RESTREPO STANDARD

Routed.
Bracketed.
Signed.

Pre-Drywall Audio Pre-Wire & Speaker Standard

Audio · Pre-Wire · Speaker · Bracket

Wire it right before the board goes up.

EDITION
v1.0 · 2026 · Audio · Pre-Wire · Speaker

VOLUME
23 · Sidecar Reference

00 PREFACE

The wire is pulled once. Every speaker home run, every keypad Cat6A (two home-runs minimum per location), every subwoofer circuit stub is routed, labeled, and service-looped before the drywall board is lifted. Once the ceiling is taped and the walls are painted, any missed run requires cutting finished surfaces, patching, and repainting. This standard codifies the pre-drywall audio and speaker discipline for the Restrepo Innovations whole-house audio program: wire specifications and code basis, home-run topology to rack, bracket placement and backer mounting, service loops and labeling, speaker cutout geometry, subwoofer pre-wire and power, keypad and control pre-wire, a 25-item pre-drywall QC gate, without-written-direction practices, trade coordination, and 25 cited primary sources. The wire is pulled once.

This standard does not replace manufacturer instructions, code authorities, or professional licensing. NEC 2023 Articles 640, 725, 800, 210, 300, 352, CEDIA RP-22 (Version 1.2, September 2023), ANSI/CEA-2010-A, NJ UCC NJAC 5:23, IEC 60268, and manufacturer installation guides govern. Verify all specifications against current product data sheets prior to procurement. See Citations for primary source URLs. Residential-only scope throughout. BX/MC cable for speaker runs, in-wall daisy-chain wiring, or amplifier loads above 70% of the minimum impedance rating all require written direction from the Restrepo principal before field implementation.

The wire is pulled once.

Route it right before the board goes up.

01 SCOPE AND APPLICABILITY

This standard governs all Restrepo Innovations luxury residential audio pre-wire scopes in new construction and gut-renovation projects. Code basis: NEC 2023 Articles 640, 725, 800; CEDIA RP-22 v1.2; NJ UCC NJAC 5:23. Applies before drywall application in every project with in-ceiling, in-wall, or rack-distributed audio systems.

Program Applicability

This standard applies to all Restrepo Innovations luxury residential audio pre-wire scopes executed in new construction or gut-renovation projects in New Jersey and contiguous markets. It governs every in-ceiling speaker home run, in-wall LCR speaker rough-in, subwoofer pre-wire, keypad Cat6A (two home-runs minimum), and control wiring installed before drywall application. The standard does not address post-drywall speaker trim-out, amplifier rack build, or system commissioning; those phases are governed by Restrepo trim-out and rack standards respectively.

Code Basis

NEC 2023 Article 640 (Audio Signal Processing, Amplification, and Reproduction Equipment) is the governing code for all audio system wiring. NEC Article 725 (Remote-Control, Signaling, and Power-Limited Circuits) governs Class 2 and Class 3 power-limited audio circuits. NEC Article 800 (Communications Circuits) governs plenum-rated cable requirements in return-air ceiling spaces. NJ UCC NJAC 5:23 adopts the NEC by reference; confirm adopted edition with local AHJ before each project. CEDIA RP-22 (Version 1.2, September 2023) is the reference design standard for immersive and distributed audio geometry. All in-wall speaker cable must be CL2 or CL3 listed under NEC Article 725. In plenum return-air spaces: CL2P or CL3P (CMP-rated) cable is required.

Zone Classification

Primary listening zones (great room, master suite, library, music room): 100-150W amplifier power per channel, full parametric EQ and room correction. Secondary listening zones (kitchen, dining room, formal living): 50-100W per channel, per-zone EQ. Ambient zones (baths, hallways, closets): 25-70W per channel, basic gain trim. Utility/value zones (mudrooms, guest utility areas): 25-50W per channel. Each zone receives its own dedicated home-run pair from the distribution closet; zone classification determines minimum wire gauge and amplifier assignment at rack build.

Spare Hardware Requirement

Minimum 5% spare conduit fittings, wire labels, back-cans, mounting brackets, and keystone jacks must be staged, labeled with project ID, and delivered at closeout of the pre-wire phase. Spare hardware staged at closeout prevents procurement delays during trim-out when individual items are no longer stocked at the field supply house. Label each spare lot with zone reference, product number, and project ID per Restrepo closeout standard.

> **NOTE · PROGRAM SCOPE**
> This standard applies from project kickoff through pre-drywall QC gate sign-off. Post-drywall trim-out, rack build, and system commissioning are governed by separate Restrepo standards. Any scope gap identified between this standard and a specific project condition requires written direction from the Restrepo principal before field work proceeds.

SCOPE AND APPLICABILITY NOTES

- Confirm AHJ adoption of NEC 2023 edition via NJ UCC amendment schedule before permit application. Some Bergen County municipalities may be on NEC 2020; code reference in this document is NEC 2023.
- Low-voltage audio wiring under Class 2 power limits generally does not require a separate electrical permit in NJ, but must be installed by a licensed low-voltage contractor per NJAC 5:23 jurisdiction requirements. Confirm with project AHJ.
- This standard applies exclusively to residential (single-family, estate, multi-family with private whole-house systems). Commercial AV installations governed by NEC Article 518, 522, and NFPA 90A are out of scope.

02 WIRE SPECIFICATIONS

NEC Article 640.6 and NEC Article 725 govern all in-wall speaker cable and Class 2/3 audio wiring. All cable in concealed wall or ceiling locations must be CL2 or CL3 listed (NEC 725). CL2P or CL3P (CMP) required in plenum return-air spaces (NEC Article 800). Wire gauge selected per run length and load impedance to keep total run resistance below 5% of speaker impedance.

APPLICATION	AWG	RATING	CODE REF	NOTES
In-wall speaker — ambient, run <= 50 ft, 8 ohm	14 AWG	CL2/CL3	NEC 725 / 640.6	Liberty 14-2-OFC or equivalent OFC CL2/CL3. Standard ambient zone run.
In-wall speaker — primary, run 51-100 ft, 8 ohm	12 AWG	CL2/CL3	NEC 725 / 640.6	West Penn 25227B (plenum) or Belden 5T00UP (CL2). Two-story or long-wing runs.
In-wall speaker — 4 ohm load, any length	12 AWG	CL2/CL3	NEC 725 / 640.6	12 AWG minimum for all 4 ohm loads. Low-Z requires lower resistance wire.
In-wall speaker — run > 100 ft, 8 ohm	10 AWG	CL2/CL3	NEC 725 / 640.6	Estate long-run closet to end-of-run. Belden 5T00UP 10 AWG CL2.
Plenum ceiling return-air space — any gauge	Per gauge	CL2P/CL3P	NEC 800	West Penn 25227B 12 AWG CMP. Never use non-plenum CL2 in return-air space.
70V / 100V Hi-Z distributed speaker	16 AWG	CL3	NEC 725 / 640.6	Hi-Z lower current; Class 3 required at 70V. NEC 640.6 Class 3 wiring method.
Keypad and control Cat6A home run	Cat6A	CMP/CMR	NEC 800	Belden REVConnect Cat6A. All keypad and touchscreen home runs from closet.
Subwoofer signal pre-wire (line-level)	18 AWG shielded 2-cond.	CL2 or CMP	NEC 725	Belden 8760 shielded for analog sub pre-out. Cat6A for IP-controlled subs.

WIRE SPECIFICATION NOTES

- Wire resistance rule: total run resistance (both conductors) must not exceed 5% of speaker impedance. For 8 ohm / 75 ft: 12 AWG (1.59 ohm/1000 ft/conductor) = 75 x 2 x 1.59 / 1000 = 0.24 ohm = 3.0% of 8 ohm. Acceptable.
- Never use lamp cord (SPT-1, SPT-2), zip cord, or unrated wire in wall or ceiling cavities. This violates NEC 725 and NJAC 5:23. Any non-CL2/CL3-rated wire requires written direction before use.
- Oxygen-free copper (OFC) is the Restrepo standard for speaker wire. Standard electrolytic copper is acceptable on value-tier zones but not specified for primary listening zones.
- Single-color cable standard: black jacket on every low-voltage run. Speaker wire, Cat6A, control, shade, and lighting all pull black. One color stocked, one color pulled, one color serviced for the life of the home.
- Spare hardware: minimum 5% spare wire labels, Cat6A keystone jacks, and back-can screws delivered at closeout, labeled with project ID.

SPEC · SINGLE-COLOR CABLE STANDARD: BLACK JACKET ON EVERY LOW-VOLTAGE RUN.
Restrepo Innovations specifies black-jacketed cable for all low-voltage disciplines — speaker wire, Cat6A, control, shade, lighting, audio, and security all pull black. Color-by-function cable schemes are deliberately rejected: no trade crew maintains a color assignment consistently past day one, and mismatched re-pulls in year three become a service liability that a rigorous label discipline prevents but jacket color cannot. Black bundles read smaller in the wall cavity and in the rack. One jacket color stocked means one color pulled, one color serviced for the life of the home.

03 HOME-RUN TOPOLOGY TO RACK

Every speaker home run terminates at the distribution closet — the single star-point for the project. No in-wall daisy-chain. No Y-splitters. Cat6A for all network audio and keypad runs. Distribution closet: dedicated 20A audio circuit and 20A network circuit; rack-mount power conditioning.

Hub-and-Spoke Architecture — Mandatory

Every speaker location receives a dedicated, uninterrupted cable home run from the distribution closet to the speaker back-can or wall bracket. No in-wall daisy-chain connections. No Y-splitters. Hub-and-spoke enables per-zone impedance control, independent DSP management, and reliable fault isolation. The distribution closet is the single star-point for all audio home runs on the project.

Distribution Closet Location and Rack

The distribution closet must be a dedicated space separate from the main electrical panel room, located at the geometric center of the home. Minimum 6U rack for 8-zone systems; 12U for 12-zone; 16U for 16-zone or larger. Rack receives one dedicated 20A audio circuit and one 20A network circuit; rack-mount power conditioning (Furman or equivalent) with surge protection and EMI filtering. Ambient temperature below 95 F.

Cat6A Home Runs for Network Audio

All Crestron DM NAX, Savant AVB, Roon Ready, and Sonos Amp endpoints receive a dedicated Cat6A home run from the distribution closet. Cat6A (TIA-568.2-D, 500 MHz, 10GBase-T) is the minimum spec for all new construction audio runs. Do not use Cat5e. Terminate with Belden REVConnect Cat6A keystones. For runs over 100 m or where galvanic isolation is required, specify OM3/OS2 fiber with a PoE media converter.

Conduit Routing from Closet

Home runs exit the distribution closet through 3/4-in. minimum EMT or Schedule 40 PVC conduit to the first penetration in each wall or ceiling chase. Conduit fill: NEC Chapter 9 Table 1, maximum 40% for three or more conductors. Label all conduit stubs at both ends before drywall with zone designation per Section 05. Pull string confirmed in every stub.

> **DONOT · NO DAISY-CHAIN WIRING**
> In-wall daisy-chain speaker wiring is not consistent with this standard. Running wire from speaker A to speaker B inside the wall creates parallel impedance loads the amplifier cannot independently control, eliminates per-speaker DSP processing, and prevents individual fault diagnosis. Any departure from hub-and-spoke topology requires written direction from the Restrepo principal with explicit documentation of the load-management plan.

HOME-RUN TOPOLOGY TO RACK NOTES

- Confirm distribution closet location with GC and architect before framing begins. Relocating the closet after framing adds significant run length and may require an additional sub-panel.
- Network audio platforms (Crestron DM NAX, Savant AVB) require a managed L2 switch. Cisco CBS350 series or equivalent with IGMP snooping and QoS DSCP marking. Savant AVB requires an AVB-certified switch.
- Spare hardware: minimum 5% spare Cat6A patch cords, keystone jacks, and conduit caps delivered at closeout, labeled with project ID.

04 BRACKET PLACEMENT AND BACKER MOUNTING

All speaker mounting brackets, back-cans, and backer boards are installed before drywall application. JBL Synthesis sealed back-boxes and Sonance R2 structural backing require framing coordination. Back-can depth is verified at every location before installation.

Pre-Construction Bracket Installation — Mandatory Before Board

Install the speaker mounting bracket, back-can, or backer board at every speaker location before drywall application. Confirm: (1) bracket is centered on the mark established in the framing plan; (2) bracket is plumb and level in the ceiling or wall plane; (3) wire has been pulled through the bracket opening with service loop secured inside the back-can; (4) model number spec sheet is taped to the inside of the back-can for future reference; (5) center of speaker location is marked on adjacent framing with chalk line so the drywall installer can preserve the location and transfer the mark to the finished surface.

Back-Can and Backer Board Specifications

JBL Synthesis SCL-3 / SCL-4: sealed wood back-box is a structural acoustic component, not optional. Fasten the back-box to adjacent framing, not to drywall alone. Sonance VP Series (VP62R, VP82R, VP86R): adjustable-bar mounting bracket attaches to adjacent ceiling joists; minimum 16-in. on-center framing spacing. Sonance Reference R1/R2: pre-construction bracket with backer board; the R2 (34-7/8 in. height) requires structural blocking between studs to provide a continuous fastening surface. Paradigm CI Elite E80-R v2 (9-3/16 in. cutout): install Paradigm mounting ring before drywall. B&W CWM7.5 S2: reservoir back-can (385 mm H x 181 mm W) is a sealed acoustic enclosure essential to rated performance; performance without the back-can will be significantly degraded. Install and fasten before board.

Sonance Invisible Series Rough-In

The Sonance IS6, IS8, and IS10 invisible series require a stiffening ring and frame installed on the back of the drywall before hanging, or fitted into the cavity after hanging via a precision-dimensioned rough opening. Pre-wire home run with service loop in the cavity before the board is installed. Do not apply heavy texture coats over 3 mm; use only thin skim coat. The IS6 mounting depth is 2.68 in.; the IS8 is 2.68 in.; the IS10 is 3.15 in. Verify wall cavity depth before specifying the Invisible Series. Mark center of speaker on framing before board is hung.

Backer Board for In-Wall Speakers

All in-wall speakers (Sonance R1/R2, B&W CWM7.5 S2, Triad Gold InWall) require a structural backer board blocking between studs at the speaker cutout location. Minimum 3/4-in. plywood backer, full width between studs, fastened with 3-in. screws into adjacent studs. Backer must span the full height of the speaker cutout plus 2 in. at top and bottom. Without a backer, the spring-clip or dog-ear mounting system bears against a single drywall layer only, which is insufficient for speakers heavier than 3 lbs. All Triad and JBL Synthesis speakers exceed this weight threshold.

> **INSPECT · BRACKET INSTALLATION INSPECTION**
> Verify at every speaker location before drywall: (1) bracket or back-can fastened to framing with appropriate screws, not to drywall alone; (2) spec sheet taped inside back-can for future reference; (3) service loop secured in back-can with cable tie; (4) center of speaker marked on framing with chalk line; (5) photograph archived to project record with date and technician initials.

BRACKET PLACEMENT AND BACKER MOUNTING NOTES

- Photo-document all bracket and back-can installations before drywall application. Archive with zone designation, date, and technician initials. Required for QC gate sign-off.
- IC (insulation contact) rated back-cans are a best practice in insulated ceiling planes even in NJ where IC rating is not required by code. IC back-cans prevent thermal bypass through the ceiling insulation.
- For plaster walls or specialty wall finishes: confirm finish depth with architect before specifying back-can depth. Plaster systems can add 1/2 to 3/4 in. to finished wall depth beyond drywall.

05 SERVICE LOOPS AND LABELING

Minimum 18-24 in. service loop at every speaker location; minimum 5 ft at rack end. Label format: Z##-ROOM-CL-A. UV-resistant heat-tolerant labels rated for -40 F to 250 F. Sleeve schedule signed by GC and Restrepo PM before drywall.

Service Loop Requirements

At each speaker location: minimum 18 to 24 inches of service loop stored in the back-can or against the bracket before drywall application. The loop is coiled and secured with a cable tie to the bracket or back-can mounting hardware. At the distribution closet: minimum 5 feet of service coil for each home run, coiled and secured in the rack enclosure before termination. Rationale: service loops allow future speaker replacement without fishing additional wire. A 24-in. loop at the ceiling gives enough slack to pull the speaker 12 inches from the ceiling opening for comfortable termination and reconnection.

Restrepo Label Format: Z##-ROOM-CL-A

Label every wire pair at both ends before drywall application with zone designation and speaker position. Restrepo standard label format: Z[zone number]-[room abbreviation]-[position code]-[speaker letter]. Examples: Z02-LIV-CL-A (Zone 2, Living Room, Ceiling, speaker A); Z02-LIV-CL-B (Zone 2, Living Room, Ceiling, speaker B); Z05-MBA-CL-A (Zone 5, Master Bath, Ceiling, speaker A); Z08-PAT-CL-A (Zone 8, Patio, Ceiling, speaker A); Z03-GRM-IW-L (Zone 3, Great Room, In-Wall, Left). Cat6A keypad runs use the same zone designation with suffix KP: Z02-LIV-KP (Zone 2, Living Room, Keypad).

Label Materials

Use UV-resistant, heat-tolerant wire labels (Brady BMP21-PLUS or equivalent) rated for attic and wall cavity environments: -40 F to 250 F, resistant to adhesive failure at humidity above 80%. Labels must remain legible for the life of the installation. Do not use paper labels, masking tape labels, or handwritten tape. At the rack end, label each home run with the same zone designation using permanent-adhesive wrap labels or flag labels; organize home runs in labeled bundles by zone number before termination.

Sleeve Schedule Documentation

The sleeve schedule is a project document that records every home run designation, wire type, gauge, rating, origination point, and termination point before drywall. The schedule is signed by the GC representative and the Restrepo project manager before drywall application proceeds. Any deviation from the schedule after sign-off requires a written change order. The sleeve schedule is archived to the project record and is available to future service technicians. Format: one row per home run, columns for zone ID, room, position, cable type, AWG, rating, and installation date.

> **SPEC · LABEL COMPLIANCE LOCK**
> Every wire pair must be labeled at both ends before drywall application. A label applied after drywall is not compliant; an unlabeled distribution-closet end cannot be traced without tone-and-probe work. Any home run without a compliant label at both ends holds the drywall schedule for that zone until remediated. Use Brady BMP21 or equivalent UV-resistant labels rated for the full thermal range of attic and wall cavity environments.

SERVICE LOOPS AND LABELING NOTES

- Label both ends of every home run before drywall. A label applied after drywall is not compliant with this standard; the distribution-closet end of an unlabeled run cannot be traced without expensive tone-and-probe work.
- For estates with 12 or more zones: use a pre-printed wire label set generated from the zone schedule in the design phase, not field-written labels. This eliminates transcription errors and ensures consistent abbreviations.
- Spare hardware: minimum 5% spare wire labels and label stock delivered at closeout, labeled with project ID.

06 SPEAKER CUTOUT GEOMETRY

One in-ceiling pair per 100 sq ft ambient; one per 60 sq ft primary. Avoid placement within 18 in. of a wall boundary. Cutout dimensions by model: VP82R 10-1/8 in., SCL-3 14.2 in. square, E80-R v2 9-3/16 in. Pivoting-tweeter aim direction marked on framing.

Spacing and Placement Rules

Ambient listening zones (background music, SPL 70 dB or below): one in-ceiling speaker pair per 100 square feet. Place speakers approximately 7 to 8 feet apart in a stereo pair configuration; aim tweeters toward the primary listening area. Primary listening zones (music-focused, SPL 85 dB or below): one in-ceiling speaker pair per 60 square feet; or one high-sensitivity single speaker per 80 square feet with tweeter pivot aimed toward seating. Avoid placing in-ceiling speakers within 18 inches of a wall boundary to prevent bass reinforcement peaks and comb filtering in the 2 to 4 kHz range.

Cutout Dimensions by Speaker Model

Sonance VP62R: 7-1/4 in. diameter cutout. Sonance VP82R: 10-1/8 in. diameter cutout (10-3/8 in. mounting depth 5-7/8 in.). Sonance VP86R: 10-1/8 in. diameter cutout. JBL Synthesis SCL-3: 14.2 in. x 14.2 in. square cutout (360 x 360 mm), mounting depth 5.8 in. Paradigm CI Elite E80-R v2: 9-3/16 in. diameter cutout, mounting depth 3-7/8 in. minimum. Revel C763: 8 in. diameter cutout, mounting depth 4-25/32 in. B&W CCM7.5 S2: 332 mm (13.1 in.) diameter cutout, depth 184 mm (7.2 in.). Sonance R1 in-wall: 7-1/2 in. W x 20-1/2 in. H cutout; Sonance R2 in-wall: 7-1/2 in. W x 33-1/2 in. H (requires structural blocking between studs).

Tweeter Pivot and Aim

All pivoting-tweeter in-ceiling speakers (Sonance VP series, Paradigm CI Elite, B&W CCM series, Revel C763/C563) must be aimed to cross at the seated listening height at the primary listening position during trim-out. Mark the intended tweeter pivot direction on the ceiling at rough-in: a small arrow drawn on the framing in the direction of the primary seating area, visible to the drywall crew so the bracket is not rotated. In a hallway or corridor, aim toward the walking path. Never leave tweeters aimed straight down in a room where primary seating is offset from center.

Back-Can Depth Verification

Verify cavity depth for every speaker location before bracket installation. Minimum cavity depth must accommodate back-can depth plus 1 in. clearance for wire loop and insulation. Critical dimensions: Sonance Invisible IS6/IS8: 2.68 in. mounting depth; minimum 3.5 in. wall cavity. B&W CWM7.5 S2: 60 mm (2.4 in.) depth; reservoir box 385 mm H x 181 mm W requires full stud-bay clearance. JBL Synthesis SCL-3: 5.8 in. depth. Any ceiling joist obstruction within the back-can footprint must be resolved at framing before the subfloor or ceiling is installed.

> **FIELD · SPEAKER CENTER MARKING PROTOCOL**
> Mark all speaker cutout center points with chalk on the back of the drywall backer or on the framing member closest to the center. Add a backup mark on the adjacent framing member in case the primary mark is covered by the board. Photograph all center marks with a reference dimension before boarding. Center marks are required for all speakers including Sonance Invisible Series, which is cut post-drywall.

SPEAKER CUTOUT GEOMETRY NOTES

- Mark all speaker cutout center points on framing with chalk lines and photograph before boarding. The photograph establishes the center for template use at cutout time post-drywall.
- For open-plan spaces over 600 square feet: specify two stereo pairs minimum. Consider island and seating group as separate sub-zones within the same amplifier zone if ceiling height and room geometry favor different aim points.
- Master bath speakers: use moisture-resistant grilles. Specify IC-rated back-cans in insulated ceiling planes even where NJ code does not require it.

07 SUBWOOFER PRE-WIRE AND POWER

In-wall and discrete active subwoofers require: (1) 12 AWG CL2 speaker wire home run; (2) 18 AWG shielded sub pre-out signal run; (3) dedicated 120VAC circuit stub at sub location. REL S/812 high-level Speakon input. 70% minimum impedance rule applies to all sub channel assignments.

In-Wall and In-Ceiling Subwoofer Pre-Wire

Sonance IW Sub (in-wall subwoofer) and the Sonance IS-series require a dedicated 12 AWG CL2 or CL3 home run from the distribution closet and a structural backer board between studs at the installation location. Subwoofer rough-in requires: (1) 12 AWG speaker wire home run from amplifier zone output; (2) 18 AWG shielded 2-conductor home run (Belden 8760 or equivalent) for line-level sub pre-out signal from the amplifier's subwoofer pre-out; (3) a dedicated 20A 120VAC circuit stub for active subwoofer amplifiers installed at or near the speaker location. The Sonance SR 2-125 amplifier for the Sonarray system is rack-mounted in the distribution closet; only the speaker wire runs to the in-wall sub.

Discrete Subwoofer Power Stub

SVS SB-3000, SVS PB-3000, REL S/812, and Paradigm Defiance X series are active (powered) subwoofers requiring a 120VAC circuit stub at the installation location. Stub: 12 AWG THWN-2 in 3/4-in. PVC Schedule 40 or EMT conduit from the nearest available 20A branch circuit. The subwoofer circuit must be on a circuit separate from the main audio rack amplifier circuit to prevent ground-loop injection. NEC 210.8(F): GFCI protection is required at all 120VAC outlets in finished living spaces per the 2023 NEC. Confirm GFCI protection at the subwoofer outlet is coordinated with the audio system ground plane to prevent nuisance trips.

Signal Path: Line-Level vs. High-Level

REL S/812: specify a 3-conductor Neutrik Speakon cable from the main amplifier's speaker outputs to the REL high-level input. This preserves the sonic character of the main amplifier-loudspeaker combination and eliminates the need for a separate sub pre-out from the rack. Pre-wire the Speakon cable in conduit from the amplifier rack to the subwoofer location before drywall. All other active subwoofers (SVS, Paradigm Defiance, JBL Synthesis SSW-1 powered versions): use the amplifier's subwoofer pre-out, routed via 18 AWG shielded 2-conductor cable in conduit from the rack to the sub location.

70% Amplifier Load Rule

No zone impedance may be lower than 70% of the amplifier's stated minimum impedance without written documentation from the project engineer. Example: a 4-ohm-stable amplifier may not be loaded below 2.8 ohms without written engineering authorization. In practice, this means no subwoofer or speaker combination below 4 ohms on a 4-ohm-rated amplifier channel without calculating the parallel impedance of all speakers on that zone and obtaining written direction. This applies to passive subwoofer channels bridged from a stereo amplifier pair as well.

> **SPEC · SUBWOOFER CIRCUIT LOCK**
> Every active subwoofer location requires a dedicated 120VAC circuit stub pulled before drywall. The subwoofer circuit is on a circuit separate from the main audio rack amplifier circuit to prevent ground-loop injection. NEC 210.8 GFCI protection applies. Structural engineering review is required before procurement of any subwoofer exceeding 40 lbs in a wall or floor application. JBL SSW-1 at 350.5 lbs always requires structural review.

SUBWOOFER PRE-WIRE AND POWER NOTES

- JBL Synthesis SSW-1: this is a theater-grade unit, 350.5 lbs net. Specify structural floor support and custom millwork cabinetry before procurement. Structural engineering review required for any sub exceeding 40 lbs in-floor or in-wall.
- For stacked dual-subwoofer deployments (asymmetrical rooms): each subwoofer feeds from an independent Class 2 circuit. Do not parallel subwoofer amplifiers without proper line-level splitting to prevent ground loops.
- Paradigm Defiance X series have Anthem Room Correction (ARC) built in. Pre-wire USB Micro-B port access at sub location or plan for wireless ARC measurement path during commissioning.
- Spare hardware: minimum 5% spare 120VAC subwoofer circuit outlets, conduit fittings, and Speakon connectors delivered at closeout, labeled with project ID.

08 KEYPAD AND CONTROL PRE-WIRE

Two Cat6A home-runs minimum at every keypad, touchscreen, and matrix amp location — Cat A active, Cat B coiled SPARE for future touchscreen or IP-device conversion. PoE: IEEE 802.3af for Crestron Horizon and TSW-570; IEEE 802.3at for TSW-770, TSW-1070, Control4 T4. Neutral wire confirmed at all Lutron RA3 and HomeWorks QSX junction boxes.

Two Cat6A Home-Runs Minimum at Every Keypad Location

Every keypad location (Lutron Sunnata, HomeWorks QSX keypad, Crestron Horizon, Crestron TSW-770, Control4 T4) receives two dedicated Cat6A home-runs from the distribution closet — Cat A active, Cat B coiled and labeled SPARE for future touchscreen or IP-device conversion. IEEE 802.3af PoE (12.95W) supports Horizon and TSW-570. IEEE 802.3at PoE+ (30W) supports TSW-770, TSW-1070, and Control4 T4. Label Cat A per the Z##-ROOM-KP format; label Cat B as Z##-ROOM-KP-SPARE.

Lutron RadioRA 3 and HomeWorks QSX Rough-In

RA3 keypads: single Cat6A from repeater or RA3 processor to each keypad. HomeWorks QSX: daisy-chain from QSX processor over Cat5e or Cat6; confirm cable spec with Lutron Designer Software. All current Lutron RA3 and QSX in-wall dimmers require a neutral wire in the junction box. Confirm neutral availability at each keypad location with the electrical subcontractor before rough-in is finalized.

Volume Control Pre-Wire

For passive in-wall volume controls: pre-wire two separate 14 AWG CL2 home runs per location: (1) amplifier output from closet to volume control input; (2) volume control output to speaker back-can. Single-wire daisy-chain through the volume control violates hub-and-spoke discipline. Passive volume controls are not preferred for primary listening zones; specify per-zone DSP at the amplifier with Cat6A keypad control instead.

Control4 SR-260 and Crestron Horizon

Control4 SR-260 remote: ZigBee RF to controller; no home run required. Crestron Horizon keypad: PoE Cat6A home run only. Control4 T4 in-wall: PoE Cat6A; requires 4-gang junction box with 5/8-in. drywall knockout. Confirm every audio zone keypad location has Cat6A home run to the managed switch before drywall proceeds.

> **FIELD · KEYPAD POE BUDGET CHECK**
>
> Calculate total PoE draw on the managed switch before finalizing keypad count. Cisco CBS350 48-port with 370W PoE budget supports approximately 28 simultaneously active keypads at 13W each. Budget 20% headroom. For estates with touchscreens (30W PoE+), recalculate with actual device power draw. A switch budget shortfall discovered at trim-out requires either a second PoE switch or a mid-span injector — plan at pre-wire.

KEYPAD AND CONTROL PRE-WIRE NOTES

- Confirm PoE budget on managed switch before finalizing keypad count. A 48-port CBS350 with 370W PoE budget supports approximately 28 simultaneously active PoE keypads at 13W each. Budget 20% headroom.
- For estates with voice control (Apple Siri via Sonos/AirPlay, Amazon Alexa via Sonos): do not install standalone smart speaker microphone hardware at keypad locations. Voice is a secondary convenience layer; keypads are primary control.
- Spare hardware: minimum 5% spare Cat6A keystone jacks, in-wall mounting brackets, and single-gang mud rings delivered at closeout, labeled with project ID.

09 PRE-DRYWALL QC GATE

Every item below is verified before drywall application proceeds. Any unchecked item holds the schedule until remediated. This checklist is the gate between audio pre-wire and drywall installation. Project lead signature is required on the QC Gate page before any board is placed.

- [ ] Speaker home runs pulled, labeled Z##-ROOM-CL-A at both ends, service loop 18-24 in. in back-can or against bracket
- [ ] Cat6A keypad and control home runs pulled, labeled Z##-ROOM-KP at both ends, service loop 5 ft at rack end
- [ ] Back-cans, brackets, backer boards installed at all speaker locations; fastened to framing, not drywall; spec sheet inside back-can
- [ ] Sonance Invisible Series stiffening rings installed before board or rough opening dimensioned to template; center marked on framing
- [ ] Sonance R2 (33-1/2 in. H) structural blocking confirmed between studs at all R2 locations; photo documented
- [ ] JBL Synthesis SCL-3/SCL-4 sealed back-boxes fastened to framing at all SCL locations; not attached to drywall alone
- [ ] All speaker wire rated CL2 or CL3 (CL2P/CL3P in plenum); no lamp cord, zip cord, or unrated wire in concealed locations
- [ ] Wire gauge matches zone: 14 AWG (ambient <=50 ft), 12 AWG (primary or 51-100 ft), 10 AWG (>100 ft); 4 ohm minimum 12 AWG
- [ ] Subwoofer power stubs: 12 AWG THWN-2 in 3/4-in. conduit at each active sub location; capped and labeled SUB-PWR-Z##
- [ ] Subwoofer signal runs: 18 AWG shielded 2-cond. (or Cat6A) rack to sub location; labeled SUB-SIG-Z##
- [ ] Conduit fill verified: maximum 40% for 3+ conductors per NEC Ch. 9 Table 1; pull string confirmed in all conduit stubs
- [ ] Speaker cutout centers chalk-marked on framing; backup mark on adjacent framing member in case primary mark is covered
- [ ] Tweeter pivot direction marked on ceiling framing for all pivoting-tweeter models; arrow toward primary seating
- [ ] Back-can depth verified: cavity accommodates back-can depth plus 1 in. clearance at every speaker location
- [ ] Cat6A terminated to Cat6A (not Cat5e) keystone jacks; labeled and documented on sleeve schedule
- [ ] Neutral wire confirmed at all Lutron RA3 and HomeWorks QSX keypad junction boxes
- [ ] Two dedicated 20A circuits (audio and network) pulled to distribution closet rack location
- [ ] Rack-mount power conditioning outlet stub confirmed; conduit cap and label at rack location
- [ ] All home runs on sleeve schedule: zone ID, room, position, cable type, AWG, CL rating, installation date
- [ ] Sleeve schedule signed by GC representative and Restrepo project manager before drywall proceeds
- [ ] Photo grid: overhead and close-up of all back-cans, brackets, labeled wire archived to project record
- [ ] Subwoofer structural review complete: subs over 40 lbs have engineering confirmation; JBL SSW-1 requires floor review
- [ ] NEC 725.136: Class 2/3 audio wiring separated from 120VAC by min. 2 in. in raceway or 6 in. unenclosed; no mixed enclosures without approved barrier
- [ ] Service loops confirmed: 18-24 in. at speaker locations, 5 ft at rack end; coiled and cable-tied to hardware
- [ ] Spare hardware minimum 5%: labels, back-can screws, Cat6A keystones, conduit fittings staged, labeled, delivered at closeout

QC GATE · 10-ITEM PRE-DRYWALL PASS/FAIL

All 10 items must be PASS before drywall application proceeds and before the system is delivered to owner. Every item is reviewed by the project lead. Any failed item holds the schedule until resolved and re-inspected.

#	QC GATE ITEM	PASS	FAIL
1	**All home runs pulled and labeled before board** Every speaker and keypad home run labeled at both ends per Z##-ROOM format; service loop confirmed in back-can and	PASS / SIGN	FAIL / HOLD
2	**Back-cans, brackets, backer boards installed** All speaker locations have bracket or back-can fastened to framing; spec sheets taped inside back-cans; documented	PASS / SIGN	FAIL / HOLD
3	**Wire rating confirmed CL2/CL3 or CMP in plenum** Visual inspection confirms no lamp cord, zip cord, or unrated wire in any concealed location.	PASS / SIGN	FAIL / HOLD
4	**Wire gauge matches zone spec** 14 AWG or heavier for ambient zones <= 50 ft; 12 AWG for primary zones and runs to 100	PASS / SIGN	FAIL / HOLD
5	**Subwoofer power and signal stubs confirmed** 120VAC stub capped and labeled at each active sub location; signal run (shielded 18 AWG or Cat6A) pulled and	PASS / SIGN	FAIL / HOLD
6	**NEC 725.136 voltage separation confirmed** Class 2/3 audio wiring separated from 120VAC by minimum 2 in. in same raceway or 6 in. if unenclosed	PASS / SIGN	FAIL / HOLD
7	**Speaker cutout centers marked on framing** Chalk marks on framing confirmed at all speaker and back-can locations with backup	PASS / SIGN	FAIL / HOLD
8	**Photo-documentation grid archived** Overhead and close-up photographs of all back-cans, brackets, and labeled wire archived to project record with	PASS / SIGN	FAIL / HOLD
9	**Sleeve schedule signed** Sleeve schedule signed by GC representative and Restrepo project manager; all rows	PASS / SIGN	FAIL / HOLD
10	**Spare hardware minimum 5% delivered and labeled** 5% spare labels, back-can screws, Cat6A keystones, conduit fittings staged, labeled with project ID, confirmed at closeout	PASS / SIGN	FAIL / HOLD

PROJECT LEAD SIGN-OFF

Signature / printed name _____ DATE MM/DD/YYYY _____ PROJECT _____

10 WITHOUT WRITTEN DIRECTION

The following practices require explicit written approval from the Restrepo principal, project engineer of record, or client before field implementation. BX/MC for audio wiring, in-wall daisy-chain topology, and amplifier loads beyond 70% of minimum impedance are framed as requiring direction, not as categorically unavailable.

BX/MC Cable for Audio Speaker Runs

Metal-clad (MC) or armored cable (BX) used in commercial audio under NEC 518.4(A) is non-standard for residential speaker runs. The metallic armor creates a grounding path that can introduce 60 Hz hum via antenna coupling and ground loops on Class 2 audio circuits. Any use of BX/MC for audio speaker wiring requires written direction from the Restrepo principal and project engineer of record before the first run is pulled.

In-Wall Daisy-Chain Speaker Wiring

Daisy-chain wiring (running wire from speaker A to speaker B inside the wall) creates parallel impedance loads the amplifier cannot independently control, prevents per-speaker DSP, and eliminates individual fault diagnosis. Any departure from hub-and-spoke topology requires written direction from the Restrepo principal with documentation of the load-management plan including impedance matching and power derating for the affected zone.

Amplifier Loads Beyond 70% of Minimum Impedance Rating

No zone impedance may be lower than 70% of the amplifier's stated minimum impedance without written documentation from the project engineer. A 4-ohm-stable amplifier may not be loaded below 2.8 ohms without written direction. Calculate parallel impedance for all speakers on a zone, including passive subwoofers bridged from a stereo pair, before specifying the amplifier channel assignment.

> **NOTE · WRITTEN DIRECTION PROTOCOL**
> Written direction is a signed project record entry specifying the scope of the deviation, the technical rationale, the responsible engineer, and the date of authorization. Verbal direction from a project manager is not sufficient. Any field technician asked to implement a practice covered in this section without a written direction document on file should stop work and contact the Restrepo principal before proceeding.

WITHOUT WRITTEN DIRECTION NOTES

- Repurposing existing non-rated wire (unused telephone wire, old speaker wire of unknown rating, Cat5 runs) for new speaker circuits requires written direction. Non-CL2/CL3-rated wire cannot legally serve as speaker cable in a concealed wall location under NEC Article 725 and NJAC 5:23.
- Mixing Class 2 audio conductors and 120VAC line voltage in the same enclosure without an approved barrier (NEC 725.136) requires written direction and AHJ approval. Do not share a 4-gang electrical box between a duplex outlet and an audio keypad without a listed barrier.
- Any field substitution of specified speaker wire gauge, rating, or amplifier assignment from the approved design requires written change-order documentation signed by the Restrepo project manager before implementation.

11 COORDINATION WITH OTHER TRADES

Audio pre-wire depends on framing, HVAC, plumbing, and electrical work that must be resolved before the board is lifted. A joint pre-drywall walk with GC, electrical subcontractor, HVAC subcontractor, and Restrepo audio lead is required before QC gate sign-off.

Framing Coordination

The Restrepo audio lead must review the framing layout with the GC crew before framing begins. Confirm: ceiling joist direction and spacing at all in-ceiling speaker locations; stud spacing and bay clearance at in-wall locations; structural blocking for back-cans heavier than 3 lbs; header configuration where in-wall speakers span a stud bay; and distribution closet framing with dedicated rack blocking and front-and-rear access.

HVAC and Plumbing Coordination

Confirm no HVAC ductwork, plumbing, or structural members obstruct any speaker cutout before framing inspection. Key conflicts: range hood exhaust duct near kitchen ceiling speakers (vibration coupling); bath exhaust fan within 18 in. of any cutout; drain or supply lines behind in-wall backer boards; plenum boundaries that trigger CMP cable requirements.

Electrical Subcontractor Coordination

The electrical subcontractor must confirm: neutral wire at every Lutron RA3 and HomeWorks QSX keypad box; dedicated 20A circuit for audio rack and separate 20A circuit for networking rack; 120VAC subwoofer stubs at all active sub locations; NEC 725.136 Class 2 separation maintained in all shared conduit. A joint pre-drywall walk with the Restrepo audio lead is required before QC gate sign-off.

Finish Carpenter and Millwork Coordination

The Restrepo audio lead must provide the millwork subcontractor a dimensioned drawing of all audio rough-in locations before fabrication. For subwoofers in custom cabinetry: confirm interior dimensions accommodate body depth and port clearance. REL S/812: 17 W x 17.5 H x 20 D in.; SVS PB-3000: 21.9 H x 18.3 W x 26 D in. Both require 4 in. rear clearance for cable access.

> **BEST · PRE-DRYWALL WALK SCHEDULING**
>
> Schedule the joint pre-drywall walk a minimum of 5 business days before the planned drywall start date. Distribute the pre-walk agenda (framing conflicts, neutral wire confirmation, HVAC duct clearances, conduit routes) to all trade leads 48 hours before the walk. Any conflict identified at the walk that cannot be resolved the same day holds the drywall schedule until written resolution is confirmed by all parties.

COORDINATION WITH OTHER TRADES NOTES

- Schedule a joint pre-drywall walk — GC, electrical sub, HVAC sub, and Restrepo audio lead — before drywall is staged. All conflicts must be resolved before QC gate sign-off.
- Where AV pre-wire overlaps theater rough-in: the theater standard governs Atmos height and subwoofer locations in that room. Coordinate zone numbers and label conventions between the two sleeve schedules.
- Confirm speaker grille and bracket face dimensions with the architect and interior designer before back-cans are ordered. JBL Synthesis SCL-3 overall dimension is 16.46 in. x 16.46 in.

REF CITATIONS & PRIMARY SOURCES

1 **NEC 2023 · NFPA 70 Full Code · NFPA**
Articles 640, 725, 800, 210, 300, 352. Primary code source for all NEC references in Vol 23.
https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-...

2 **NEC Article 640 · Audio Systems · Code Book City**
640.6 wiring methods: Class 2 (<=25V/100W); Class 3 (70V/100W); CL2/CL3 in-wall.
http://www.codebookcity.com/codearticles/nec/necarticle640.htm

3 **NEC Article 725 · Class 2 and Class 3 · Mike Holt**
725.51 conduit fill; 725.136 voltage separation; CL2/CL3 listing requirement for in-wall speaker wire.
https://www.mikeholt.com/newsletters.php?action=display&letterID=1698

4 **NEC Article 800 · Communications Circuits · Scribd**
Plenum cable CMP requirement for return-air spaces. CL2P/CL3P for speaker wire in plenum.
https://www.scribd.com/document/146224335/Lv-6

5 **CEDIA RP-22 v1.2 · Immersive Audio Design · CEDIA**
Immersive audio design recommended practice. Speaker placement, SPL targets, subwoofer placement.
https://cedia.org/site/assets/files/6057/cedia-cta_rp22_v1_2_sept_2023.pdf

6 **ANSI/CEA-2010-A · Subwoofer Measurement · HomeTheaterHifi**
2-meter ground-plane quasi-anechoic subwoofer maximum output measurement protocol.
https://hometheaterhifi.com/technical/technical-reviews/rp22-immersive-aud...

7 **NJ UCC NJAC 5:23 · Electrical Subcode · Cornell Law**
NJAC 5:23-3.16: NJ UCC adopts NEC by reference. Low-voltage contractor licensing requirement.
https://www.law.cornell.edu/regulations/new-jersey/N-J-A-C-5-23-3-16

8 **IEC 60268 · Electroacoustics · Sonance Spec Guide**
IEC 60268-5 loudspeaker measurement; IEC 60268-19 in-wall back-can volume specs.
https://tecso.com.mx/wp-content/uploads/downloads/Sonance/Sonance_Spe...

9 **AES67 · Network Audio Interoperability · Crestron DM NAX**
RTP streams; 48/96 kHz; PTP IEEE 1588 v2; DM NAX and Dante AES67 compatibility mode.
https://docs.crestron.com/en-us/8425/Content/Topics/Product-Manual/DM-...

10 **Sonance VP Series · VP62R / VP82R / VP86R · Sonance**
VP62R 7.25 in. cutout; VP82R 10.125 in. cutout 5.875 in. depth; VP86R carbon fiber cone.
https://sonance.com/collections/visual-performance

11 **Sonance Reference R1/R2 · In-Wall Speakers · Sonance**
R1 cutout 7.5 in. W x 20.5 in. H; R2 cutout 7.5 in. W x 33.5 in. H. Carbon fiber/Rohacell.
https://sonance.com/products/93346

12 **Sonance Invisible Series IS6/IS8/IS10 · Sonance**
IS6: 2.68 in. depth; IS8: 2.68 in. depth; IS10: 3.15 in. SonARC EQ presets required.
https://sonance.com/collections/invisible-series

13 **Sonance DSP 8-130 MkIII · 8-Zone Amplifier · Sonance**
8 zones, 130W/ch at 8 ohm, SonARC v2, Class D fanless, 12 AWG terminal blocks, IP control.
https://sonance.com/products/93538

14 **JBL Synthesis SCL-3 · In-Ceiling Speaker · JBL**
14.2 x 14.2 in. cutout, 5.8 in. depth, 91 dB, 300W RMS, sealed back-box required.
https://www.jblsynthesis.com/products/loudspeakers/SCL-3-.html

15 **JBL Synthesis SSW-1 · In-Room Subwoofer · JBL Synthesis**
Dual 15 in. woofers, 5000W RMS, 350.5 lbs, 15 Hz -6 dB. Structural floor review required.
https://www.jblsynthesis.com/products/loudspeakers/SSW-1.html

16 **Crestron DM-NAX-AMP-X300 · Network AV Amp · Crestron**
4x75W or 2x150W; DM NAX/Dante/AES67; DSP matrix; 70V/100V Hi-Z capable; NEC 640.
https://www.crestron.com/Products/Catalog/AV-Over-IP/DM-NVX-AV-Over-I...

17 **NAD CI 8-150 DSP · 8-Zone Amplifier · Crutchfield**
150W/ch at 8 ohm (all channels); HybridDigital NCore; 4 ohm stable; browser DSP; 2U.
https://www.crutchfield.com/p_745CI8150/NAD-C-I8-150-DSP.html

18 **Paradigm CI Elite E80-R v2 · In-Ceiling Speaker · Paradigm**
9-3/16 in. cutout, 3-7/8 in. depth, 93 dB, 15-160W, AL-MAC tweeter, ART surround.
https://www.paradigm.com/en/in-ceiling-speakers/ci-elite-e80-r-v2

19 **Bowers & Wilkins CCM7.5 S2 · In-Ceiling · B&W**
332 mm (13.1 in.) cutout, 184 mm depth, Nautilus tube tweeter, 88 dB, 6.5 in. Aramid woofer.
https://www.bowerswilkins.com/en-us/product/in-wall-in-ceiling-speakers/re...

20 **Revel C763 · In-Ceiling Speaker · Crutchfield**
8 in. cutout, 4-25/32 in. depth, 88 dB, 10-140W, MCC cone, boundary compensation switch.
https://www.crutchfield.com/p_265C763/Revel-C763.html

21 **Sonos Amp Gen 2 · 125W Streaming Amp · Sonos**
125W/ch at 8 ohm, HDMI eARC, banana plug terminals, sub pre-out, 1U rack, PoE not required.
https://www.sonos.com/en-us/shop/amp

22 **SVS SB-3000 · Sealed Subwoofer · SVS Sound**
13 in. driver, 800W RMS, 18-270 Hz +/-3 dB, DSP Bluetooth app, 3 PEQ bands, 3-12V trigger.
https://www.svsound.com/products/sb-3000

23 **REL S/812 · Music Subwoofer · The Absolute Sound**
12 in. active + 12 in. passive, 800W, 19 Hz -6 dB, Neutrik Speakon high-level input.
https://www.theabsolutesound.com/articles/rel-acoustics-s812-sub-bass-sys...

24 **Liberty 14-2-OFC · CL2/CL3 Speaker Wire · Liberty Cable**
14 AWG, 2-conductor, oxygen-free copper, CL2/CL3 rated. Standard residential speaker run.
https://secure.libertycable.com/residential/bulk-wire-connectors/direct-burial...

25 **West Penn 25227B · 12 AWG CMP Plenum Speaker Wire · Wire & Cable Your Way**
12 AWG, 2-conductor, unshielded, CMP-rated (plenum). For HVAC-adjacent runs in return-air ceilings.
https://www.wireandcableyourway.com/west-penn-25227b-12-awg-2-condu...