



GAI-TRONICS®
A HUBBELL COMPANY

700 Series 24 V dc Page/Party® System Design

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Confidentiality Notice

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General Information



GAI-Tronics' Page/Party systems are modular industrial communications systems, incorporating from two to possibly hundreds of stations. Available in several forms, each station includes a handset, two amplifiers (one for the handset and the other to drive one or more paging speakers), associated controls, and a paging speaker (usually mounted separately). Wire all stations in parallel and add additional stations at any time.

Develop the system's layout and an installation plan prior to installing a GAI-Tronics Page/Party system. Select handset station locations carefully, taking convenience, accessibility, and personal safety into account. Consider the ambient noise level or reverberation, in each area, when selecting the quantity and locations for the paging speakers.



The speaker amplifier, in each station, drives one horn-loaded page speaker. Add additional speaker amplifier stations, to the system, to increase the paging speaker coverage. Connect several paging speakers, to a single station, in quiet areas, such as offices or living quarters. Refer to Pub. 42004-135, Speaker Installation, or consult with a GAI-Tronics sales representative for additional system planning information.

Design Considerations

System Power

 **WARNING**  — NEVER connect 24 V dc Page/Party equipment to a supply voltage greater than 28.8 V dc or equipment damage may result.

GAI-Tronics' 24 V dc Page/Party system equipment is for operation from a 24 V dc rechargeable battery. A battery charger may be connected to the battery to maintain the charge.

 **CAUTION**  — Do not operate this equipment from a battery charger with the batteries disconnected. Most chargers have an unloaded output of 35 to 45 volts dc that can damage 24-volt dc equipment.

Ground the negative side of the battery system at only one point to eliminate hum and noise induced in the system from the power source.

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Electrical Noise

Consider the following suggestions to avoid electrical noise caused by slip rings and SCR (silicon control rectifier) power supplies:

Slip Rings—Use an RF (radio frequency) alternative and avoid using slip rings as audio conductors. Slip rings are a source of electrical noise and are not reliable.

SCR Power Supplies—When installing a Page/Party system in areas where SCR power supplies provide power to motors or other heavy equipment, consider using the following recommendations to reduce electrical noise:

1. *Separation*—Locate Page/Party system cables as far as possible from SCR power supply input or output cables. Electrical coupling, between cables, decreases with the square of the distance, between the cables.
2. *Shielding*—Use shielded (armored) system cables if the cable must be run in the same bundle or cable tray with the SCR power supply cables. Shielded cables reduce capacitive coupling between SCR power supply cables and Page/Party audio cables.
3. *Fiber Optic Cables*—Use fiber optic audio cables in cable trays as an alternative to shielded cables. Fiber optic cables are immune to SCR-generated electrical noise.
4. *Isolation*—Batteries/battery chargers in 24 V dc systems usually provide isolation from the SCR noise, on the ac power system. Cable separation and shielding as mentioned above still apply.

NOTE: Avoid battery chargers that use SCRs in their design.

System Cable

Wire all stations in parallel. Good planning minimizes the required cable for the installation. GAI-Tronics supplies multi-conductor cable, specifically for this application. This cable is color-coded to match the termination points, in the enclosures, to simplify installation. The accompanying system connection diagrams provide the number, size, and color-coding, of the conductors, in the cable (see the [Connection Diagrams](#) section).

Carefully consider cable power losses when planning a Page/Party system using 24 V dc stations. The number of units, in parallel, on one cable, and the total cable length, are restricted when using the same cable types that the 120 V ac Page/Party systems use (see [Table 1](#)).

Branch lines, from the 24 V dc source, can contain from one to six stations. The maximum cable span is 4,000 feet for a single station when using No. 8AWG power conductors. Systems with multiple stations may require multiple branches to meet the maximum cable length and number of stations per branch requirements. It is assumed that stations are evenly spaced along the cable when two or more stations are connected on a single branch.

Each amplifier contains two fuses in the 24 V dc input circuit to protect and isolate the handset and speaker amplifier circuitry in the event of an internal failure.

Power line wiring, to each amplifier or group of amplifiers, in a branch circuit, should have a fuse or circuit-breaker to protect against wiring failures. Determine fuse or circuit breaker ratings from the cable size in the branch. Consult the National Electrical Code (NFPA70) or Canadian Standards Association (CSA 22.1) for the maximum allowable capacity of the wire used. A 15-amp fuse or circuit breaker should be installed for each branch line at the point where it connects to the battery when cables with No. 14 AWG power line conductors are used.

Table 1. Maximum Cable Distance (ft)*

Number of Units	No. 14 AWG Total / Between	No. 12 AWG Total / Between	No. 10 AWG Total / Between	No. 8 AWG Total / Between
1	977 / 977	1,554 / 1,554	2,471 / 2,471	3,931 / 3,931
2	651 / 325	1,037 / 518	1,648 / 824	2,620 / 1,310
3	489 / 163	777 / 259	1,236 / 412	1,966 / 655
4	391 / 98	622 / 155	988 / 247	1,572 / 393
5	325 / 65	518 / 103	823 / 165	1,310 / 262
6	279 / 46	444 / 74	706 / 117	1,123 / 187
9	196 / 21	311 / 34	494 / 55	786 / 87

*Based on the following assumptions:

- Continuous tone (alarm) signals drive each station’s speaker amplifier to a maximum of 12 watts.
NOTE: If the station is used for speech (audio) signals only, the distances stated above can be multiplied by a factor of 2 because speech signals do not have the energy content that a continuous tone has; therefore, they do not require as much average current and thus less cable IR drop will result.
- GAI-Tronics-supplied cable is used.
- Wire resistance (ohms) is the nominal value for the applicable AWG at 1,000 feet of bare copper, stranded wire @ 20 °C (68 °F). Wire resistance values used are as follows:
No. 14 AWG = ~2.525 ohms; No. 12 AWG = ~1.588 ohms; No. 10 AWG = ~0.999 ohm; No. 8 AWG = ~0.628 ohm
- DC V at cable run’s feed point (Float charge of connected batteries) = ~26.6 V dc
- DC V at the last unit in cable run = 21 V dc minimum
- Station unit current draw (I) is the same regardless of the unit’s placement along the cable run for ease of calculation. (1.1 amperes when unit is producing a 12-watt sine wave output.)
- Distances reflect a 3% reduction for margin of error.

The following formula may be helpful in calculating the approximate maximum distance for a SINGLE station for conditions other than those listed above.

For **CONTINUOUS** tone applications with minimum distortion:

$$\frac{V_{\text{FEEDPOINT}} - V_{\text{MINIMUM}}}{(2 \times \text{AWG WIRE RESISTANCE PER FOOT @}\sim 20^{\circ}\text{C}) \times \text{UNIT I [IN AMPS @12W OUT]}} = \text{APPROXIMATE MAXIMUM DISTANCE IN FEET}$$

For **SPEECH** operation only, multiply the above result by a factor of two.

Example: What is the approximate maximum distance for a **single** dc station if the voltage feed is 27.5 V dc and a No. 14 AWG wire is used @ 20 °C?

Info:

- No. 14 AWG @ 20° C = ~0.002525 ohm per foot × 2 for LOOP R
- VFEEDPOINT = 27.5 V dc

Solution:

$$(27.5 \text{ V} - 21 \text{ V}) / ((2 \times 0.002525 \text{ } \Omega/\text{ft}) \times 1.1 \text{ A})$$

$$= 6.5 / 0.005555$$

= 1,170 feet (for **CONTINUOUS TONE** signal), or up to ~2,340 feet (factor of 2) for **SPEECH** only signals

Additional Station Installation

Consult the 24 V dc system layout diagrams, at the end of this manual, when installing additional stations. These figures, in conjunction with the station installation information, and cable layout guide, provide the information necessary to install additional Page/Party stations.

Installation

Station and Speaker Amplifier Enclosures



Each Page/Party station includes a plug-in amplifier that mates with a fabricated steel, cast aluminum, or molded reinforced non-metallic enclosure. Each enclosure provides a terminal strip for connecting the inter-station cable.

Enclosures are packed separately from the plug-in amplifiers at the factory. This allows the amplifiers to remain protected while the enclosures are installed and wired. This is particularly important during system installation in areas under construction.

The 16-gauge steel enclosures do not have openings for conduits or cables since the location of these can vary with each installation. Drill or punch the necessary openings before mounting the enclosure. Locate the openings either along the top or bottom of the enclosure and near the rear surface. Avoid the top center because of possible interference with the plug-in amplifier receptacle. A drill template is supplied with each enclosure.

Cast aluminum enclosures are drilled and tapped on the top and bottom for specially designed hub plates. The enclosures include plates for a single 1.25-inch conduit unless special arrangements are made. Plates for a single 0.5-inch, 1.5-inch, or dual 1.25-inch conduits are available.

Molded enclosures are supplied without any conduit openings. Sealed threaded hubs are recommended. Each enclosure includes a drill template.

 **CAUTION**  —Use caution when drilling holes to avoid damaging the internal electrical components and wiring.

The suggested mounting height, for all station enclosures, is 54 inches (137 cm). Subsets with remote subset amplifiers have an 8-foot (244 cm) connector cable. Mount the enclosure, for the remote subset amplifier, within reach of the remote subset's 8-foot connector cable. Desktop or desk-edge station enclosures are often mounted in the knee-well of a desk.

Line Balance Assembly

Each GAI-Tronics Page/Party system requires one line balance assembly. Its function is to properly load the page and party line circuits. When using GAI-Tronics standard cable, select a location that is:

- near the electrical center of the system
- adjacent to an indoor station in a relatively quiet area

For larger systems or when using other types of cable, contact a GAI-Tronics representative for further information. The line balance assembly has one electrical adjustment that must be made while using a station (see the Line Balance Adjustment section). The preferred method for mounting the line balance assembly is as follows:

1. Suspend the assembly from the lower side of the indoor wall station using a 1-inch conduit nipple (not supplied).
2. Connect one twisted pair wire for the page circuit and another for each of the party lines between the terminal blocks of the line balance assembly and the associated indoor wall station.
3. Make the wiring connections between the No. 305 Series Line Balance assembly and the station enclosure (see the Connection Diagrams section).

Inter-station Conduit and Cable

Inter-station cables are generally run in cable trays or conduit. The outside diameters of the GAI-Tronics cables discussed in this publication are provided below to assist in determining the conduit sizes required (see Table 2). Size and installation of conduit and cable must meet the requirements of applicable electrical codes.

Table 2. Cable Information

Cable	Conductors	O.D.
60038-101	8	0.60 in (15.1 mm)
60029-101	16	0.68 in (17.2 mm)

Include a ground conductor, with green/yellow insulation, along with the cable, when cable runs are not in conduit or are in non-metallic conduit. Non-metallic enclosures with cable runs in metallic conduit and cable without a ground conductor, in metallic conduit, require a bond between the conduit(s) and the ground terminal (point 3), within the enclosure.

Lug and attach the conductors, of the GAI-Tronics system cable, to the terminals; either in accordance with the color codes, on the applicable accompanying diagrams (see the [Connection Diagrams](#) section), or in accordance with special drawings for this purpose.

NOTE: Some cables have a *spare* orange conductor. Insulate this conductor and do not connect it to any terminal strip(s), in the enclosures, unless otherwise instructed.

GAI-Tronics cable is a Class 1 cable (maximum voltage is less than 600 V). In a cable tray, Class 1 cables may only be grouped with other Class 1 cables. Long runs of GAI-Tronics cable in proximity to other 600-volt cable may induce an undesirable amount of hum onto the Page/Party system's signaling lines. To reduce undesired hum, GAI-Tronics recommends separating cable runs over ½ mile long from 600-volt cable by a minimum of 12 inches.

Automatic Speaker Muting

One of the many features of GAI-Tronics' Page/Party system equipment is automatic speaker muting. When the push-to-page switch is pressed at a particular station, the paging speaker connected to that station is silenced to prevent acoustic feedback to the handset microphone. The paging speaker is still live to broadcast paging calls from other stations while the handset is in use for party line conversation.

For cases where the muting feature is not necessary or may be a disadvantage, defeat it as follows:

1. Locate the lugged violet wire attached to terminal point 7 (MUTE), on the terminal block in the enclosure of the station to be modified.
2. Transfer the lugged violet wire to terminal point 8 (PAGE L1).

Amplifiers and Subsets

After making any necessary muting changes:

1. Unpack and install the amplifier for each station.
2. Unpack the remote subsets (for desktop, desk-edge, or panel mount stations) and plug each into the bottom sides of the amplifier enclosure (see [Table 3](#) for the series numbers covered by this bulletin).

Table 3. Station Enclosure, Amplifier, and Subset Compatibility

System	Enclosure	Amplifier	Subset
Single Party Line	702, 732, 733	701	None
Single Party Line	7245	723	711, 716, 726
Multiple Party Line	703, 7325, 7335	701	None
Multiple Party Line	7245	723	7115, 7165, 7265

NOTE: The above stock numbers are simplified. Most stock numbers include a single digit letter or three-digit suffix (i.e. 702A, 711-101).

Checkout and Adjustment

Test all field wiring connections (page line, party line(s), mute, dc power, and speaker) between stations, and complete the line balance assembly adjustment to minimize sidetone. Sidetone is sound diverted from a telephone's microphone to the earpiece so that the speaker can hear their own voice.

Initial Start-up

1. Ensure that all handsets are on-hook.
2. Apply dc power and check the station next to the line balance assembly.
3. Press the push-to-page switch (handset pressbar on some stations) and speak directly into the microphone of the handset.

The broadcast should be heard at all paging speakers in the system except those associated with the station under test.

4. After installing all stations, in the system, adjust the line balance assembly to optimize sidetone rejection on the page line (see the [Line Balance Adjustment](#) section below).

NOTE: Do not adjust station (amplifier) controls until the line balance assembly is adjusted.

5. Release the push-to-page switch and check the party line(s) sidetone level by speaking into the microphone of the handset.

Little or no sidetone should be heard from the handset earpiece if the system is working properly. The line balance assembly contains a fixed resistor load for each party line so party line sidetone rejection only occurs if the line balance assembly is properly connected. No party line adjustments are provided.

6. Check party line operation by conversing between two or more stations.

Line Balance Adjustment

The handset earpiece should emit little or no sidetone when the system is properly balanced. There will be a high level of sidetone, perhaps enough to cause feedback, if the line balance assembly is not connected properly.

To set the control for proper page circuit loading:

1. Remove the line balance assembly cover to expose the line balance control.
2. Lift the handset from the adjacent handset hook and press the push-to-page button.
3. From a normal speaking distance (approximately ½ inch), blow steadily into the handset microphone and adjust the control to minimize receiver sidetone.

NOTE: Make this adjustment only after initial system installation unless adding or removing more than 10 speaker amplifiers to/from the system. Repeat this adjustment after adding or removing more than 10 speaker amplifiers.

4. After the final adjustment, replace and secure the cover with the four mounting screws to discourage tampering by unauthorized personnel and to prevent entry of contaminants.

Amplifier Adjustment

Each amplifier has a paging speaker volume control. It is accessible from the front panel with a screwdriver but is concealed behind the metal GAI-Tronics nameplate. To reach it, simply loosen (do not remove) the two nameplate screws and pivot the nameplate around the left screw. This control is adjusted at the factory so that a moderate page level produces 4 watts of output power.

Additional Handset/Speaker Amplifier Controls

Each handset/speaker amplifier has three additional internal controls; receiver volume control, transmission volume control, and receiver sidetone control. These controls are accessible using a screwdriver through holes in the chassis. A fourth hole allows access from the rear for the paging speaker volume control. Controls are factory-adjusted for optimum results in most industrial applications. Do not readjust these controls to solve system problems until other possible faults are checked, such as a missing, defective, or improperly connected line balance assembly.

There is very little drop in receiver (handset earpiece) volume level due to system cable losses. The only reason to reset the receiver volume control is to compensate for extremely high ambient noise levels (up to 110 dB), or to meet individual personnel needs.

Receiver sidetone rejection is noticeably affected by cable impedance at stations more than 3,000 feet (1 km) from the line balance assembly. Use the receiver sidetone control to compensate for this by rotating the control clockwise approximately 60 degrees for 3,000 feet (1 km) of cable length.

System Troubleshooting

Hum or Buzz

Hum or buzz, on the page circuit (or on one or more party circuits), is usually due to a short circuit of one of the two conductors of a circuit to ground or an unbalanced leakage to ground. The voltage drop from each conductor of a twisted pair cable to ground should be the same and there should be no voltage drop across the two conductors if there are no significant leakage paths or short circuits to ground.

Use an ohmmeter to check junction points, in the system, to locate the source of the ground to correct the problem. Another way to locate a ground fault is to disconnect each affected circuit until the fault disappears. Faults may also be in a plug-in amplifier; however, most ground circuits occur in improper terminations or by small strands protruding from an improperly lugged wire.

Junction boxes filled or partially filled with water can be a source of grounded or near-grounded circuits. In many cases, there are deposits in the boxes that, when combined with water, produce conductive or corrosive solutions. These deposits cause leakage between circuits and can corrode the wire and terminals.

Isolation of field wiring may be necessary for test purposes. Connect a 33-ohm, 1/2-watt resistor across L1 and L2 of the Page/Party line circuits if the isolation removes the line balance assembly from the operating portion of the system. Remove the resistors after completion of the tests.

Feedback or Distortion in the System

Each page and party circuit must be loaded to the optimum 33 ohms using the line balance assembly. A disconnected or defective line balance assembly causes excessive gain and will break into feedback quite easily. Voice distortion and a high level of sidetone, in the handset receiver, are also effects of a disconnected or defective line balance.

The line balance assembly terminates each party line with a fixed 33-ohm resistor. The page line has an adjustable control to compensate for the number of speaker amplifiers in the system. Improper adjustment affects gain and increases the level of sidetone (see the [Line Balance Adjustment](#) section).

Very Low Audio Level on One or More Lines at all Stations

A system, or part of a system, may continue to function with a dead short across the page or party circuits. The audio level, of the system will be low, decreasing to minimum level, in the vicinity of the short circuit, if this occurs. Locate the short circuit the same way as locating a ground, by checking junction points with an ohmmeter.

Cross Talk

Cross talk, or inter-channel interference, is generally caused by accidental crossing of circuits in a junction box. To check for this condition, measure the resistance between the circuits of the interfering channels. The resistance should be infinite or a very high value. Leakage or shorts to ground in two or more circuits can also result in cross talk on the affected circuits.

Audio Voltage

In a properly operating system, audio voltage across any of the page or party circuits (L1 or L2) will be 0.5 to 0.75 volts ac on peaks when an audio signal is present: i.e., someone is speaking into a handset. The voltage is proportional to the loudness of the person's voice who is using the handset.

Static Charges

Induced ac voltage may exist from the conductors of the page and party line circuits to ground in many normal installations. The voltage may be as high as 50 volts or more. This voltage is induced into the circuits by capacitance to the ac power circuit (generally carried in the same cable, and also from power cables running parallel to the communication cables). This voltage is inconsequential and can be ignored. Problems occur only if one side of the page or party circuit becomes grounded.

One Inoperative Station in a Working System

Except for a wiring error, an inoperative station indicates a defect in the amplifier at the station. This is checked quickly by installing a spare amplifier or exchanging amplifiers with a proper operating station.

Special Installation Notes

GAI-Tronics' Page/Party system equipment does **not**, in normal operation, produce arcs, sparks, or heat that would ignite industrial gases or dust. Many standard GAI-Tronics products are NRTL approved for use in the USA and Canada, for intended use, in specified Division 2 areas, if professionally installed and maintained.

Proper installation is defined as:

- mounting and wiring per factory directions without unauthorized modification,
- following all requirements of the U.S. National Electric Code (NFPA-70) or the Canadian Electric Code (CSA Standard C22.1),



Installers must be familiar with these codes and consult the codes as required. The most applicable parts of the N.E.C. code are in articles 500-503.

The most applicable parts of the Canadian code are in Section 18. Some, but not all, significant points are:

- Conduits, in a Class I, Division 2 area, to or from a non-hazardous area, or an adjacent Class I, Division 1 area, must have approved seals in the boundary.
 - Conduits or raceways, in a Class II, Division 2 or Class III area, must have dust seals at entrances to dust-tight equipment and at boundaries to other areas unless such conduits or raceways are also dust-tight.
 - Explosion-proof (Division 1) equipment may be installed, in a Division 2 area, but must have the same conduit and cable seals as if installed in the corresponding Division 1 area.
 - Sealing of multi-conductor cables or conduits containing multi-conductor cables in Class I, Division 1 or 2 areas must be around each conductor of the cable—except where type MI cable is used.
-

Safe Power Connection/Disconnection

To satisfy Division 2 requirements, the equipment will not create arcs or sparks in normal operation when completely installed and powered. Installing or removing an amplifier or plugging in a live enclosure is not normal operation and can create arcs.

 **CAUTION**  —To guarantee safety, do not insert or remove equipment from live enclosures, unless the area is known to be non-hazardous at the time.

A better method is to use a separate power disconnect, to safely disconnect power to the enclosure, in either of two ways:

- Install an explosion-proof disconnect switch (*may be in the Division 2 area*).
- Install an ordinary disconnect switch in a non-hazardous area (*outside the Division 2 area*).

Either method always allows the use of the switch to disconnect power before installing/removing an amplifier from its enclosure. Connect field wiring using the instructions for the same equipment, in non-hazardous areas.

Connection Diagrams

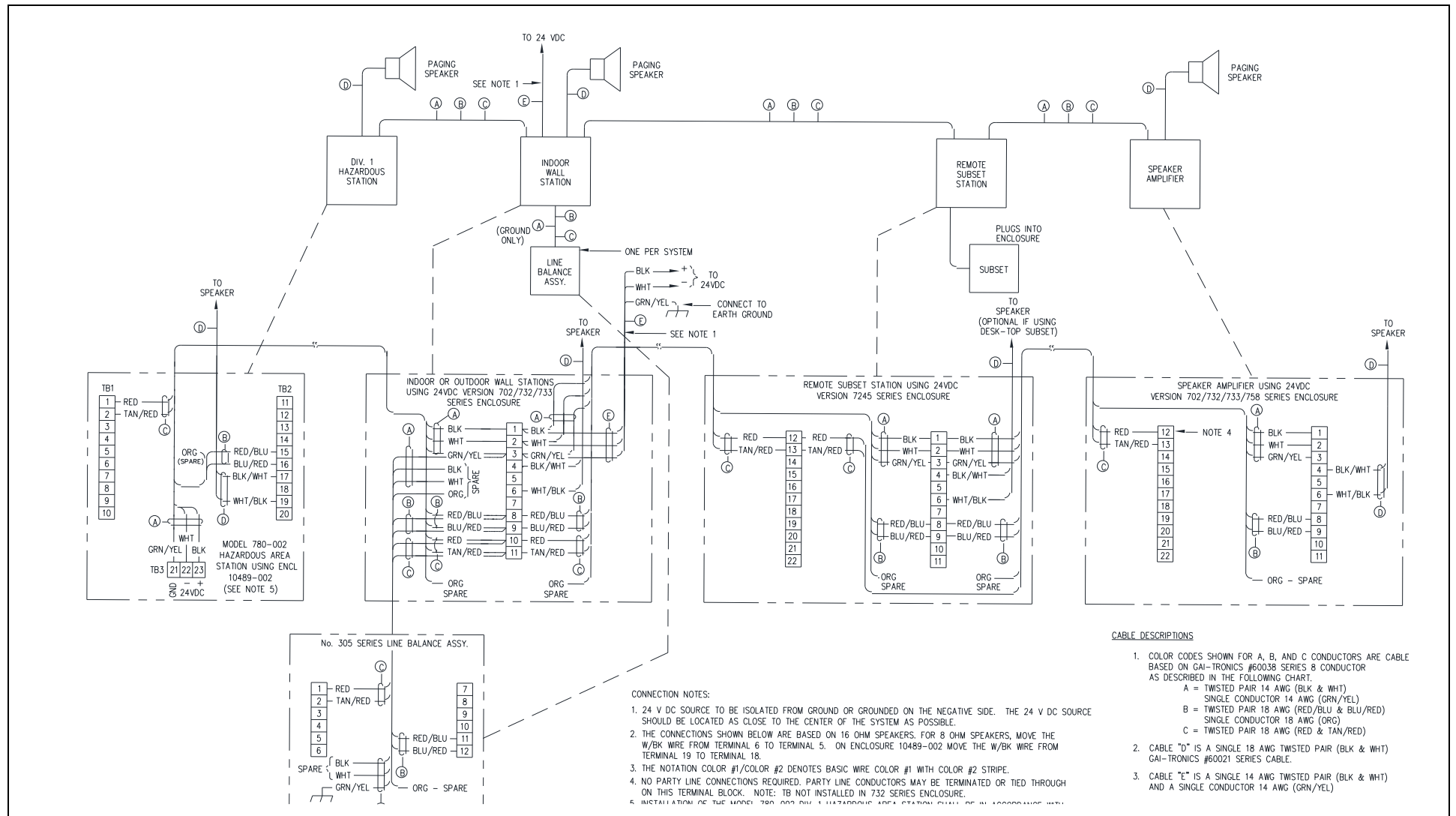


Figure 1. Typical Single Party System Connection Diagram

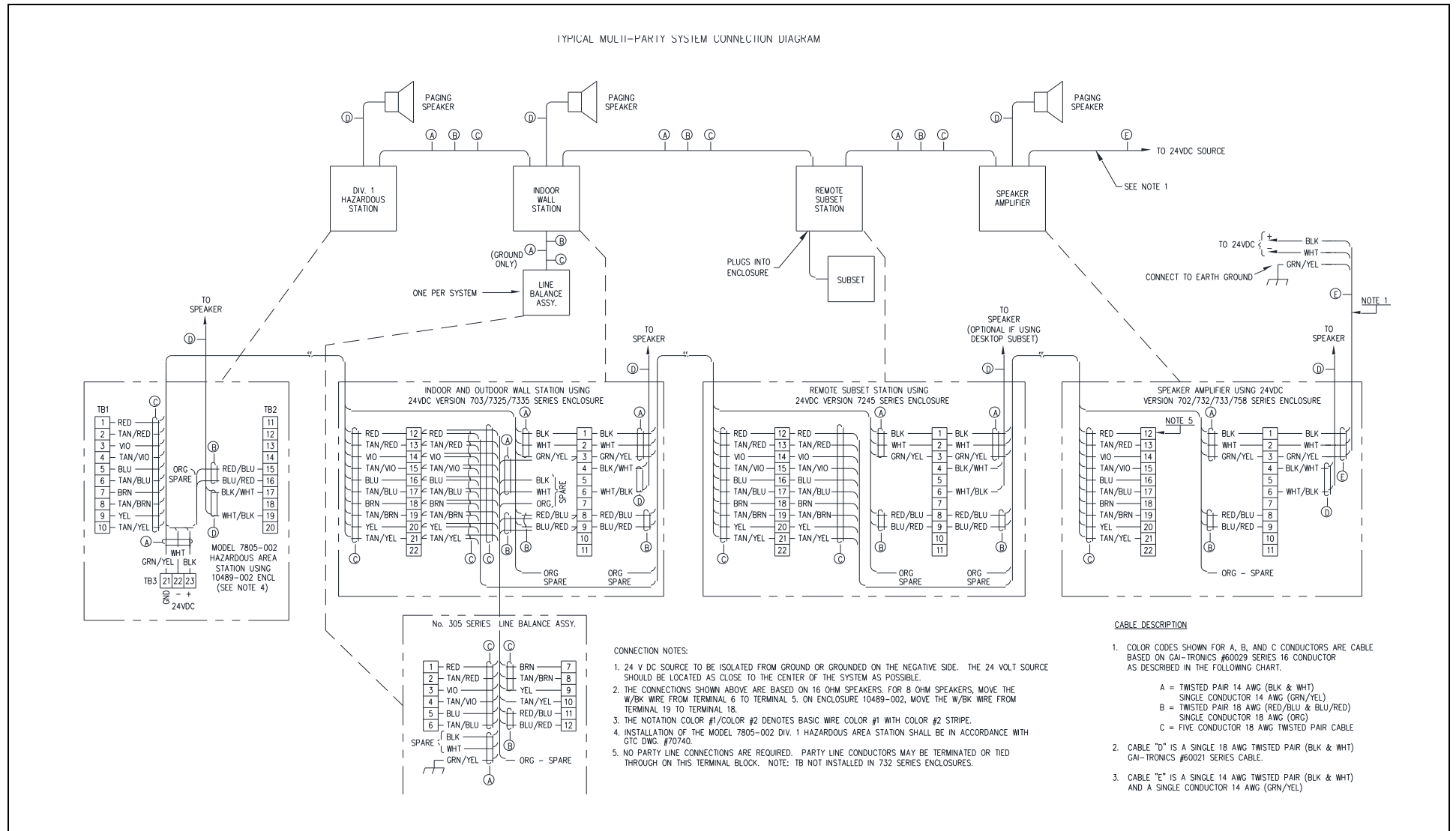


Figure 2. Typical Multi-Party System Connection Diagram