Chapter 3

FIELD ELECTRONICS

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3 BUILDING THE FIELD ELECTRONIC SYSTEMS

3.1 FIELD ELECTRONICS AND SCORING SYSTEM

Items required:

- Wire cutter/pliers (for cutting cable wraps)
- Field Electronics Case: includes Station Control Cabinets (SCCs), LED Display units, Team Lights, E-Stop switches, and field electrical cables and harnesses.
- Scoring System Case: includes power strips, printer, LCD display, Keyboard, Mouse, Field Control User Interface (FCUI), Field Access Point (AP), Pit Display laptop, Spare laptop, Scoring I/O panels, and miscellaneous cables.
- Scorpion Case: Includes Event Server, Backup Server, Field Router, Scan Converter, UPS, and Arena Signal Light.
- Game Specifics Case: Targets and Touchscreens.

3.1.1 Overview of Electronics Installation

The Field Electronics installation consists of four elements. They are:

1) Locating main Scoring components on the Scoring Table.
2) Placing the main Field Electronics on the field ends.
3) Routing and connecting cables to appropriate termination points
4) Dressing and securing cable bundles for protection.

3.1.2 Scoring System Location

The location of the Scoring System tables is determined by the site plan for the event. The Scoring table is located at mid-field and generally about 8 to 10 feet from the field side border.

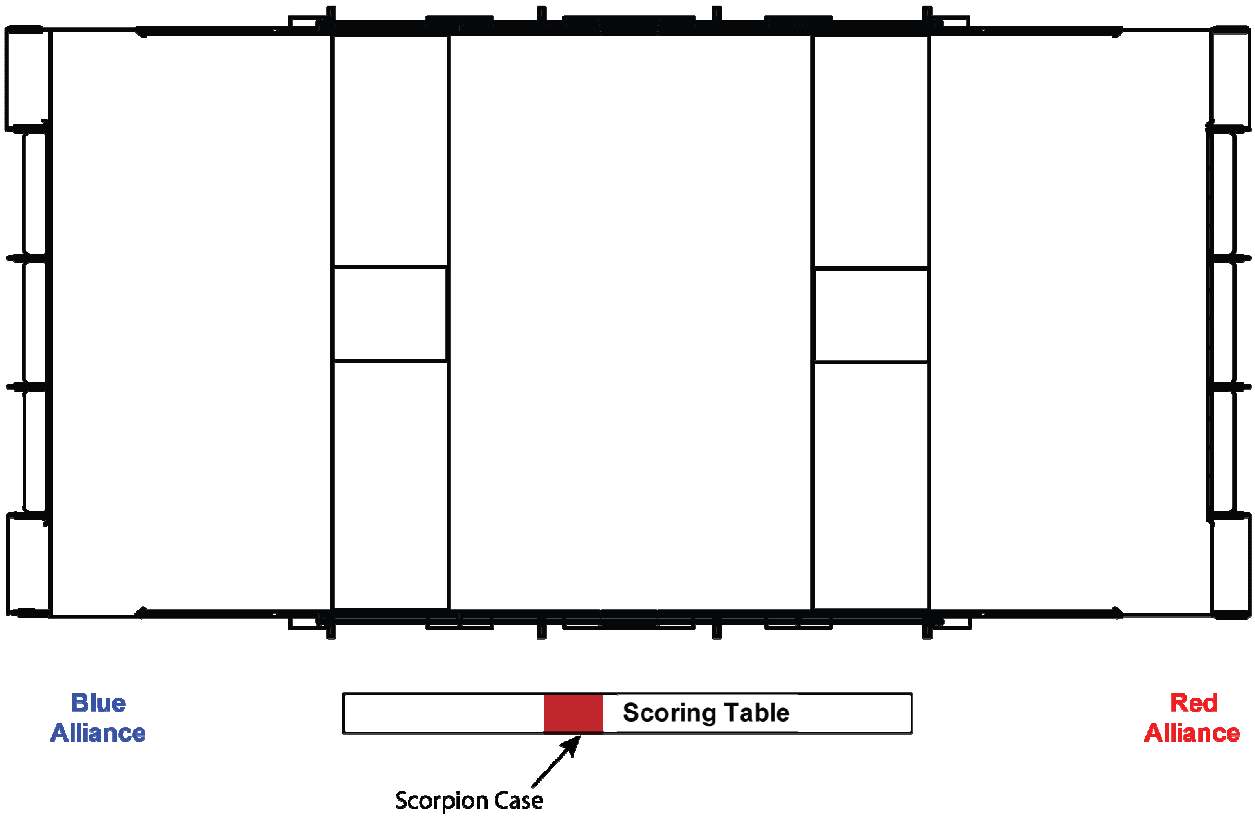


Figure 1 : Field Layout

The Red Alliance Home zone and field equipment is located to the right-hand end of the field when observed from the Scoring table. The Blue Alliance Home zone and field equipment is located to the left-hand end of the field when observed from the Scoring table.

3.1.2.1 Laying Out the Scoring Table (Crew of two people)

Having determined the location of the Scoring table, one crew can unload the contents of the Scoring case and move the Scorpion Case into position next to the Scoring Table. Verify with the Event office and/or Facility services that the 120VAC 4-way drop, Ethernet (CAT5) for Internet, and the Ethernet cable routed to the Pit designated for the Pit computer & monitor (optional), have been installed. These cables must be available at the Scoring table. Also inquire about having sufficient cableways provided to protect cables crossing to/from the Scoring table to the field.

The equipment that must be placed on top of the Scoring table includes the FCUI, LCD Monitor, Scan Converter, CRT Monitor, Keyboard, Mouse, Printer, and Arena Signal Light.

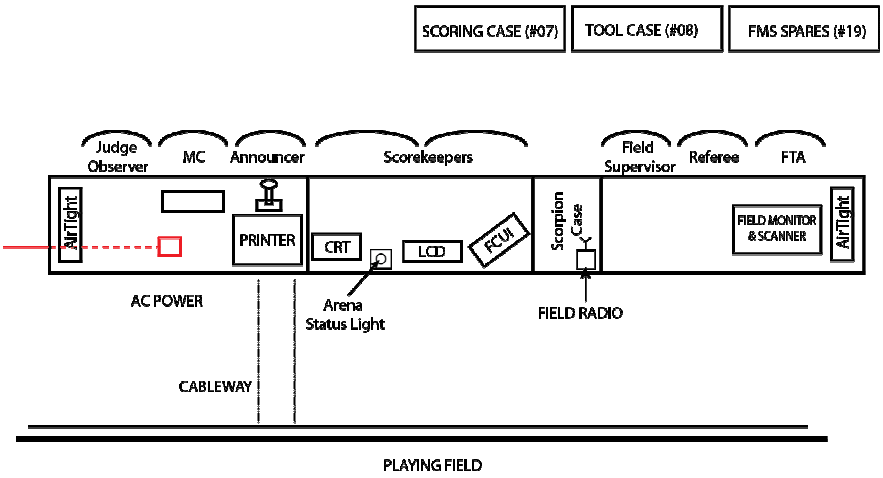


Figure 2: Scoring Table Layout

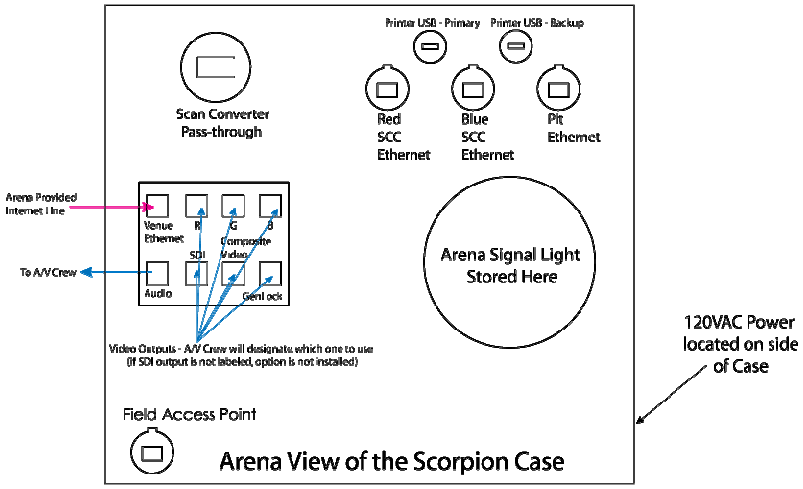


Figure 3: Scorpion Case - Arena View

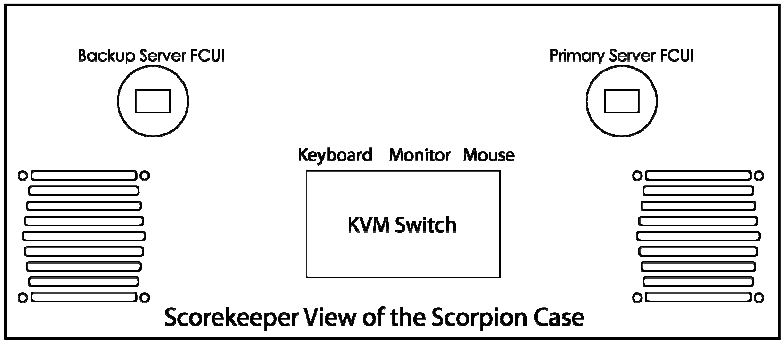


Figure 4: Scorpion Case - Scorekeeper View

3.1.3 Field Electronics (Case #06)

The Field Electronics case contains:

- Station Control Cabinets (SCCs) – 2
- LED Display Units - 8
- Team Light – 8
- E-Stop Button - 6
- SCC Ethernet Cable – 2
- Field Power Cable – 2
- Field electrical cables (yellow Allen Bradley cabling)
- Power strip – 2
- Classmate power supply - 6

Figure 5 depicts the layout of the basic electronics modules and is viewed such that you are outside and behind the playing field at the end and looking back towards the playing area. All equipment is mounted from behind the Field End panels (i.e., on the outside of the field). The equipment mounted to the field is laid out identically for each field end.

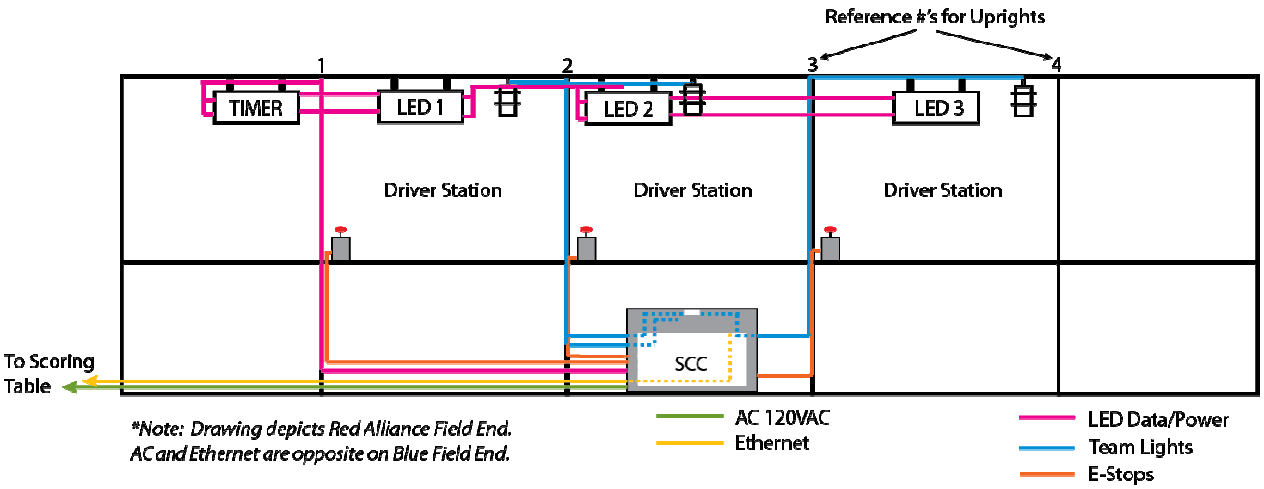


Figure 5: Basic Field End Wiring

The following steps are followed to position the electronic equipments:

1) Place 1 Station Control Cabinet at each end of the field in the center of Driver Station 2 as shown in the figure above. Note; the SCC has tape on the handle as well as indicator lights to indicate the appropriate field end to which is should be placed.
    a. The SCC with Blue tape should be placed at the Blue alliance end of the field and when powered on will have Blue LED's.
    b. The SCC with the Red tape should be placed at the Red alliance end of the field and will light up Red.
    c. The Spare SCC is stored is road case #19 and has Black tape on its handle. It has no lights.

2) Team Number LED Display units #1, #2, and #3 are mounted at each of the three driver stations. There are 15 holes in the top rail counting from left to right. #1 hole is on the left end.
3) Start with LED #1 on the left, LED #2 in the center, and LED #3 on the right side. The LED Display assembly is attached by hooking the "J" hooks into the # 2 and # 6 holes of the 15 holes pre-drilled in the top frame of each section as shown.

4) Mount the Timer LED Display Unit to the Driver Station 2 Panel, hanging the Timer "J" hooks at the #10 and # 14 holes in this center panel.

   NOTE: To make it more apparent to the audience, the Timer LED has white borders (white Gaffer's tape) on the horizontal rubber pads above and below the display, the Team Number LEDs do not. *Be sure to use the right display for the right purpose!*

5) Mount one Team Light assembly onto each of the three driver stations by sliding the light hanger over the # 8 hole in the top frame. Secure the light by inserting the locking pin through the light plate and #8 hole.

6) Fasten one E-stop Assembly onto the left end of each Drivers Station shelf in the positions shown above to the corresponding Velcro pads, such that the cable connector is on the side closest to the left edge of the top panel for ease in routing and connecting the plugs.

7) The Field Radio is a Cisco wireless access point which connects via a single Ethernet cable to the Scorpion Case. This cable provides data and power, no other connection is necessary.

When radio(s) are connected to this Access Point, the center Status Light will be **BLUE**

8) During the competition the radio shall sit on top of Case 33 – Scorpion Case as shown.

3.1.4 Scoring (Case #07)

The Scoring case includes:

- CRT Monitor - 1
- Power strips - 2
- Printer - 1
- LCD monitor – 3
- Keyboard – 3
- Mouse – 3
- Field Control User Interface (FCUI) - 1
- Pit Display netbook – 1
- FTA Laptop/Desktop – 1
- Inspector Laptop/Desktop – 1
- DMX Controller – 2 (1 additional in Case #19)
- Scoring I/O panels – 4 (1 additional in Case #19)
- Required cabling

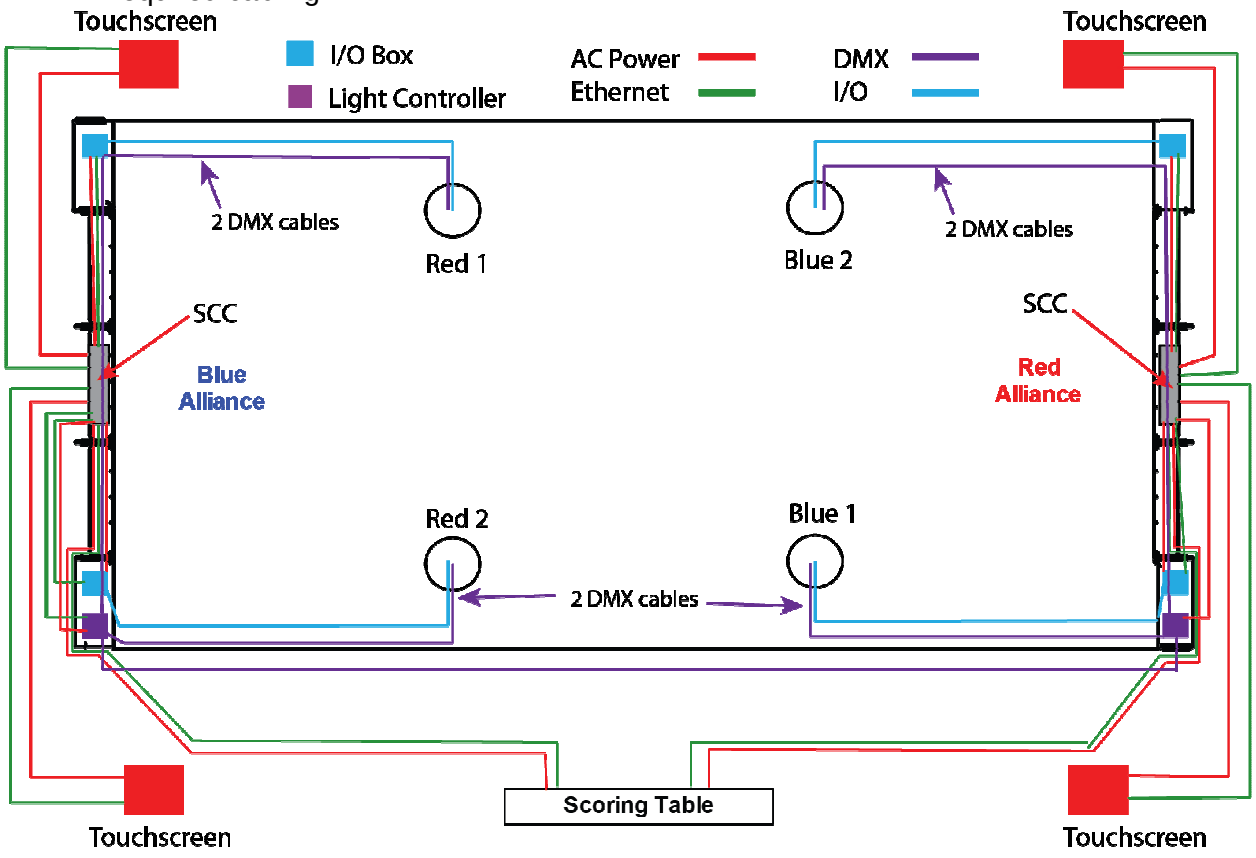
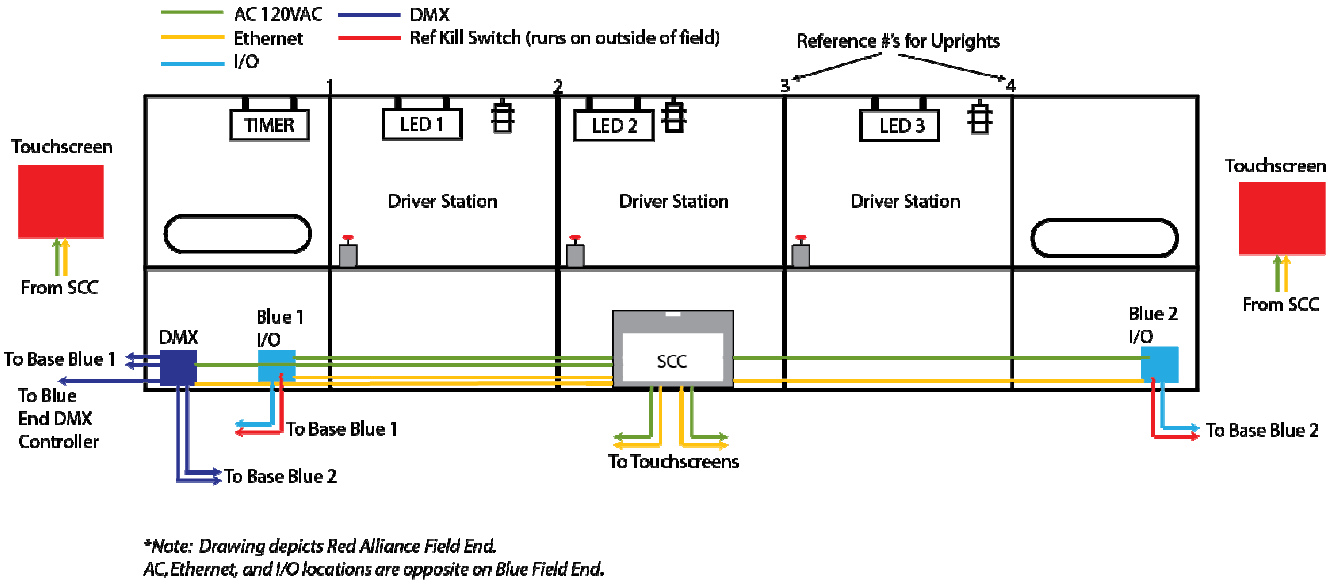


Figure 6: 2011 Field Wiring Diagram

Figure 7 depicts the layout of the scoring specific electronics required for the 2011 game. Scoring I/O panels and the DMX Control boxes are stored in the Scoring Case (#07).



**Note: Drawing depicts Red Alliance Field End.*
AC, Ethernet, and I/O locations are opposite on Blue Field End.

Figure 7: *2011-Specific* Field End Wiring

3.1.5 Electrical Cabling

Only 1 AC cable and 1-shielded Ethernet cable connect from the Scoring table to the SCCs at each end of the field.

The Field Radio cable runs from the radio to the Scorpion Case.

The general routing of cables is depicted on the 2011 Field Wiring Diagrams above (Figures 7 and 8). To keep the cabling task simple, cabling distribution is broken into four categories:

> ***Note:*** *Be sure to feed all field-side cables between the outrigger uprights and the field side. Do not lay cables outside the outriggers over the trip guards.*

Group A – Two types of cables running from the Scoring equipment to the SCCs at each end of the field. They are Field AC Power and the Network (Ethernet) cables.

Group B – Interconnect the LED Display Units, Team lights, and E-Stops to the SCC.

Group C – Field Radio cable and AirTight cabling.
Group D: – All cables required for real-time scoring and field effects.

NOTE: While rugged, all wiring harnesses need to be handled with reasonable care. The connectors are made of ABS plastic and will break if stepped on.

Ensure that the cables are not left lying on the floor where the connectors can be stepped on. When installing or removing, hang the cable connectors on the field end or other places where they are not prone to damage.

3.1.6 Installing Group "A" Cabling

Group "A" cables (Field Power, color-coded Red, and Ethernet color coded Green) should be laid, starting from the Station Control Cabinets at the field ends and ending at the Scoring table. This allows excess cable to be stored underneath the Scoring table.

AC Power cable (100' heavy duty) –There is an AC Power cable to feed each end of the field. The 3-pin round female plug should be connected to a Tripp lite power strip behind the SCC. A short cable is provided to go from the power strip to the AC receptacle on the SCC. The AC cables are connected to the Tripp lite power strips at the Scoring table. The strips, in turn, are plugged into the AC receptacles provided from the Arena.

Network Shielded CAT 5 Cable (75 feet) - The Ethernet cable from the Blue end of the field connects to designated SCC RJ-45 input on the top of the SCC. A similar connection is made at the Red SCC.

At the Scoring Table, all Ethernet RJ-45s must be plugged into the corresponding ports labeled on the Scorpion Case.

NOTE #1: *Do not allow teams to plug into the arena network*. Testing has been extensive to ensure quick response through the industrial network now standard in the FMS. Allowing teams to receive Internet on the subnet set up behind the Field Router could have detrimental effects on arena performance. Teams can potentially connect to the Arena Network at the FCUI or the ports on the back of the SCCs. If you find them doing this, promptly remove them. ***If Internet access is required at the Scoring Table for webcasting the event, contact FRC Engineering Support for assistance.***

NOTE #2: Looping 11" or 14" tie-wraps through the holes of the end frame top rails initially helps to form the harness support required for finishing the cable installation.

Be alert for additional power or camera cabling running on the audience side supporting the A/V crew and confirm that the cable will not interfere with the gates and is safely stowed along the side of the field.

3.1.7 Installing Group "B" Cabling

Group B includes all cables used at both ends of the field. and plug into the Station Control Cabinets. Refer to the Station Control Panel (below) drawings for the layout and location of interconnections.

3.1.7.1 LED Power/LED Data

The primary LED Power and Data cables are 16 feet long and are routed from connections LED Pwr and LED DATA on the left side panel of the Station Control Cabinet. They feed along the base flange of the diamond plate to the far left-side Upright and then up to the top of the Field end panel. The connectors must then be attached to the TIMER Display at the left end receptacles.

At the Station Control Cabinet, the cables are attached to the LED PWR and LED DATA receptacles as shown in this figure. Be sure to tighten the locking cap on the LED DATA plug on the Station Control Cabinet.

3.1.7.2 LED Power/Data Jumpers

The short Power and Data cables interconnect serially from the TIMER output to the Team Number 1 LED inputs (6'), from #1 LED outputs to the Team Number 2 LED input (6'), #2 LED output to # 3 Team Number LED inputs (6'). The 6-foot cables with the Amphenol 5-pin plugs deliver the Com data while the 3-pin cables provide the AC power for the LEDs.

3.1.7.3 Team Lights

Team Light cabling all runs directly from the Station Cabinet to each light. Attach the yellow Allen Bradley cables to the corresponding ports on the I/O module mounted just about the SCC.

Route wire according to Figure 5:

1) Team Light #1 and #2: From the Station Control Cabinet up the left post to the top of the Upright and then over to the #1 and #2 light assemblies.
2) Team Light #3: From the Station Control Cabinet up the right post to the top of the Upright and over to the #3 light.

3.1.7.4 E-Stops

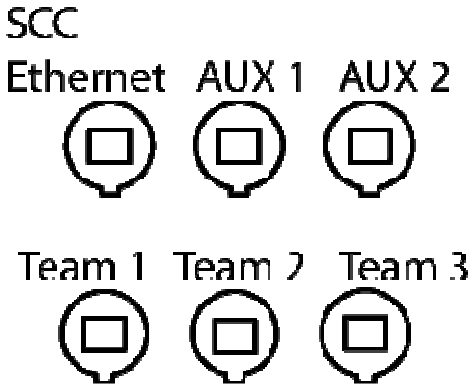
E-stop cabling all runs directly from the Station Cabinet to each E-stop. Attach the yellow Allen Bradley cables to the corresponding ports on the I/O module mounted just about the SCC.

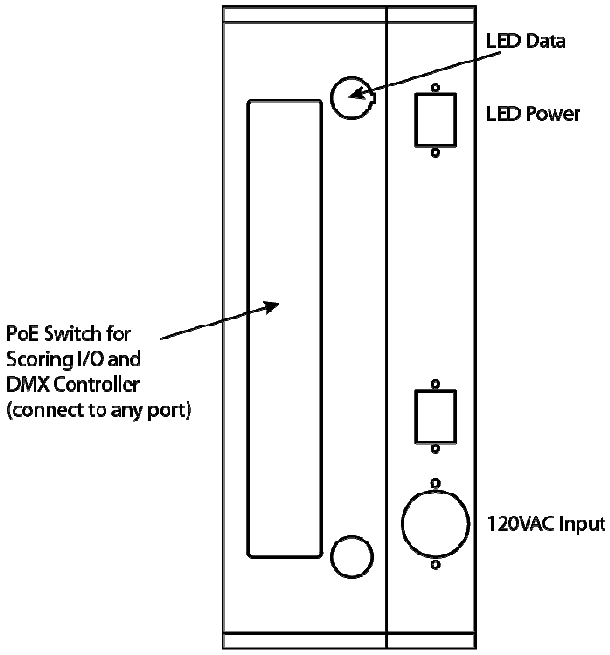
Route wire according to Figure 5:

1) E-stops #1: From the Station Control Cabinet up the far left Upright to the Driver Station shelf.
2) E-stops #2: From the Station Control Cabinet up the left Upright to the Driver Station shelf.
3) E-stops #3: From the Station Control Cabinet up the right Upright to the Driver Station shelf.
4)
5) Team Light #3: From the Station Control Cabinet up the right post to the top of the Upright and over to the #3 light.

3.1.7.5 Station Control Cabinets (SCC)

The SCC has connections located on the top and left side. They are for connecting the E-Stops, Ethernet, Team Light, AC Power, LED AC power, and LED Data cables, Scoring I/O, Touchscreens, and the DMX Controller. The 120 VAC Main Power receptacle is located on the left side of the SCC.





3.1.8 Installing Group "C" Cabling

Typically the Access Point is located on top of the Scorpion Case. Run a single Ethernet cable from the Access Point to the corresponding connection on the Scorpion Case. This connection will provide power and communication to the Access Point.

DO NOT power on the Access Point without the antennas connected!

3.1.9 Installing Group "D" Cabling

All cabling in Group D is required for operation of the Tower Bases.

3.1.9.1 Tower Bases

Tower Bases are wired directly to the Scoring I/O panel and DMX Controllers. See Section 3.1.9.3 for a picture of the connections at the Scoring I/O panel.

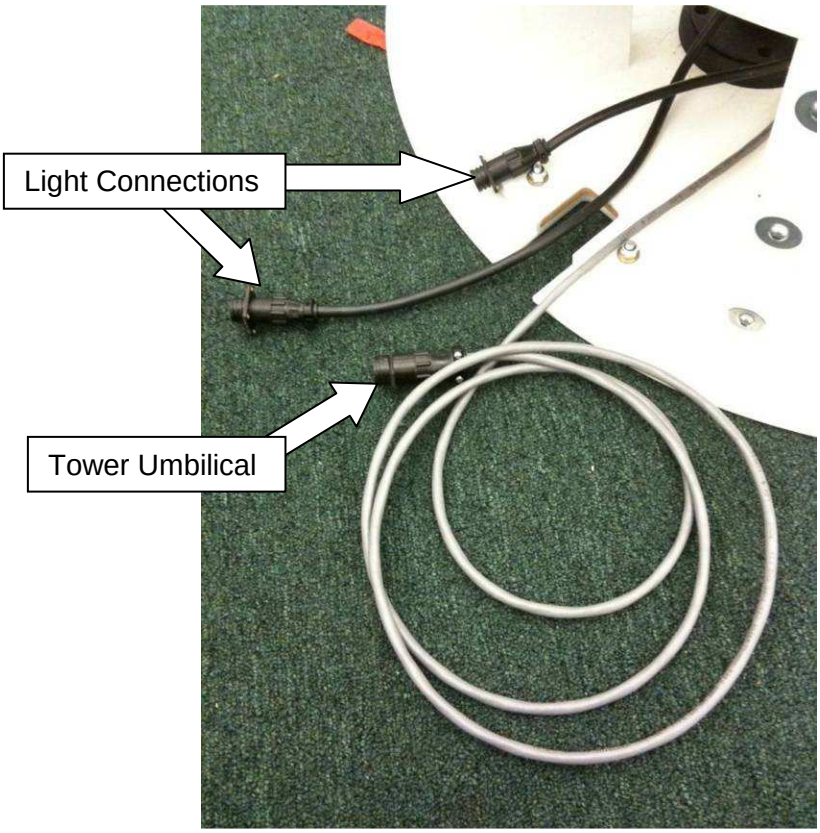


Figure 8: Tower Base connections

Figure 9: Tower Example (Prototype)

3.1.9.2 Scoring I/O Panel

The Scoring I/O panel sits on the floor behind the field wall in each corner of the field. A 120VAC power cable and an Ethernet cable are needed to connect it with the SCC.

1. Connect the 120VAC to the power strip behind the SCC.
2. Connect the Ethernet to any of the ports on the POE Switch on the left side of the SCC.
3. Connect the Tower Umbilical to the adapter at the I/O panel.

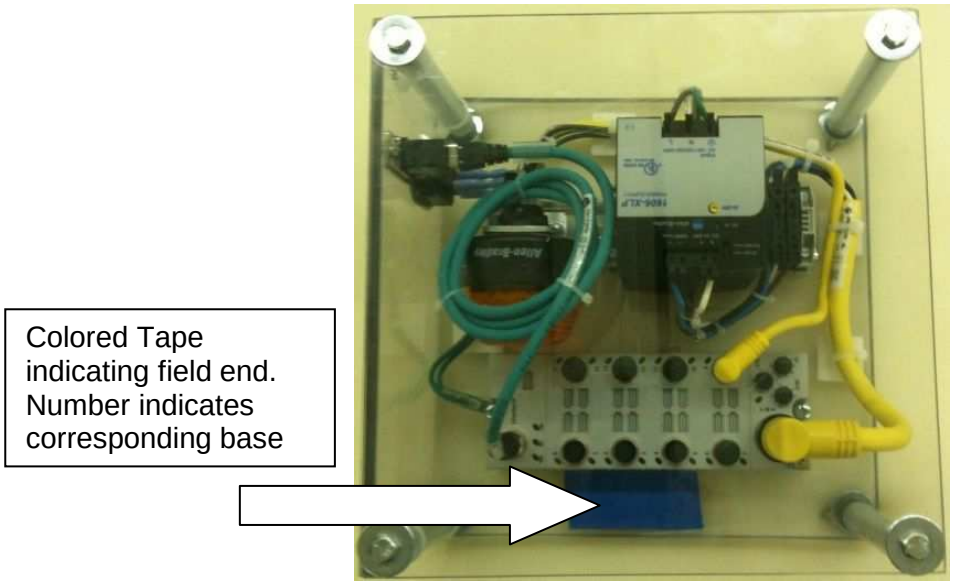
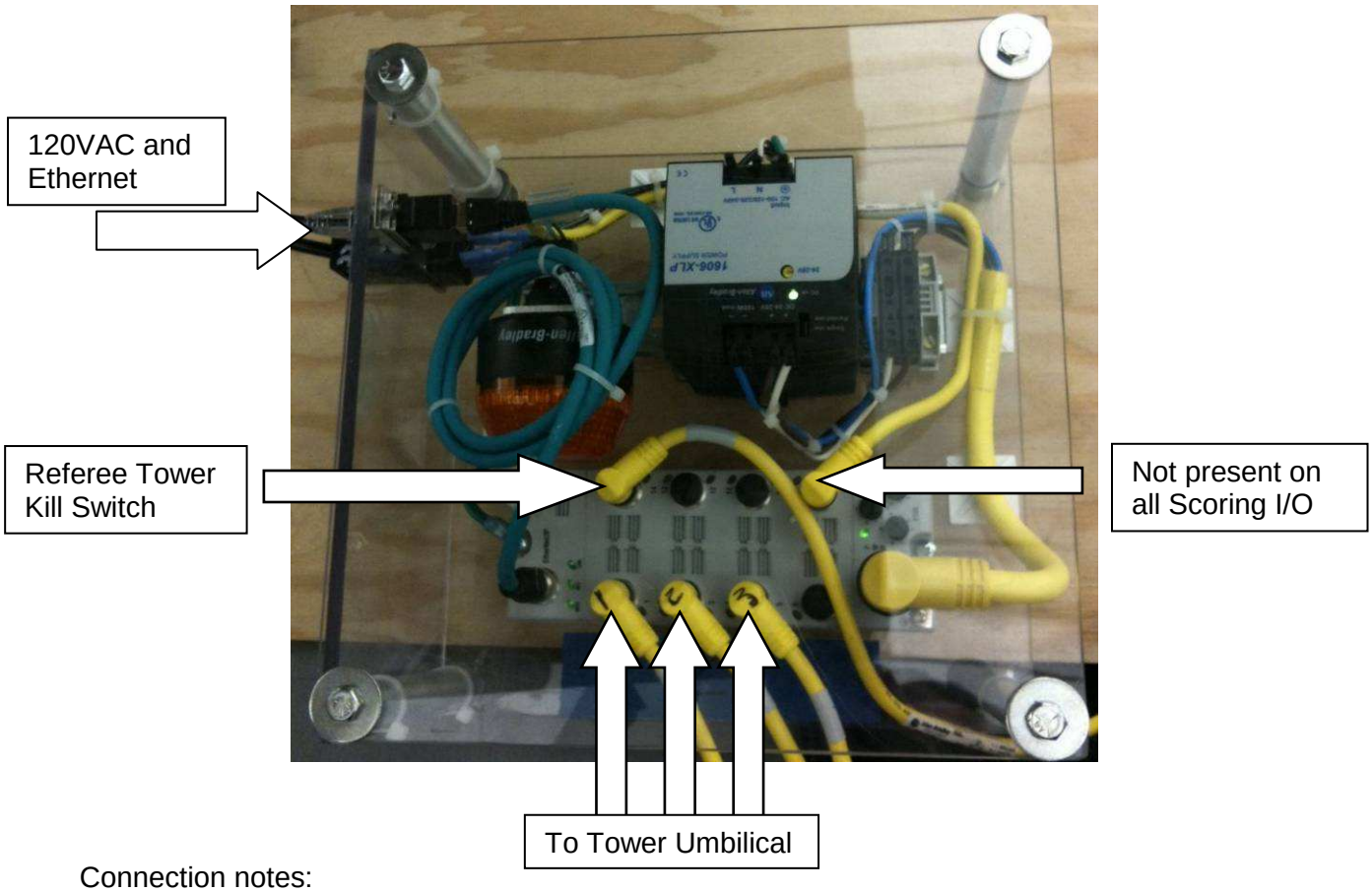


Figure 10: Scoring I/O Panel

The Scoring I/O panel is the main interface between the Target sensors and FMS. There are 5 Scoring I/O panels included with the Field. Each has a colored label and is numbered to indicate onto which field end and to which base they should be installed/connected. The panel with the black tape is the Spare and is stored in Case 19.

3.1.9.3 Setting up the Scoring I/O and connecting to the Tower Base

The Scoring I/O box is placed on the floor at each corner of the playing field, behind the field wall. The picture below shows the location and the connections.



Connection notes:

1. The Referee kill switch is used to disable the Tower in the event that a MINIBOT is deployed prior to the final 10 seconds of the match. This switch is placed on the outside of the playing field directly across from the Tower Base

3.1.9.4 Setting up the DMX Controller and connecting to the Tower Base

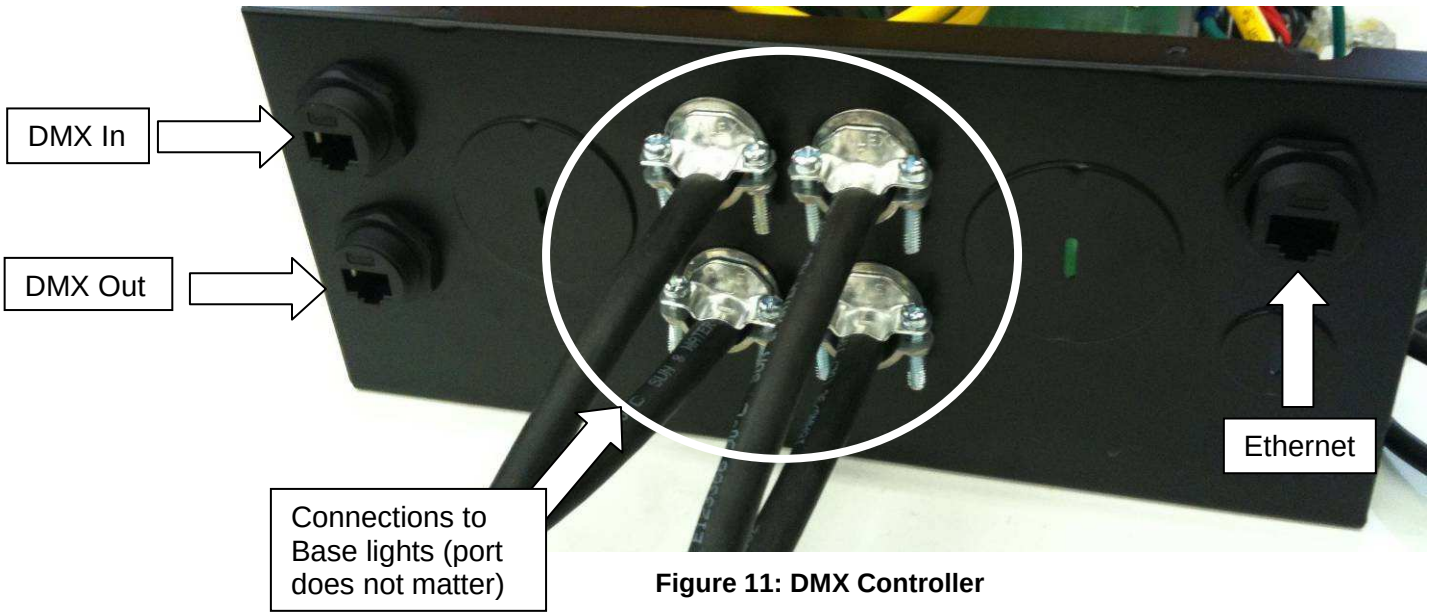


Figure 11: DMX Controller

Figure 11 shows DMX Controller. Some relevant notes regarding this device:

1. There are two controllers on the playing field, master and slave. Each is located on the Scoring Table side of the field next to the Scoring I/O box.
2. The controllers are linked using the together via a 75ft Ethernet cable which runs along the field border on the Scoring Table side of the field.
    a. Blue side DMX Out to Red Side DMX In.
3. The Ethernet port of the DMX controller connects to any of the Ethernet ports on the left-hand side of the SCC.

3.1.9.5 Setting up the Touchscreens

Recording the placement of the game pieces on the scoring pegs is handled by volunteers using touchscreens. There are 4 touchscreens on the playing field; each is located in a corner.

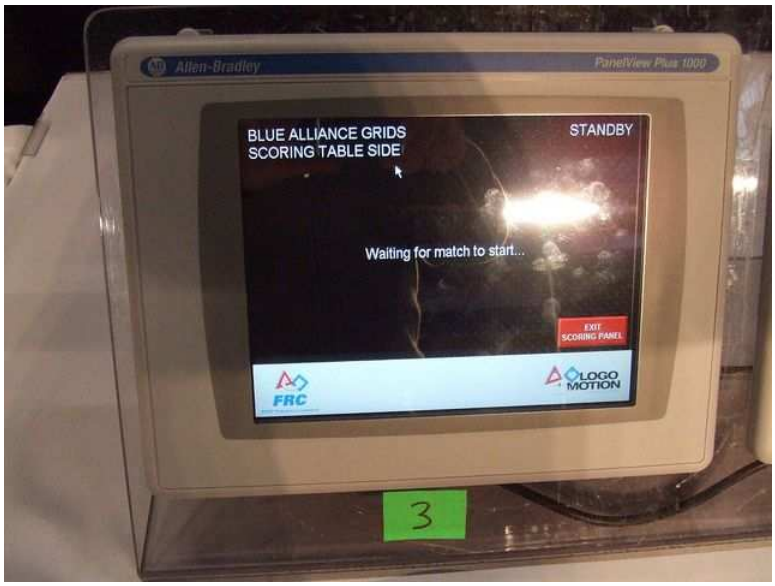


Figure 12: Touchscreen

Figure 6 and Figure 7 show the wiring required to connect the touchscreens into the playing field. Each touchscreen is mounted on a microphone stand.

NOTE: THE RED/BLUE TOUCHSCREENS ARE PLACED ON THE OPPOSITE END OF THE FIELD FROM THE END WHICH THEY ARE SCORING. This is so that the scorer has a clear view of the pegs, i.e the Red touchscreens are placed at the Blue end of the field.

3.2 DRESSING AND SECURING CABLES

When the cables have been fully interconnected, the installing team should inspect, secure, and dress, as necessary, all electrical cables for best appearance and safety of the equipment and all participants to the game. The following items should be reviewed and addressed in this step:

- LED Display and Team Light cables should be dressed and secured neatly by tyraps using the unused holes in the top rail of the Driver's Station. Suggestion: Looping 11" or 14" cable wraps through the holes of the end frame top rails initially helps to form the harness support required for finishing the cable installation.

- Cables running vertically should be secured by cable wraps to cable wrap pads mounted on the Uprights in a tidy manner inside the hinged vertical joint structures.

- Cables and any excess at the Station Control Cabinet should be coiled and stowed behind the unit when the SCC has been placed in the proper location under the shelf at the center of the #2 Driver's Station. Verify that the E-stops are secured in their correct position at the left-side edges of the Driver's Station shelves and that the E-stops are not activated (i.e. up position – rotate clockwise to deactivate).

- Any slack in cables running to the Scoring table should be taken up towards the table and secured. Cable bundles under the Driver's Station shelves should be drawn together and secured by tyraps around the bundle. For cables immediately under the Driver's Station shelves, ensure they are safe from being pinched by the swing out support blades holding the drivers' shelves. Cables should neatly go down the end poles and be secured to the pole as necessary for support.

- Cables should be routed along the outer edge of the side railings, under the gate ramp and secured to the tyrap anchor pads as necessary. Be sure that the cables are kept up against the side of the field and clear of any diamond plate or weight edges that could damage the cables.

- As noted above, be sure to feed all field-side cables between the outrigger uprights and the field side. Do not lay cables outside the outriggers over the trip guards.

Revision history:

Rev0: 24January2010 Original