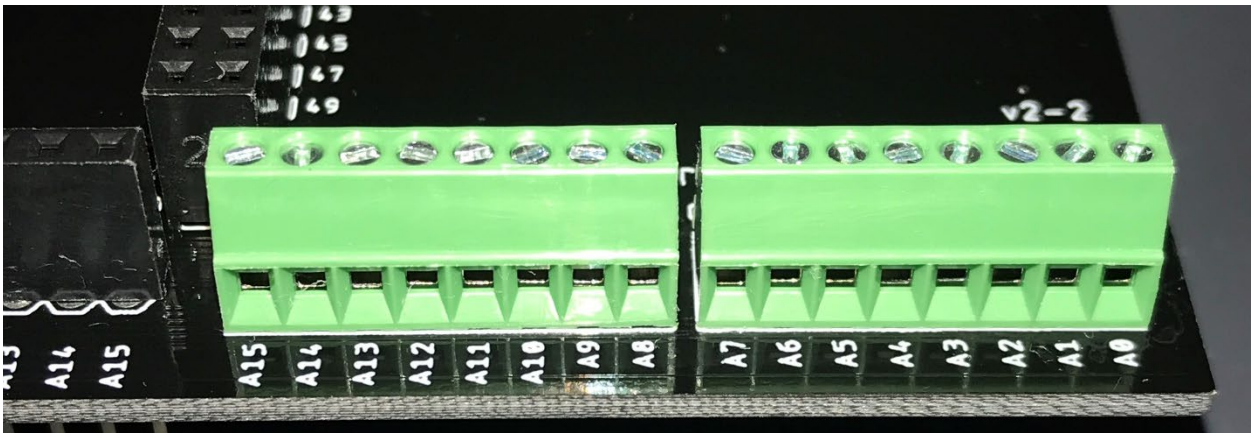


Figure 5: Analog Input Terminals, A0 – A15

On the lower left of the Riser board are the Reset Button and the Power Supply Terminal. The Reset button resets the interface microcontroller. It is provided since the installed interface's button cannot easily be reached.

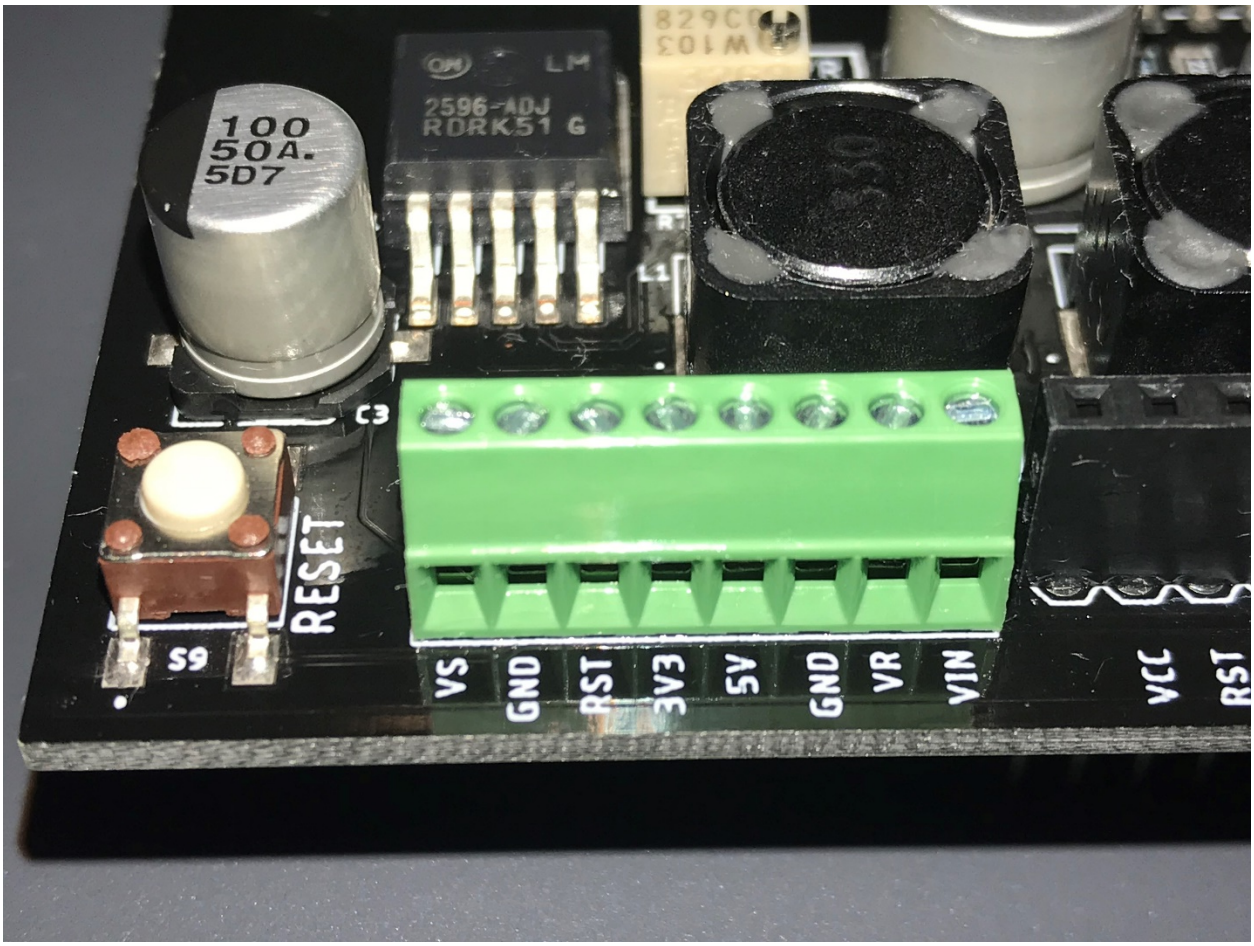


Figure 6: Riser Board Reset Button and Power Supply Terminal

On the middle left of the Riser board is the voltage adjustment potentiometer for the on-board DC:DC Power Supply.

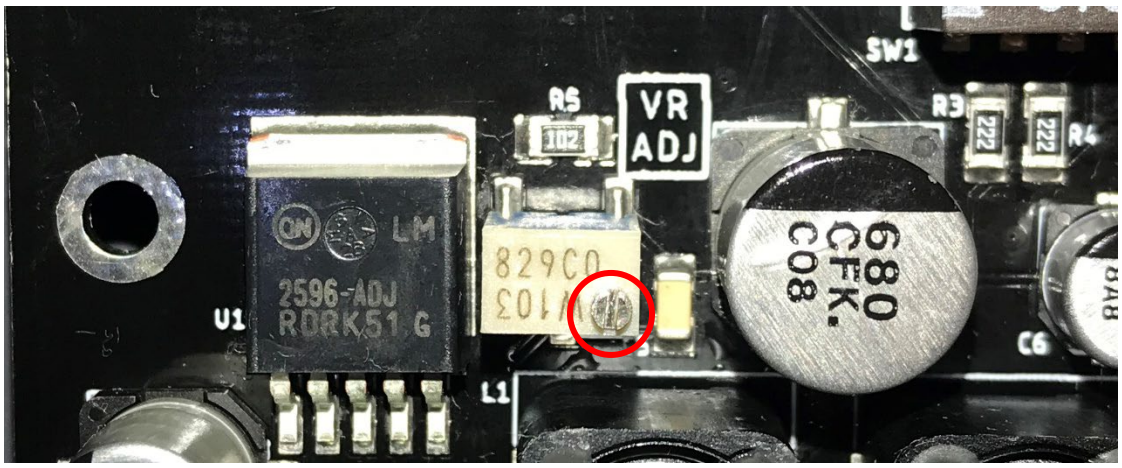


Figure 7: Riser Board DC:DC Power Supply Voltage Adjustment

On the middle of the Riser board is the DC:DC Power Supply power switch.

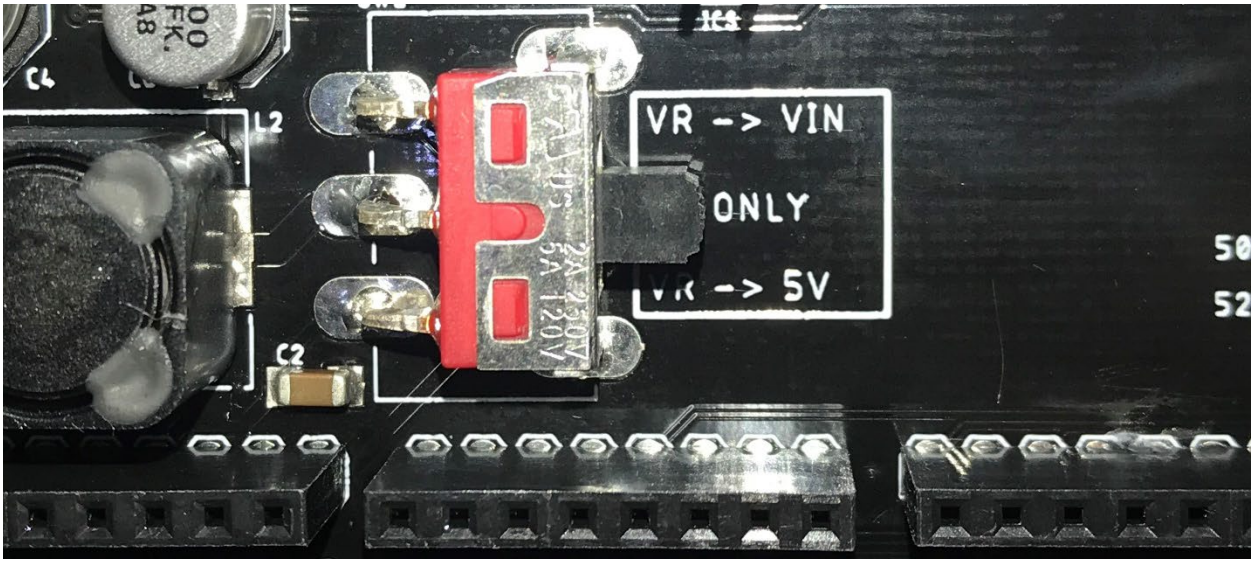


Figure 8: Riser Board DC:DC Power Supply Power Switch

On the upper left of the Riser board is the serial communications and AREF terminal.

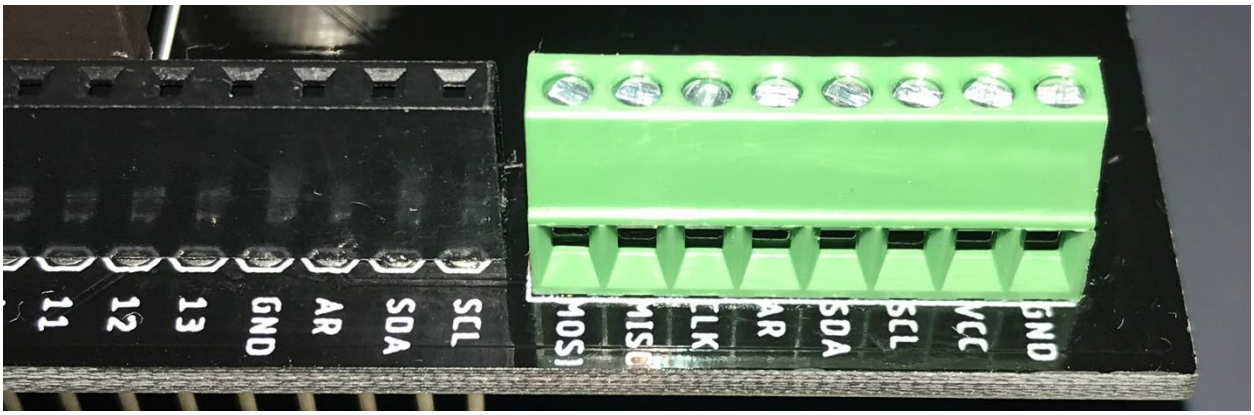


Figure 9: Serial Communications and AREF terminal

On the middle of the Riser board is the UniShield function switch set.

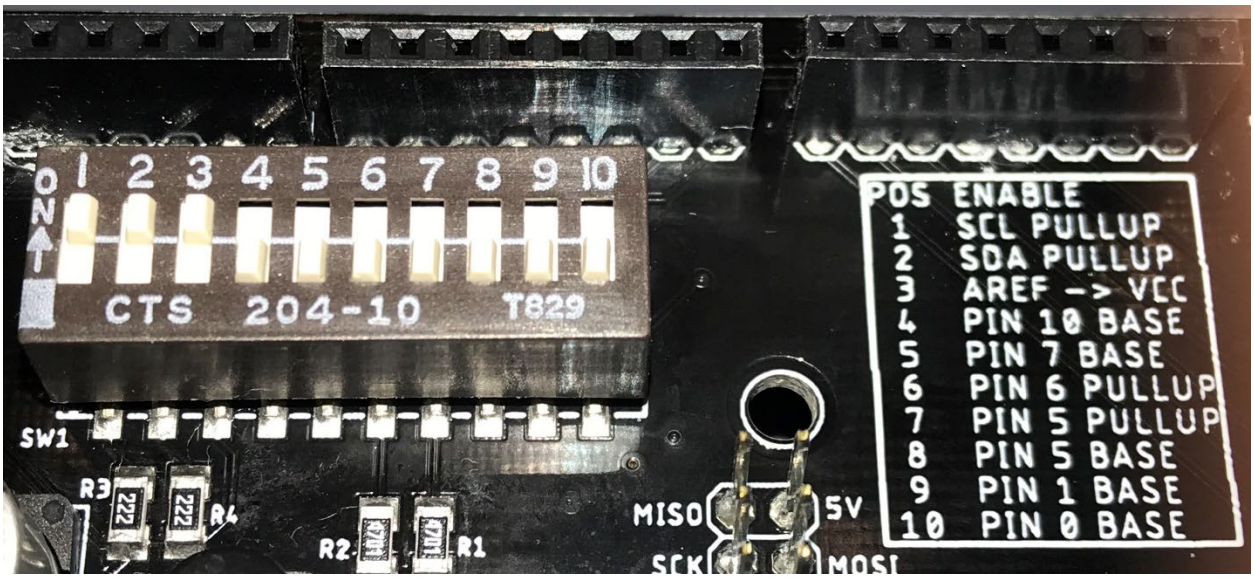


Figure 10: UniShield Function Switch Set

Configuration

⚠ THE UNISHIELD HAS THREE ITEMS WHICH MUST BE CONFIGURED PRIOR TO USE:

1. DC:DC Power Supply (DDPS) output
2. UniShield functions
3. Base board I/O driver switches

The first two can only be adjusted without a native shield stacked on top of the Riser board since it will block physical access. If adjustment needs be made, the native shield must be temporarily removed. The third may not be required, but Riser must be disassembled per below if so.

DC:DC Power Supply

The input of the on-board DDPS is Riser board is terminal VS. The output of this power supply is pin VR. The voltage on pin VR is set by the DDPS voltage adjustment potentiometer, labeled "VR ADJ" (see Figure 7). The 3-position Power Switch (labeled SW2) has 3 locations which determine where the output power of the DDPS is directed (see Figure 8):

POWER SWITCH SETTING	**POWER SUPPLY FUNCTION**
VR → VIN	Directs the DDPS output to the VIN pin of the interface. This will power the interface in such a way that the interface's internal regulator will further regulate power for the interface's use. The DDPS voltage should be set at 7 - 9V when using this location. The VR terminal on the Riser Board will also contain this voltage.
VR ONLY	Directs the DDPS output to the Riser board VR terminal only. The interface will not receive any power from the Riser board and will need to be powered externally. This can be user to power devices other than the interface. NOTE: THIS IS THE DC:DC POWER SUPPLY VOLTAGE SETTING POSITION.
VR → 5V	Directs the DDPS output to the 5V pin of the interface. This will power the interface such that it will not use its internal 5V regulator. This may prevent overheating of the interface regulator in circumstances where high voltage and current are required by the interface and its native shield. NOTE The DDPS voltage MUST BE SET TO 5V when using this location. The VR terminal on the Riser Board will also contain this voltage.

⚠ Configure the DDPS with the POWER SWITCH IN THE VR POSITION ONLY. With the VS and GND pins properly wired per "Installation" below and the Power Switch in the VR ONLY position, apply power to the Riser board. Apply a Volt-Ohm Meter's leads to VR and GND and read the voltage of the DDPS output. Adjust the "VR ADJ" potentiometer using a micro flat blade screwdriver. Clockwise will increase the voltage, and counterclockwise will decrease it. If using the VR → VIN Power Switch location, adjust voltage into the appropriate range, 7 – 9V. If using the VR → 5V location, adjust the voltage to be 5.0V exactly. If using the VR ONLY location (i.e. to power devices other than the interface), adjust the voltage as required. DO NOT MOVE THE POWER SWITCH TO THE VR → VIN or VR → 5V locations if either exceeds VIN or 5V voltages, respectfully. Once the appropriate voltage is set, move the Power Switch to the correct location.

UniShield Functions

The Riser board contains a 10-position slide switch set to control different functions of the UniShield (see Figure 10). The switches enable the following functions:

SWITCH LOCATION	ENABLE FUNCTION	DESCRIPTION
1	SCL PULLUP	Ties the microcontroller SCA (I2C clock) pin to a 2.2k ohm pull-up resistor. This is provided for connection to I2C devices which do not have internal pull-up resistors.
2	SDA PULLUP	Ties the microcontroller SDA (I2C data) pin to a 2.2k ohm pull-up resistor. This is provided for connection to I2C devices which do not have internal pull-up resistors.
3	AREF → VCC	Ties the AREF pin to the interface VCC pin. This will be 5V for 5V interfaces and 3.3V for 3.3V interfaces.
4	PIN 10 BASE	Connects the interface pin 10 to the Base board. In cases where a shield is used and pin 10 is needed for SPI communications, disconnecting this line may ensure proper operation of the SPI bus.
5	PIN 7 BASE	Connects the interface pin 7 to the Base board. In cases where a shield is used and pin 7 is needed for SPI communications, disconnecting this line may ensure proper operation of the SPI bus.
6	PIN 6 PULLUP	Ties pin 6 to a 4.7k ohm pull-up resistor. This is provided for connection to 1-wire devices to prevent the need for an external pull-up resistor.
7	PIN 5 PULLUP	Ties pin 5 to a 4.7k ohm pull-up resistor. This is provided for connection to 1-wire devices to prevent the need for an external pull-up resistor.
8	PIN 5 BASE	Connects the interface pin 5 to the Base board. In cases where a shield is used and pin 5 is needed for SPI or 1-wire communications, disconnecting this line may ensure proper operation of the SPI or 1-wire bus.
9	PIN 1 BASE	Connects the interface pin 1 to the Base board. In cases where a shield is used and pin 1 is needed for serial communications, disconnecting this line may ensure proper operation.
10	PIN 0 BASE	Connects the interface pin 0 to the Base board. In cases where a shield is used and pin 0 is needed for serial communications, disconnecting this line may ensure proper operation.

The switches will be set during manufacturing; however, the defaults are as follows:

SWITCH LOCATION	DEFAULT POSITION: NO COMMUNICATION SHIELD	DEFAULT POSITION: WI-FI SHIELD	DEFAULT POSITION: ETHERNET SHIELD
1	ON	ON	ON
2	ON	ON	ON
3	ON	ON	ON
4	ON	OFF	OFF
5	ON	OFF	ON
6	OFF	OFF	OFF
7	OFF	OFF	OFF
8	ON	OFF	ON
9	OFF	OFF	OFF
10	OFF	OFF	OFF

If configuring the UniShield for connection to 1-wire devices, switches 6, 7, and 8 may need configuration. No external 4.7k pull-up resistor is needed when configuring using pins 5 or 6. If using on other available pins, an external pull-up resistor is required.

1. For UniShields without a communications shield or with an Ethernet shield, the 1-wire bus can be connected to either pin 5 or 6. If connecting to 5, ensure switches 7 and 8 are ON. If connecting to pin 6, ensure switch 6 is ON.
2. For UniShields with a Wi-Fi communications shield, the 1-wire bus can only be connected to pin 6. Ensure switch 6 is ON in this case.

Base Board Switches

As noted above, the Base board contains a slide switch for each I/O pin. Follow the steps above if any of these switches need to be updated in order to disconnect the I/O pins (P) from their respective drivers (D).

Installation

⚠ The system builder is responsible for proper design, integration, wiring, and configuration. BruControl will not assume any liability for the builder's failure to meet the UniShield's specifications and operating parameters.

Mount shield assembly to DIN rail base by locating upper track on the rail and snap lower down. Care must be taken to provide adequate ventilation in the control enclosure such that the heat generated by the driver chips can be transferred away from the board. Care also must be taken to prevent any contact to board circuitry by external wires, tools, or equipment. Good installation practice dictates that low voltage devices such as microcontrollers be isolated and shielded from high voltage devices and equipment. Perform all wiring with the power

disconnected. Ensure all power supplies are of high quality (switching type with appropriate protections and filtering).

Using appropriate wire size for current loads, wire the Base board's blue power terminals: 5V to 24 VDC for each bank VA or VB. Do not daisy chain wires unless assurance is made that net current requirements are not approached. Wire each I/O pin according to the device/sensor being connected. Inputs to the interface should be connected to P pins and high current, high voltage driver outputs from the interface should be connected to D pins. Consult the interface's respective Interface Wiring Map to determine which I/O pin applies to which BruControl pin/port combination.

Using appropriate wire size for current loads, wire the Riser board's green terminal pins per the chart below (see Figures 5, 6, 9). If the interface microcontroller is powered through the USB port or via its native barrel jack, the interface will be powered but the rest of the UniShield will not function.

RISER TERMINAL PIN	DESCRIPTION
VS	DC:DC power supply input, 7 – 24 VDC. 3A maximum input current.
GND	Ground. Wire all grounds in a STAR pattern (to a singular point).
RST	Interface reset. Momentarily ground this line to reset the interface.
3V3	3.3V output of the interface's 3.3V regulator.
5V	5V output of the interface's 5V regulator OR VR when set to 5V output.
VIN	VIN pin of the interface OR VR when power switch set to VR → VIN.
A0 – A15	Interface analog input pins, associated to BruControl ports 100 – 115.
VCC	Interface's operating voltage. Output of the onboard regulator powering the microcontroller chip.
SCL	I2C bus clock signal.
SDA	I2C bus data signal.
AR	AREF. Analog reference voltage. Must not exceed interface's VCC.
CLK	SPI bus clock signal.
MISO	SPI bus Master In Slave Out signal (ties to slave SDO pins).
MOSI	SPI bus Master Out Slave In signal (ties to slave SDI pins).

Assembly

The MEGA UniShield comes assembled, however should an interface need to be exchanged, it may be disassembled. In addition, if disconnection of a particular Base board I/O P pin from the driver input is desired, the following steps may be followed. NOTE: The components of the

UniShield are delicate and must be handled accordingly. In addition, electronics are sensitive to electrostatic discharge, so ensure the operator is grounded before handling the assembly.

1. Remove the UniShield from its assembly and perform these steps on a static-free worktable. Do not attempt to perform this operation with the UniShield mounted in its control enclosure.
2. With the UniShield upright on the worktable, remove the 2x Phillips head screws on either side of the Riser board (see Figure 10). Do not let the Riser board move until both screws have been removed.
3. Rotate the UniShield so that the base carrier sits on its right side. Gently rotate the Riser board 90 degrees to the right so it is facing flat and upside down on the worktable (see Figure 11). Note the Riser and Base boards are connected by a ribbon cable. <u>This cable is delicate and must not have any tension placed on it.</u>
4. If replacing the Interface microcontroller board, follow these steps:
    a. While firmly holding the Riser board, slowly and carefully remove the Interface microcontroller board. This is best accomplished by working around the interface to back it off the Riser board pins a few millimeters at a time. Doing so will prevent any sudden movements and bent pins.
    b. In a similar manner, slowly install the new Interface microcontroller board. Once the pins are lined up, systematically place pressure on them so that the boards always remain parallel and until the interface microcontroller is fully seated on the Riser board's pins.
5. The Base board slide switches are now fully exposed and may be changed. Use a small flat blade screwdriver to gently change any particular I/O pin-driver connection switch (see Figure 3).
6. Rotate the Riser board to the left 90 degrees, aligning the two screw holes, then rotate the assembly to the left and replace the Philips-head screws.
7. Test the UniShield assembly on a test bench before reassembling into its control enclosure.

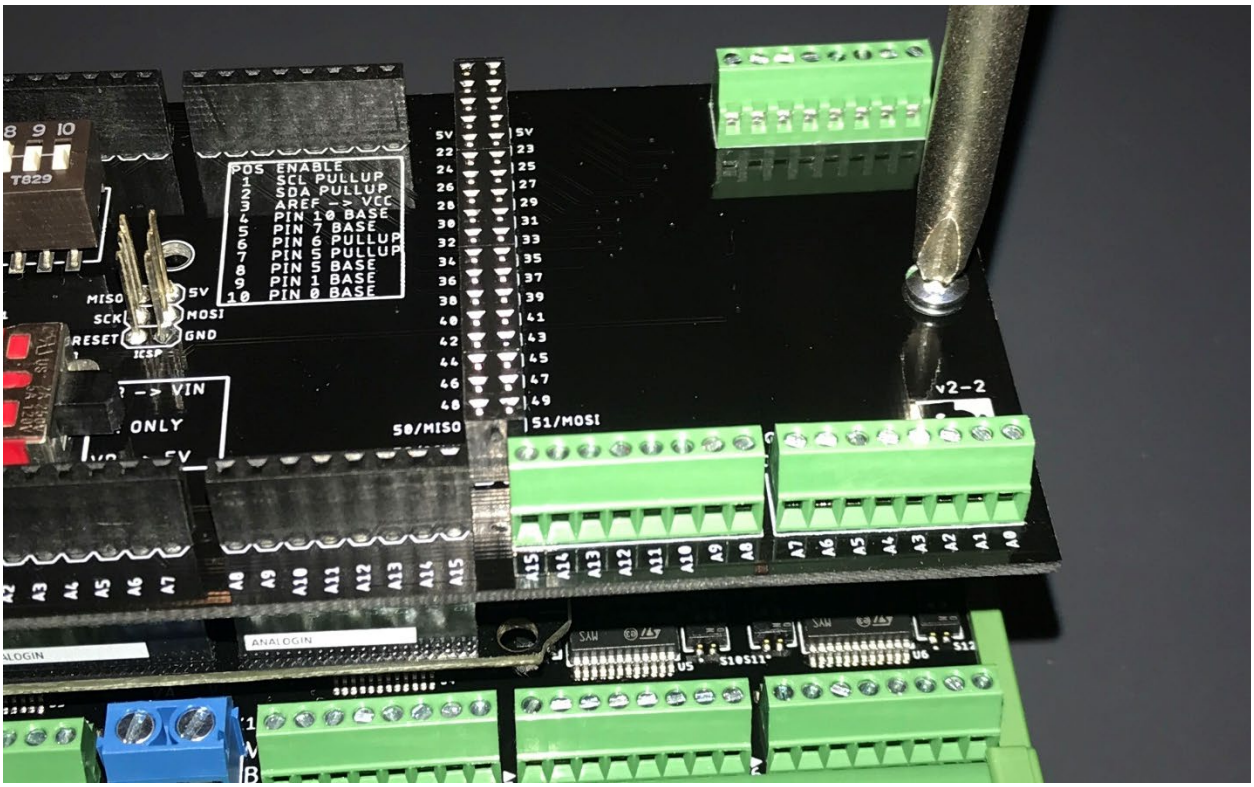


Figure 11: Riser Board Screws (right side only shown)

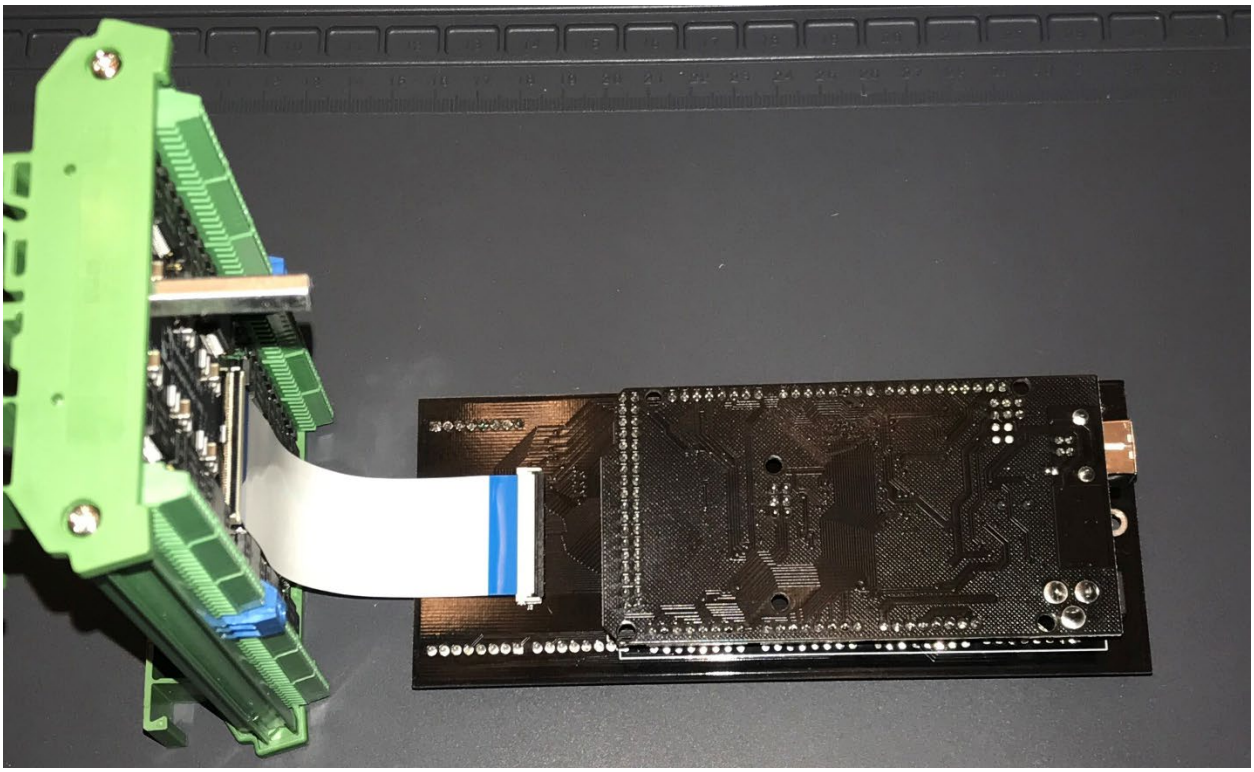


Figure 12: UniShield base/carrier upright with Riser Board rotated flat to surface.

Contact BruControl at info@brucontrol.com with any questions or concerns.