

Chapter
4

**FIELD
ELECTRONICS**



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4 BUILDING THE FIELD ELECTRONIC SYSTEMS

4.1 FIELD ELECTRONICS AND SCORING SYSTEM

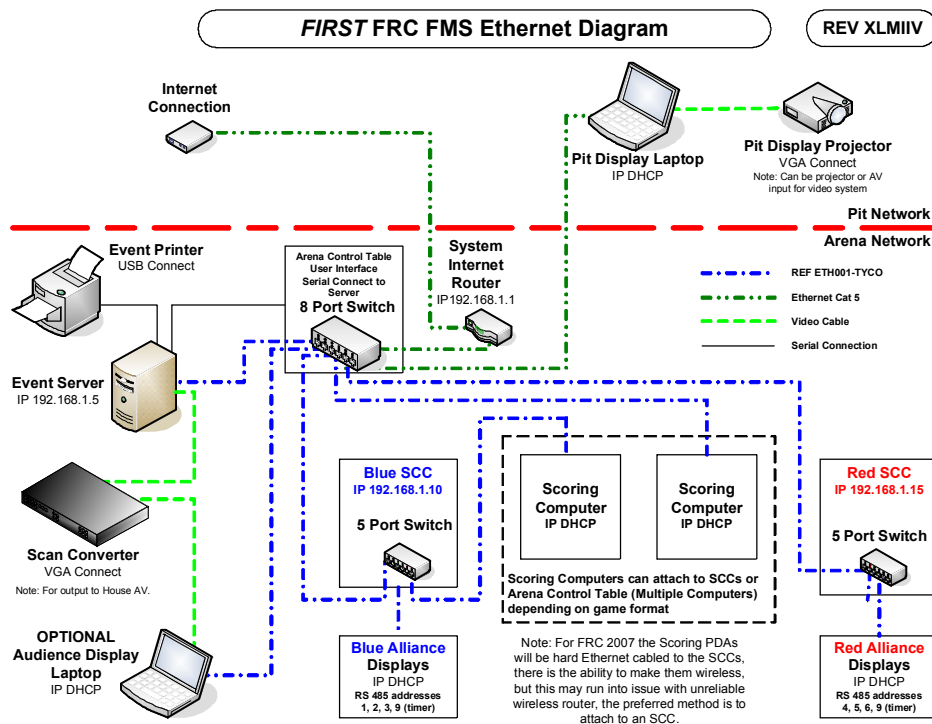
Items required:

- Wire cutter/pliers (for cutting cable wraps)
- Field Electronics Case: includes Station Control Cabinets (SCCs), LED Display units, Field Light Assemblies, E-Stop switches, power strips, and field electrical cables and harnesses.
- Scoring System Case: includes Event Server, CRT Monitor, Scan converter, Ethernet router (may be wired or wireless), power strips, printer, LCD display, Keyboard, Mouse, Field Control User Interface (FCUI), Pit Display laptop, Spare laptop, Referee Scoring Boxes, Lap Counter Decoder, Lap Counter Transmitters (mounted on Flags), and miscellaneous cables. Lap Counter Brackets (with receivers) are included in the Case #31, Bases.
- Banked Radios, and cables (included in the Lexan case).

4.1.1 Overview of Electronics Installation

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

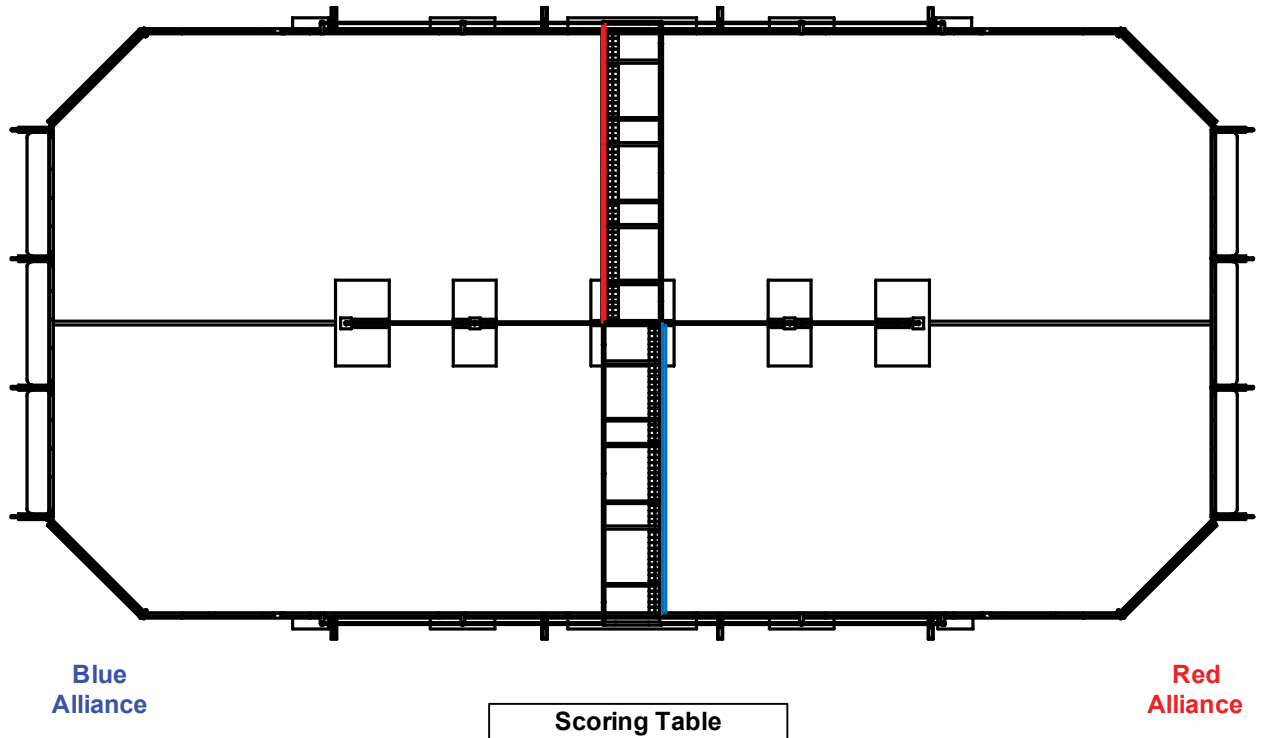
- 1) Locating main Scoring components on the Scoring Table.
- 2) Placing the main Field Electronics on the field ends.
- 3) Routing and connecting cables to appropriate termination points
- 4) Dressing and securing cable bundles for protection.



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4.1.2 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.



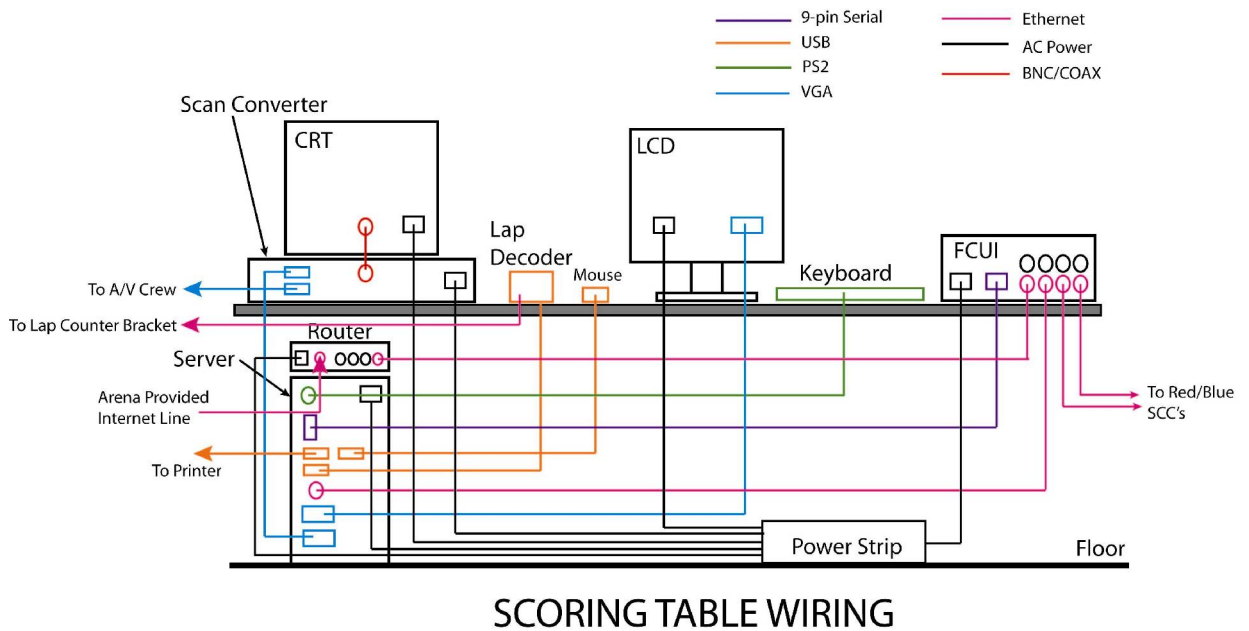
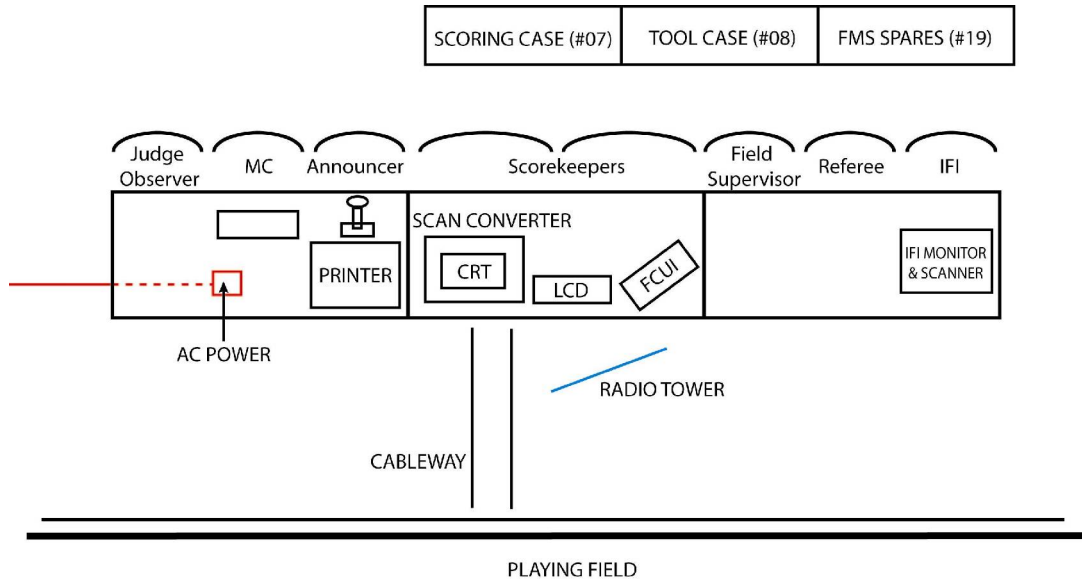
The Red Alliance Home zone and field equipment is located to the right-hand end of the field when observed from the Scoring table. The Blue Alliance Home zone and field equipment is located to the left-hand end of the field when observed from the Scoring table.

4.1.2.1 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. 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, 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.

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



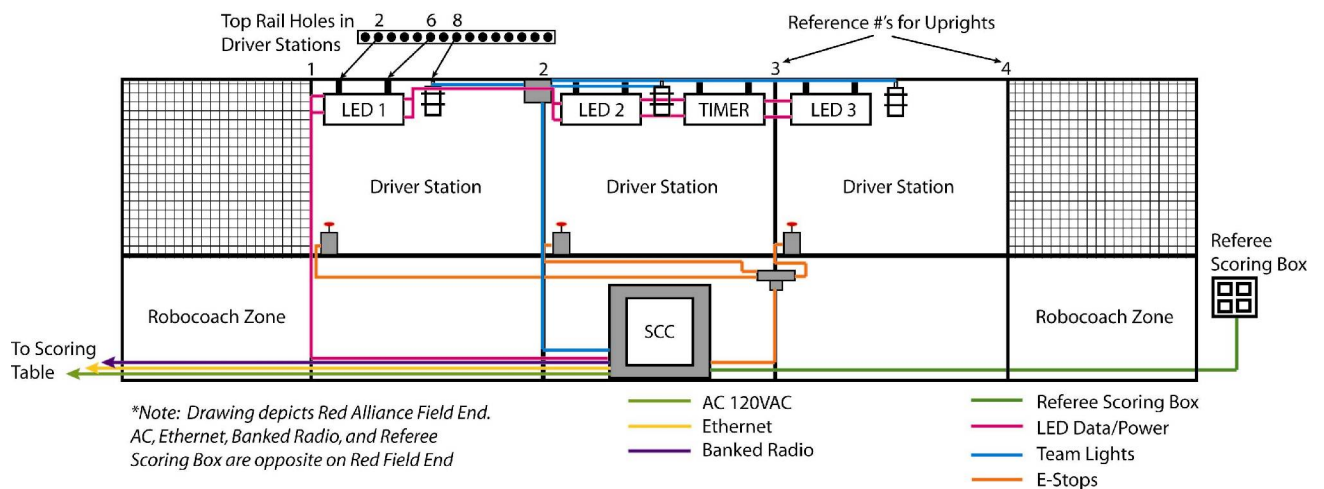
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4.1.3 Field Electronics (Case #06)

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 (wiring harnesses, etc.)

Referee scoring boxes are stored in the Scoring Case (#07). The Field End diagram shown below depicts the layout of the electronic modules and is viewed such that you are outside and behind the playing field at the end and looking back to the playing area. All equipment is mounted from behind the Field End panels (i.e., on the outside of the field). The equipment is laid out identically for each field end.



CAUTION

The Station Control cabinet weighs approximately 110 pounds and features a pair of rollers on the forward side of the cabinet base and flat mounting feet on the backside of the unit. The unit is moved by lifting the handle on the top of the cabinet and tilting the unit forward to engage the rollers. Use care to ensure that you have full control of the unit by its handle before tilting the box.



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When maneuvering the cabinet into its operating position under the Driver Station shelf, it may be necessary to use the top and/or side handles. Use caution when gripping the side handles as any attached connectors on the side panel connection plates may obscure and interfere with your grip and control of the cabinet.



The following steps are followed to position the electronic equipments:

Place 1 Station Control Cabinet assembly at each end of the field at the center of Drivers Station 2 as shown in the figure above. Note; the SCC has a Blue/Red selector switch on its front panel. The SCC switched to Blue should be placed at the Blue alliance end of the field. The remaining SCC should be on Red and is placed at the Red alliance end of the field.

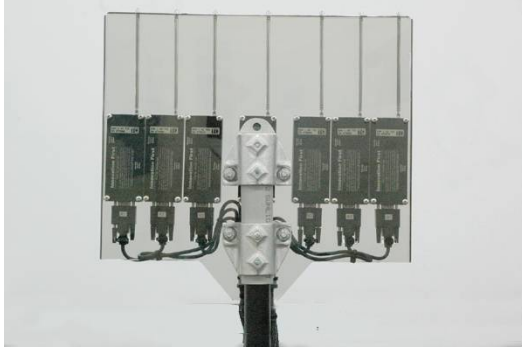
- 1) Team Number LED Display units #1, #2, and #3 are mounted at each of the three driver stations. There are 15 holes in the top rail counting from left to right. #1 hole is on the left end.
- 2) Start with LED #1 on the left, LED #2 in the center, and LED #3 on the right side. The LED Display assembly 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.
- 3) 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!*

- 4) 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.
- 5) 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.
- 6) The Banked-Radio Panel containing seven (six plus spare) Operator Interface transceivers is mounted onto a radio-stand tripod. The Banked Radio panel is typically located in the center of the playing field, just in front of the Scoring-table side. The cables and the radios are numbered as R1, R2, R3 and R4 (spare) for the Red

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alliance. B1, B2, B3, and B4 (spare) are for the Blue alliance. The Extender harness is designated as "E1 E2, E3, and E4. The Extender can be used as a backup if either of the two main radio cables has a failure.



Banked Radio



Blue and Red Banked Radio Cable Connections.

Note: Your radios may differ in appearance from those shown above.

- 8) To mount the radio bank expand the tripod and slip the radio bank mounting bracket over the tripod shaft. Lock the radio bank in place by gently tightening the Allen screw on the back of the bank. Run the "R" cable harness toward the Red Alliance end of the field. Run the "B" cable harness into the Blue end of the field.

4.1.4 Scoring (Case #07)

The Scoring case includes:

- Event Server –2 (primary and backup)
- CRT Monitor - 1
- Scan converter - 1
- Ethernet router – 2 (may be wired or wireless)
- Power strips - 2
- Printer - 1
- LCD monitor – 2
- Keyboard – 2
- Mouse – 2
- Field Control User Interface (FCUI) - 1
- Pit Display laptop – 1
- Referee Scoring Boxes – 3
- Lap Counter Decoder – 2
- Lap Counter Transmitters – 24 (6 pre-mounted on Flags)
- Required cabling

Photos of the Game Specific scoring equipment are shown below:

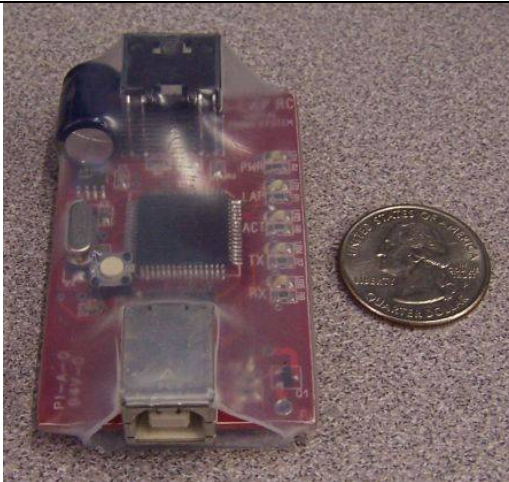
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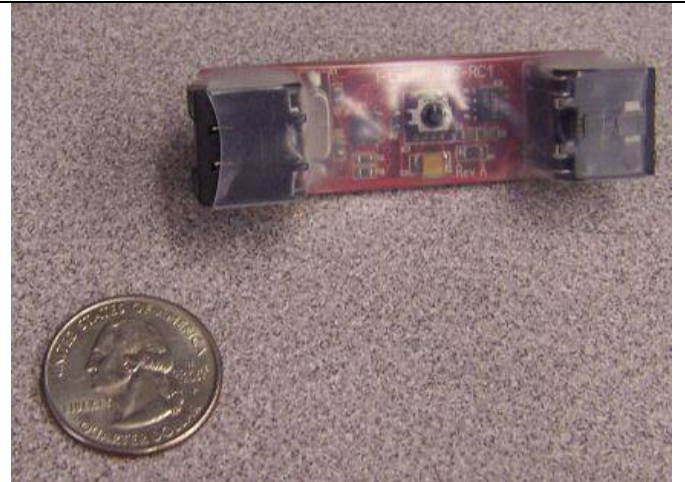
Referee Scoring Box (prelim)



Lap Counter IR Transmitter



Lap Counter Decoder



Lap Counter IR Receiver

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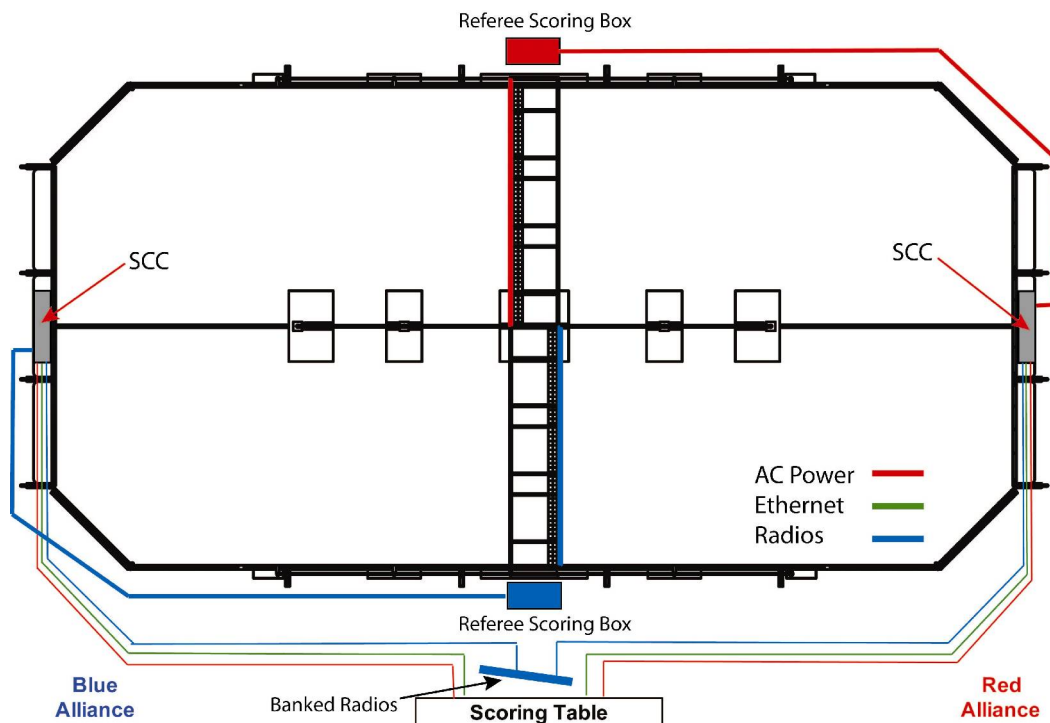


Figure 1: 2008 Field Wiring Diagram

4.1.5 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 Banked Radio cable harnesses remain the same as 2007 and run from the radio tripod directly to each end of the field.

The general routing of cables is depicted on the 2008 Field Wiring Diagram above. To keep the cabling task simple, cabling distribution is broken into three 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 – Banked Radio cabling runs from the tripod stand to each SCC unit at the field ends. Cables with connectors labeled **R1** to **R4** go to the **Red** end of the field; the **B1** to **B4** connectors plug onto the SCC unit at the **Blue** end of the field.

Group D: – All cables required for real-time scoring.

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

4.1.6 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 the SCC AC receptacle at the ends of the field. The AC cables are connected to the Triplite 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 one of the SCC RJ-45 Round Network connections (1 of 3). The Ethernet cable at the Red end of the field is also plugged into one of the SCC’s Network plugs.

At the Scoring end all Ethernet RJ-45s are plugged into the FCUI in any of the open ports numbered 1 to 8. The FCUI then is connected to the router through one of its network slots. **DO NOT plug the RJ-45s into the Internet slot on the Router!** This is reserved for the Internet connection coming from the facility to connect the arena subnet to the outside world.

NOTE: Do not allow teams to plug into the arena network; **this includes Webcasts!** 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 router (i.e. the FCUI side of the router) could have detrimental effects on arena performance. Teams can potentially connect to the Arena Network at the FCUI, the network Router, or the ports on the back of the SCCs. If you find them doing this, promptly remove them.

NOTE: 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.

The only *FIRST* cable that runs along the side of the field opposite the scoring table is the one connected to the Red Referee Scoring box. However, be alert for additional camera cabling running on the audience side supporting the A/V and confirm that the cable will not interfere with the gates and is safely stowed along the side of the field.

4.1.7 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.

4.1.7.1 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 rear 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 #1 Team Number LED 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.

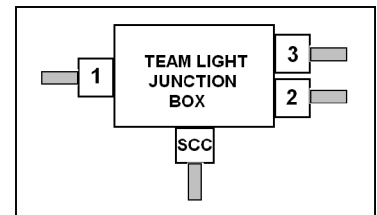
4.1.7.2 LED Power/Data Jumpers

The short Power and Data cables interconnect serially from the #1 LED Display output to the Team Number #2 LED inputs (6'), from #2 LED outputs to the Timer input (3'), Timer output to # 3 Team Number LED inputs (3'). The 3-foot and 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.

4.1.7.3 Team Lights

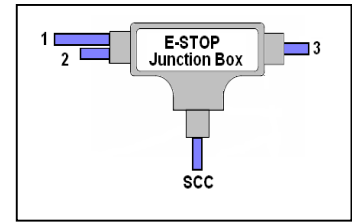
Install the Team Light Junction box at the top of Upright #3. Connect the 9-foot 5-pin umbilical plug to the receptacle at the back of the SCC. At the junction box connect the left side 3-foot cable to Team light #1; the right side 3-foot cable to Team Light #2, and the 9-foot cable to Team Light #3.

Typically the routing is from the Station Control Cabinet up the left post to the top of the end section and then over to the #1 and #2 light assemblies. The 9-foot #3 Team light cable should be routed along the top channel to the #3 Team light.



4.1.7.4 E-Stops

The E-Stop cabling also features a T-shaped junction box. The box is typically mounted with cable-ties to the upright at the right side of the SCC, at a height just below the Player shelf. A pre-installed strap holder is provided at this location.

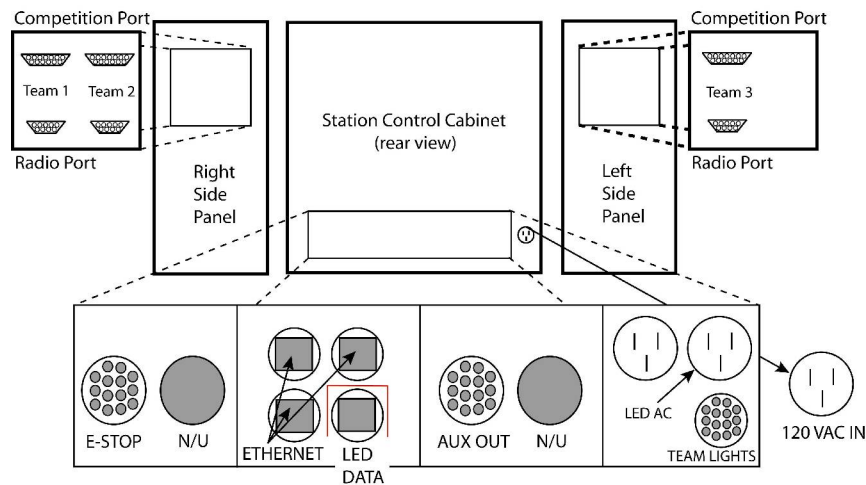


The single right side 18-inch cable connects to #3 E-Stop. The 6-foot cable on the left side connects to the #2 E-stop, and the 12-foot cable attaches to the #1 E-stop. The cable exiting at the bottom port of the junction attaches to the rear of the SCC on the far right receptacle.

Wire Pinch Hazard: Be sure to support all E-Stop cables with cable-ties, inserted through strap holders installed just under each end of the Player shelves. Failure to do so will allow the cables to droop down and potentially get pinched by the shelf support blade.

4.1.7.5 Station Control Cabinets (SCC)

The SCC has 4 connection panels located on the back of the console. They are for connecting the E-Stops, Ethernet, Team Light, AC Power, LED AC power, and LED Data cables, and the Referee Scoring boxes. The 120 VAC Main Power receptacle is also located on the back of the SCC.



STATION CONTROL CABINET CONNECTOR LAYOUT

Additional panels on the right and left sides of the console have the receptacles for the alliance Competition and Banked radio cables.

4.1.8 Installing Group “C” Cabling

Typically the Banked Radio tower is located directly in front of the Scoring-table. The harness containing the Blue alliance cables (B1, B2, B3 and spare B4) should be routed to the Blue Station Control unit and plugged into the corresponding Radio Port DB9 receptacles. The Red alliance harness (containing cables R1, R2, R3, and spare R4) will extend down the length of the field toward the Red Alliance Station Control unit and be plugged into the corresponding Radio Port DB9 receptacles.

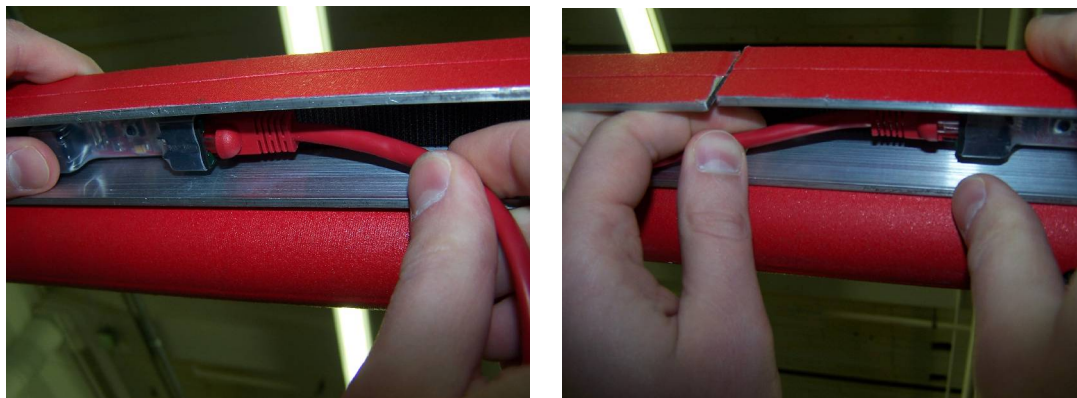
4.1.9 Installing Group “D” Cabling

All cabling in Group D is required for operation of the Lap Counter and Referee Scoring boxes.

4.1.9.1 Lap Counter System

The Lap Counter System includes 3 components: The Decoder, IR Receivers, and IR Transmitters. The Decoder connects via a single USB cable to any USB port on the Event Server. The Decoder then sits on the Scoring Table.

The IR Receivers are pre-installed into u-channel brackets that mount onto the Overpass. A 2ft CAT5 cable connects each receiver. Since there are two sensor brackets for each side of the field, a short cable section is provided to connect the sensors in one bracket to the sensors in the other. This connection is as shown to the right. Be sure to fit the cable completely up inside the bracket to protect it from snagging as robots pass by.



As shown in the photos below, the two sides of the field are linked together via a single 10ft CAT5 cable that loops around the top center of the Overpass. Be sure to neatly attach the cable on both ends as shown below to the right.



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Once this cable is in place and well positioned, drape the FRC banner over the top of the Overpass as shown, pull it down firmly into place. During transportation, this banner is housed in the lid of the Game Equipment road case, number 28.



A 25ft CAT5 cable connects the Decoder to the 1st IR receiver in the blue u-channel. This cable should loop around the Overpass End Support up to the u-channel. The other end of this cable will be bundled with other cables and taped down to the carpet on its way to the Scoring Table.

Later, during the matches, the queuing staff will give to each team their flag, which has the IR Transmitter attached, enclosed in clear polycarbonate boxes. Four full sets of transmitters (24 total) are included with each field.

4.1.9.2 Referee Scoring Boxes

Each hand-held Referee Scoring Box consists of two components, the Ball Tracking box and the Robot Tracking box. The two boxes are linked together via a 15-pin cable (same as a Competition cable). Each pair of boxes is connected to the SCC Aux Output connector via a 50ft umbilical cable. See the 2008 Field Wiring Diagram.

4.2 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 tyrap 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).
- 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 tyrap 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.

Note regarding E-Stop cabling:

Be sure to affix the E-Stop cables (the ones that pass UNDER the driver station shelves) to the cable tie supports, DO NOT let them drape down. Failure to do so may result in the shelf support blades pinching the cables.

Note regarding Lap Counter cabling:

IR Receivers and cabling is secured into the u-channel brackets with Velcro. Check to ensure this Velcro is tight preventing the IR receivers from coming loose during competition.

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Revision history:

1.1 1/2/2008 First edits