The ARENA includes all elements of the game infrastructure that are required to play CRESCENDOSM presented by Haas: the FIELD, GAME PIECES, queue area, team media area, designated TECHNICIAN area, and all equipment needed for FIELD control, ROBOT control, and scorekeeping.

Figure 5-1 CRESCENDO ARENA (queue area, TECHNICIAN area, and media area not pictured)

The ARENA is modular and assembled, used, disassembled, and shipped many times during the competition season. It undergoes wear and tear. The ARENA is designed to withstand rigorous play and frequent shipping. Every effort is made to ensure that ARENAS are consistent from event to event. However, ARENAS are assembled in different venues by different event staff and some small variations occur. For details regarding assembly tolerances, please refer to the 2024 ARENA Layout and Marking Diagram. Successful teams will design ROBOTS that are insensitive to these variations.

Illustrations included in this section are for a general visual understanding of the CRESCENDO ARENA, and dimensions included in the manual are nominal. Please refer to the official drawings for exact dimensions, tolerances, and construction details. The official drawings, CAD models, and drawings for low-cost versions of important elements of the CRESCENDO FIELD are posted on the CRESCENDO Playing FIELD web page on the FIRST website.

5.1 FIELD

Each FIELD for CRESCENDO is an approximately 26 ft. 11¼ in. (~821 cm) by 54 ft. 3¼ in. (~1654 cm) carpeted area bounded by inward facing surfaces of the ALLIANCE WALLS, SOURCES, AMPS and AMP pocket walls, and guardrails.
The FIELD is populated with the following elements:

- 1 AMP per ALLIANCE,
- 1 SPEAKER per ALLIANCE,
- 1 SOURCE per ALLIANCE, and
- 1 STAGE per ALLIANCE.

The surface of the FIELD is low pile carpet, Shaw Floors, Philadelphia Commercial, Neyland II 20, “66561 Medallion.” Neyland II carpet is not available for purchase, and the closest equivalent is Shaw, Philadelphia Brand, Profusion 20, Style 54933. The edge of the carpet is secured to the venue floor using 3M™ Premium Matte Cloth (Gaffers) Tape GT2 or comparable gaffers tape.

Guardrails form the long edges of the FIELD. Guardrails are a 1 ft. 8 in. (~51 cm) tall system of transparent polycarbonate supported on the top and bottom by aluminum extrusion. There are 4 gates in the guardrail that allow access to the FIELD for placement and removal of ROBOTS. The gate passthrough, when open, is 3 ft. 2 in. (~97 cm) wide. Gates are closed and shielded during the MATCH.
There are 2 versions of guardrails and DRIVER STATIONS used for competitions. 1 design is reflected in the 2024 Official FIRST FIELD Drawings & Models. The other is designed and sold by AndyMark. While the designs are slightly different, the critical dimensions, performance, and expected user experience between them are the same unless otherwise noted. Detailed drawings for the AndyMark design are posted on the AndyMark website. All illustrations in this manual show the traditional FIELD design.

### 5.2 Areas, Zones, & Markings

FIELD areas, zones, and markings of consequence are described below. Unless otherwise specified, the tape used to mark lines and zones throughout the FIELD is 2-in. (~5 cm) 3M™ Premium Matte Cloth (Gaffers) Tape (GT2), ProGaff® Premium Professional Grade Gaffer Tape, or comparable gaffers tape.
• **ALLIANCE AREA:** a 26 ft. 11¼ in. wide by 9 ft. 10¼ in. deep (~821 cm by ~300 cm) infinitely tall volume formed by, and including the ALLIANCE WALL, the edge of the carpet, ALLIANCE colored tape, guardrail, and the AMP wall.

• **AMP ZONE:** a 10 ft. 10 in. long by 1 ft. 5¾ in. wide (~330 cm by ~45 cm) infinitely tall volume defined by the AMP wall, guardrail, ALLIANCE WALL, and ALLIANCE-colored tape. The AMP ZONE includes the tape.

• **CENTER LINE:** a white line that bisects the length of the FIELD

• **COACH LINE:** a black line in the ALLIANCE AREA that extends from the end of the ALLIANCE WALL (AMP side) to the edge of the ALLIANCE AREA

• **ROBOT STARTING ZONE:** a 6 ft. 4½ in.-wide by 23 ft. 8¾ in.-long (~193 cm by ~721 cm) infinitely tall volume bounded by the ALLIANCE WALL, AMP ZONE, opponent’s SOURCE ZONE, and black tape. The ROBOT STARTING ZONE includes the black tape and excludes the AMP ZONE and SOURCE ZONE tape.

• **SOURCE AREA:** a 5 ft. ¾ in. wide by 15 ft. 10½ in. long (~154 cm by ~484 cm) infinitely tall volume bounded by the SOURCE wall, the edge of the carpet, and ALLIANCE-colored tape. The SOURCE AREA includes the tape.

• **SOURCE ZONE:** an infinitely tall parallelogram shaped volume bounded by the SOURCE wall, the opponent’s ALLIANCE WALL, and ALLIANCE-colored tape. The SOURCE ZONE is 1 ft. 6¾ in. deep (~48 cm) with respect to the SOURCE wall and includes the ALLIANCE-colored tape.

• **SPIKE MARK:** 1 of 11 1 ft. 1 in. (33 cm) marks used to identify placement of NOTES before the MATCH. The 3 marks in front of each SPEAKER are made with black tape, and the 5 marks along the CENTER LINE are made with black marker (see Figure 6-2).
• STAGE ZONE: an infinitely tall 6-sided volume surrounding the STAGE bounded by and including the ALLIANCE-colored tape.

Figure 5-5 Blue STAGE ZONE

• STARTING LINE: a white line spanning the ALLIANCE AREA and adjacent SOURCE AREA that is parallel to and located 2 ft. (~61 cm) from the bottom square tube of the ALLIANCE WALL to the near edge of the tape.
• WING: an infinitely tall volume bounded by the ALLIANCE WALL, opponent’s SOURCE wall, guardrail, the ALLIANCE colored line that spans the width of the FIELD, and AMP wall.

5.3 AMP

Figure 5-6 AMP

An AMP is a structure used by ROBOTS to pass NOTES to the ALLIANCE AREA. There is 1 AMP per ALLIANCE. Each AMP has a vertical pocket that is 3½ in. deep (~10 cm), 1 ft. 6 in. tall (~46 cm), and 2 ft. wide (~61 cm).
The bottom of the pocket is 2 ft. 2 in. (~66 cm) from the carpet. Each AMP is 4 ft. 1½ in. (~126 cm) from the closest ALLIANCE WALL.

There are 2 sets of lights on top of the AMP; ALLIANCE-colored AMP lights and an amber Coopertition light. AMP lights indicate the number of NOTES accumulated for AMPLIFICATION or Coopertition. The Coopertition light indicates progress toward Coopertition.

The AMP light behavior and meaning are as follows:
- bottom light on: the ALLIANCE has 1 NOTE towards AMPLIFICATION (or Coopertition)
- both lights on: the ALLIANCE has 2 NOTES toward AMPLIFICATION (1 of which can be used for Coopertition)
- top light blinking at 2Hz: the SPEAKER is AMPLIFIED (see Section 6.5.3 AMPLIFICATION).

The Coopertition light behavior and meaning are as follows:
- blinking at 1 Hz: it’s AUTO or the initial 45 seconds of TELEOP and the ALLIANCE has not used a NOTE for Coopertition
- solid on:
  o if initial 45 seconds of TELEOP, the HUMAN PLAYER has used a NOTE for Coopertition
  o if after the initial 45 seconds of TELEOP, both ALLIANCES have used a NOTE for Coopertition
- off: the Coopertition window has expired, and Coopertition was not accomplished

A wire panel (Uline H6277BL) is horizontally installed to the top of the guardrail and between the AMP and the ALLIANCE WALL.

5.4 SOURCE

A SOURCE is an assembly through which HUMAN PLAYERS feed NOTES into the FIELD. The SOURCE wall, the FIELD-facing side of the SOURCE, separates the SOURCE ZONE from the SOURCE AREA. Each SOURCE has a 6 ft. 3 ¼ in. wide by 6 in. tall (~191 cm by ~15 cm) opening through which NOTES pass to the FIELD; the bottom of the opening is 3 ft. ¾ in. (~93 cm) from the carpet. A 50° sloped tunnel, called the CHUTE, leads to the
opening in the SOURCE wall. The CHUTE extends into the SOURCE AREA such that the bottom edge of its SOURCE AREA opening is 4 ft. 4¾ in. (~134 cm) above the carpet.

5.5 STAGE

![Figure 5-8 STAGE](image)

Each STAGE is a 3-legged structure and 10 ft. 1 in. (~307 cm) from its corresponding ALLIANCE WALL. Each STAGE consists of truss feet, truss segments, truss junctions, aluminum framing, and polycarbonate sheets. The center core of the structure suspends from the truss such that aluminum surfaces are 2 ft. 4¼ in. (~72 cm) above the carpet, however certain features decrease the effective clearance under the core of the STAGE. The least amount of clearance is where polycarbonate gusset plates are above truss feet resulting in an actual clearance of 2 ft. 3⅞ in (~71 cm).

3 chains, designated STAGE Left, STAGE Right, and Center STAGE, as shown in Figure 5-9, span the space between each STAGE truss leg. Chains attach to each leg via a carabiner, eye bolt, and mounting gusset 4 ft. (~122 cm) above the carpet. Chains droop such that their lowest points are 2 ft. 4⅛ in. (~72 cm) from the carpet, and the chain rests 1 ft. 4⅝ in. (~42 cm) from the face of the STAGE core. The chain is ¼-in. Grade 43 zinc plated chain.
The core structure of the STAGE is a 6-sided column covered by polycarbonate walls. Each of the 3 wider walls have an opening, covered by a flap, which leads to a TRAP. The bottom of each opening is 4 ft. 8½ in. (~144 cm) above the carpet. The TRAP is the volume bounded by the 4 square tube segments highlighted in Figure 5-10 and the plastic panels covering the volume’s front and back.

Figure 5-10 TRAP highlighted in green
A MICROPHONE is a vertical post centered above each TRAP and mounted to the top of the core structure. Each MICROPHONE is a 1-ft. tall (~30 cm) piece of 1¼ in. Schedule 40 (1.66 in. (~4 cm) outer diameter) aluminum pipe. The top of each MICROPHONE is 7 ft. 4¼ in. (~224 cm) above the carpet.

![Figure 5-11 MICROPHONE highlighted in green](image)

A PODIUM is an ALLIANCE colored HDPE panel attached to the STAGE leg facing the ALLIANCE WALL. Each PODIUM is 1 ft. 5¾ in. tall by 10 in. wide (~45 cm by ~25 cm) and mounted just above the top of the truss foot.

![Figure 5-12 PODIUM](image)
The ALLIANCE WALL separates ROBOTS from DRIVE TEAM members in the ALLIANCE AREA. It consists of 3 DRIVER STATIONS and the vertical surfaces behind the SUBWOOFER.
5.6.1 SPEAKER

A SPEAKER consists of a SUBWOOFER and all elements above and behind the ALLIANCE WALL. The SPEAKER features an opening through which ROBOTS score NOTES. The opening is bounded by SPEAKER components and the top of the ALLIANCE WALL. The lowest edge of the SPEAKER opening is 6 ft. 6 in. (~198 cm) from the carpet, and the highest edge of the opening is 6 ft. 10 ⅞ in. (~211 cm) above the carpet. The opening is 3 ft. 5⅜ in. (~105 cm) wide and extends 1 ft. 6 in. (~46 cm) into the FIELD. The plane of the opening is at a 14° upward angle relative to the carpet. The roof inside the SPEAKER forms a concave surface against which NOTES bounce.
The SUBWOOFER is a 6-faced element centered below each SPEAKER and positioned against the ALLIANCE WALL. The SUBWOOFER is 3 ft. 1 in. (~94 cm) tall and the vertical panels are 8⅜ in. (~21 cm) tall. The SUBWOOFER extends 3 ft. ⅛ in. (~92 cm) from the ALLIANCE WALL. Vertical faces are black HDPE, the side inclined faces are ALLIANCE-colored HDPE, and the center inclined panels are vinyl-coated polycarbonate.

Lights indicate if the SPEAKER is AMPLIFIED and if so, how much AMPLIFICATION time remains. Light strings in the top of the SPEAKER match the ALLIANCE color and turn on if the SPEAKER is AMPLIFIED. ALLIANCE colored lights in the SUBWOOFER turn on when AMPLIFICATION starts and recede, second by second, as AMPLIFICATION progresses, and if AMPLIFICATION ends before the countdown completes (because the maximum number of NOTES have been scored), the SUBWOOFER and SPEAKER lights turn off.

5.6.2 DRIVER STATIONS

Figure 5-16 DRIVER STATION (ALLIANCE AREA perspective and FIELD perspective)
A DRIVER STATION is 1 of 3 assemblies within an ALLIANCE WALL behind which a DRIVE TEAM operates their ROBOT. Each DRIVER STATION is made from a 3 ft. ¾ in. (~93 cm) tall diamond plate base topped with a 3 ft. 6 in. (~107 cm) tall transparent plastic sheet and a top rail. An aluminum shelf is attached to each DRIVER STATION to support an OPERATOR CONSOLE. The shelf is 5 ft. 9 in. (~175 cm) wide and 1 ft. ¼ in. (~31 cm) deep. There is a 4 ft. 6 in. (~137 cm) long by 2 in. (nominal) wide strip of hook-and-loop tape (“loop” side) along the center of the support shelf that may be used to secure the OPERATOR CONSOLE to the shelf.

There may be a ramp available at events for DRIVE TEAMS with limited mobility. It is specially designed to allow an individual using a wheelchair to access the DRIVER STATION shelf and/or see onto the FIELD; however, this accommodation is available to anyone who using a wheelchair or other physical disability that obstructs their view of the FIELD. Teams should speak to the FTA before MATCHES begin to ensure that it is available for each of the team’s MATCHES.

This ramp is available at many Regional and District events. For questions please connect with the local Program Delivery Partner.

Each DRIVER STATION contains the following elements for DRIVE TEAMS:

- 1 Ethernet cable: attaches to the Ethernet port of the OPERATOR CONSOLE and provides connectivity to the FIELD Management System (FMS)
- 1 120VAC NEMA 5-15R power outlet (i.e. standard US outlet): located on each DRIVER STATION shelf and protected by its own 2-Amp circuit breaker. It can be used to power the OPERATOR CONSOLE. DRIVE TEAMS are responsible for monitoring their power consumption as a tripped breaker in the outlet does not constitute an ARENA FAULT. For some events in regions that don’t use NEMA 5-15 shaped outlets, event organizers may install appropriate plug adapters to be used throughout the event.
- 1 Emergency Stop (E-Stop) button: located on the left side of the DRIVER STATION shelf and is used to deactivate a ROBOT in an emergency
- 1 Autonomous Stop (A-Stop) button: located on the right side of the DRIVER STATION shelf and is used to DISABLE a ROBOT during AUTO
- 1 team sign: located at the top of each DRIVER STATION. The FIELD facing side of the sign displays the team number in the ALLIANCE color. The ALLIANCE AREA side of the sign displays the following information in red:
  - Pre-MATCH: team number and ROBOT connection state
  - During the MATCH:
    - progress toward RP threshold (n/a during the Playoff Tournament),
    - time remaining in AMPLIFICATION, and
    - remaining MATCH period time.
- 1 timer (in DRIVER STATION 2 only): displays the official time remaining in the MATCH period on the FIELD-facing side (in white) and official time remaining in the MATCH period and MATCH scores on the ALLIANCE AREA facing side (in red).
- 1 team LED stack: indicates ALLIANCE color, ROBOT status, E-Stop and A-Stop status, and is centered at the top of each DRIVER STATION.

The stack includes 2 identical ALLIANCE-colored ROBOT status LEDs above a third amber A-stop/E-stop LED. LED states are as follows:

- ROBOT status LEDs
  - Solid: indicates that the ROBOT is connected and enabled. This only happens during a MATCH.
Blinking: indicates that either the FMS is preset for the MATCH and the ROBOT is not connected yet, or it’s during a MATCH and the corresponding ROBOT is BYPASSED, has lost connectivity, or the E-stop was pressed.

Off: indicates that the ROBOT is linked and DISABLED prior to the start of the MATCH. This light is also off, regardless of ROBOT connection status, after the MATCH has concluded.

- A-Stop/E-stop LED
  - Solid: the ROBOT is DISABLED due to a press of the team E-stop button, the FIELD E-stop button, or by the scorekeeper via the FMS.
  - Blinking: the ROBOT is DISABLED for the remainder of AUTO due to a press of the team A-Stop button.
  - Off: the ROBOT is not DISABLED by the FIELD.

- FMS hardware and wiring: mostly located below shelves in the 2 DRIVER STATIONS closer to the scoring table.

5.7 GAME PIECES

![Figure 5-17 NOTE](image)

A NOTE is an orange foam torus with a 10 in. (~25 cm) inside diameter, 1 ft. 2 in. (~36 cm) outside diameter, and 2-in. (~5 cm) thickness. A NOTE weighs 8.3 ± 0.2 oz (~235.3 ± 6g). NOTES are available for purchase from AndyMark, [am-4999](mailto:am-4999).

NOTES undergo wear and tear during a competition. Generally, a NOTE that still appears to look approximately like a NOTE is considered a NOTE for the purposes of rule evaluation and scoring, whether damaged or not. Small chunks of a NOTE are not considered a NOTE.

A HIGH NOTE is the same size, shape, and material as a NOTE but also has 3 equidistant pieces of white gaffers tape that wrap around the circular cross-section.
5.8 AprilTags

AprilTags are 8½ in. (~20 cm) square targets located above SUBWOOFERS, on SOURCE walls, above AMP walls, and above TRAPS. There are 16 unique markers on the FIELD, positioned as shown in Figure 5-19.

All markers are from the 36h11 tag family, IDs 1-16. AprilTags 1-10 are mounted to and centered on a 10½ in. (~27 cm) square polycarbonate panel; AprilTags 11-16 are mounted to an aluminum plate. Each marker has an identifying text label. If AprilTags experience wear and marking during MATCHES, they are repaired with gaffers tape.
Figure 5-20 AprilTag sizing (plastic mounted, then aluminum mounted)
SOURCE AprilTags (IDs 1, 2, 9, and 10) are mounted to the SOURCE wall. The bottom of each tag’s panel is 4 ft. ⅛ in. (~122 cm) above the carpet and 1 ft. 7⅜ in. (~50 cm) from the vertical center of the SOURCE.

Figure 5-21 SOURCE AprilTags

SPEAKER AprilTags (IDs 3, 4, 7, and 8) are mounted to the ALLIANCE WALL. The bottom of each tag’s panel is 4 ft. 3⅛ in. (~132 cm) above the carpet. 1 tag (IDs 4 and 7) is vertically centered above each SUBWOOFER. The 2nd tag (IDs 3 and 8) is shifted toward DRIVER STATION 2 and the edge of its panel is 1 ft. 5 in. (~43 cm) from the vertical center of the SPEAKER ALLIANCE WALL plastic.
AMP AprilTag panels (IDs 5 and 6) are 4 ft. ¾ in. (~122 cm) above the carpet and centered vertically above the AMP wall.
STAGE AprilTag plates (IDs 11-16) are 3 ft. 11½ in. (~121 cm) above the carpet and centered vertically on each of the 3 wide faces of the STAGE core. These tags are behind ¼-in. (~6 mm) thick polycarbonate.

For further marker locating information please refer to the 2024 ARENA Layout and Marking Diagram. Printable versions of the markers are available on the 2024 Playing FIELD webpage.

5.9 The FIELD Management System

The FIELD Management System (FMS) is all the electronics responsible for sensing and controlling the FIRST Robotics Competition FIELD. The FMS encompasses all FIELD electronics, including computers, REFEREE touchscreens, the wireless access point, sensors, stack lights, A-Stops and E-Stops, etc.

When a DRIVE TEAM connects the Ethernet cable from their assigned DRIVER STATION to their OPERATOR CONSOLE, the Driver Station Software on the OPERATOR CONSOLE computer communicates with FMS. Once connected, the open ports available are described in Table 8-5.

Note that ROBOT code cannot be deployed while connected to the FMS. Additional information about the FMS may be found in the FMS Whitepaper.

The FMS alerts participants to milestones in the MATCH using audio cues detailed in Table 5-1. Please note that audio cues are intended as a courtesy to participants and not intended as official MATCH markers. If there is a discrepancy between an audio cue and the FIELD timers, the FIELD timers are the authority.

<table>
<thead>
<tr>
<th>Event</th>
<th>Timer Value</th>
<th>Audio Cue</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATCH start</td>
<td>0:15 (for AUTO)</td>
<td>“Cavalry Charge”</td>
</tr>
</tbody>
</table>
### 5.10 FIELD STAFF

FIELD STAFF are responsible for making sure the MATCHES are cycled through efficiently, fairly, safely, and with a spirit of cooperation, Gracious Professionalism, and generosity of spirit. FIELD STAFF roles are filled by volunteers from the community who prepare for the event with thorough training and certification. There are 3 FIELD-side key volunteer roles with whom teams should be familiar and are encouraged to use as resources to make their event experience valuable (in whatever way the team defines “valuable”).

- **Head REFEREE** – trains, directs, and supervises REFEREES. They oversee all scoring processes and procedures in collaboration with the FIRST Technical Advisor (FTA). They interact with STUDENTS, volunteers, and contracted/FIRST staff. The Head REFEREE is positioned between the FIELD and the scoring table and wears a yellow shirt. The Head REFEREE has final authority for decisions regarding MATCH scores, penalties, and YELLOW and RED CARD assignments. For additional details, please refer to the Head REFEREE role description.
- **FIRST Technical Advisor (FTA)** - ensures events run smoothly, safely, and in accordance with FIRST requirements. The FTA collaborates with FIRST staff, event staff, and other event volunteers in many different areas at events. The FTA is the liaison between FIRST HQ and the event for all things related to the FIELD, ROBOTS, and game, acts as a team advocate for all teams competing at the event, and is a major point of escalation and conflict resolution for the event. For additional details, please refer to the FTA role description.
- **FIELD Supervisor** - directs activity on the FIELD to ensure efficient execution of the MATCHES, pacing of the event, and smooth flow of MATCH play. FIELD Supervisors are responsible for ensuring the FIELD is intact and lead FIELD Reset teams, who are responsible for resetting the FIELD after each MATCH in preparation for the subsequent MATCH. For additional details, please refer to the FIELD Supervisor role description.

<table>
<thead>
<tr>
<th>Event</th>
<th>Timer Value</th>
<th>Audio Cue</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUTO ends</td>
<td>0:00 (for AUTO)</td>
<td>“Buzzer”</td>
</tr>
<tr>
<td>TELEOP begins</td>
<td>2:15</td>
<td>“3 Bells”</td>
</tr>
<tr>
<td>Final 20 seconds</td>
<td>0:20</td>
<td>“Guitar Riff”</td>
</tr>
<tr>
<td>MATCH end</td>
<td>0:00</td>
<td>“Buzzer”</td>
</tr>
<tr>
<td>MATCH stopped</td>
<td>n/a</td>
<td>“Foghorn”</td>
</tr>
</tbody>
</table>