2.1 Meter Slip Ring-Bypass Project

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Abstract

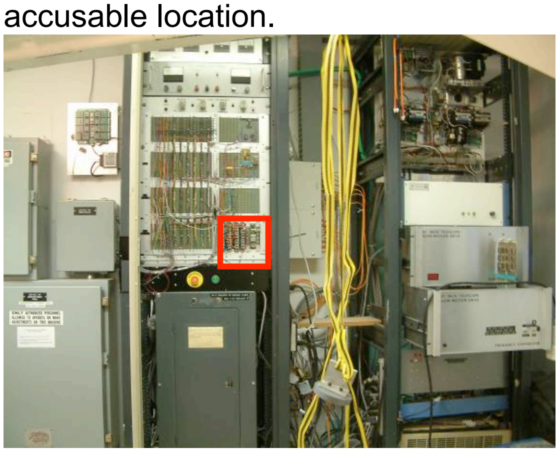
Objective: Something worked toward or striven for; a goal. This report will describe in detail a project that will allow wireless communication inside and above the rotation point of the 2.1 meter (82”) telescope dome. The telescope is located at the University of Texas McDonald Observatory which is located 16 miles west of Fort Davis, TX. The goal of this project is to bypass the old and current method of getting control to the above rotation point of the dome. The old method is using slip rings that were implemented in the late 30’s. The new system will be wireless serial command which will allow the control lines to be taken off the slip rings, leaving only power and ground. In this report it will describe how the slip rings were by-passed, what microcontroller system was used, how the wireless units were set up and finally how the system was put in place.

The 2.1 meter (82”) telescope was first built in the late 1930’s. This system was state of the art and also the 3rd largest in the world when it was first implemented. It can be expected that 80 years can do a lot to the TCS or telescope control system of the telescope. The project or 2.1 meter (82)” slip ring by-pass project is to bypass the old slip ring system of the telescope. The entire TCS will be redone in the next several years to come. This paper will be a technical description of the 2.1 meter Slip ring bypass project. The project was just to prove the concept that wireless control can be achieved above the rotation point of the dome. Another aspect that had to be considered is when using the new wireless control the in place control system could not be disrupted at anytime. The Telescope is used 365 nights a year thus meaning the TCS had to be 100% functional at all times. The project will be described step by step so when the signal leaves the first switch to actually moving the shutters of the dome. The signal goes from switch to STAMP microcontroller unit to MOXA serial wireless unit to another MOXA wireless unit then to another STAMP which is hooked to shutter control above the rotation point of the dome. The single function that was chosen was to gain control of opening and closing the shutters. It was chosen because of its very curtail nature of protecting the telescope from outside elements. If the system works the other functions that are above the rotation point will be implemented when the rest of the TCS is in place, ex. Wind screens, crane, service platform, lights and rotation of the dome if need be.

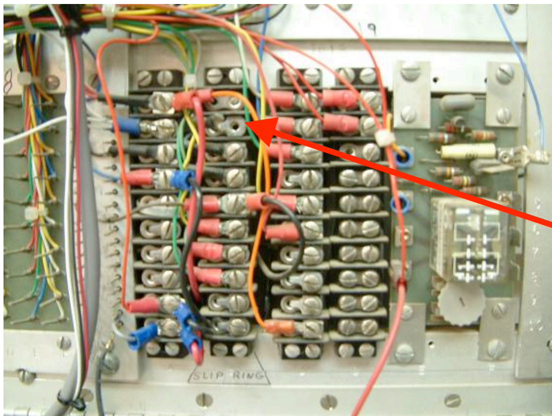
The signal first starts on the dome floor of the telescope at the main control board. The old controls had to be used, there could be no additional switch’s added or changed to the main unit. This switch is a single pull double through switch. In the up position the switch allows -28 VDC to flow to open the shutters. Once the switch is in the down position it will then allow +28VDC to flow and close the shutters. If the switch is pointed straight out toward the user this allows 0VDC to flow and no action will be taken.

Picture 1: taken by Corby B. Bryan. Main control unit dome floor.

The power for this switch comes from the Control unit. Once a signal is transmitted it is then sent via wire to the “old control room”. This room is located on the west wall of the telescope and was once the old control room. In this room there is a panel that the signal from the shutter switch goes to. The signal is then separated several times so that it can go to different places in the dome. Some of the controls go to the new control room, hand paddles and the slip rings. All these signals are wired in parallel with each other. The main question that stands is where is the plug in point for the microcontroller that I will be using. An EX OS or Observing Support employee named Rodney Cantwell had began to make tie in points on this old control unit. It was very well labeled and in a very accusable location.

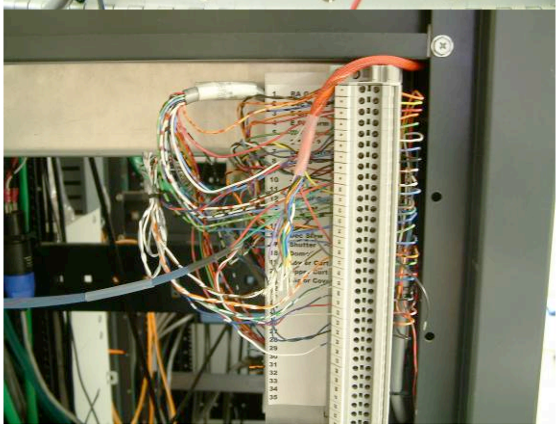


Picture 2: taken by Corby B. Bryan. Control panel switch board in old control room.



Picture 3: taken by Corby B. Bryan. Terminal strips where control lines get onto slip rings. TB-19 –B2

Solderless wire taken off of slip rings.



Picture 4: taken by Corby B. Bryan. Addition by Rodney Cantwell. This is where tie in to STAMP occours.

The first thing to do was to disconnect the shutter signal coming from the control board from the slip ring on TB-19 B2. A set of wires was made so that tapping into the tap in point would be easy to do. Only the shutters are hooked up but there are enough wires in the cable so that when the entire project is implemented other controls can be easily added.

The shutter control now goes to the STAMP microcontroller interface board. The boards that were used were designed by Mark Blackley of the Observing Support staff at McDonald Observatory. These boards made the project very easy to do and they were designed so that you could use any port as and input, output or RS232 serial control port. All the inputs, outputs and RS-232 are designed on I/O cards and all cards use Iso-Optilation to protect the microcontroller from any power surge that might come to harm the microcontroller.

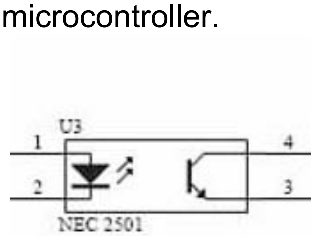


Figure 1: made by Corby B. Bryan from schematic drawings by Mark Blackley. Shows example of Iso-Optilation.

The STAMP BS2- P40 series microcontroller which is designed by Parallax was used to interpret the ±28 VDC control signal that comes from the switch on the main control unit. The voltage comes to you on a single wire so the same wire is split into two wires and hooked to two different ports on the STAMP. What happens when you send a voltage to these input cards it activates an LED that then shines onto a photo transistor. A transistor is set up so that when light hits the “base” it lets current flow from “collector” to “emitter” thus in this case turning on the port. If there is no light the port cannot turn on. The STAMP interface board is set up so that the port will only turn on when the port is LOW. The -28 VDC goes to port 1 and does what is called reverse biasing an LED so the LED will turn on when a negative voltage hits it. The opposite goes for port 0 which is normal bias in that it is hooked up normally to the LED so that it may turn on when a positive voltage exists. In this case the voltage will be +28 VDC. The STAMP input modules are designed to handle up to 60 VDC/AC. There is a resistor that is needed for the purpose of limiting the current on the LED. Using V= IR we have 28 VDC and a .02 mA draw on the LED so solving for R we get about 1400 which is a 1.4 KΩ resistor. Actual implementation is a 1.2 KΩ resistor in series with a 300Ω resistor as to limit the current more than required. The STAMP is also powered by a +5VDC power supply in order to supply it power with an isolated ground from the telescope.

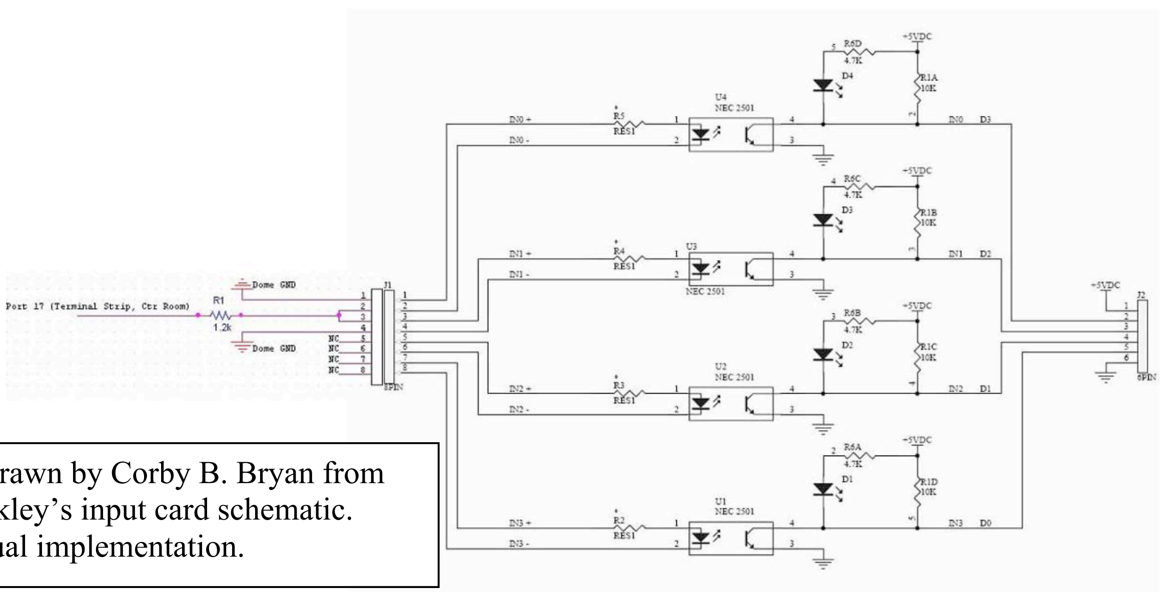
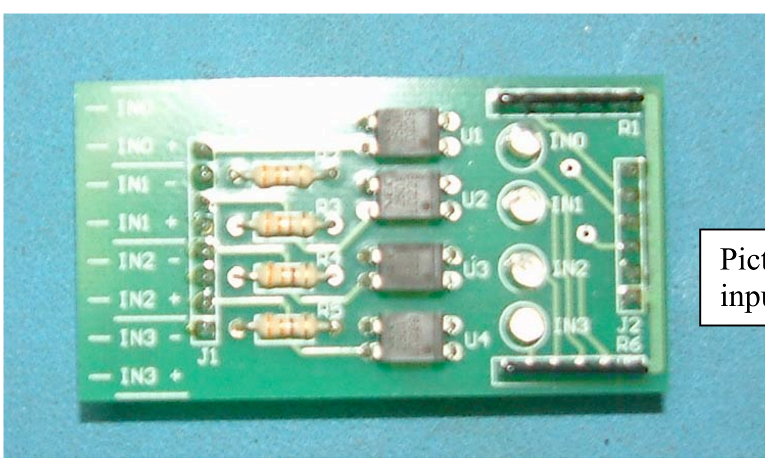
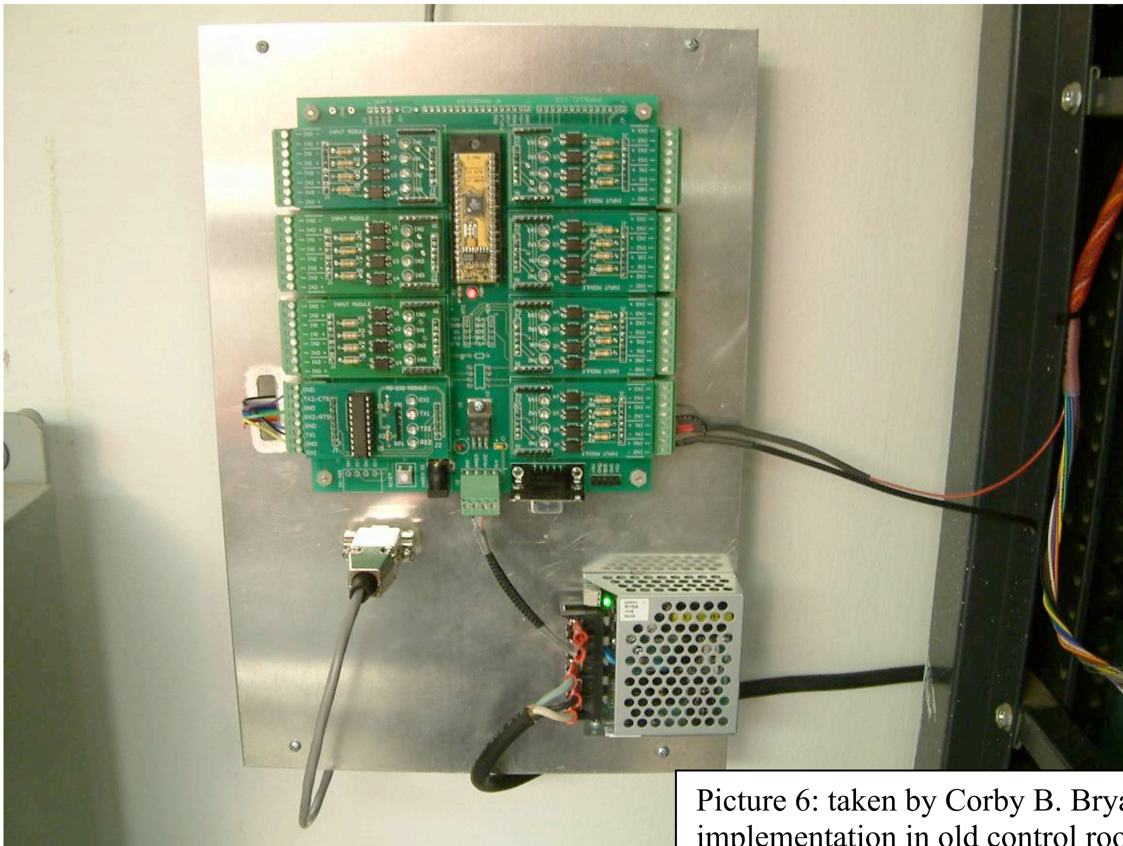


Figure 2: drawn by Corby B. Bryan from Mark Blackley’s input card schematic. Shows actual implementation.



Picture 5: taken by Corby B. Bryan. example of input module.



Picture 6: taken by Corby B. Bryan. Actual implementation in old control room.

As said before the shutter control wire is hooked to port 0 and 1 of the STAMP. The STAMP has 30 I/O ports so they are arranged in a band of MAINIO 15 port and an AUXIO 15 port configuration. The control comes into MAINIO ports 0 and 1. The actual code is written in BASIC using the Parallax compiler for the BASIC STAMP SERIES. The code is set up so that it checks the ports and then stores a number in a string depending on what the ports are reading. Remember STAMP interface and I/O modules are based on an inverse logic system so the port has to be LOW for it to be on. Here is sudo code of the INPUT STAMP code.

- If port 1 is LOW or control board switch in the up position, Open the shutters
    - Store an ASCII value in string 1 = 0
    - Else store ASCII value in string 1 = 1
- If port 0 is LOW or control board switch in the down position, Close the shutters
    - Store an ASCII value in string 0 = 0
    - Else store ASCII value in string 0 = 1
- Then Serial out the command using a start bit every 500 ms or ½ second.
    - OPEN SHUTTERS = *10
    - CLOSE SHUTTERS = *01
    - NO ACTION = *11

The Serial out command is set up to work on 9600 true baud rate. That was chosen because the stamp has to be programmed at that baud rate so it made things easier to debug if any problems came up. The Star in the serial transmission is used so that the other STAMP that will be receiving this command will know that that is the start of each transmission. The STAMP interface also has RS-232 cards so this allows us to not tie up the main programming port. The Serial out command is set to output on AUXIO port 13. On the RS-232 module that port is labeled "Tx" for transmit. The only pins hooked up on the serial DB-9 connector will be Tx, Rx, and Ground (pins 2,3 and 5). The ground pin must be connected and MUST be the same as the STAMP microcontroller ground. The next step in the system is to transmit a signal to the first wireless unit and then to the second.

The wireless or MOXA NPort 2004 serial Ethernet transmission units are what will now be the medium of travel instead of using the slip rings. So now the STAMP is sending a transmission every 500ms to the wireless unit via serial cable. The MOXA units have four serial ports on them that are in the form of a RJ-45 connection. The RJ-45 connection looks the same as any standard Ethernet port on the back of a modern computer. Only port 1 will be used for this project. Obviously the transmission has to go from one place to another so there are two MOXA units. One is located on the North Pole of the telescope support structure. This is where the support structure and the telescope point to the North Star, Polaris. The other MOXA wireless unit is on a set of stairs that are on the rotating part of the dome. The stairs start near a platform that is called the bridge that lead up to the upper part of the dome to do repairs on the telescope.

Picture 7: taken by Corby B. Bryan. MOXA UNIT on north pole.

Picture 8: taken by Corby B. Bryan. MOXA UNIT on stairs above dome rotation point.

tie strap easily changed when the permanent implementation goes into affect. The wireless units are set up in the following fashion.

- MOXA INPUT wireless unit (North Pole)
  - Ethernet IP address static = 192.168.126.251
  - Wireless LAN IP address static = 192.168.127.252
  - SSID = MOXA MCD 82
  - WLAN MODE: Ad-hoc
  - Port 1
    - Mode: TCP Client
    - Baud: 9600
    - Parity: none
    - Data bits: 8

    - Stop bits: 1
    - Flow Control: none
    - FIFO: enable
    - Interface: RS-232
    - Local TCP port: 4001
    - Enable port: 966
  - Ports 1, 2, 3 set up the same way but not in use.
- MOXA OUTPUT wireless unit (On Dome Stairs)
  - Ethernet IP address static = 192.168.126.253
  - Wireless LAN IP address static = 192.168.127.254
  - SSID = MOXA MCD 82
  - WLAN MODE Ad-hoc
  - Port 1
    - Mode: TCP Server
    - Baud: 9600
    - Parity: none
    - Data bits: 8
    - Stop bits: 1
    - Flow Control: none
    - FIFO: enable
    - Interface: RS-232
    - Local TCP port: 4001
    - Enable Port: 966
  - Ports 1, 2, 3 set up the same way but not in use.

The units have to be in Ad-hoc mode because there is no computer controlling them. Also the INPUT MOXA must be in TCP client mode and the OUTPUT MOXA in TCP server mode. This way since you have a static IP address the ports are now mapped so that when an input is received at the North Pole the ON DOME unit transmits exactly what the INPUT MOXA is receiving to the STAMP on dome. Now a cable is attached to the output MOXA unit via RJ-45 cable to serial. Once again only the Tx, Rx and Ground pins (2, 3 and 5) are being used. This cable now goes to another STAMP microcontroller which is located above the dome rotation point underneath the bridge platform.

The on dome STAMP is set up to receive the wireless communication and then act accordingly. The original thought was to just tap into the ±28 volt system that was already in place on the dome but many problems accord with that. The place to tie into the shutter control is on a terminal strip named TB-500. There were four places TB-500-16A and B for shutter control, TB-500-17A and B for dome ground, TB-500-26A and B for +28 VDC and TB500-27A and B for -28 VDC. However the colors of the wires are consistent with the wires coming from the ±28 VDC power supply but there is no voltage on the wires. Between the mess of wires and grease it was decided to use new 24 VDC power supplies. The old ±28 VDC power supply will be removed when the new TCS goes in. The relays that are going to be tripped to start the three phase shutter motors trip at around 22 VDC. So the 24 VDC power supplies will work just fine for this purpose. To power the relay the use of two +24 VDC power supplies will be used in series with each other. They are hooked together this way so we can get ±24 VDC. There will also be a 5 VDC power supply to supply power to the STAMP at a constant 5 VDC. This will also be an isolated ground from the dome ground. If this is not that way there is a big possibility of getting damaged signals. The ground of the ±24 VDC must be the same as the dome ground. The power supplies will be mounted on the door of the box that the STAMP will be contained in. They all need to be in a consoled box for the reason of light and heat. The instruments in the dome are sensitive to the LED’s that will be on the board and as well heat that the STAMP or power supplies give off could potentially damage the exposures that the astronomers might take.

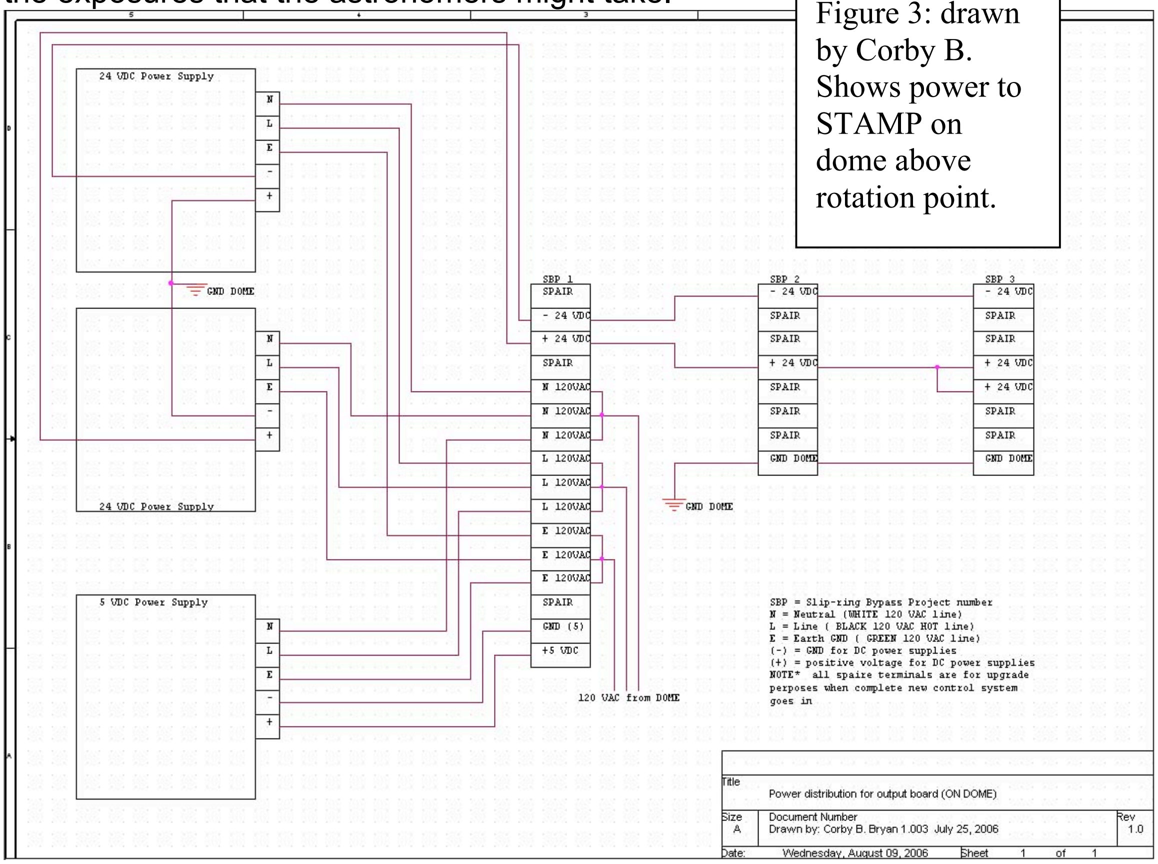


Figure 3: drawn by Corby B. Shows power to STAMP on dome above rotation point.

The voltages all go to other terminal strips that were named SBP1, 2 and 3. (Slip ring By-pass Project) The STAMP interface board is the same as the old control room board however instead of input modules on the board there are now output modules. The ports are configured in the same way in that port 1 opens the shutters and port 0 closes them. Here is an example of the sudo code that runs the output STAMP microcontroller. It is the same STAMP series so it is coded in basic as well.

- If Serial in command is *01
    - Open the shutters
    - Make sure that close shutters port or port 0 is OFF
- If Serial in command is *10
    - Close the shutters
    - Make sure that open shutters port or port 1 is OFF

- If Serial in command is *11
    - Don’t do anything
    - Make sure ports 1 and 0 are OFF.
- If Serial in command FIALS or loses signal
    - SOUND ALARM to warn observer
    - Continue to check if communication signal is back
    - If communication is reestablished resume normal operation

The serial port is also set up for 9600 baud rate. This is left separate from the main serial port so that programs can be reloaded and program can be debugged if need be. There are also resistors set up so that if for some reason both ports are turned on allowing both +24 VDC and – 24 VDC to flow witch would create the situation of a short it will not allow the max amount of current to flow or ruin anything. The output ports are opposite of the input ports being that there are high power mosfets to control the output to the shutter relay. All connections are made at TB-500.

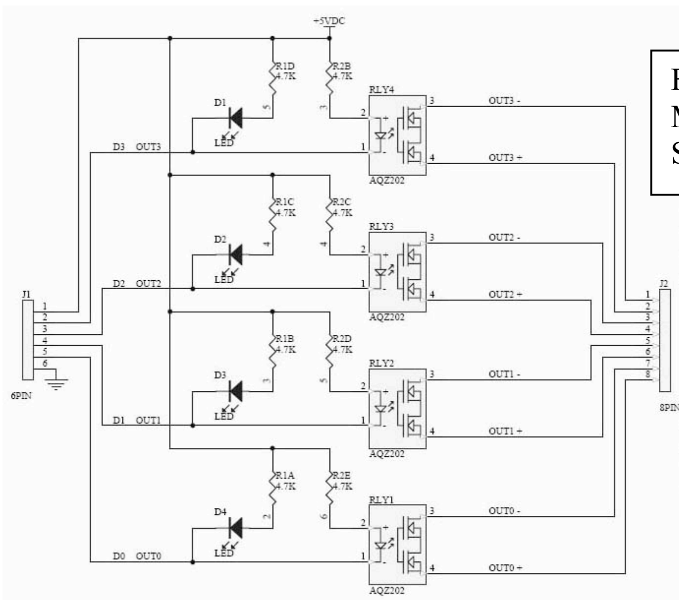
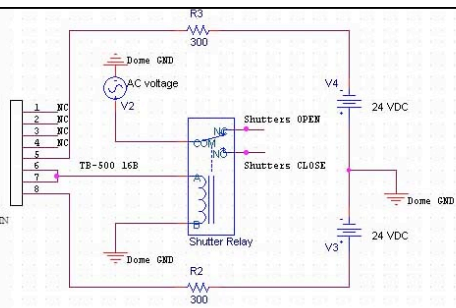
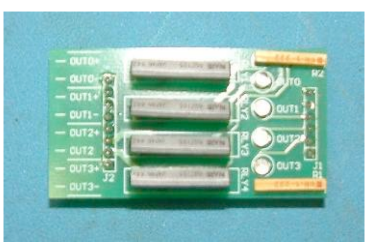
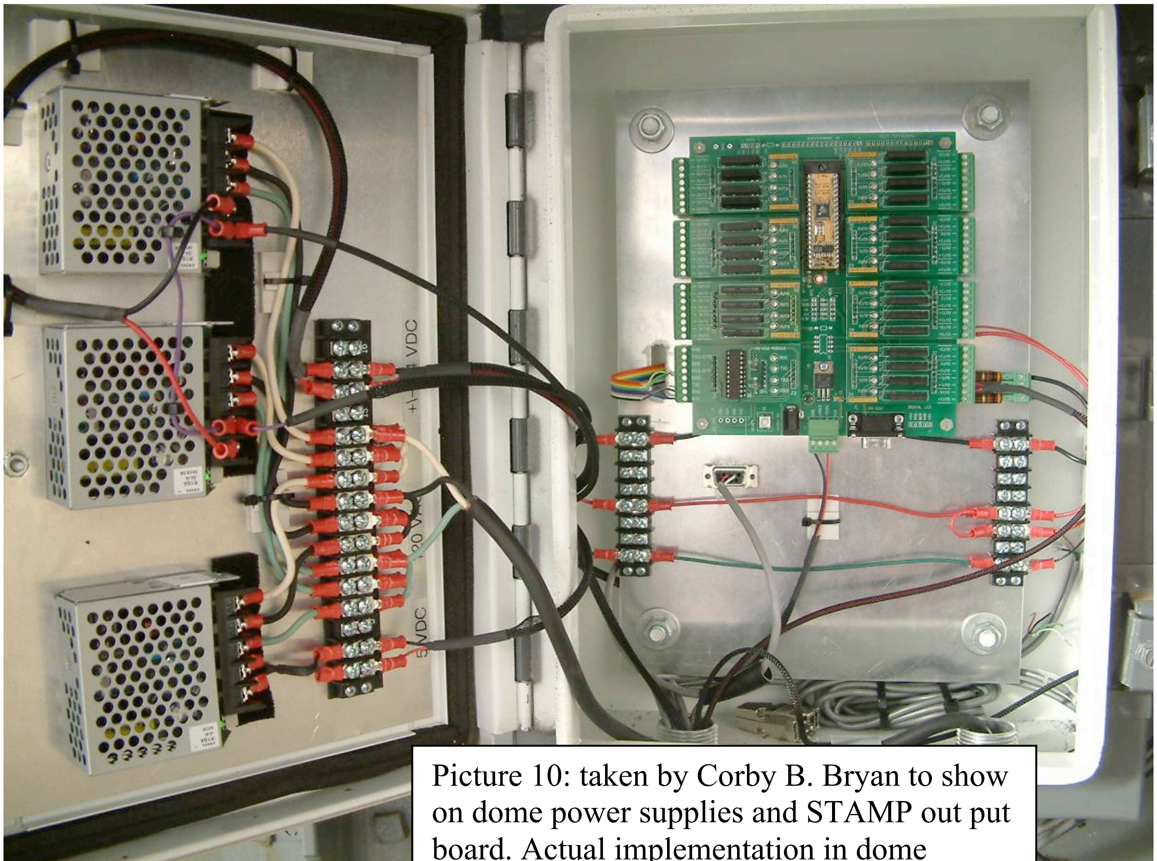


Figure 4: drawn by Corby B. Bryan from Mark Blackley’s output port module. Shows actual implementation on dome.





Picture 9: taken by Corby B. Bryan to show example of output port.



Picture 10: taken by Corby B. Bryan to show on dome power supplies and STAMP out put board. Actual implementation in dome

The power supplies are power with 120 VAC from the dome power supply. Now that all connections are made there is a fail safe system in place. There is a small control module on the bridge of the maintiance platform that is above the dome rotation point. This control will work no matter if the wireless is working or not. If the wireless does fail however this will be the only way to open or close the shutters unless the slip ring for shutter control is reattached. This control box mused be used if the alarm on the output STAMP is activated.

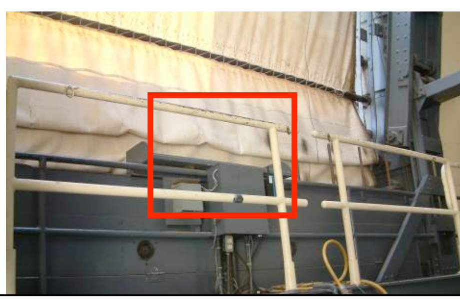


Figure 11: taken by Corby B. Bryan, platform and back up control box above dome rotation point.

Figure 12: taken by Corby B. Bryan to show backup control of shutters on

In the beginning it was unclear if the wireless slip ring bypass system was going to work at all. Now the system has been implemented and has been running since August 6th 2006 @ 3:30 PM. The goal of having a system to bypass the old system of using slip rings has been accomplished through the use of STAMP module interface and Serial MOXA wireless units. The rest of the controls will be implemented when the entire TCS is finished and the extra serial ports will prove to be a valuable asset when full dome automation is in place.

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