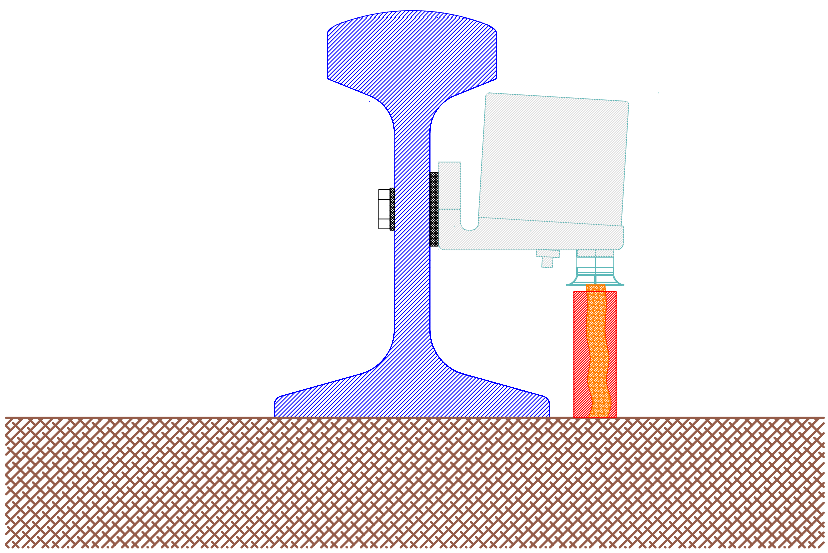
From Science to Solutions

SAIC AEI System

Installation Manual



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1.0 Introduction

1.1 About This Guide

This manual provides instructions for installing and optimizing the equipment at an Automatic Equipment Identification (AEI) site. It explains installation and optimization for each component of the AEI system. The following summarizes the purpose of each chapter in this guide.

1.0 Introduction

The chapter you are currently reading summarizes the information provided in the other sections of this manual.

2.0 Installation Procedure

This chapter includes the following sections:

Overview

Overviews the installation section of this manual.

Site Preparation

Outlines site considerations, construction, and installation for single track and double track AEI sites.

AEI Component Installation

Includes installation procedures for the following AEI System components:

- Tiefenbach wheel transducer
- TDA-105
- Antenna
- Presence detector
- Heliax coaxial cable

3.0 Optimization Procedure

This chapter includes the following sections:

Overview

Overview of the optimization section of this manual.

APU Application Software

Provides an in-depth explanation of the APU-102 application software and the initial steps necessary to log on and navigate through the software.

System Optimization

Provides optimization recommendations for the APU-102 System software.

RF Power Optimization

Instructions for RF unit optimization.

Wheel Detector Optimization

Lists optimization steps for the Tiefenbach wheel detector and its interface, the TDA-105.

Loop and Loop Detector Optimization

Includes procedures for loop and loop detector optimization.

System Operational Checkout

This checkout procedure offers a method for testing system operation. It demonstrates how to simulate a train from the track using the software or the APU-102 buttons.

Appendix A: Site Optimization Checklist

Assists in verifying that all optimization procedures were completed.

Appendix B: Installation Tools and Supplies

Provides a general list of all tools and supplies usually supplied by the installation contractor. Does not include material usually supplied in SAIC installation kits.

Appendix C: Site Drawings

This appendix contains generic site installation drawings, with an indexed listing at the beginning. The drawings are arranged in the order they will normally be used at the site.

Index

Refer to this index to find the page number(s) for topics covered in this manual.

1.2 Additional Documentation

For AEI System operation, APU application software user interface, system troubleshooting, a detailed description of system components, and a glossary of AEI System terms, refer to the AEI System Operations Manual.

1.3 Additional Information

This manual does not include information on intermodal, nonstandard, and colocated installations. If your installation includes any of the following, contact SAIC for additional information.

- Intermodal antennas (tiers 1 and/or 2)
- The following non-standard installations:
  - Three or more tracks
  - SmartPass or RailPass integrated readers
  - More than one wheel transducer per track
  - More than one presence loop per track
  - Switch point (route) indication
  - Double track unrestricted sites with inside (island) huts
  - Sites with concrete or steel ties
- Colocated installations, such as:
  - Scales
  - Humps
  - Defect detectors

2.0 Installation Procedure

2.1 Overview

This chapter explains how to prepare and install an AEI site. If your site installation involves a procedure not included here, refer to section 1.3, Additional Information.

2.2 Site Preparation

2.2.1 Site Considerations

Pre-construction

1) Find the transducer location first. This is the center of the site. The center of the transducer must be located between two ties. This allows the cable at the bottom of the transducer to enter the Carflex conduit without binding.
2) Find the tower locations. Since the center of the antennas and the center of the transducer must line up, the towers will be offset from the transducer. (The antennas mount to the side of the tower.)

Areas to Avoid

SAIC recommends that the following site areas are avoided. Use this list as a guide only. Since all installations are unique in some manner, avoiding these areas is not always possible. A survey of each site should be done to determine preferred equipment locations, conduit runs, and antenna configuration based upon the particular application. The user and the system integrator must ensure correct and accurate system operation in the event the areas described below cannot be avoided.

- Large metallic objects and obstructions in close proximity to the reading area
- Areas where reverse train movements occur
- Areas where train switching moves occur
- Areas where train stoppage in front of reader systems is likely to occur
- Areas with severe or multiple curves in the track
- Switches
- Track joints

2.2.2 Construction

1) Install house foundation legs at top of tie level. All trenching is to be 36" below top of tie.
2) Set tower foundations.
3) Install all conduits in the same trench. Conduit runs on drawings are guidelines. They may be changed to fit site specific requirements.
4) Install tower sections and tower caps.
5) Install low antenna mounts (if required).
6) Install tower junction box and splice pedestal as needed. Location of pedestal is a suggestion; it may be moved to fit site specific requirements.
7) Install Carflex conduit from pedestal to transducer location.
8) Install loop cable with Carflex conduit.
9) Run loop cables to pedestals.
10) Install ground rods and cabling. (Pigtail at corner ground rods into hut).
11) Attach ground wire to low mount with a ground lug (if low mount required).
12) Use the CADWELD exothermic welding system for ground cable to grounding rod connections.
13) Tamp all excavations and trenches.
14) Restore ballast to pre-dig condition. Supply fresh ballast where required.
15) Tape all ends of exposed conduits or Carflex conduit to prevent water, rocks, or other debris from entering.
16) Clean up site area.

2.2.3 Single and Double Track Sites

Single Track Site Installation

1) Set instrument house, securing all four corners.
2) Connect ground wire pigtails to ground panel.
3) Seal cable entry holes with Ductseal.
4) Mount parapanel antennas with check tags.
5) Install Sealtite assy and 4' coax jumpers to parapanel antennas.
6) Insert check tag cable into Sealtite assy to tower junction box.
7) Pull in 1/2" heliax and 4c 22 gauge check tag cable from near side tower junction box to bungalow. (3” conduit)
8) Pull in 1pr 16 gauge loop lead-in and 2pr 18 gauge transducer cables from splice pedestal to building. (1” conduit)
9) Mount antennas without check tags to remaining locations.
10) Pull in 1/2" Heliax cable from far side antenna box.
11) Splice, waterproof, and terminate all cables.
12) Install the Tiefenbach transducer. Refer to Section 2.3.1 *Tiefenbach Installation* for installation instructions.

Double Track Site Installation (Restricted)

1) Set instrument house, securing all four corners.
2) Connect ground wire pigtails to ground panel.
3) Seal cable entry holes with Ductseal.
4) Mount parapanel antennas with check tags to towers on all sites. The near track gets the antenna with a check tag. The check tag is mounted on the antenna that is on the bungalow side of the tracks. On double tracks, the far track also gets an antenna with a check tag. It is mounted on the antenna farthest from the bungalow.
5) Install Sealtite assembly and 4' coax jumpers to parapanel antennas.
6) Insert check tag cable into Sealtite assembly to antenna junction box.
7) Pull in 1/2" Heliax cable and 4c 22 gauge check tag cable from each tower junction box. (3" conduit)

8) Pull in 1 pair 16 gauge loop lead in and 2 pair 18 gauge transducer cables splice pedestal to building. (1” conduit)

9) Mount log periodic antenna. (if required by site configuration)

10) Pull in 1/2" Heliax cable from each log periodic antenna. (1 ¼” conduit). (if required by site configuration)

11) Pull in 1ea 1pr 16 gauge loop lead in and 2pr 18 gauge transducer cables from far track pedestal. (1” conduit)

12) Splice, waterproof, and terminate all cables.

13) Install the Tiefenbach transducer. Refer to Section 2.3.1 *Tiefenbach Installation* for installation instructions.

2.3 AEI Component Installation

2.3.1 Wiring Diagram

Use the following wiring diagram to make connections when installing the AEI components.

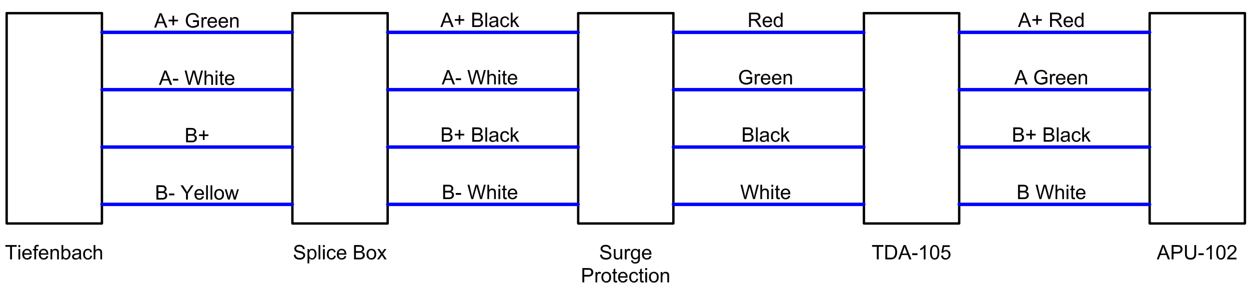


Figure 2.1: Wiring Diagram

2.3.2 Tiefenbach Transducer Installation

Mount the Wheel Detector

For full size drawing, refer to drawing number 101-08 in Appendix C: Site Drawings when performing this procedure.

Caution	Verify that the APU-102 is turned off before beginning this procedure.

1) Locate the rail mounting position between the ties and on the centerline of the antennas.

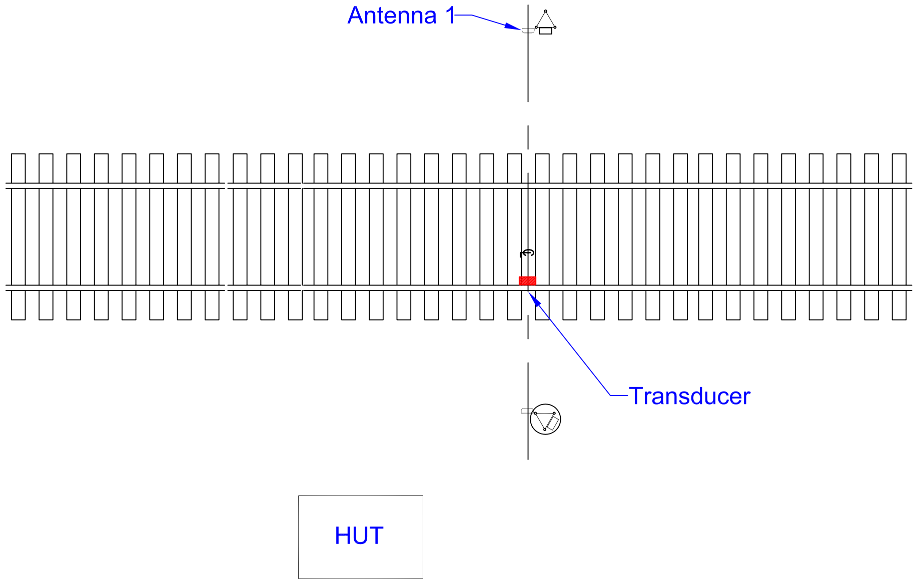


Figure 2.2: Single transducer installation location

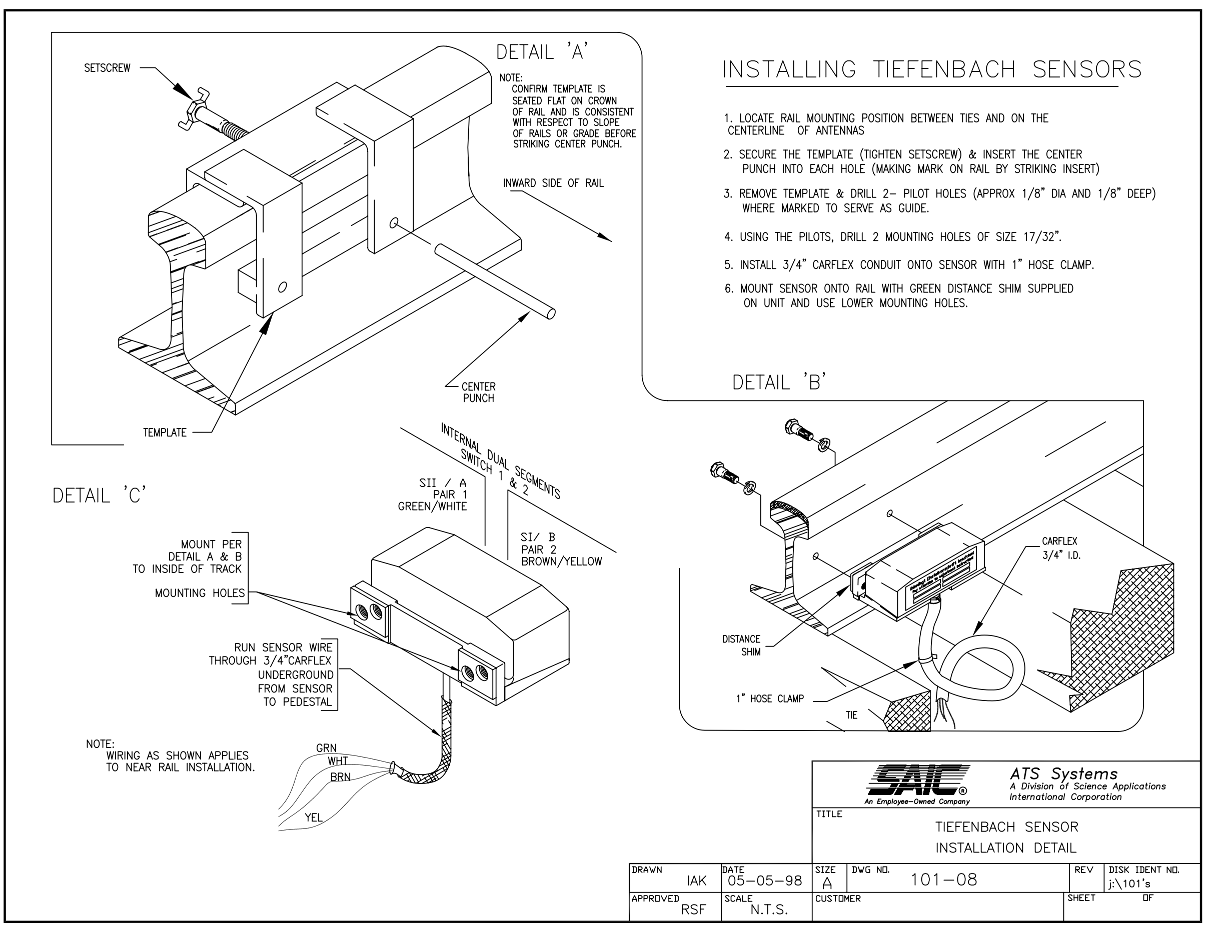


Figure 2.3: Tiefenbach transducer installation

2) Secure and level the rail mounting template and tighten setscrew.
3) Insert the center punch into each hole and mark the rail by striking the center punch.
4) Remove template and drill two pilot holes (approximately 1/8” diameter and 1/8” deep) where marked to serve as a guide.
5) Using the pilot holes, drill two 17/32” mounting holes.

Tip	Drilling these holes is much easier if you use a rail mounted drill.

6) Pull the 4-conductor sensor cable through the 3/4” Carflex conduit to the splice box.
7) Connect the end of the 3/4 inch Carflex conduit around the transducer flange with the 1 inch adjustable clamp.
8) Use the transducer’s *lower* mounting holes to mount the transducer onto rail with one green distance shim on each mounting stud (for rail heavier than 90 lbs, up to 136 lbs) or *without* green distance shims (for rail lighter than 90 lbs). For rail greater than 136 lbs, an increased spacer is required. There are 2 different shades of red spacers. Stack one of each shade together for spacing.
9) Tighten the transducer rail mounting bolts.

Verify Transducer Is Parallel With Top of Rail

1) Measure the distance between the top left side of the transducer (at ridge) and the bottom of the ball of the rail.
2) Perform the same measurement for the top right side of the transducer.

NOTE	If the distance for one side measures within 3 mm of the other side, the transducer is installed correctly with respect to the top of the rail.

2.3.3 TDA-105 Installation

Refer to Figure 3.8: TDA-105 layout and Figure 3.11: Wiring Flow Chart when following the steps below.

1) Mount the TDA-105 on the wall near the lower left corner of APU-102.
2) When wiring the TDA-105 to the sensor, keep the following points in mind:

Required!	Reliable connections at splice box and protection panel are IMPERATIVE for correct operation of wheel detectors.

a) Refer to your particular site drawing when checking hut wiring as there may be a change in color designation.

b) If the wheel detector splice is in an underground splice box, the splice must be soldered and waterproofed. If ring terminals are used in a weatherproof junction box, verify crimps are secure and proper ring terminals are being used with transducer lead and shielded pair cable to protection panel.

3) Using the supplied DC input cable, install DC power from the hut DC distribution point to TDA-105 interface board J3. Input voltage and range from +9 to +36 VDC.

4) Connect earth ground to chassis ground point on the TDA-105 with the # 6 ground wire.

5) Connect the transducer wiring from the surge protection panel to the TDA-105 J1 inputs 1, 2, 5, and 6 (left to right) as shown in the following image and in drawing 601-419H, Appendix C.

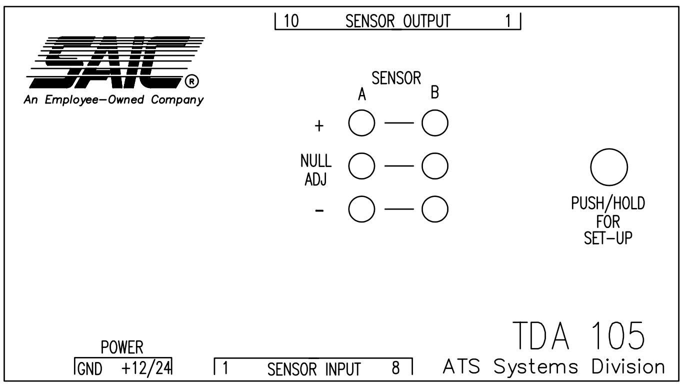


Figure 2.4: TDA-105 case

2.3.4 Antenna Installation

1) Place the center of the antenna 3 feet 6 inches above the top of the rail and 11 feet 6 inches away from the center of the rail. (The tower face should be 12 feet from the center of the rail.)

2) Place the second antenna directly across from the first.

3) Refer to Appendix C: Site Drawings for detailed installation drawings.

2.3.5 Presence Detector Installation

Loop Installation

When laying out the loops, keep the following guidelines in mind:

1) Place the loop wire at least four inches away from the rail at all points (to the side of rail and where it passes under the rail).

2) Fasten the loop to each tie to prevent movement.

Loop Design

The loop may be constructed of #10 or larger insulated wire in neoprene or similar non-metallic jacket. When installing cable, keep the following guidelines in mind:

1) Be careful not to cut the wire insulation.

2) Keep loop wire away from contact with gauge plates, switch rods, switch movements, and other metallic parts.

3) Fasten the loop securely to prevent loop movement on the rail and ensure a stable frequency.

Refer to *Appendix C: Site Drawings* for loop installation drawings.

Note: if using alternate presence detection, refer to appropriate documentation.

2.3.6 Heliax Coaxial Cable Installation

Refer to manufacturer's documentation for connector and wiring installation procedures.

2.4 Preparation for Optimization

Unless the site optimization process is to begin immediately, disconnect the negative battery cable connection between the battery and the APU-102, and make sure that the APU-102 and battery charger are turned off.

3.0 Optimization Procedure

3.1 Overview

This chapter explains the APU application software and the procedures for optimizing all AEI system components.

3.2 APU Application Software

3.2.1 General Information

Local and Remote User Access

There are two types of access available to the user, local and remote. Local access requires a computer equipped with a standard communications package and a cable from the local port of the APU-102 to the computer. Remote access requires a computer equipped with a Hayes compatible modem and a standard communications package.

The communications settings are:

Type	Baud Rate	Word Length	Parity	Stop Bits
Local	2400 (9600 may also be used)	7 or 8	N or E	1 or 2
Remote	Modems will negotiate best speed.	7 or 8	N or E	1 or 2

Table 3.1: Communications Modem Settings

APU-102 Software Programs

The APU-102 uses two different software programs: the *APU application software* program and the *Mini Remote Support* and *ROMSHELL* programs. The APU application software runs the APU-102's normal functions. SAIC incorporates its Standard Remote Support into this application software. The Mini Remote Support (MRS) and ROMSHELL programs are standalone software programs that are installed as a failsafe and used for recovery and diagnostics. When the SYS light/LED is on steadily, the APU-102 is running the APU application software. When the SYS light/LED is flashing, the APU-102 is running MRS or ROMSHELL.

APU Application Software

The APU application software is stored on the solid state disk (Disk-on-Chip for P-Series APU) along with the train information. It logs the train axles, correlates the axles into cars, and associates the tags with the cars. It is a multitasking program that allows the system to record a train output to both a remote unit and a local unit at the same time.

When the APU application software is running, you connect to the APU-102 via the Front Door. This allows you to define the system parameters and individual session parameters, delete trains, and view the systems log, for example. You always connect to the APU application software via the Front Door unless there is a software problem.

Mini Remote Support (MRS) Start-up ROM 4.1 and earlier

Mini Remote Support (MRS) is a version of the SAIC Systems Remote Support software. When this program or the APU application software is running, you can log into the APU's Back Door. Logging into the Back Door via the MRS program allows you to dial in to the APU, transfer individual files, and download new code. However, these functions are not menu driven.

MRS is programmed onto an EPROM at the SAIC facility before the unit is shipped to the customer. The APU-102 boots to the EPROM first, then looks to see if the APU application software is available. If there is any problem with the APU application software, the APU-102 loads the MRS program. The EPROM is located on the Solid State Disk and can be identified by the name "Start-up ROM".

Every fifth time the APU-102 boots (restarts), the MRS or ROMSHELL program is loaded, stays in MRS mode for 20 minutes, then reboots. To access the MRS mode directly, press and hold the SYS button, then turn on the APU-102.

ROMSHELL Start-up ROM version 5.0 or higher

ROMSHELL (Start-up ROM version 5.0+) replaces MRS. It has all the features of MRS listed above, but is accessible with any commercial communication software program. The ROMSHELL interface is detailed in the AEI System Operations Manual.

Main Menu Options

There are two APU-102 Main Menu options, the System Menu and the Supervisory Menu.

The System Menu functions provide accessibility to a wide range of reports and other information that can be generated from the stored data.

The Supervisory Menu provides functions to reconfigure the operational parameters of the APU-102 as well as clearing the APU-102 of all trains and status information. The same data is available whether accessing the APU-102 from a remote site via the modem or on-site via the local communications port. For detailed information about these menus, see the *System Menu* and *Supervisory Menu* sections later in this chapter.

Multiple Sessions

The APU-102 supports up to four virtual APU's on one system. Each virtual APU, called a "session", can be configured according to the needs of the railroad it supports. When accessing the site, the first question the APU-102 software asks is *which* virtual APU (or session) you want to access. Each session has its own password protection. (See *Passwords*) Once you gain access to a session, any parameters you change affect only your session.

Each session on the APU-102 is capable of reporting consist and maintenance reports to the host of your choice. Sessions can be configured for different purposes. For example, a customer may set up Session 1 for standard consist and maintenance reporting to its normal host system, then configure Session 2 to report different types of information (such as scale reports) to other facilities on the railroad. This often happens when the host system to which the AEI reports are sent cannot handle the type of data the other facility needs.

Each session uses the same tag information but is completely independent when formatting and transmitting the information. The owner of the APU-102 is responsible for the initial setup of each session, while the session owner has the ability to customize the individual session. After you select a session, password entry is required.

Passwords

SAIC Systems delivers the systems with default passwords set up in the APU-102. Both the System Menu and the Supervisory Menu are password protected. Also, a password is available for each session's host interface. The System and Supervisory passwords are only visible under the Supervisory Menu display of the site parameters where separate password fields are maintained. Each session is independent of one another, so passwords for one session would not be available to other session users. The System Menu and the Supervisory Menu require different passwords from the host system. The following are the APU-102 default passwords:

Default Passwords	
System Menu	**Supervisory Menu**
SECRET	SUPER

Table 3.2: Default Passwords

Inactivity Time-outs

There are numerous inactivity timeouts built into the APU-102. Their purpose is to remind the user that action has not been taken for a particular amount of time or to log the user off in case the user has forgotten to do so. At the Session Select menu, the APU-102 pauses for three minutes. The APU-102 then beeps and redisplays the Session Select menu. This represents one timeout period. The following table demonstrates how time-outs work:

Screen	Number of 3-minute inactivity time-outs allowed	Result
Session Select Menu	3	APU-102 logs user off.
Password	2	Returns to Session Select menu screen.
System Menu	1	APU-102 logs user off and returns to Session Select menu screen.
Supervisory Menu	1	Returns to System Menu screen.

Table 3.3: Inactivity Time-outs

On-line Help

Throughout the user command interface in the System Menu or Supervisory Menu, you may type **<?>** following a command to display available information about the command. If you do not remember the command, enter **<?>** at the command prompt and the software shows what commands you can currently use.

Example: Typing **<D><?>** describes the Directory command and any options available with that command.

Command Formats

When entering commands in a string, always type a comma between them.

Example: To use the Check Tag Sequence (CT) command to verify that Reader #0 and all antennas for a particular site are working correctly, enter **CT,0,*** for the command string.

3.3 System Optimization

3.3.1 System Power On Checks

1) Power on the APU-102 to make sure the Search LEDs are operational. They should come on when power is applied and turn off once the APU-102 has initialized completely (approximately 45 seconds).

3.3.2 Local Connection

Laptop Computer Connections

1) Connect DB9F-DB25M RS232 cable with null modem adapter (or a straight through cable pins 2-2, 3-3, and 5-7) to serial port 1 or 2 of laptop computer and the local port of APU-102 located on the bottom of the APU-102.

2) Turn on laptop computer with any communications software that supports ANSI terminal emulation installed on computer.

3) Set communications parameters to 2400 baud, no parity, 1 stop bits, 8 data bits, no flow control. You are now ready to enter the Front Door of the APU-102.

   Note: If the local port on the APU is configured for 9600 baud, set the communication program on your computer to 9600 baud as well.

4) Select terminal emulation mode and press **<Enter>**. The APU application software prompts you to log in.

3.3.3 Log On To the APU-102

1) After connecting to the APU-102 through either the local or remote port (modem), press <**Enter**> to activate the Session Select menu screen.

```
1. SAIC Documentation
2. Inactive Session, Not Available for Selection
3. Inactive Session, Not Available for Selection
4. Inactive Session, Not Available for Selection
5. Log Off

Select the Appropriate Session # ( 1, 2, 3, 4 or 5 )
Session #: _
```

Options 1 - 4 on this menu represent the four available sessions in the APU-102. Option 5 logs you off the Session Select menu and, if accessed through the remote port, disconnects the modem.

2) To log on to a session, enter the number corresponding to the desired session. The APU-102 will request the password for the session.

3) Enter the correct system password. The system and supervisory password fields are a maximum of six ASCII, printable characters. (Application version 5.0 or higher can have a seven character password limit.) As the password is entered, an asterisk (*) displays where you type the character. After the correct system password is entered, the Logon menu will open.

```
SAIC Documentation
Automatic Equipment Identification System
APU software Version 5.0
AMTECH Model AI1200 Ver 2.80 SN97514
Wed 06/30/04  13:06:23
Host Reporting: On, All
Last LOGON: Wed 06/30/04  13:01:52

USID:         SAIC0ICU812
Site Name:    Test
APU102:Main 1>_
```

The APU-102 will not transmit critical system messages until the System Menu password is entered. This is to ensure that this information is available to authorized users only and that the remote terminal is ready to display data from the site. If the password is entered incorrectly, the APU-102 displays the message "INVALID PASSWORD". The password field displays again to allow you a second chance. If the password is invalid on the second try, the system again displays the invalid password message and returns the user to the Session Select menu. The second chance to enter the password allows an authorized user access without needing to reenter the session.

After the password is accepted, the cursor flashes at the *APU102:Main* > prompt with the corresponding session number and, if applicable, a "Train Recording" message. If there are no Train Recording messages, the APU-102 reports that there are no current system messages. If a Train Recording message exists, but the wrong password is entered, the APU-102 transmits the message.

At the *APU102:Main* > prompt, you may choose to enter the System Menu or, depending on your level of system authority, the Supervisory Menu.

3.3.4 Initial Configuration and Tests

1) Check the current software version and update if needed. To verify that the APU-102 has the correct software version running, log into the *Main1* prompt, press the "/" key, then **<Enter>**. This shows the current running version. Check with SAIC Customer Service to see if an update is needed.

2) Before a train can be recorded properly, acquisition parameters need to be set to site-specific values (transducer spacing, gain and threshold, antenna read lobes and reader configuration, inter-track communications, and REDI interface - if site is a hybrid).

3) Update the site *Operating* parameters. Because each site may vary, the operating parameters need to be checked to make sure they apply to the site you are working on. Change to the Supervisory Menu to perform editing functions. A reboot is required to activate parameter changes.

4) Update the site *Session* parameters. If there is a phone line available for transmission to the host, update Session parameters as required and test the Host Reporting operation.

5) Verify the AC power fail transformer operation by observing the I/O screen while testing. Log onto the APU-102 and Press the "I" key, then <Enter> at the APU102: Main prompt.

   NOTE: Communications software must be in ANSI mode to read this screen.

   Observe the 24 VAC line. I/O information is continuously updated.

6) Verify AC power fail test. To do this, turn off breaker to AC power fail transformer, wait 10 seconds and turn back on. Log on to APU-102 and change to the Supervisory Menu. Enter the **SYS** command, PID 1, and verify you see the following messages in the

system error log. Verify the power fail messages occur at the same time that the breaker was tripped and reset.

```
AC Pwr Fail
```

Followed by:

```
AC Pwr Restored
```

3.4 RF Power Optimization

3.4.1 Equipment Required

The following equipment is necessary to optimize RF power:

- Bird RF Power Analyst Model 4381 with 5W (400-1000 Mhz) and 500mW-(850-960 Mhz) heads or equivalent
- N to N Coax cable 4 ft (Male both ends)
- 50 ohm 5W terminator
- Programmed passive transponder tag mounted to metal backplate
- Digital multimeter

3.4.2 Watt Meter Setup

1) Install 5W 400-1000 Mhz element into the forward element receptacle.
2) Install 500mW 850-960 Mhz element into the reflected element receptacle.
3) Range 5, X1 scale.

3.4.3 Railcar-Only Site (Single Reader - Multiplexed RF)

1) Make sure RF power is off. The Search 0 and 1 LEDs on the APU-102 front panel should be off when RF is off to both channels.
2) Enter the **RFON** command from either menu and turn both channels of Reader 0 on by typing the **RFON,0,*** command. This turns RF on for both Channel 0 and Channel 1 of Reader 0.
3) With a digital multimeter on the DC V scale, measure the RF PWR at the RF unit. Place your positive lead on the AR2200 RF unit RF PWR terminal and the negative lead on the RF GND terminal inside the AR2200 RF unit.

4) With both RF channels on in multiplex mode, the RF PWR should be no less than 12.5 VDC and no more than 13 VDC. The RF PWR is supplied from the 12v power supply inside the APU-102. Adjust VR1 on the APU-102 power supply board for Reader 1 until the RF PWR at the RF unit is at least 12.9 VDC. If this is not done, all power measurements from this point forward may be incorrect.

Caution	Verify RF power is off before connecting or disconnecting any RF cables in the sections that follow. Press any key to turn off RF power. Make sure Search 0 and 1 on front panel of APU-102 are off.

RF Power at Source

1) Measure power at the starting point, or source, first. If it is low here, the rest of the system will not operate correctly.
2) Make sure RF power is off to RF unit.
3) Find the N-N jumper running from the RF unit Channel 0 to the coax lightning arrestor. Disconnect from arrestor end and connect to Forward element of RF meter.
4) Connect 50 ohm 5W terminator to the reflected element of the watt meter.
5) Enter the **RFON** command from either menu. To turn on RF to Channel 0 only, type the **RFON,0,0** command.
6) Turn on watt meter and press the FWD PEP button. This displays the forward peak envelope power. The power at the RF source should be no less than 1.4W. The forward power at source should not exceed 2W.
7) If the forward power is less than 1.40W with the 4-foot jumper in, you can try adjusting the 12v supply voltage up to gain some RF PWR. Make sure you do not exceed 13VDC RF PWR. If adjusting the RF PWR up does not bring the forward power up to at least 1.4W, the AR2200 must be replaced or repaired. The same is true for power over 2W. If you cannot adjust RF PWR down enough to get the forward power under 2W, replace the AR2200. Do not attempt to adjust the RF unit's supply voltage lower than 12.5 VDC.
8) Record measurements for future diagnostic evaluation.
9) Repeat above steps for Channel 1. Use the **RFON,0,1** command to turn power on to Channel 1.
10) Press any key to turn off RF power. Make sure Search 0 and 1 on front panel of APU-102 are off.

Tip	The 5W head has a +/- 250mW tolerance rating. If you are unsure the readings are correct or suspect an RF unit out of specification, install the 500mW head in the forward element with (2) 3dB in-line attenuaters to reduce the power below 500mW from the RF unit. Turn power on to the channel in question, note the reading, and divide the reading in half. This will give you a more accurate reading because the 500mW head has on a +/- 25mW tolerance and you will know within 25mW the actual power of the source.

Standing Wave Ratio at Source

1) Remove 50 ohm terminator and attach coax coming from the antenna to the reflected element of the meter.
2) Turn RF power on to Channel 0 by typing the **RFON,0,0** command from either menu.
3) Two elements are required for this mode and they must have a 10 to 1 power range ratio. Press the SWR key momentarily. If average reflected power is between 10% and 120% of full scale and the average reflected power is less than 120% of the reflected element range, SWR will be displayed. If any of the above conditions are not met, an error message will display. Two arrows pointing to the right (“greater than” symbols) indicate over-range, while two left pointing arrows (“less-than” symbols) indicate under-range or too little power.
4) The SWR should fall between 1.01 (0% reflected power) and 1.5 (4% reflected power). If the SWR exceeds 1.5 there could possibly be a bad connection or a coax cable problem. Double check the connectors for correct assembly. Too much reflected power degrades power at the antenna and causes low handshake counts on the transponder tags being read. Record results for future diagnostic use.
5) Repeat the above steps for Channel 1. Type the **RFON,0,1** command for Channel 1. Record the results for future diagnostic use.
6) Press any key to turn RF power off.
7) Reconnect coax cables to original positions.

RF Power at Antenna

1) Disconnect coax cable from Antenna 0.
2) Connect coax to the forward element of the watt meter with the 50 ohm terminator still attached to the reflected element of the meter.
3) Turn on RF power to Channel 0 by typing the **RFON,0,0** command from the either menu of the APU-102.

4) Press the FWD PEP key to measure peak envelope power. There should be no less than 1.0 watts of power at the antenna.

Standing Wave Ratio at Antenna

1) Remove 50 ohm terminator and attach N-N jumper from the antenna to the reflected element of the meter.
2) Turn RF power on to Channel 0 by typing the **RFON,0,0** command from either menu.
3) Two elements are required for this mode and they must have a 10 to 1 power range ratio. Press the RFL PEP to measure the reflected peak envelope power. Record the results for future diagnostic use.
4) Press the SWR key momentarily. If average reflected power is between 10% and 120% of full scale and the average reflected power is less than 120% of the reflected element range, SWR will be displayed. If any of the above conditions are not met, an error message will display. Two arrows pointing to the right (“greater than” symbols) indicate over-range, while two left pointing arrows (“less-than” symbols) indicate under-range or too little power.
5) The SWR should fall between 1.01 (0% reflected power) and 1.5 (4% reflected power). If the SWR exceeds 1.5 there could possibly be a bad connection or a coax cable problem. Double check the connectors for correct assembly. Too much reflected power degrades power at the antenna and causes low handshake counts on the transponder tags being read. Record results for future diagnostic use.
6) Repeat the above steps for Channel 1. Type the **RFON,0,1** command for Channel 1. Record the results for future diagnostic use.
7) Press any key to turn RF power off.
8) Reconnect coax cables to original positions.

If Less Than 1W of Power at Antenna

1) Double check coax cable type to make sure correct cable is being used.
2) Double check RF PWR at RF unit to make sure you have at least 12.5VDC. You can increase this power to give you more power at the antenna as long as you do not exceed 2W at source and 13VDC of RF PWR. The reason for having at least 1W of power at the antenna is due to the speed of the site. If the site is high speed (above 45mph) the transponder tag will be in the read window a shorter amount of time therefore you will want the biggest read window possible to make sure the tag is read.
3) Double check SWR to make sure there is not excessive reflected power.
4) Record measurements for future diagnostic use.
5) Turn RF power off and reconnect coax to antenna.
6) Repeat these steps for Antenna 1.

Measuring Horizontal Read Window

1) The horizontal read window is defined as the horizontal distance a tag may be read in front of an antenna. The tag should be passed in front of antenna directly above edge of ties (approximately 4 ft). Tag should be held horizontally to insure accuracy of read window
2) Turn RF power on to Channel 0 only using the **RFON,0,0** command from the either menu on the APU-102.
3) Make sure the Sonalert switch, which is located on the motherboard at the bottom of the APU-102, is in the correct reader position for the reader being measured. It should be set for Reader 1 or Reader 2. Refer to APU-102 system interconnect diagram in the *AEI System Operations Manual* for proper position of the switch.
4) Attach programmed passive transportation tag to metal plate approximately 3 times the size of the tag.
5) Listen for the Sonalert in the building and face Antenna 0 at the edge of the ties, approximately 10 feet to one side of the antenna. Simulate a tagged railcar passing the site by holding the tag attached to the 3’ x 2’ metal plate at the edge of the ties 3.5 feet from the top of the rail and walking on either side of the antenna until the Sonalert sounds.
6) Mark at the edge of ties where the Sonalert first came on.
7) Continue walking past the antenna with tag in the same position until the Sonalert stops. Mark this point at the edge of ties.

8) Measure from the point where the Sonalert first sounded to the point where it stopped with a tape measure. This will be the horizontal read window for this antenna.

9) Round the measurement up to the nearest foot. Horizontal read windows with at least 1W of power at antenna should be approximately 13-16 feet wide on a Parapanel antenna and approximately 7 feet ± 2 feet for a low profile antenna.

10) Record this measurement on paper for reference and in the APU-102 acquisition parameters under Reader 1 “Ant0PassiveLobe.”

11) Repeat the above steps for Antenna 1.

12) Record the measurement for Antenna 1 on paper for reference and in the APU-102 acquisition parameters under Reader 1 “Ant1PassiveLobe.”

Tip	If expected window widths are not obtained and power levels are correct, check RF unit range potentiometer setting.

3.4.4 Railcar-Only Site (Dual Reader - Dedicated RF)

NOTE	For dual reader dedicated RF sites that there should be a separate AR2200 RF unit for each antenna. RF unit for Antenna 0 should have a 50 ohm terminator plugged into Channel 1, and the RF unit for Antenna 1 should have a 50 ohm terminator plugged into Channel 0.

1) Make sure RF power is off by checking the Search 0 and 1 LEDs on the APU-102 front panel for both reader 1 and 2. When RF is off to both channels, all search LEDs should be off.

2) From either menu, enter the **RFON** command and type **RFON,0,*** to turn both channels of Reader 0 on. This turns on RF to both Channels 0 and 1 of Reader 0.

3) With a digital multimeter on the DC V scale, measure the RF PWR at the RF unit. On the AR2200 place your positive lead on the RF PWR terminal and the negative on the RF GND terminal inside the AR2200 RF unit.

4) With both RF channels on in multiplex mode, the RF PWR should be no less than 12.5 VDC and no more than 13VDC. The RF PWR is supplied from the 12v power supply inside the APU-102. Adjust VR1 on the APU-102 power supply board for Reader 1 until the RF PWR at the RF unit is at least 12.9VDC. If this is not done, all power measurements from this point forward may be incorrect.

5) Repeat the above steps for Reader 1 by typing **RFON,1,*** to turn on RF to both channels of Reader 1. Adjust VR2 on the APU-102 power supply to adjust RF PWR for Reader 1.

RF Power at Source

1) Power should be measured at the starting point, or source, first. If it is low here, the rest of the system will suffer.

2) Make sure RF PWR is off to RF unit. Find the N-N jumper running from the RF unit #1 Channel 0 to the coax lightning arrestor. Disconnect from arrestor end and connect to Forward element of RF meter.

3) Connect the 50 ohm 5W terminator to the reflected element of the watt meter

4) From either menu, select the **RFON** command. Turn on RF to Channel 0 only by typing **RFON,0,0.**

5) Turn on watt meter and press the FWDCW PEP button. This displays the forward peak envelope continuous wave power. The power at the RF source should be no less than 1.4 W. The forward power at source should not exceed 2W.

6) If the forward power is less than 1.40W with the 4-foot jumper in, you can try adjusting the 12v supply voltage up to gain some RF PWR. Make sure you do not exceed 13VDC RF PWR. If adjusting the RFPWR up does not bring the forward power up to at least 1.4W, the AR2200 must be replaced or repaired. The same is true for power over 2W. If you cannot adjust RF PWR down enough to get the forward power under 2W, replace the AR2200. Do not attempt to adjust the RF unit's supply voltage lower than 12.5 VDC.

7) Record measurements for future diagnostic evaluation.

8) Repeat the above steps for Channel 1. Use the **RFON,1,1** command to turn power on to Reader 1, Channel 1.

9) Press any key to turn RF power off. Make sure Search 0 and 1 for both readers on front panel of APU-102 are off.

Tip	The 5W head has a +/- 250mW tolerance rating. If you are unsure if the readings are correct or suspect a RF unit out of specification, install the 500mW head in the forward element with (2) 3dB in-line attenuaters to reduce the power below 500mW from the RF unit. Turn power on to the channel in question and note the reading. Divide the reading in half. This will give you a more accurate reading because the 500mW head has on a +/- 25mW tolerance and you will know within 25mW the actual power of the source.

Standing Wave Ratio at Source

1) Remove the 50 ohm terminator and attach coax coming from antenna to the reflected element of the meter.

2) Turn RF power on to Reader 0, Channel 0 by typing **RFON,0,0** from either menu.

3) Two elements are required for this mode and they must have a 10 to 1 power range ratio. Press the SWR key momentarily. If the average reflected power is between 10% and 120% of full scale and the average reflected power is less than 120% of the reflected element range, SWR will display. If any of the above conditions are not met, an error message will display. Two arrows pointing to the right ("greater than" symbols) indicate over-range, while two left pointing arrows ("less-than") symbols indicate under-range or too little power.

4) The SWR should fall between 1.01 (0% reflected power) and 1.5 (4% reflected power). If the SWR exceeds 1.5, there could possibly be a bad connection or a coax cable problem. Double check the connectors for correct assembly. Too much reflected power degrades power at the antenna and causes low handshake counts on the Transponder tags being read. Record results for future diagnostic use.

5) Repeat the above steps for Reader 1, Channel 1. Type **RFON,1,1** for Reader 1, Channel 1. Record results for future diagnostic use.

6) Press any key to turn RF power off.

7) Reconnect coax cables to original positions.

RF Power at Antenna

1) Disconnect coax cable from Antenna 0.

2) Connect coax to the forward element of the watt meter with the 50 ohm terminator still attached to the reflected element of the meter.

3) Turn on RF power to Reader 0, Channel 0 by typing (Reader 1 or Reader 2) from either menu of the APU-102.

4) Once again press the FWD PEPCW key to measure peak envelope continuous wave power. There should be no less than 1.0 watts of power at the antenna.

Standing Wave Ratio at Antenna

1) Remove 50 ohm terminator and attach N-N jumper from the antenna to the reflected element of the meter.
2) Turn RF power on to Reader 0, Channel 0 by typing the **RFON,0,0** command fromeither menu.
3) Two elements are required for this mode and they must have a 10 to 1 power range ratio. Press the RFL PEP to measure the reflected peak envelope power. Record the results for future diagnostic use.
4) Press the SWR key momentarily. If average reflected power is between 10% and 120% of full scale and the average reflected power is less than 120% of the reflected element range, SWR will be displayed. If any of the above conditions are not met, an error message will display. Two arrows pointing to the right ("greater than" symbols) indicate over-range, while two left pointing arrows ("less-than" symbols) indicate under-range or too little power.
5) The SWR should fall between 1.01 (0% reflected power) and 1.5 (4% reflected power). If the SWR exceeds 1.5 there could possibly be a bad connection or a coax cable problem. Double check the connectors for correct assembly. Too much reflected power degrades power at the antenna and causes low handshake counts on the Transponder tags being read. Record results for future diagnostic use.
6) Repeat the above steps for Reader 1, Channel 1. Type the **RFON,1,1** command for Reader 1, Channel 1. Record the results for future diagnostic use.
7) Press any key to turn RF power off.
8) Reconnect coax cables to original positions.

If Less Than 1W of Power at Antenna

1) Double check coax cable type to make sure correct cable is being used.
2) Double check RF PWR at RF unit to make sure you have at least 12.5VDC. You can increase this power to provide more power at the antenna as long as you do not exceed 2W at source and 13VDC of RF PWR. The reason for having at least 1W of power at the antenna is due to the speed of the site. If the site is high speed (above 45mph), the Transponder tag will be in the read window a shorter amount of time. You will, therefore, want the largest read window possible to make sure the tag is read.
3) Double check SWR to make sure there is not an excessive reflected power.
4) Record measurements for future diagnostic use.
5) Turn RF power off and reconnect coax to antenna.

6) Repeat above steps for Reader 1 Antenna 1 using the **RFON,1,1** command.

Measuring Horizontal Read Window

1) The horizontal read window is defined as the horizontal distance in front of an antenna that a tag may be read. The tag should be passed in front of antenna directly above edge of ties (approximately 4 ft). Hold the tag horizontally to ensure accuracy of read window.

2) Turn RF power on to Reader 0 Channel 0 only, using the RFON,0,0 command from either menu on the APU-102.

3) Make sure the Sonalert switch, which is located on the motherboard, is turned on for Reader 1. Refer to APU-102 system interconnect diagram in *3.0 AEI System Components and Functions* in the *AEI System Operations Manual* for proper switch position.

4) Attach programmed passive transportation tag to metal plate approximately 3 times the size of the tag.

5) Listen for the Sonalert in the building. Face Antenna 0 at the edge of the ties, approximately 10 feet to one side of the antenna. Simulate a tagged rail car passing the site by holding the tag attached to the 3' x 2' metal plate at the edge of the ties 3.5 feet from the top of the rail and walking on either side of the antenna until the Sonalert sounds. Mark at the edge of ties where the Sonalert first came on and continue walking past the antenna with tag in same position until the Sonalert stops, mark this point at the edge of ties. Measure from the point where the Sonalert first sounded to the point where it stopped with a tape measure, this will be the horizontal read window for this antenna.

6) Round measurement up to the nearest foot.

7) Horizontal read windows with at least 1W of power at antenna should be approximately 13-16 feet wide on a Parapanel antenna and 7 feet +/- 2 feet for a low profile antenna.

8) Record this measurement on paper as a record and in the APU-102 Acquisition parameters for Reader 1 “Ant0PassiveLobe”.

9) Repeat above steps for Reader 1 Antenna 1 using the **RFON,1,1** command.

10) Record measurement for Antenna 1 on paper and in the APU-102 Acquisition parameters for Reader 2 “Ant1PassiveLobe”.

Tip	If expected window widths are not obtained and power levels are correct, check RF unit range potentiometer setting.

3.4.5 RF Module Range Sensitivity Adjustment

The range sensitivity adjustment feature of the AR2200 RF module provides a means for unwanted tag signals to be screened without decreasing RF power. This feature may be used to desensitize the reading range of the system.

The range sensitivity modulator allows selective setting of the effective noise threshold of the system. This is accomplished by injecting AM modulation onto the IF signals, thus increasing the threshold noise level. A tag signal is decoded as valid by the reader only when its signal exceeds the preset threshold.

NOTE	This adjustment has negligible effect on passive tags, but does impact battery-powered tag read performance. SAIC does not use this adjustment in an attempt to control read performance. Installing a jumper at JP1, near the transformer on the RF interface board, disables the range sensitivity adjustment. The range is preadjusted to maximum, but installing the jumper ensures the maximum range.

Older RF units produced prior to 1993 may not have the jumper override option and must be manually adjusted. Adjustments are made to the range sensitivity potentiometer located on the RF interface board. If range potentiometers are the small plastic type, set the maximum range by turning the potentiometers fully counterclockwise (CCW). These multi-turn potentiometers usually have click stops. For potentiometers without click stops, turn 4 full rotations counterclockwise. If range potentiometers are the large metal type, set the maximum range by turning the potentiometers fully clockwise (CW).

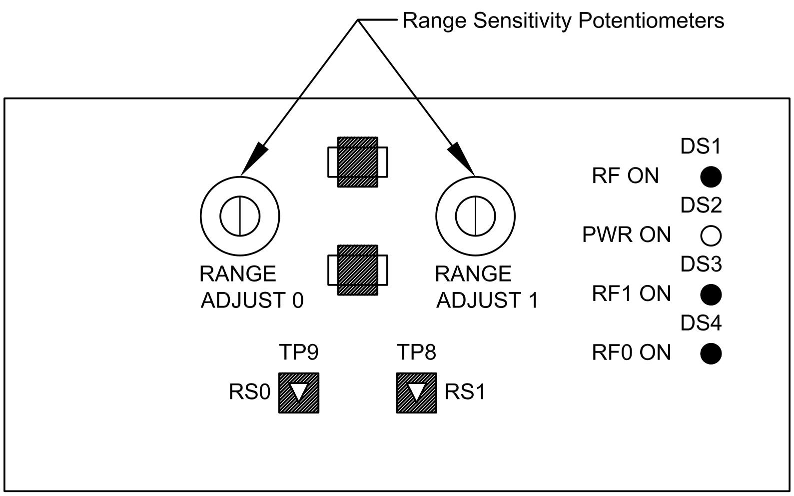
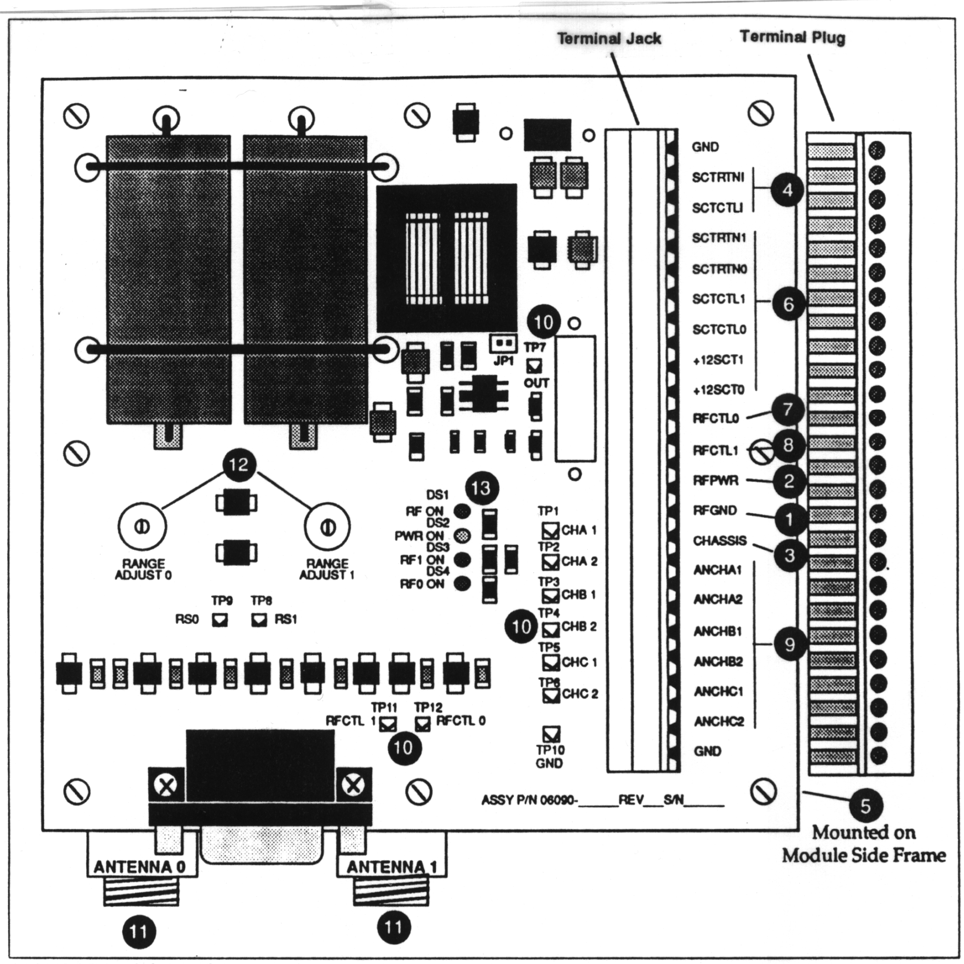


Figure 3.1: RF Module range sensitivity adjustment potentiometers



AR2200 RF Module Interface

1. 12 VDC RF Ground
2. 12 VDC RF Power
3. Case Chassis Ground
4. RF Module-to-Reader System Check Tag Control Inputs
5. Output Signal Jumper
6. System Check Tag Output Connections (RF Module Side Only)
7. RF Output Control, Antenna 0
8. RF Output Control, Antenna 1 (Not Used in Normal Mode)
9. IF Signals
10. Test Points (1 through 10)
11. Antenna Output Ports
12. Range Adjustment Potentiometers (Channel 1 Inactive)
13. Status Indicator Lights

Figure 3.2: Location of range sensitivity potentiometers on RF module

3.5 Wheel Detector Optimization

This chapter provides instructions on optimizing the axle acquisition side of the system through the Tiefenbach wheel detector and the TDA-105 wheel detector interface card.

3.5.1 Materials and Tools Required

The following materials and tools are required to perform the optimization procedure:

- Small trim potentiometer adjustment tool
- Test plate
- Tiefenbach alignment plate and cable set
- Brass adjusting nut (supplied with Tiefenbach) or 3-mm allen wrench.

3.5.2 TDA-105 Adjustment

Refer to Figure 3.7 and 3.8 when completing this procedure.

1) With the small trim potentiometer adjustment tool, adjust the null potentiometer for the A and B segments until both positive and negative LEDs are extinguished. Adjust positive and negative LEDs for one segment, then adjust them for the other segment. The following table indicates which direction to turn the null potentiometer:

	To Turn LED Off	To Turn LED On
Segments A and B Positive	Counterclockwise	Clockwise
Segments A and B Negative	Clockwise	Counterclockwise

2) With both LEDs on the TDA-105 extinguished, push and hold SW5. If the LEDs illuminate, continue to hold SW5 and adjust the null potentiometer further until both LEDs are again extinguished. This process fine tunes the null potentiometer adjustment.

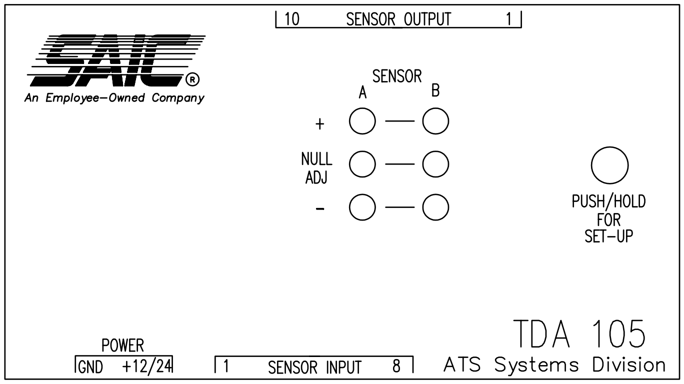
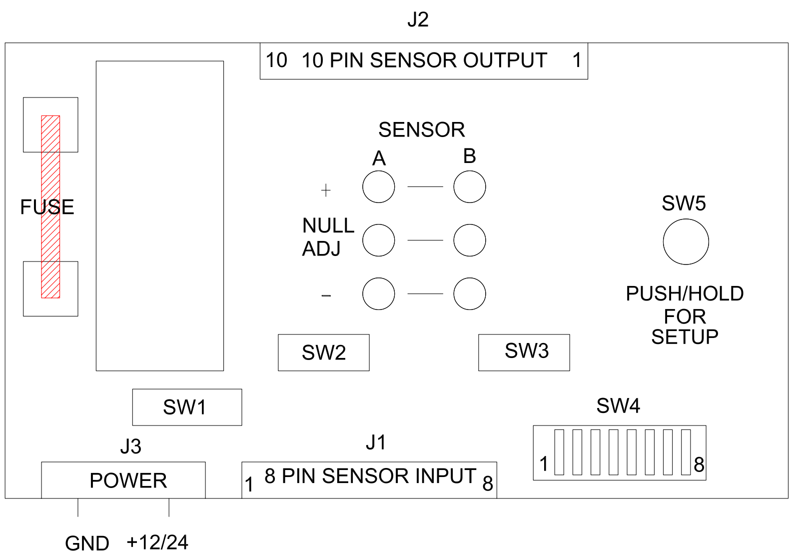


Figure 3.3: TDA-105 case



Tiefenbach			Servo		
Switch	**ON**	**OFF**	**Switch**	**ON**	**OFF**
SW1	1,8	2,3,4,5,6,7	SW1	2,3,6,7	1,4,5,8
SW2	1,3	2,4	SW2	2,4	1,3
SW3	1,3	2,4	SW3	2,4	1,3
SW4	1,8	2,3,4,5,6,7	SW4	2,3,6,7	1,4,5,8

Figure 3.4: TDA-105 layout and switch positions

If you encounter problems with the adjustment, verify that the TDA-105 is set to the switch positions listed in Figure 3.4 or on the back of the TDA-105 cover.

The TDA-105 adjustment procedure is now complete.

3.5.3 Tiefenbach Transducer Adjustment

The following procedures put the Tiefenbach wheel detector back into specification, if needed, after mounting and wiring is completed and the TDA-105 is installed and adjusted.

Checking the Required Parameters

1) Before adjusting the Tiefenbach transducer, verify that the following system parameters are set up in the *Acquisition* section of the APU application software:

Parameter Name	Required Value
WheelDetectorSeparation	40
WheelDetectorGain	99
WheelDetectorThreshold	30
WheelDetCsegMode	2

2) Make any required changes.

3) Reboot the APU-102 in order for the parameters to take effect.

For more detailed information on setting wheel detector parameters, refer to Appendix A: System Parameters in the AEI System Operations Manual.

Setting the Tiefenbach Segment Switching Distance

1) Attach the adjustment test box to the TDA-105 J2 output connector.
2) Verify that both LEDs for the TDA-105 A and B segments are OFF. If not, adjust the TDA-105 null potentiometer until both LEDs are extinguished. (*Refer to: TDA-105 Adjustment* above.)
3) Place the test plate on top of the rail with the feet aligned evenly on the rail and the stud/stand-off in the center of the transducer, between the SI and SII segments.

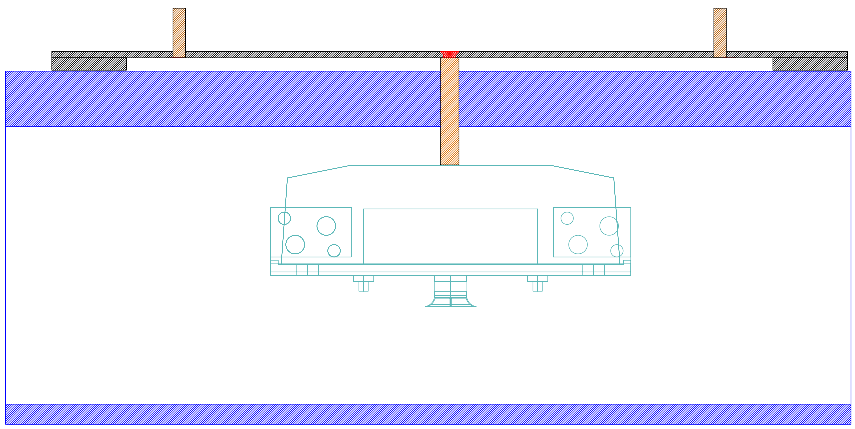


Figure 3.5: Tiefenbach transducer test plate

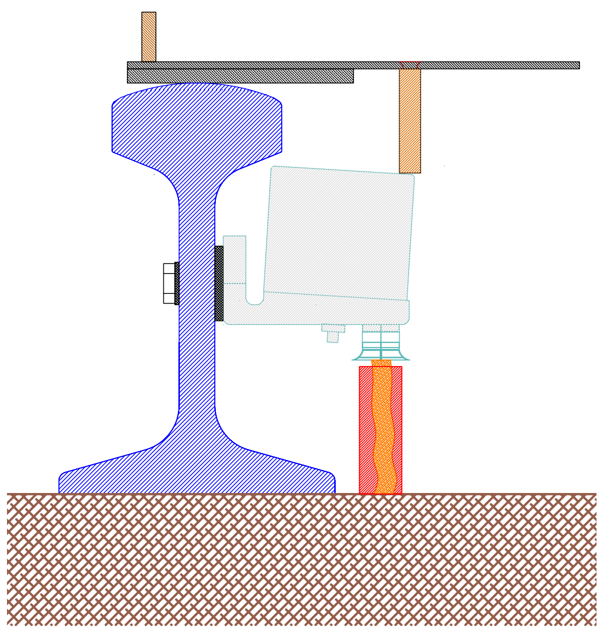


Figure 3.6: Tiefenbach transducer test plate, end view

4) Remove the plastic retaining nut from the adjusting stud under the SI (B segment) side of the transducer.

5) The adjusting stud can be rotated by using one of two methods. Either:

   a) Screw on the brass adjusting nut firmly, press the adjusting stud in and rotate counterclockwise until the B side (green) LED on the adjustment test box turns on.

OR

   b) Use the appropriate hex key to push in and rotate the adjusting stud counterclockwise (left) until the B side (green) LED on the adjustment test box turns on.

Tip	Looking at the top of rail, the LED turns off by rotating the adjusting shaft clockwise and turns on by rotating the adjusting shaft counterclockwise. The goal is to find a setting where both LEDs are just turning on.

WARNING	Do not overtighten the adjusting shaft. Doing so may damage the anti-displacement device inside sensor.

6) When you find the correct switching distance, the LED will light. Release pressure on the adjusting stud.

7) While holding the adjusting stud from turning with the hex key, remove the brass adjusting nut (if used) and reinstall and tighten the plastic retaining nut until it is just snug. Do not overtighten.

8) Repeat steps 4 through 7 for the SII (A segment) side of the transducer, *making not to over-tighten the plastic retaining nut*. The red LED on the adjustment test box will light.

9) Rock the test plate several times back and forth to ensure both internal sensors are set within range and as close as possible to the same level (both LEDs are on).

   Raise the pin side of the plate from the transducer while maintaining contact with the rail and slowly lower while observing the LED's. Verify the LED's light up at the same time. Repeat adjustments as necessary.

Tip	If you follow the steps above and have problems with the adjustment, refer to either Figure 3.8 above or the label inside the TDA-105's cover to verify the Tiefenbach switch positions.

Your Tiefenbach transducer and TDA-105 should now be properly adjusted and connected as indicated in the following diagram.

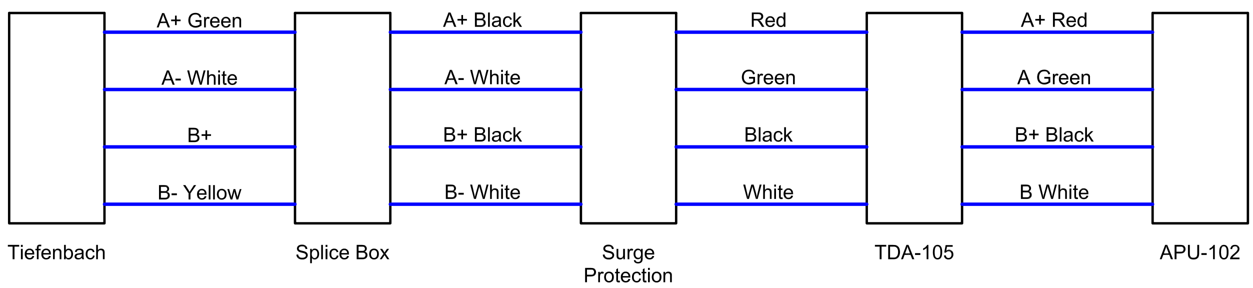


Figure 3.7: Wiring Diagram

3.5.4 Tiefenbach Wheel Detector Testing

Before testing the wheel detector, make sure you have performed the adjustments phase of this procedure. Refer to Figure 3.8 when performing the following test.

Voltage Checks

Before testing the transducer and TDA-105 voltages, check the DC voltage supplied to the TDA-105 at J3. J3 pin 1 is DC common, J3 pin 2 may be connected to either +12 or +24 VDC.

Transducer Voltages (Sensor Input)

Voltage across either transducer segment should be approximately 5VDC ± 0.5 V with no wheel or metal over the transducer. “A” segment voltage may be measured at J1 pin 1 (+) and pin 2 (-). “B” segment voltage is measured at J1 pin 5 (+), J1 pin 6 (-). Placing a piece of test metal over a transducer segment causes the corresponding segment voltage to rise to approximately 9.5 VDC ± 0.5 VDC. (This voltage varies depending on the size and placement of metal over transducer segment.)

TDA-105 Output Voltages

TDA-105 voltages may be measured at the TDA-105 or the APU-102 main block. For procedure clarity, voltages at the TDA-105 will be listed; however, it is recommended that the voltages also be checked at the APU-102 main block to verify proper wiring.

1) Confirm no metal is present over the transducer. Voltage should measure 0.0 VDC ±0.1 VDC.

2) Place a piece of test metal over each transducer segment, check voltage of the "A" segment at J2 pin 1 (+) and J2 pin 2 (-), then check the "B" segment voltage at J2 pin 6 (+), J2 pin 7 (-). Voltage across each segment should rise to approximately 3.5 VDC ±0.5 VDC.

LED Test Method

With the Tiefenbach and TDA-105 connected as in drawing 101-07, confirm proper Tiefenbach and TDA-105 adjustment using the following steps:

1) Turn on the APU-102.
2) Lay a coin on the SII side of the transducer. The A+ LED on the TDA-105, and the WDA and Search LEDs on the APU-102 should light.
3) Remove the coin from the SII side of the transducer. The LEDs on both the APU-102 and the TDA-105 should go off. The search LEDs will remain on until the antenna times out.
4) Lay a coin on the SI side of the transducer. The B+ LED on the TDA-105 and the WDB and Search LEDs on the APU-102 should light.
5) Remove the coin from the SI side of the transducer. The LEDs on both the APU-102 and the TDA-105 should go off. The Search LEDs will remain on until the antenna times out. The wheel transducer activity can also be monitored on the APU's I/O screen.

The site is now ready for evaluation of axle information using actual trains.

3.6 Loop and Loop Detector Optimization

3.6.1 Connecting the Loop Testing System

1) Verify the loop is installed correctly according to the following list. Refer to the drawings in *Appendix C: Site Drawings* for reference.
    a) Inspect loop (should be #6 Bond strand) for cuts in insulation or exposed wires. These should be repaired and waterproofed immediately.
    b) Make sure loop wire is installed with at least 3-4 inches of clearance to all metal (rail, tie plates, etc.)
    c) Make sure there is no metal debris near loop wire (brake shoes, tie plates, or any discard metal).
    d) Make sure loop wires are crossed at least five times per foot between where the loop wire leaves the ties and the junction box.

e) Make sure loop wire is not run under or around wheel detectors as this may cause interference to the wheel detector.

f) Inspect splice to make sure waterproofing is adequate. Water in splice can cause intermittent operation.

2) Unscrew cable connected to the loop detector and install the loop excitation module from the loop testing system into the connector.

3) Connect the loop excitation module to the frequency tester and press and hold the Test button for one minute. The frequency should be very stable (not more that 1-2 Hz of fluctuation per minute).

If the frequency shifts radically, inspect loop for metal objects, loop wire running too close to rail, tie plates, or moving switches and then correct. Retest with frequency tester until frequency is stable. Reconnect the cable harness to the loop detector.

3.6.2 Testing the Loop

1) Set loop sensitivity on the loop detector to **9** and lay a piece of metal on the loop wire at the track. The loop detector LED will flash for two seconds, then lock on and the APU-102 search LED will turn on, indicating that the loop detector is on and that train presence is issued to the APU-102.

2) Remove the piece of metal. The loop detector LED will flash for two seconds and then turn off. The APU-102 LEDs will turn off (after a timeout period) indicating that train presence has cleared on the APU-102. The presence activity can also be monitored on the APU's I/O screen.

   If presence does not turn on and off with the above steps, inspect the loop for distance from any metal object (rail, tie plates, etc.), damage, correct installation, and splice making good connection.

3) Reset sensitivity to **1**.

4) Verify the following loop detector settings:

Switch	Setting
Mode:	Infinite
Frequency:	Single tracks: Use either Low or High frequency. Double tracks: Use Low and High frequency, one for each track.
Sensitivity:	1
Delay:	2 seconds DELAY DIP switch 2 = ON 1,3-6 = OFF
Extend:	2 seconds EXTEND DIP switch 4 = ON 1-3,5-6 = OFF

913AI LOOP DETECTOR FRONT PANEL

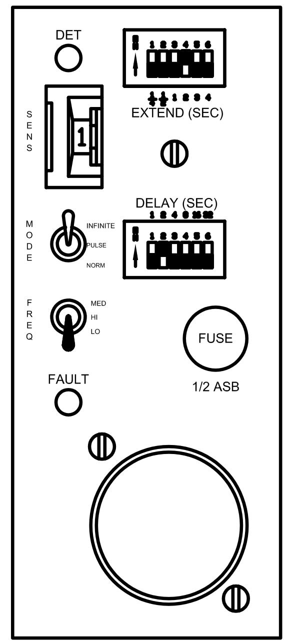


Figure 3.8: Loop detector settings

3.7 System Operational Test

Refer to Section 5.0 in the AEI System Operation Manual for this procedure.

3.8 Additional Information

For system testing and troubleshooting information, see the AEI System Operations Manual.

Appendix A – Site Optimization Checklist

A.1 Site Information

Site Name	
Site Number	
Track Number	
Mile Post	
Customer	
Job Number	
City	
State	
Team Leader	
Installers	
Site Contact Name	
Site Contact Telephone Number	
APU Primary Telephone Number	
APU Secondary Telephone Number	
Site Voice Telephone Number	
Installation Completion Date	
Customer Service Optimization Date	

A.2 Other Information

Date phone line(s) installed: ______________________

- ☐ Company (railroad) line
- ☐ Bell line

Date AC power installed: ______________________

A.3 System Type

☐ AEI Intermodal DT	☐ AEI Rest. DT	☐ LS Hybrid AEI Rest. DT
☐ AEI Intermodal ST	☐ AEI Rest. ST	☐ LS Hybrid AEI Rest. ST
☐ System 2000E	☐ AEI Unrest. DT	☐ LS Hybrid AEI Unrest. DT
☐ Tracker	☐ AEI Unrest. ST	☐ LS Hybrid AEI Unrest. ST
☐ Other		

A.4 Equipment Inventory

Building manufacturer		Serial Number:			
APU serial number:		APU serial number:			
S1200 serial number:		D1200 serial number:			
AR2200 Frequency		Serial Number:		Tier	
AR2200 Frequency		Serial Number:		Tier	
AR2200 Frequency		Serial Number:		Tier	
AR2200 Frequency		Serial Number:		Tier	
AR2200 Frequency		Serial Number:		Tier	
AR2200 Frequency		Serial Number:		Tier	
913I Loop Detector Voltage					
Epic III Frequency					

Antenna Type		
☐	E-5900 Hirschman Parapanel 2” Hardware (927965-900)	Serial Number:
☐	E-5901 Hirschman Parapanel 4” Hardware (927965-901)	Serial Number:
☐	AA3110 Scala Parapanel Antenna 915 MHz	Serial Number:
☐	SRL441P Log Periodic	Serial Number:
☐	SRL470 Log Periodic	Serial Number:
☐	AA3230 Ground Parapanel	Serial Number:
☐	AI1601 SmartPass	Serial Number:
☐	Check Tag AT5720	Serial Number:

Check the appropriate item below:

A.4.1 Protector Panel Type:

- ☐ SBB2707N1
- ☐ SBB2707N2
- ☐ SBB2707N3
- ☐ SBB2707N5
- ☐ SBB2707N6
- ☐ SPI
- ☐ SuppressSurge
- ☐ Other

A.4.2 Battery Charger Type:

- ☐ PS19
- ☐ NRS 24/30
- ☐ Customer Furnished
- ☐ Other

A.4.3 Battery Type:

- ☐ 4-3VB9 - 80 AMP 24 Volt
- ☐ 4-3VB11 - 100 AMP 24 Volt
- ☐ 12AVR-45 Unigy 12 Volt
- ☐ Customer Furnished
- ☐ 650A05 Absolyte
- ☐ Other

A.4.4 Wheel Detector Type:

- ☐ 40003237 Dual Servo
- ☐ 400080221 Servo Zero Speed
- ☐ 50-0902 Tiefenbach Dual Head
- ☐ 4000832210 Servo Zero Speed
- ☐ 4000832220 Servo Zero Speed
- ☐ Customer Furnished

Serial Number: ______________________

A.4.5 Hut/Enclosure Equipment

Initial each line when completed

_______ AC power fail transformer

_______ Coax cable termination - inside

_______ Door and floor vents open/removed

_______ Exhaust fan and heater/thermostat

_______ Protection panel checks

_______ Conduit sealant

A.4.6 Railside Equipment

Initial each line when completed

______	Antenna checks	______	Antenna 0 distance to target rail
______	Splice box (waterproofing)	______	Antenna 1 distance to target rail
______	Wheel detector mounting checks	______	Coax cable termination - outside
______	Check tag wiring	______	

☐ 0 = Right ☐ 1 = Left   Interference Unit Position (Double Track Only)

A.5 System Equipment Setup and Operational Checks

Initial each line when completed:

______ Loop detector and loop operation

______ (2 Second Delay / 2 Second Extend / Sensitivity 0 - 1 / Mode = Infinite)

______ AC power transformer operation

______ Wheel detector setup, operation

______ TDA-105 setup and operation

______ Wheel detector to antenna offset _____ft. ☐Right or ☐Left

______ SmartPass setup and operation

______ AR2200 RF unit(s) operational tests

______ APU-102(s) operational tests

______ Test double track presence

______ Indicate port used for ITC ☐ AUX1PORT.DAT ☐ AUX2PORT.DAT

______ Verify ITC communication

______ Verify LVD-2000 operation (if equipped)

A.6 APU-102 Software Setup and Testing

Initial each line when completed:

_______ Initial each line when completed:

_______ APU-102 software version ___________

_______ Modem card type & serial number:

_______ Update site operating parameters

_______ Update site session parameters

_______ Left to right direction: ☐ E-W ☐ W-E ☐ N-S ☐ S-N ☐ U-D ☐ D-U

_______ Remote support (if possible)

A.7 RF Power Optimization

AVI tier 0	Channel 0	Channel 1
RF PWR at source		
Reflected power at source		
SWR at source		
RF PWR at antenna		
Reflected power at antenna		
SWR at antenna		
Horizontal read lobe		
Approximate length of run		
Coaxial cable type		
Attenuation		
Check tag operation		
DC input to AR2200	VDC	

AVI tier 1	Channel 0	Channel 1
RF PWR at source		
Reflected power at source		
SWR at source		
RF PWR at antenna		
Reflected power at antenna		
SWR at antenna		
Horizontal read lobe		
Approximate length of run		
Coaxial cable type		
Attenuation		
Check tag operation		
DC input to AR2200	VDC	

AVI tier 2	Channel 0	Channel 1
RF PWR at source		
Reflected power at source		
SWR at source		
RF PWR at antenna		
Reflected power at antenna		
SWR at antenna		
Horizontal read lobe		
Approximate length of run		
Coaxial cable type		
Attenuation		
Check tag operation		
DC input to AR2200	VDC	

A.8 Site Drawing

Sketch site layout below and include the following:

1) All tracks in immediate area.
2) Direction arrow showing North.
3) Any buildings, metal fences in front of or behind antennas.
4) Overhead high voltage power lines.
5) Transducer location.
6) If double track, detail below with track numbers, i.e. Trk 1/Trk 2.
7) Conduit sizes.

Appendix B – Tools and Supplies

The following is a list of tools and supplies usually provided by the installation contractor. It does not include material usually supplied in SAIC installation kits.

General Construction Tools

- Picks
- Rake
- Shovels
- Others as required by nature of construction requirements, soils, etc.

General Mechanic's Tools

- Hammers, pliers, screwdrivers, wrenches, etc.

Crimpers

- Regular
- Terminal ring

Digital Test Meter

Drills

- Battery hand drill – 3/8" drive, including:
  - Flathead bit
  - Phillips head bit
  - Standard set of drill bits

Ground Rod Driver

Hammers

- Claw
- Sledge – 6lb.

Heliax Stripping Tool (LDF and/or as required)

Level

Power Equipment

- Backhoe
- Crane (1-ton capacity)

Saws

- Hacksaw
- PVC

Screwdrivers

- 1/8" blade
- ¼" blade
- #2 Phillips
- 1/16" jewelers
- ½" nut driver

Soldering Iron (butane)

Supplies

- Cutting oil
- Electrical tape – black
- Grease pen
- Marking paint
- Solder – 60/40 rosin core
- Tie wraps – 1/8" x 8"

Tapes

- Fishtape – 150 ft (45m) minimum
- Measuring tape – 150 ft (45m) minimum

Transducer (Wheel Sensor) Tools

- 17 mm x 32 mm drill bit
- Rail drill
- Tiefenbach drill guide w/punch

Wire Tools

- Lineman’s wire cutter
- Regular 6” diagonal wire cutter
- Wire stripper

Wrenches

- 10” adjustable
- 3/8” drive SAE socket set (up to ¾”)
- 3/8” drive metric socket set
- Ratchet
- 3/8” extension

Other Tools (optional)

- Foundation leg template
- GPS reader
- Portable generator

Appendix C – Site Drawings

The following are site installation drawings listed in the order they would likely be used at a site.

These drawings are for reference **ONLY** and are not intended to be a comprehensive drawing package.

Refer to your customer specific practices and drawings for site specific installation information.

Drawing Name	Drawing Number
SLU/SHU Single Track Low/High Speed Unrestricted System Perspective	101-01
SLU/SHU Single Track Low/High Speed Unrestricted Site Layout with Splice Pedestal	101-02
SLU/SHU AEI Site Elevation	101-03
SLU/SHU Grounding Plan	101-04
Single Track Loop Layout	101-05
DC Protection Terminal Blocks SLU/SHU	101-06
SLU/SHU AEI System Flow – Tiefenbach Transducers	101-07
Tiefenbach Sensor Installation Detail	101-08
Junction/Pull Box A10R106CA w/CASH132A-LT3	101-09
Loop Detector Front Panel (913AI)	101-10
Erico Ground Panel Assembly Detail	101-11
Presence Loop – System Flow – Zero Speed Transducer	101-12
Parapanel Antenna Mounting Detail	101-13
Check Tag Wiring Detail	101-14
DLR/DMR Double Track Low/Medium Speed Restrictive System Perspective	101-15
DLR/DMR & Double Track Low/Medium Speed Restricted Site Layout	101-16
DHR Double Track High Speed Restrictive System Perspective	101-17
DHR Double Track High Speed Restricted Site Layout	101-18
DLR/DMR Antenna Elevation Detail w/Conduit Detail (Signal height)	101-19
DLR/DMR Antenna Elevation Detail w/Conduit Detail (Alternate mounting for Narrow Track Centers)	5284-06
DHR Antenna Elevation Detail w/ Conduit Detail (Signal height)	101-20
DLR/DMR/DHR Grounding Plan	101-21
Double Track Loop Layout	101-22
DLR, DMR, DHR AEI System Flow – Tiefenbach Transducers	101-23

Drawing Name	Drawing Number
DLR, DMR, DHR, AEI Double Track Communications	101-24
SLU/SHU AEI System Flow – Tiefenbach Transducers for Route indication	101-26
LVD-2000 Wiring Diagram	70-0178-00
DLR, DMR, DHR, DMU and DLU AEI – LVD-2000 System Flow	70-0180-00
DLR, DMR, DHR AEI System Flow – Tiefenbach Transducers and Epic III Presence Circuit	70-0093-00
SLU/SHU AEI System Flow – Tiefenbach Transducer, ARMS Power Supply, SuppressSurge Protection Panel, and Epic III Presence Circuit	70-0187-02
APU102 Single Track System Diagram	601-419H
APU-102 Interconnect Drawing, 486SLC CPU w/ USSD	N/A
APU-102 Interconnect Drawings, Pentium CPU	N/A

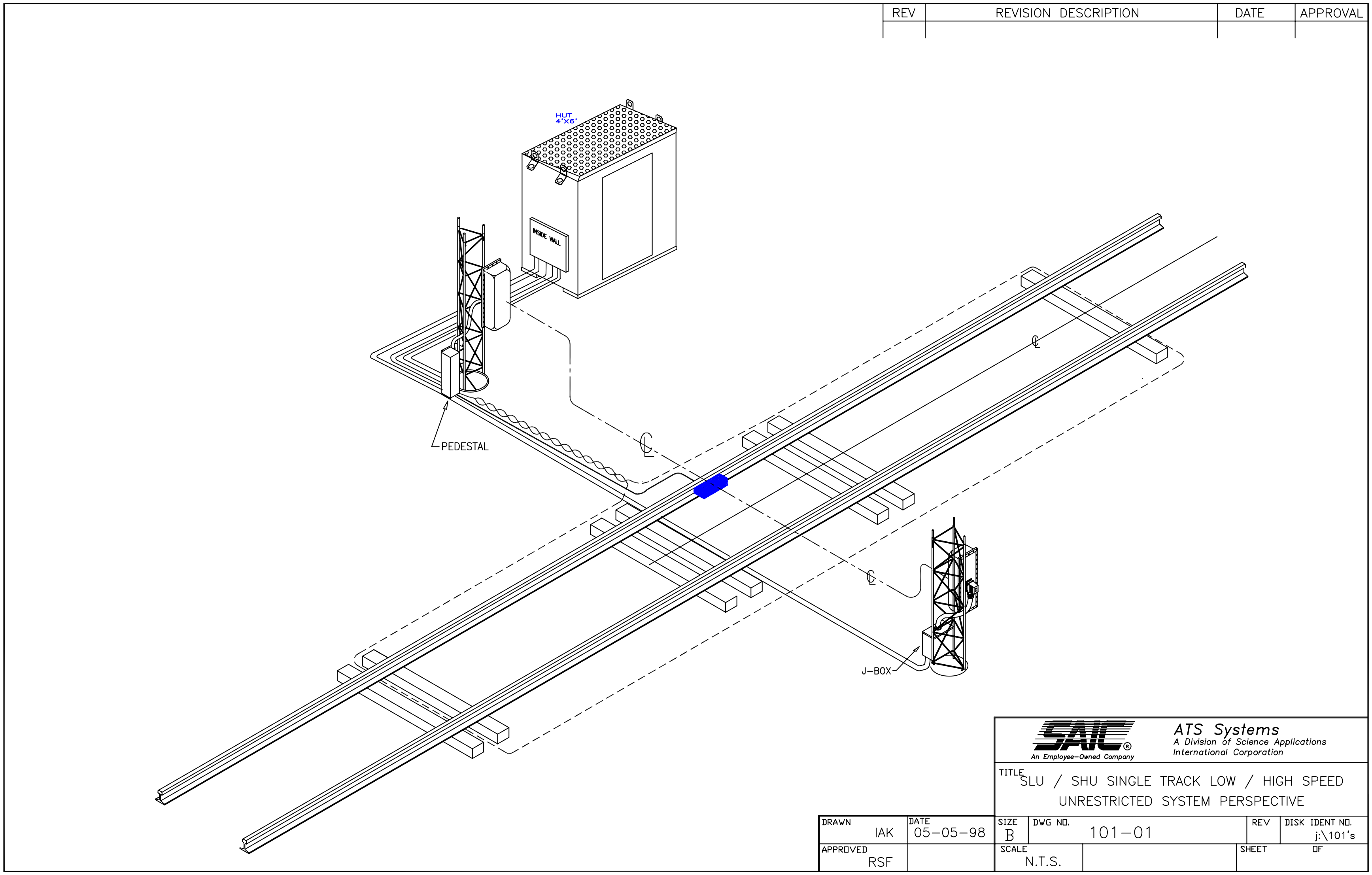


Figure C.1: SLU/SHU Single Track Low/High Speed Unrestricted System Perspective Drawing Number: 101-01

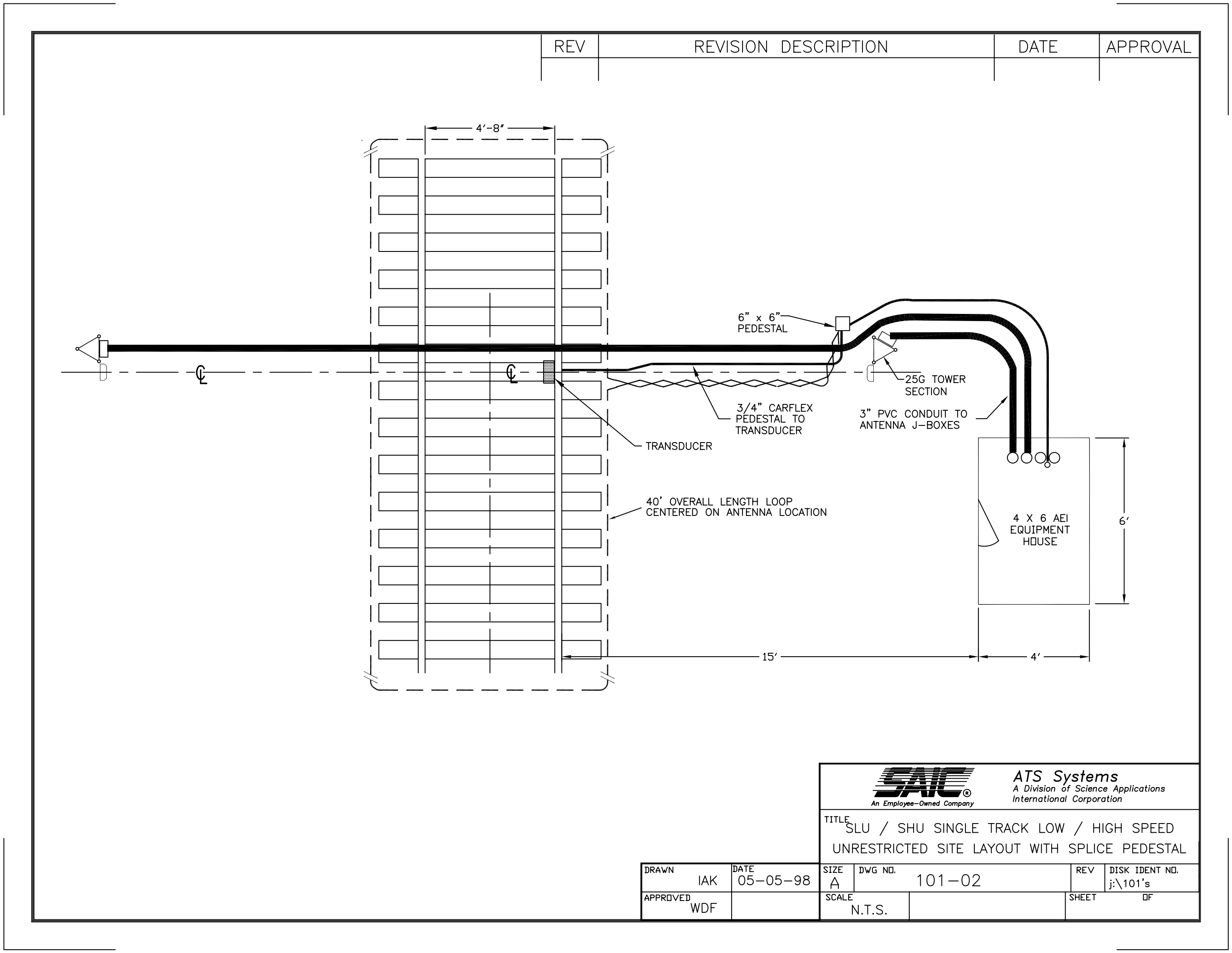


Figure C.2: SLU/SHU Single Track Low/High Speed Unrestricted Site Layout With Splice Pedestal   Drawing Number: 101-02

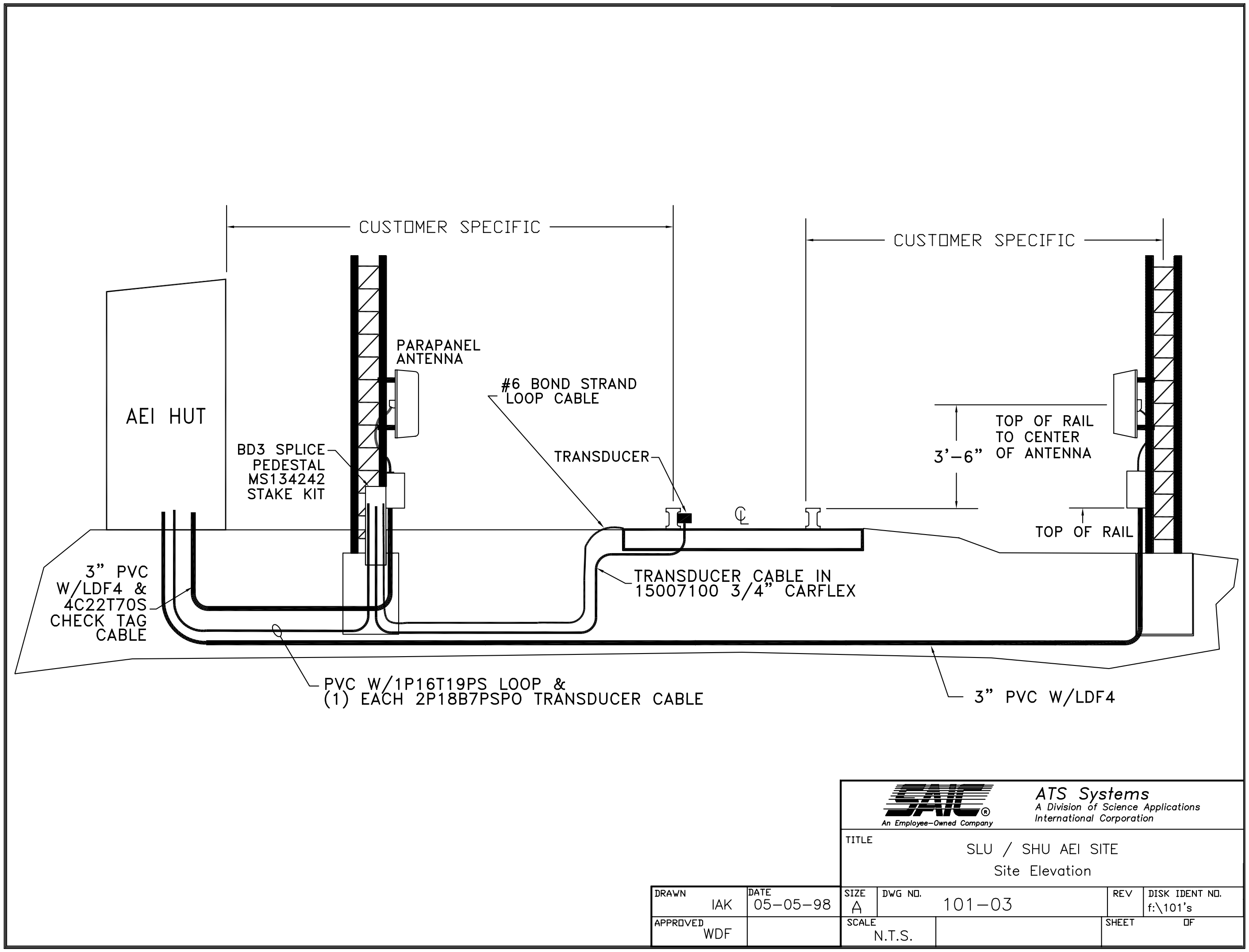
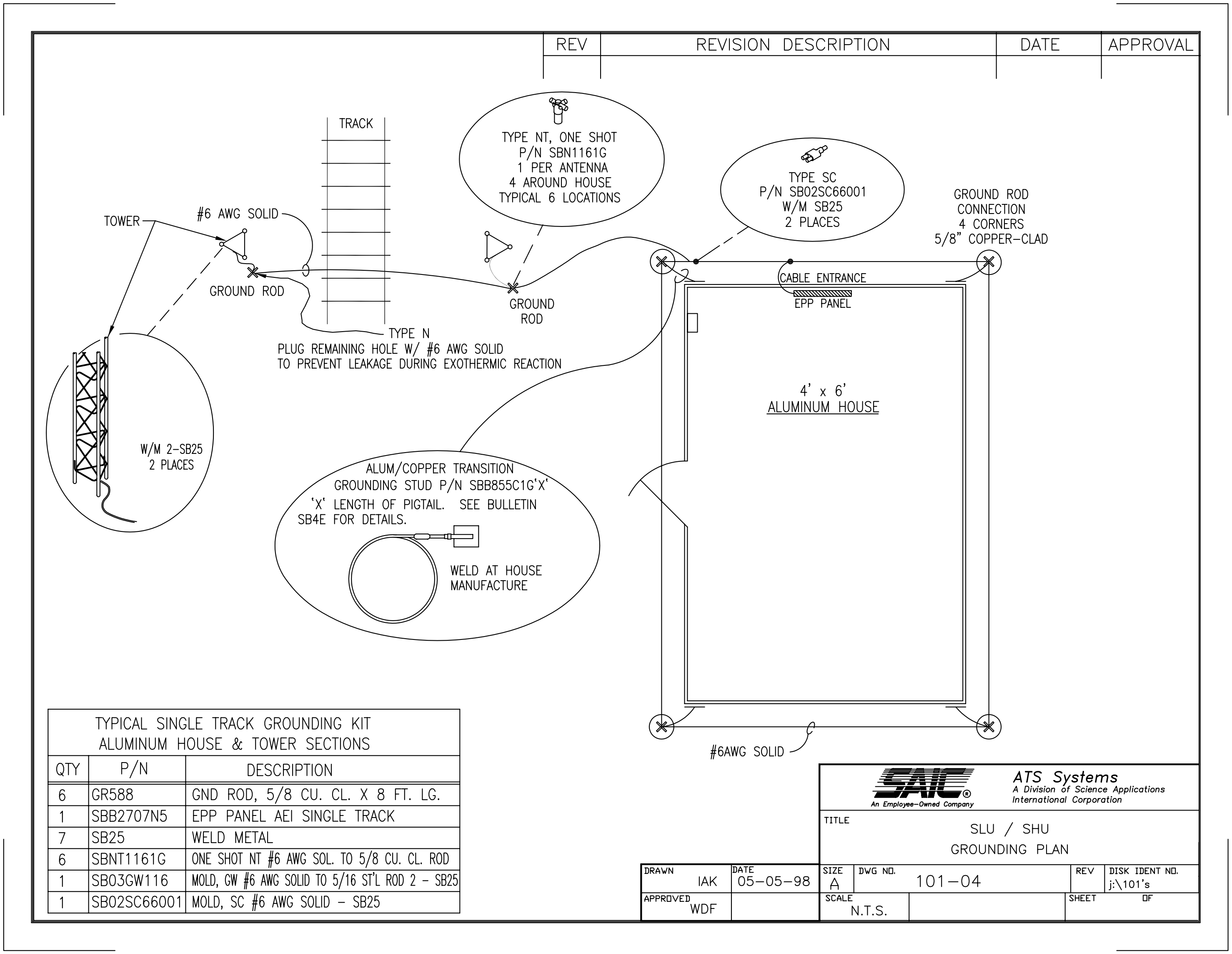


Figure C.3: SLU/SHU AEI Site Elevation Drawing Number: 101-03



TYPICAL SINGLE TRACK GROUNDING KIT
ALUMINUM HOUSE & TOWER SECTIONS

QTY	P/N	DESCRIPTION
6	GR588	GND ROD, 5/8 CU. CL. X 8 FT. LG.
1	SBB2707N5	EPP PANEL AEI SINGLE TRACK
7	SB25	WELD METAL
6	SBNT1161G	ONE SHOT NT #6 AWG SOL. TO 5/8 CU. CL. ROD
1	SB03GW116	MOLD, GW #6 AWG SOLID TO 5/16 ST'L ROD 2 - SB25
1	SB02SC66001	MOLD, SC #6 AWG SOLID - SB25

Figure C.4: SLU/SHU Grounding Plan Drawing Number: 101-04

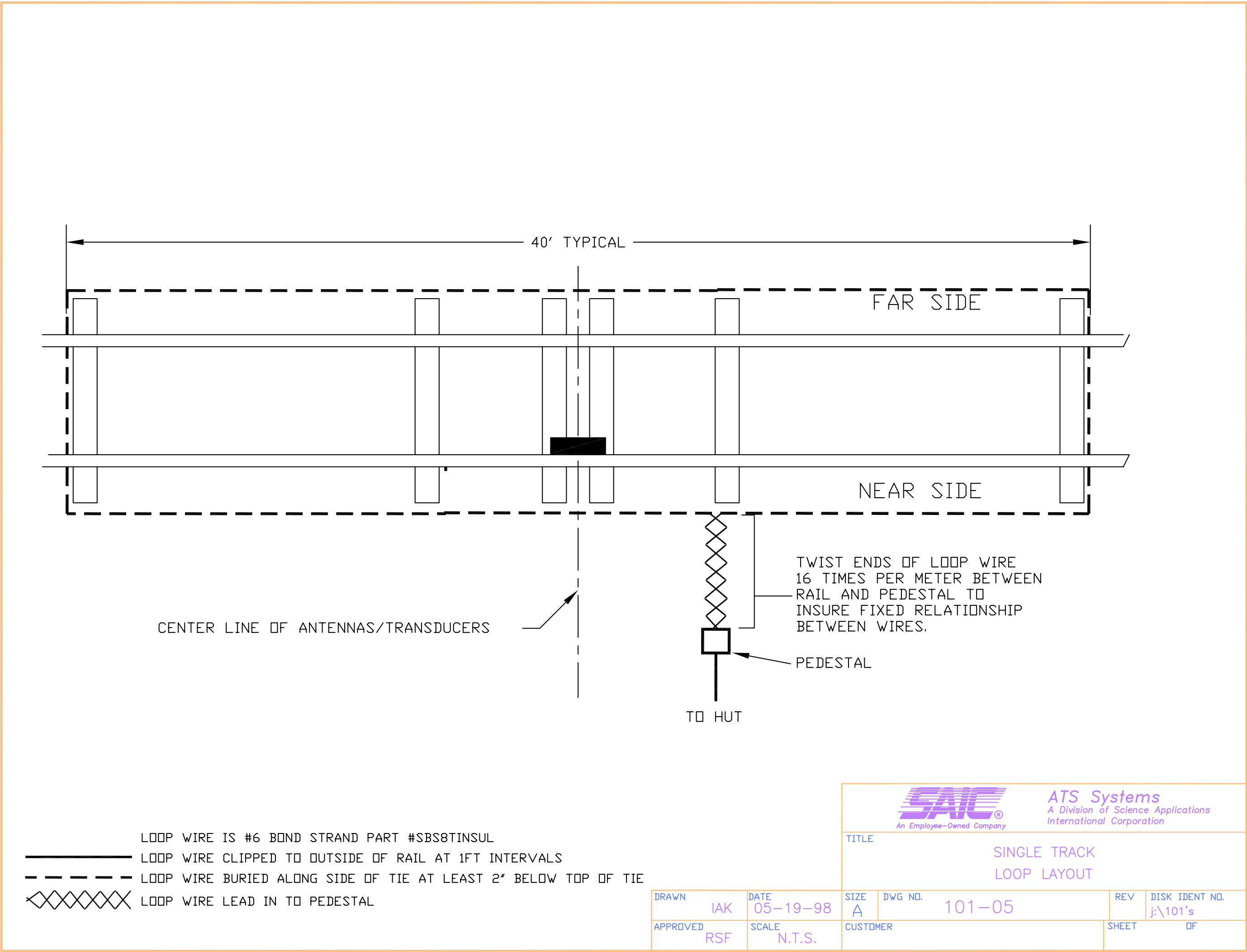


Figure C.5: Single Track Loop Layout Drawing Number: 101-04

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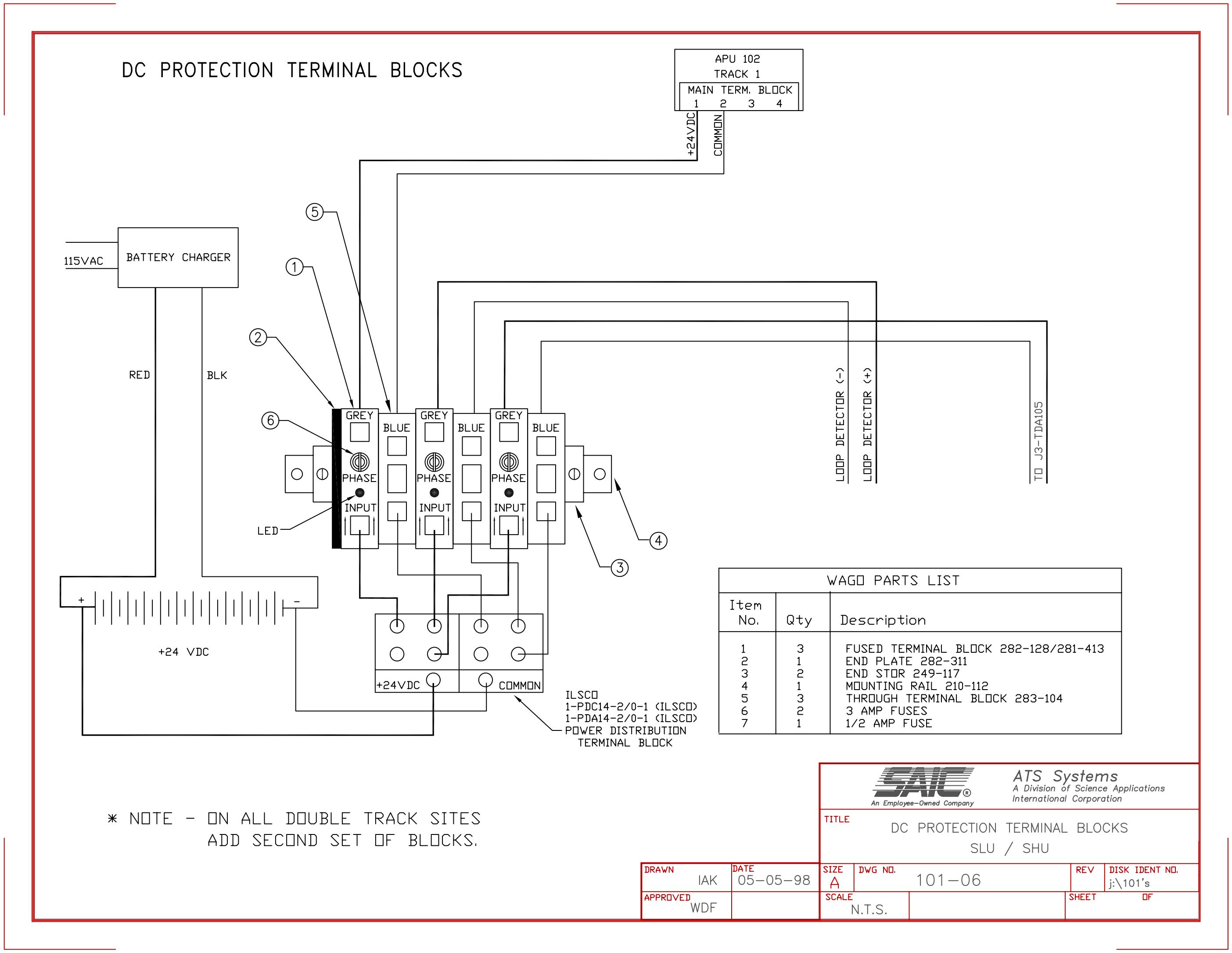


Figure C.6: DC Protection Terminal Blocks SLU/SHU

Note: On all double track sites add second set of blocks.

Drawing Number: 101-06

LVD-2000 replaces DC distribution/protection blocks. Refer to LVD-2000 drawings if equipped.

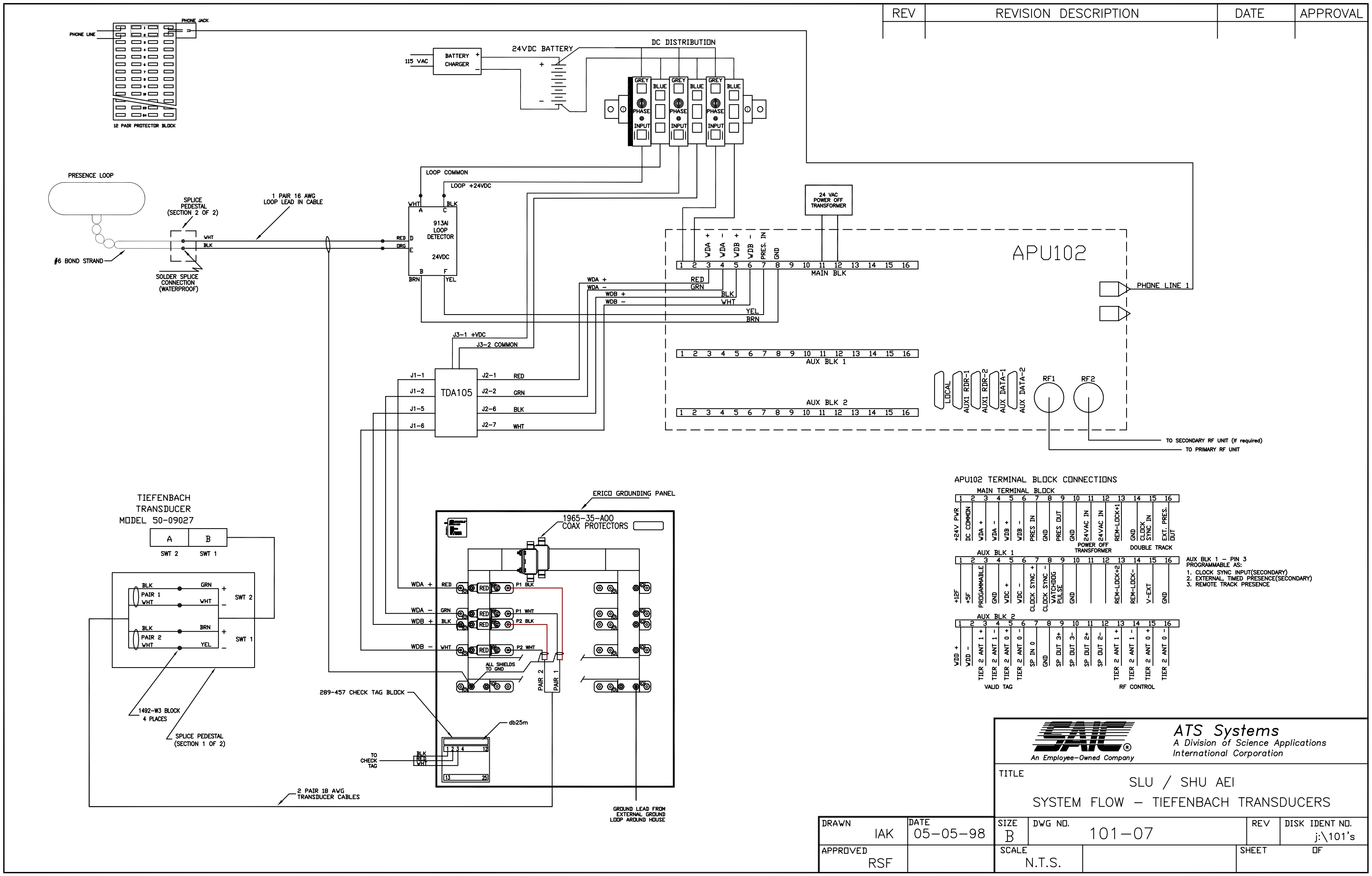


Figure C.7: SLU/SHU AEI System Flow – Tiefenbach Transducers

Drawing Number: 101-07

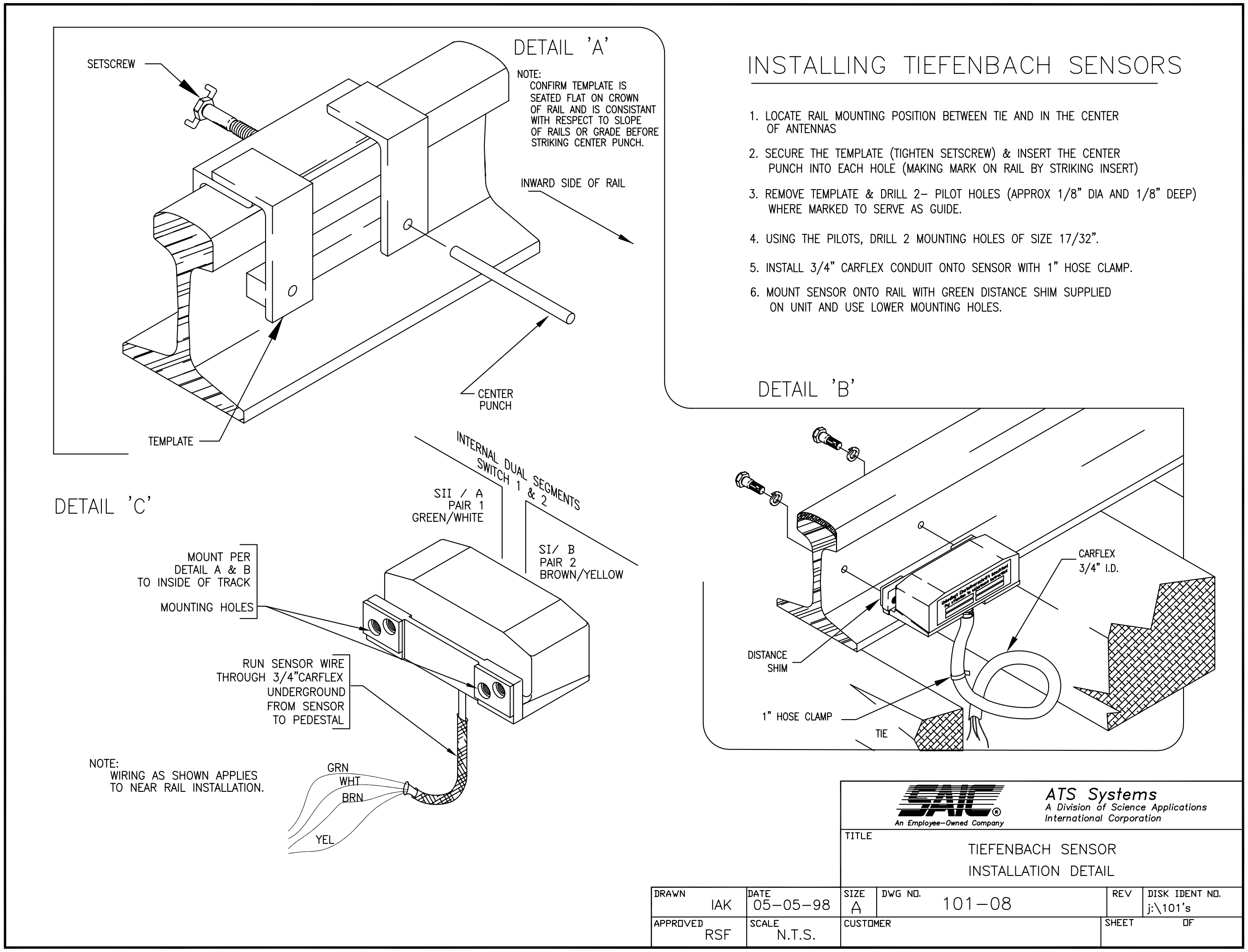
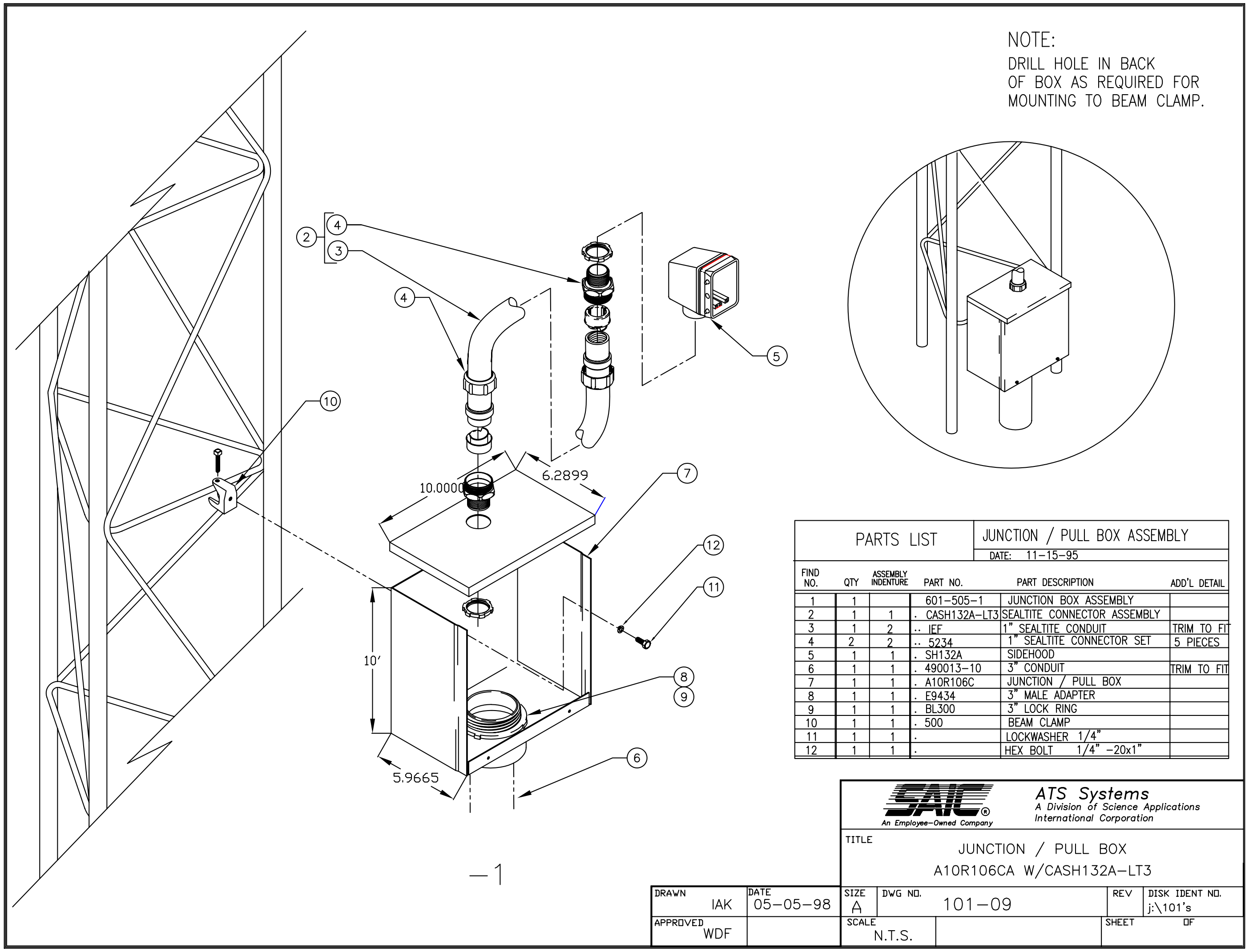


Figure C.8: Tiefenbach Sensor Installation Detail Drawing Number: 101-08



PARTS LIST — JUNCTION / PULL BOX ASSEMBLY — DATE: 11-15-95

FIND NO.	QTY	ASSEMBLY INDENTURE	PART NO.	PART DESCRIPTION	ADD'L DETAIL
1	1		601-505-1	JUNCTION BOX ASSEMBLY	
2	1	1	. CASH132A-LT3	SEALTITE CONNECTOR ASSEMBLY	
3	1	2	.. IEF	1" SEALTITE CONDUIT	TRIM TO FIT
4	2	2	.. 5234	1" SEALTITE CONNECTOR SET	5 PIECES
5	1	1	. SH132A	SIDEHOOD	
6	1	1	. 490013-10	3" CONDUIT	TRIM TO FIT
7	1	1	. A10R106C	JUNCTION / PULL BOX	
8	1	1	. E9434	3" MALE ADAPTER	
9	1	1	. BL300	3" LOCK RING	
10	1	1	. 500	BEAM CLAMP	
11	1	1	.	LOCKWASHER 1/4"	
12	1	1	.	HEX BOLT 1/4" -20x1"	

Figure C.9: Junction/Pull Box A10R106CA w/CASH132A-LT3 Drawing Number: 101-09

913AI LOOP DETECTOR FRONT PANEL

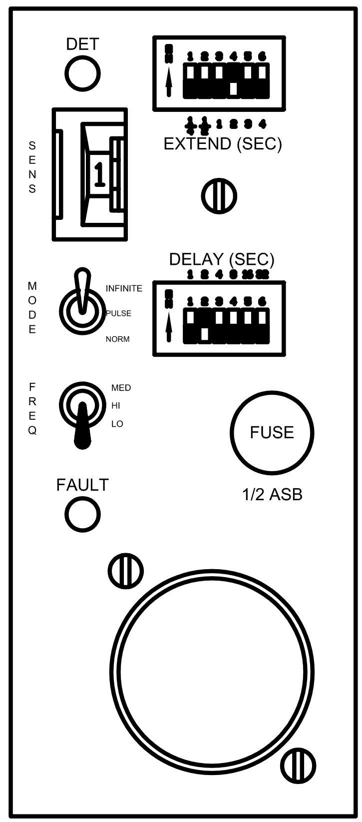


Figure C.10: Loop Detector Front Panel (913AI) Drawing Number: 101-10

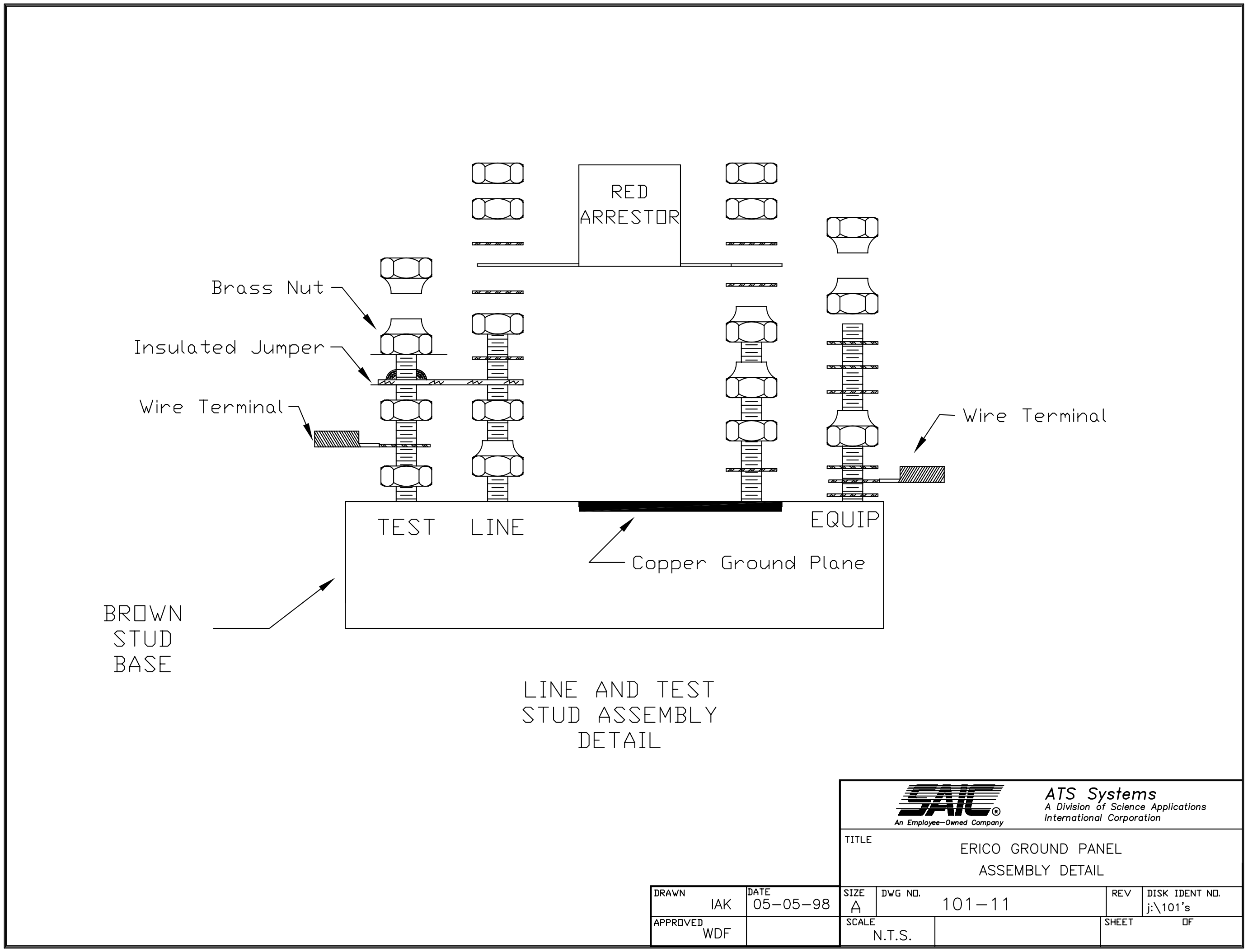


Figure C.11: Erico Ground Panel Assembly Detail Drawing Number : 101-11

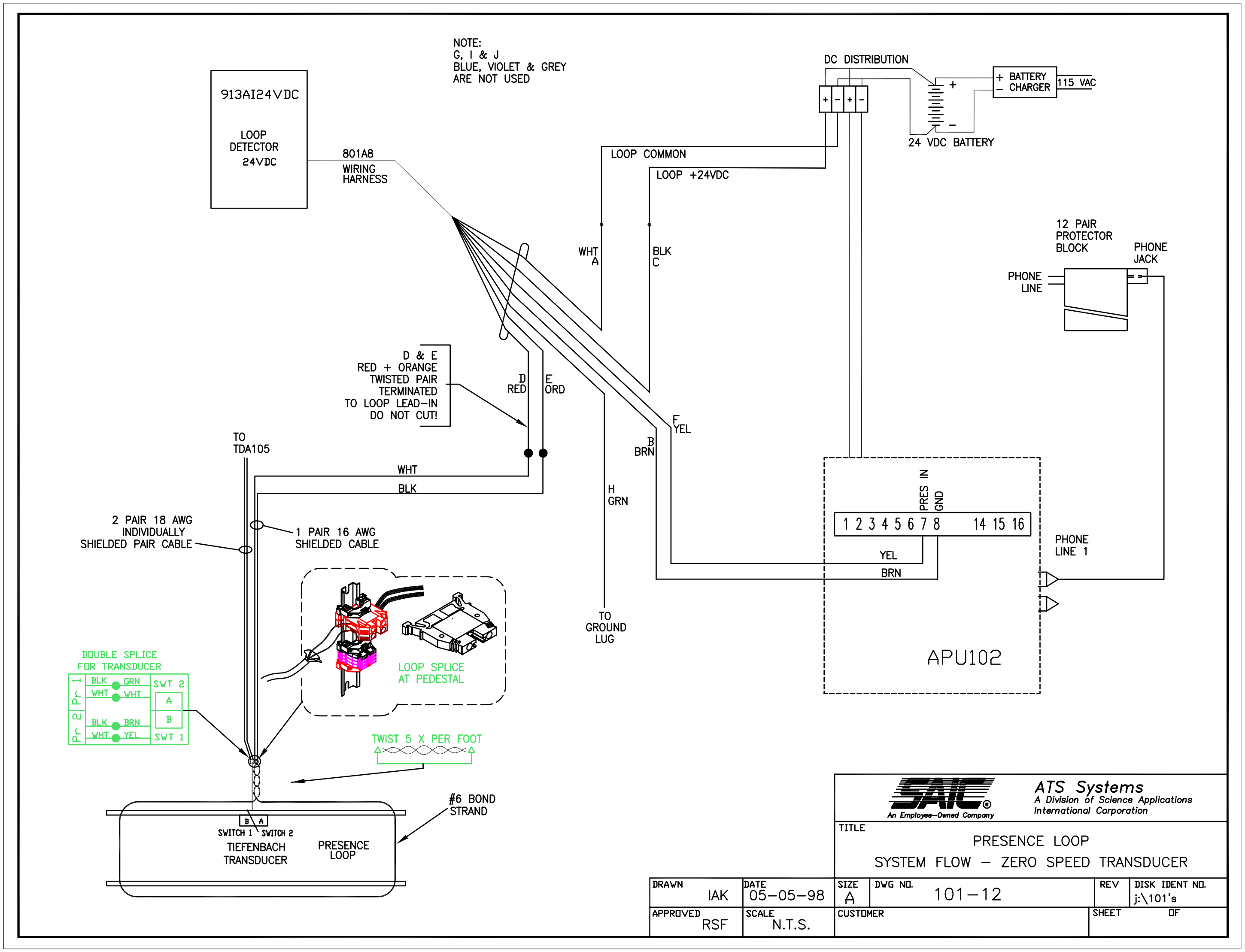


Figure C.12: Presence Loop – System Flow – Zero Speed Transducer Drawing Number: 101-12

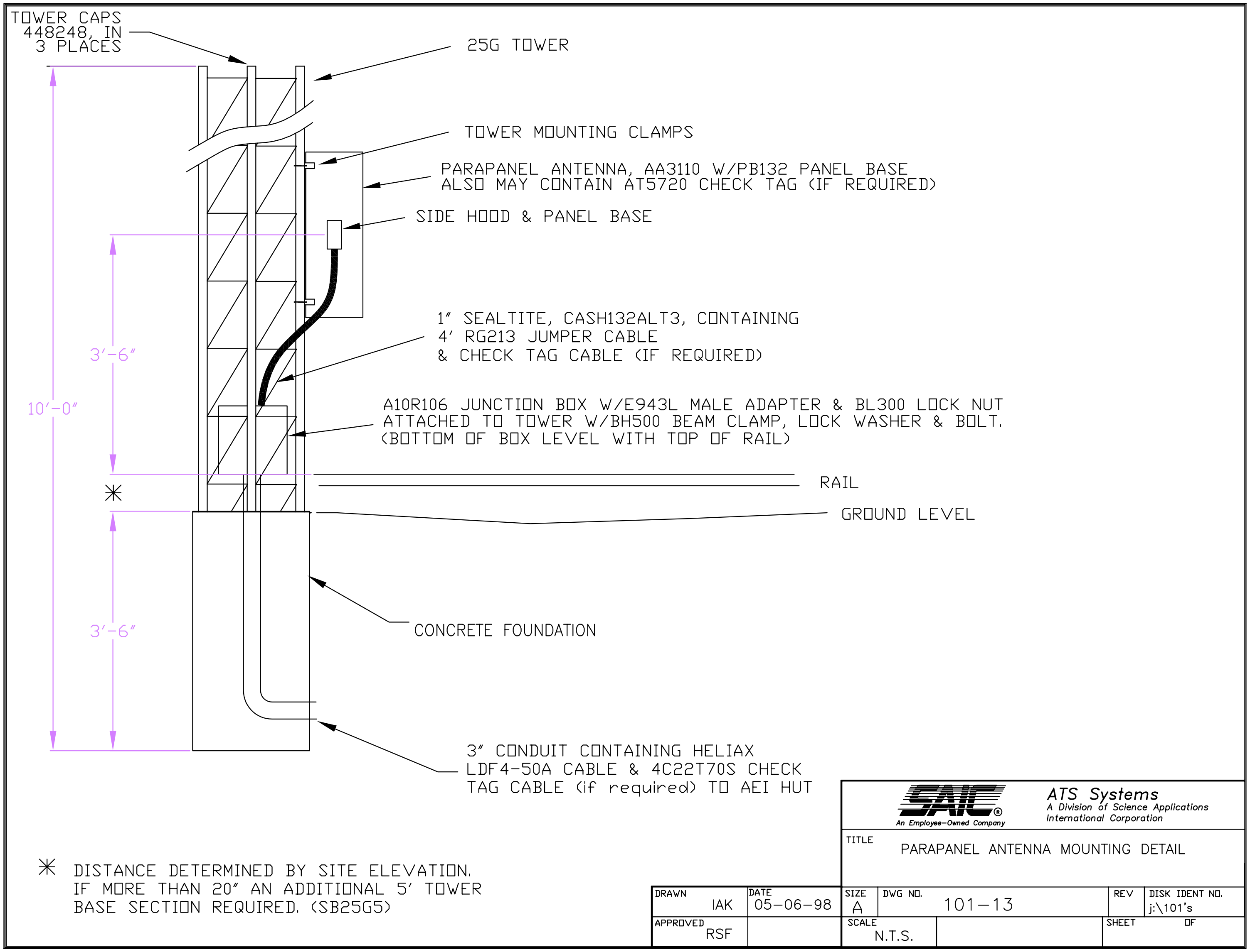


Figure C.13: Parapanel Antenna Mounting Detail

Drawing Number: 101-13

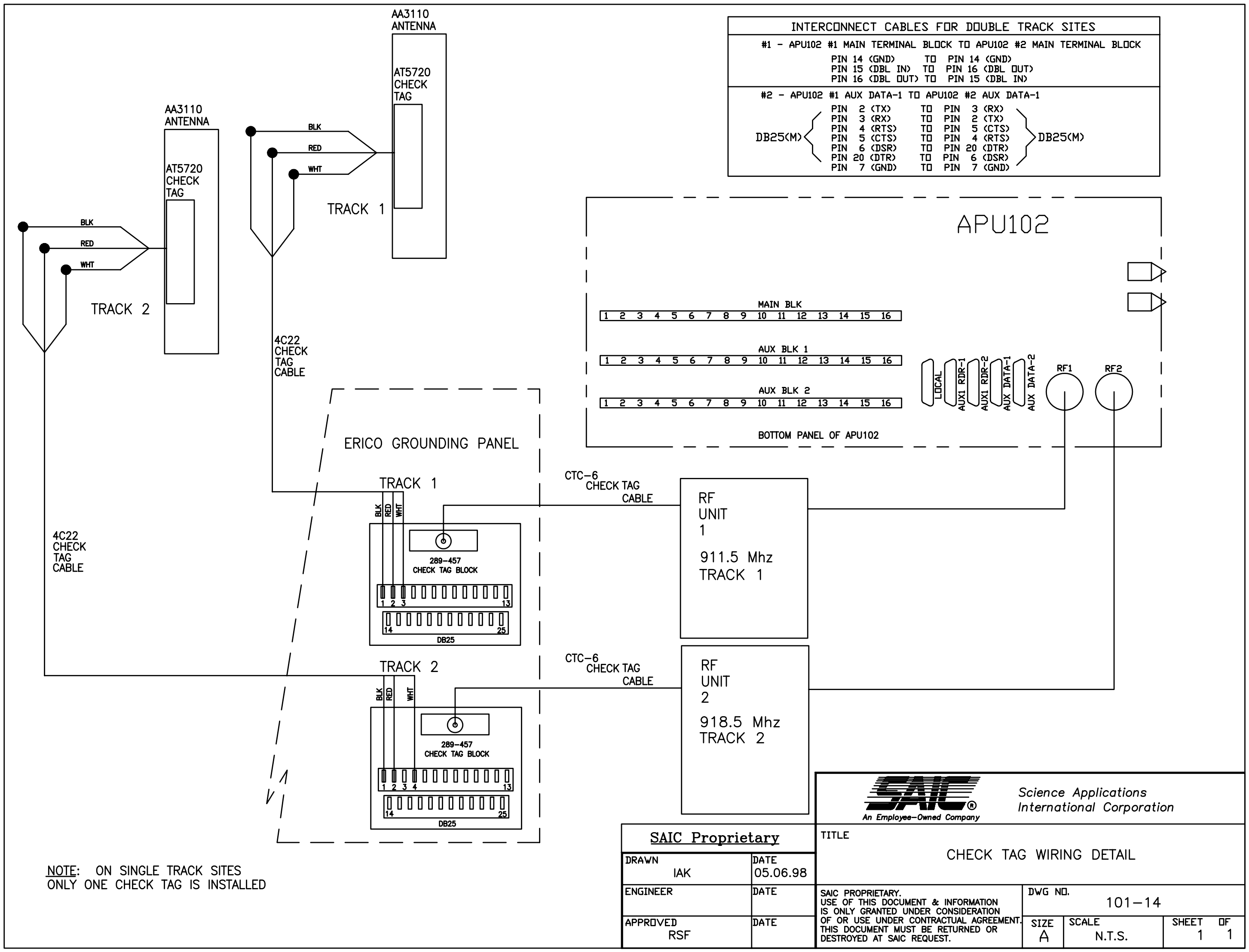

INTERCONNECT CABLES FOR DOUBLE TRACK SITES
#1 - APU102 #1 MAIN TERMINAL BLOCK TO APU102 #2 MAIN TERMINAL BLOCK
PIN 14 (GND) TO PIN 14 (GND)
PIN 15 (DBL IN) TO PIN 16 (DBL OUT)
PIN 16 (DBL OUT) TO PIN 15 (DBL IN)
#2 - APU102 #1 AUX DATA-1 TO APU102 #2 AUX DATA-1
DB25(M)
PIN 2 (TX) TO PIN 3 (RX)
PIN 3 (RX) TO PIN 2 (TX)
PIN 4 (RTS) TO PIN 5 (CTS)
PIN 5 (CTS) TO PIN 4 (RTS)
PIN 6 (DSR) TO PIN 20 (DTR)
PIN 20 (DTR) TO PIN 6 (DSR)
PIN 7 (GND) TO PIN 7 (GND)
DB25(M)
AA3110 ANTENNA
AT5720 CHECK TAG
BLK
RED
WHT
TRACK 1
TRACK 2
4C22 CHECK TAG CABLE
APU102
MAIN BLK
AUX BLK 1
AUX BLK 2
LOCAL
AUX1 RDR-1
AUX1 RDR-2
AUX DATA-1
AUX DATA-2
RF1
RF2
BOTTOM PANEL OF APU102
ERICO GROUNDING PANEL
CTC-6 CHECK TAG CABLE
289-457 CHECK TAG BLOCK
DB25
RF UNIT 1
911.5 Mhz
TRACK 1
RF UNIT 2
918.5 Mhz
TRACK 2
NOTE: ON SINGLE TRACK SITES ONLY ONE CHECK TAG IS INSTALLED
SAIC Proprietary
DRAWN IAK
DATE 05.06.98
ENGINEER
DATE
APPROVED RSF
DATE
An Employee-Owned Company
Science Applications International Corporation
TITLE
CHECK TAG WIRING DETAIL
SAIC PROPRIETARY. USE OF THIS DOCUMENT & INFORMATION IS ONLY GRANTED UNDER CONSIDERATION OF OR USE UNDER CONTRACTUAL AGREEMENT. THIS DOCUMENT MUST BE RETURNED OR DESTROYED AT SAIC REQUEST.
DWG NO. 101-14
SIZE A
SCALE N.T.S.
SHEET 1 OF 1

Figure C.14: Check Tag Wiring Detail Drawing Number: 101-14

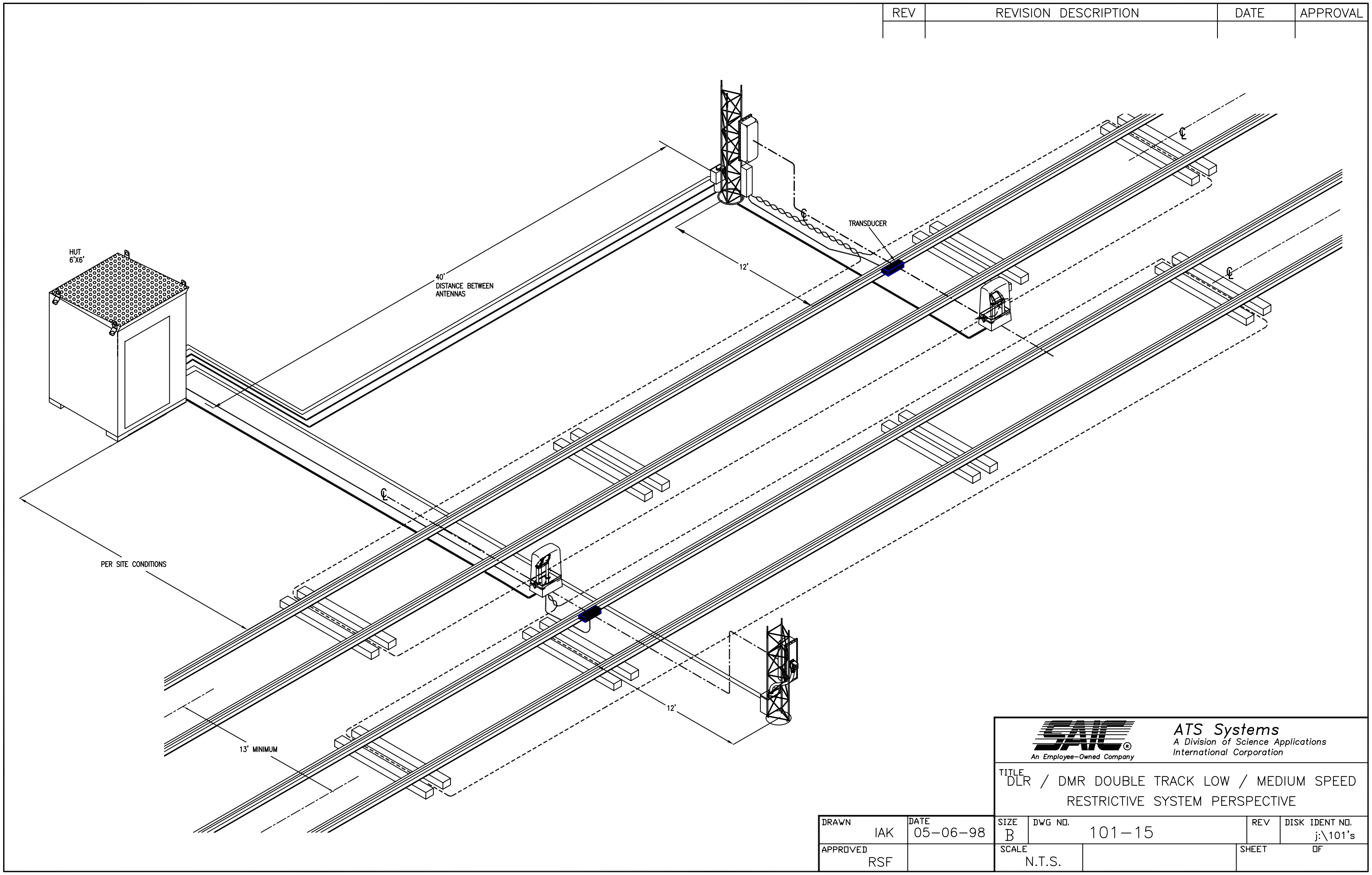


Figure C.15: DLR/DMR Double Track Low/Medium Speed Restrictive System Perspective Drawing Number: 101-15

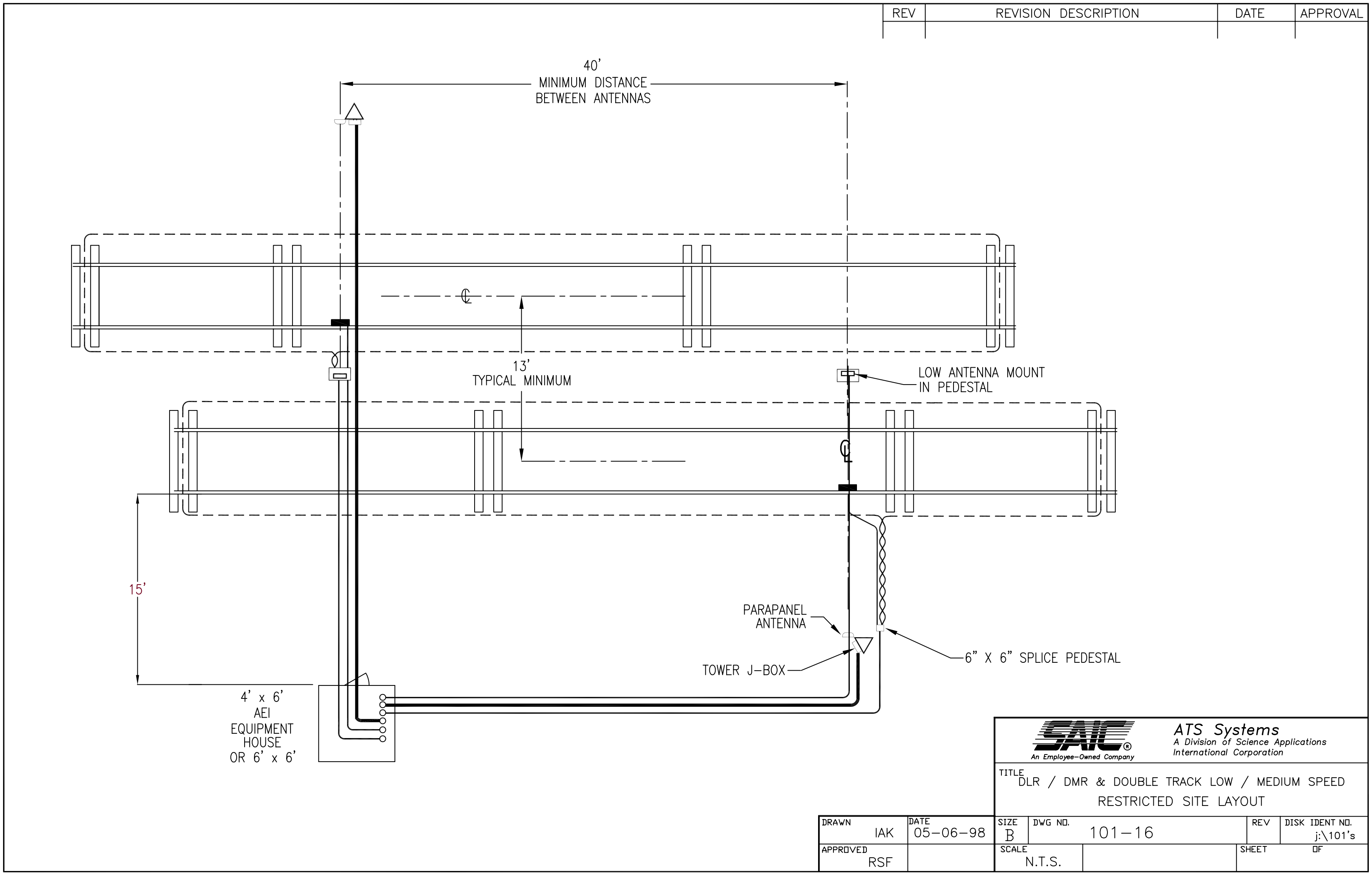


Figure C.16: DLR/DMR & Double Track Low/Medium Speed Restricted Site Layout Drawing Number: 101-16

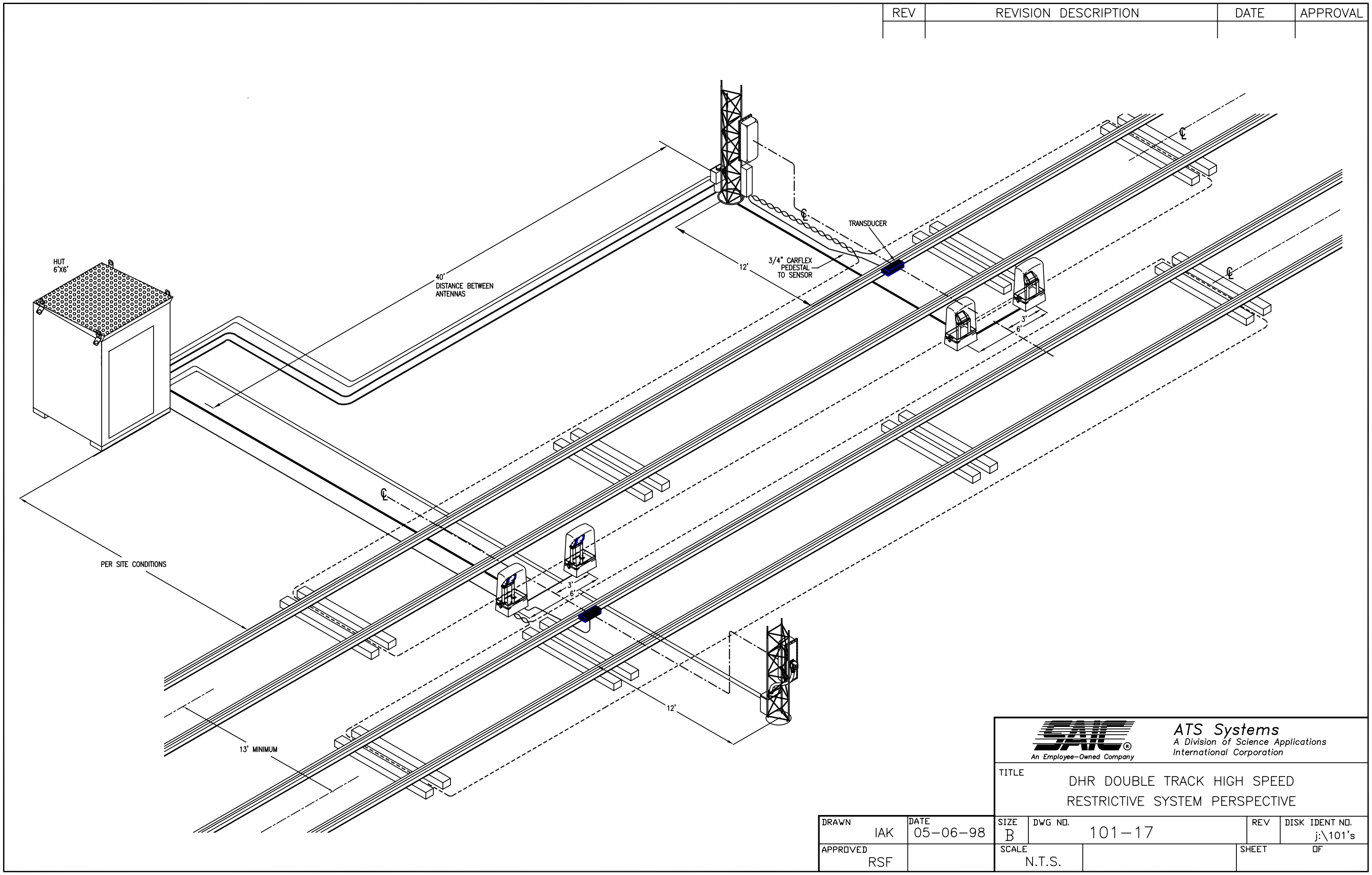


Figure C.17: DHR Double Track High Speed Restrictive System Perspective   Drawing Number: 101-17

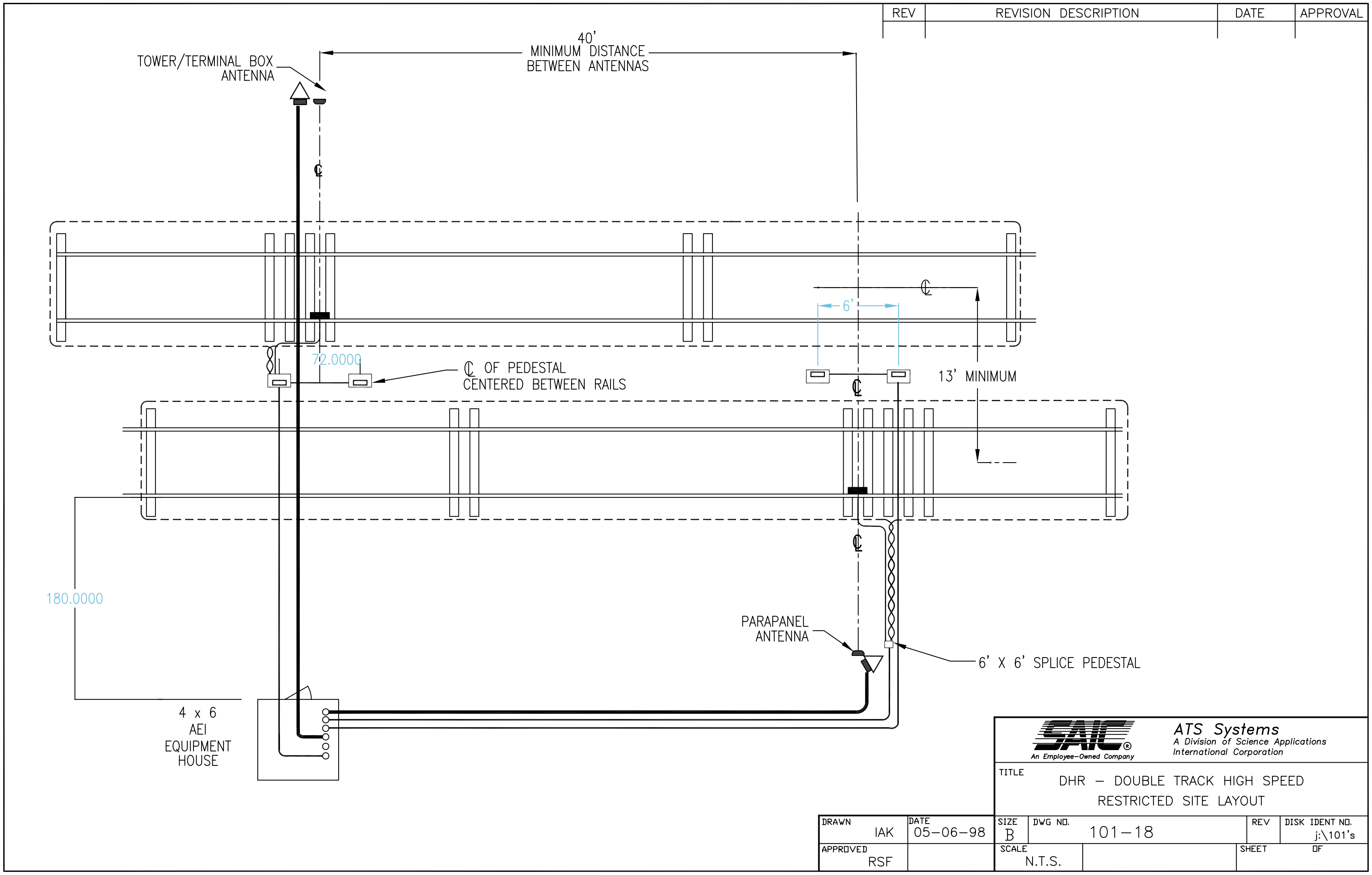


Figure C.18: DHR Double Track High Speed Restricted Site Layout Drawing Number: 101-18

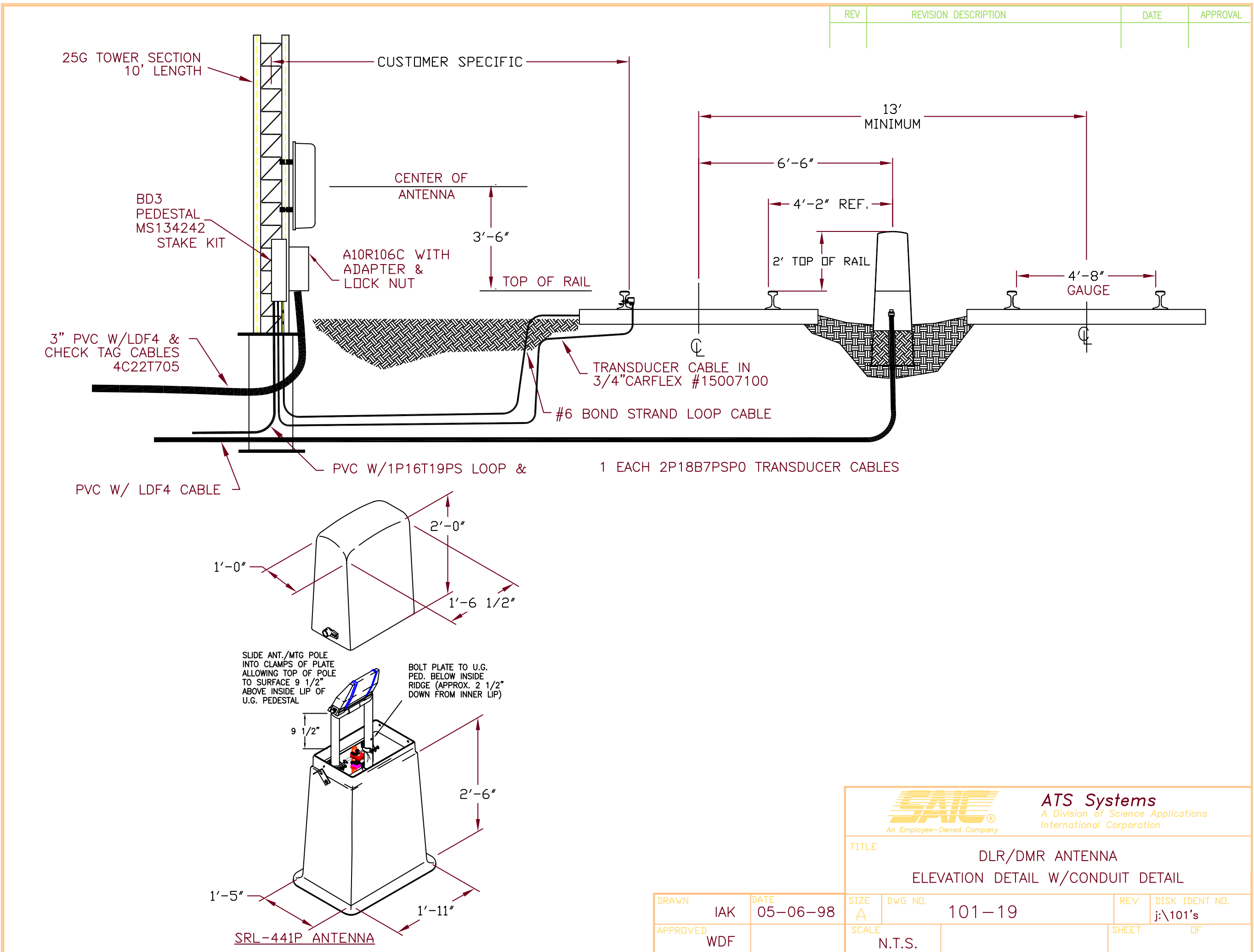


Figure C.19: DLR/DMR Antenna Elevation Detail w/Conduit Detail Drawing Number: 101-19

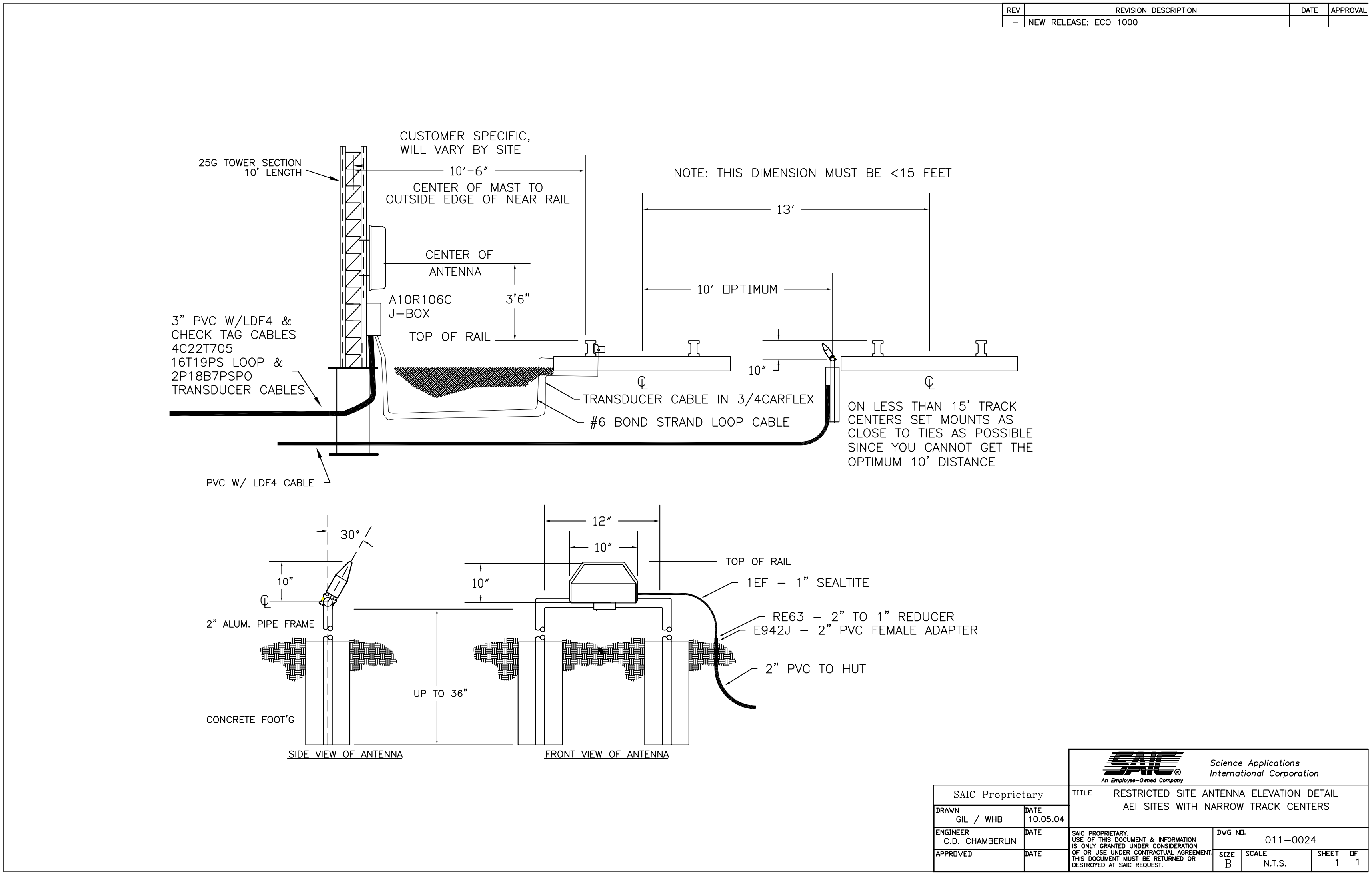


Figure C.20: DLR/DMR Antenna Elevation Detail w/Conduit Detail (Narrow Track Centers) Drawing Number: 011-0024

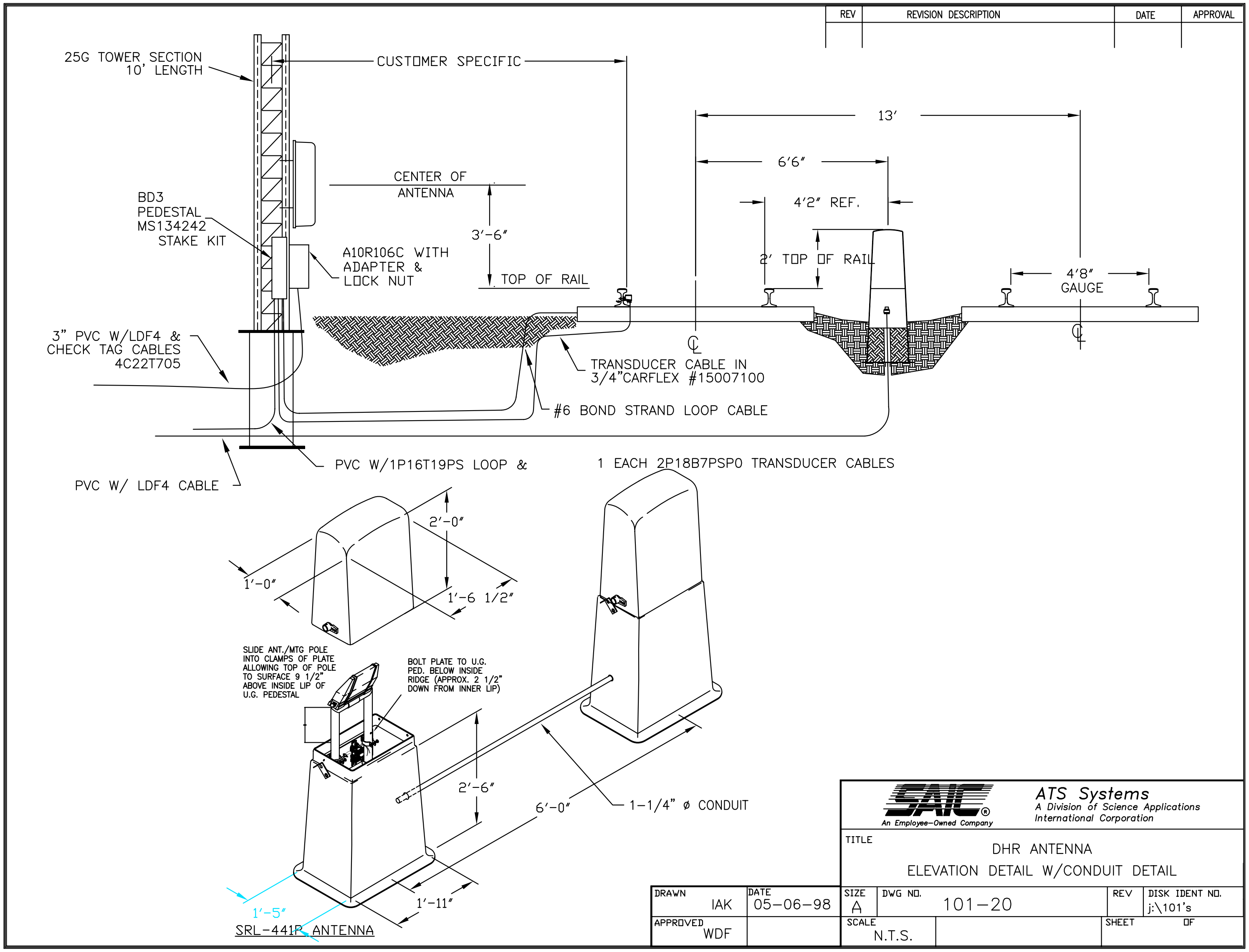
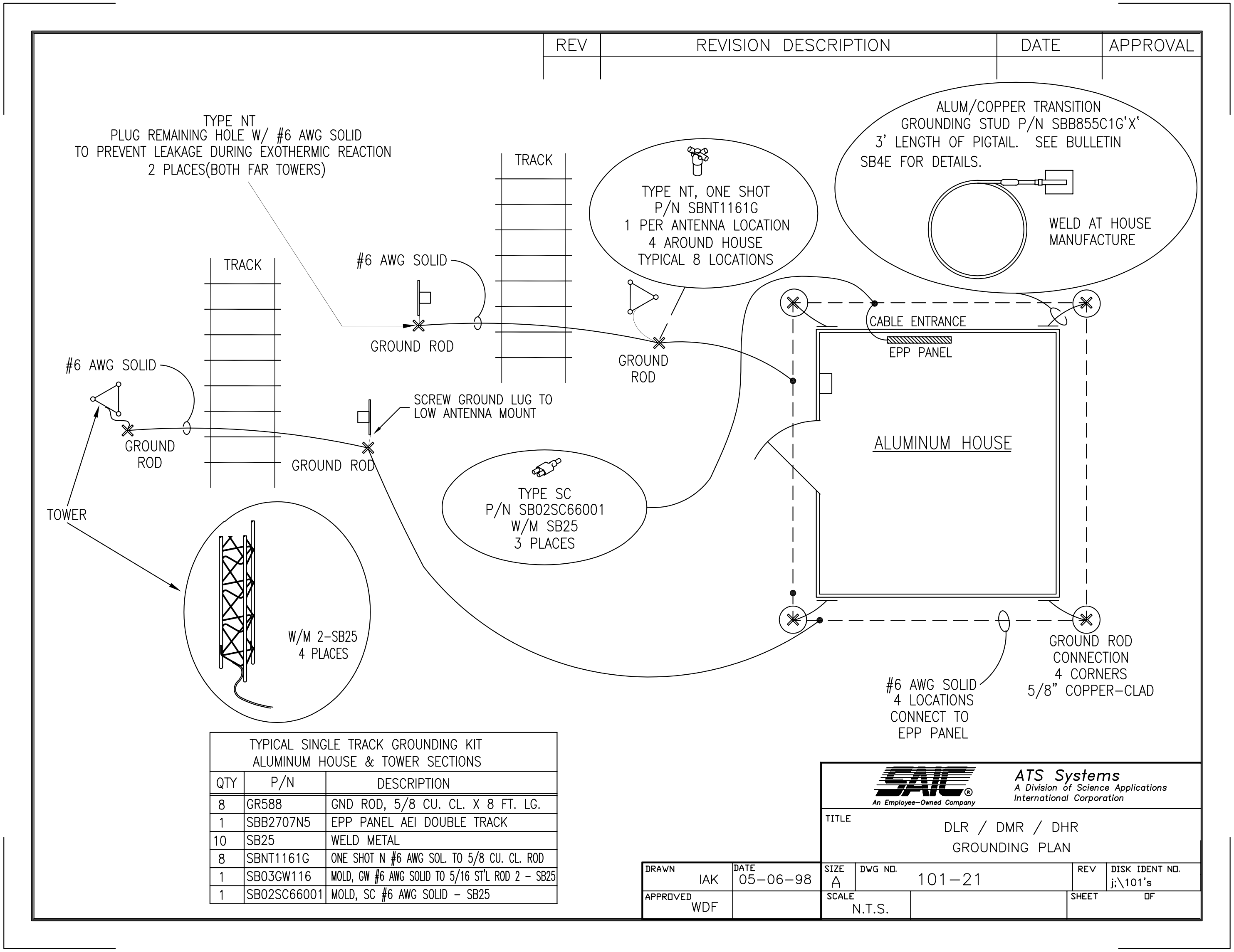


Figure C.21: DHR Antenna Elevation Detail w/ Conduit Detail Drawing Number: 101-20



TYPICAL SINGLE TRACK GROUNDING KIT
ALUMINUM HOUSE & TOWER SECTIONS

QTY	P/N	DESCRIPTION
8	GR588	GND ROD, 5/8 CU. CL. X 8 FT. LG.
1	SBB2707N5	EPP PANEL AEI DOUBLE TRACK
10	SB25	WELD METAL
8	SBNT1161G	ONE SHOT N #6 AWG SOL. TO 5/8 CU. CL. ROD
1	SB03GW116	MOLD, GW #6 AWG SOLID TO 5/16 ST'L ROD 2 - SB25
1	SB02SC66001	MOLD, SC #6 AWG SOLID - SB25

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Figure C.22: DLR/DMR/DHR Grounding Plan Drawing Number: 101-21

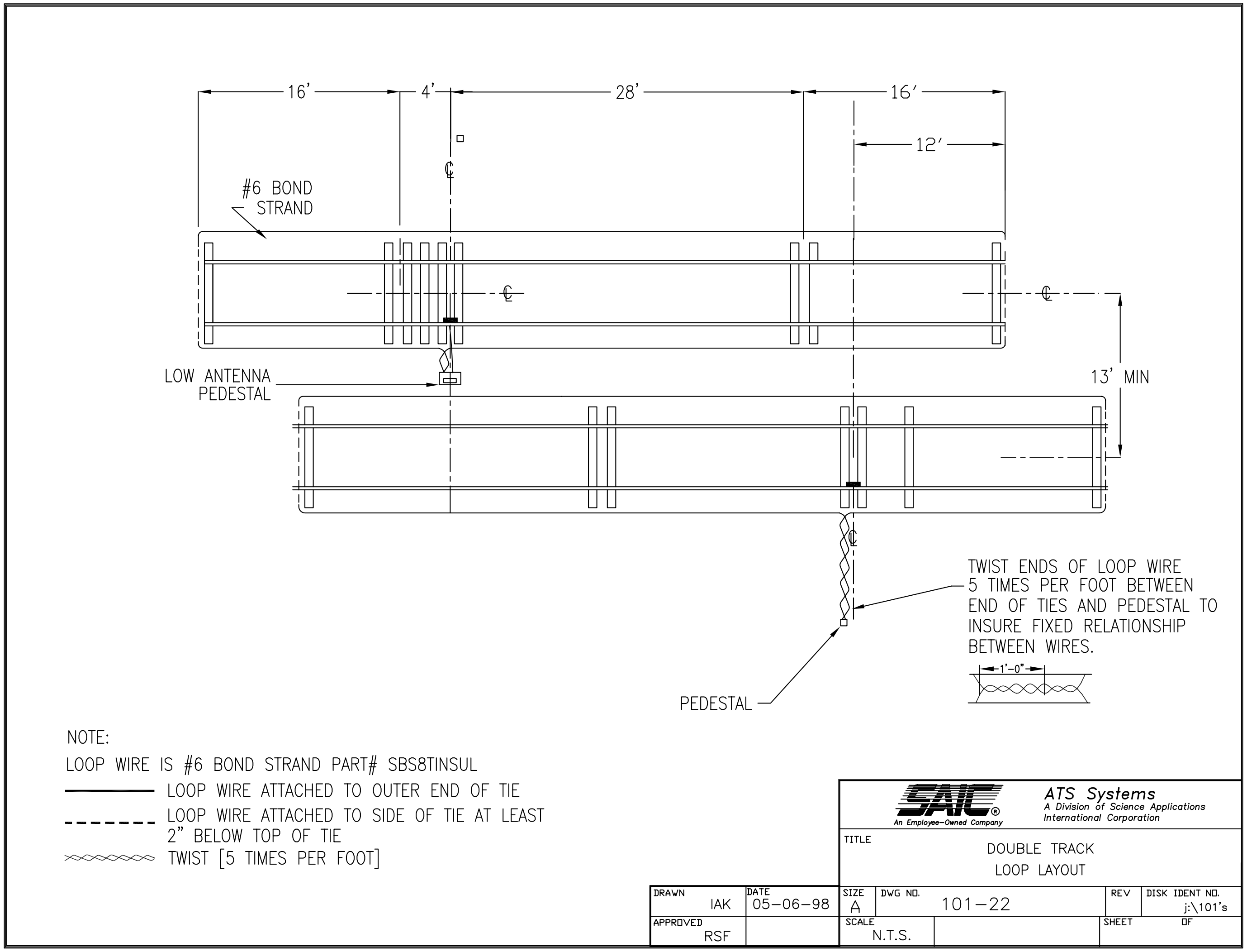

Figure C.23: Double Track Loop Layout

Drawing Number: 101-22

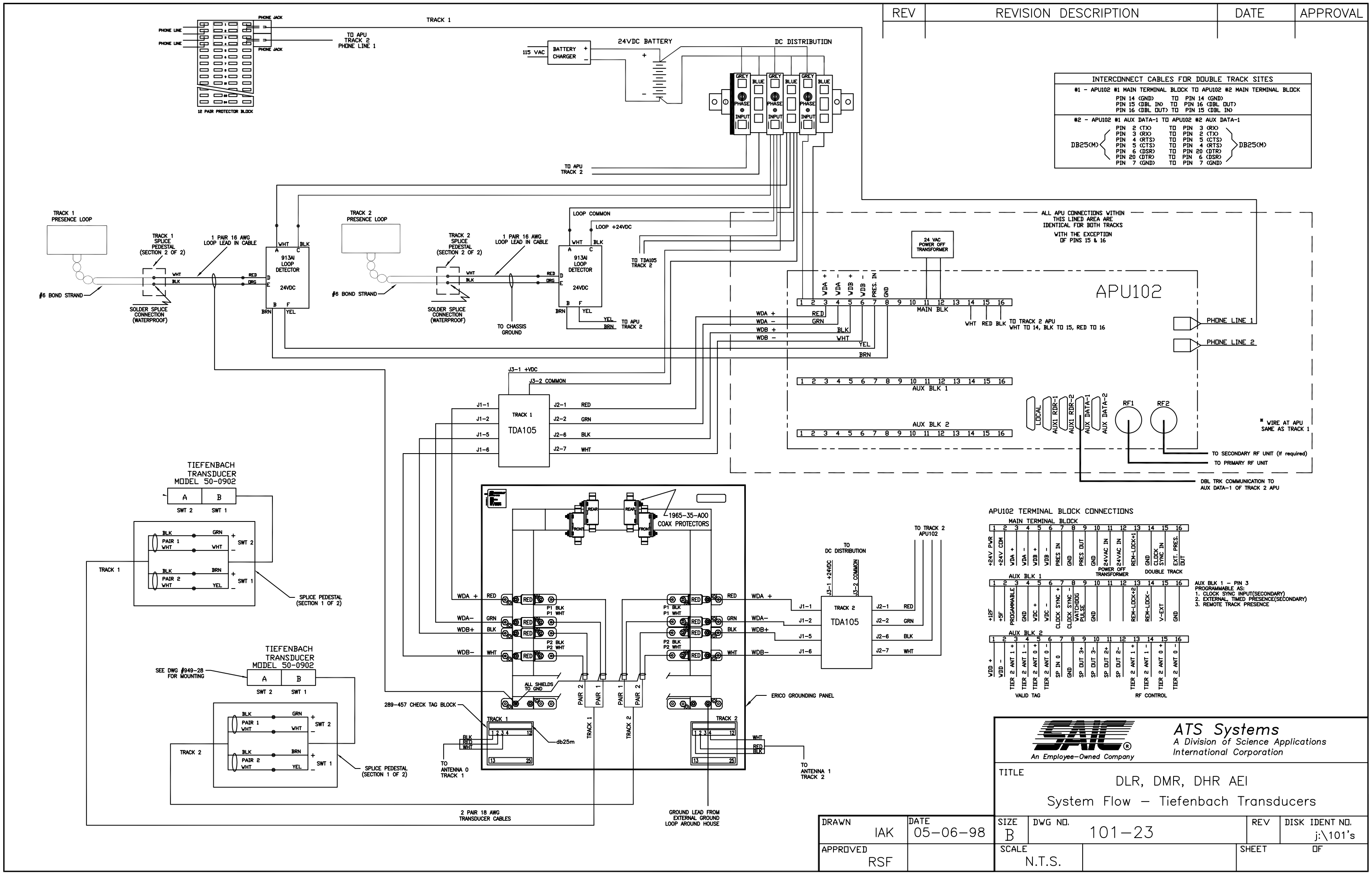

Figure C.24: DLR, DMR, DHR AEI System Flow – Tiefenbach Transducers and Presence Loop Drawing Number: 101-23

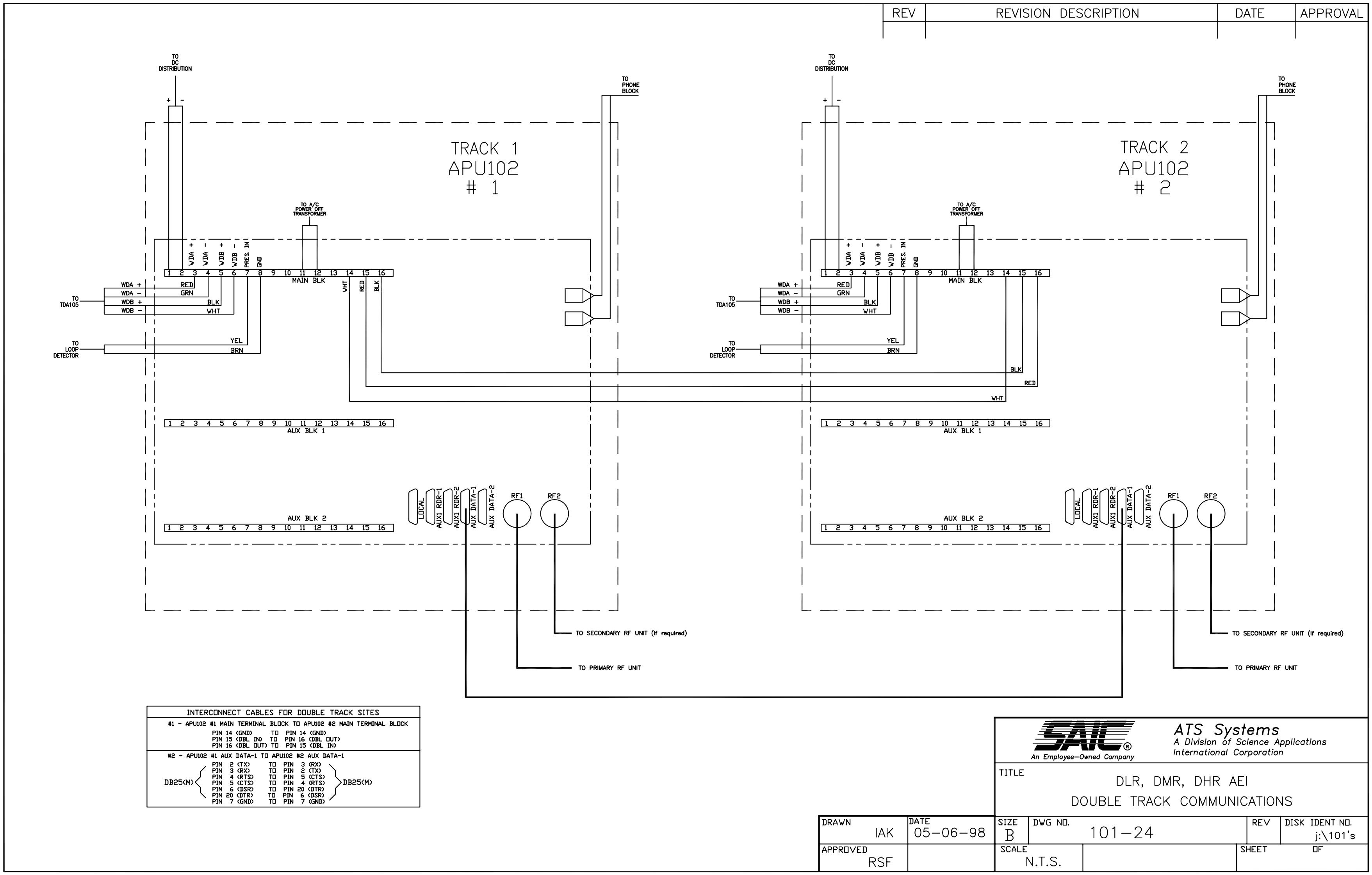

Figure C.25: DLR, DMR, DHR, AEI Double Track Communications

Drawing Number: 101-24

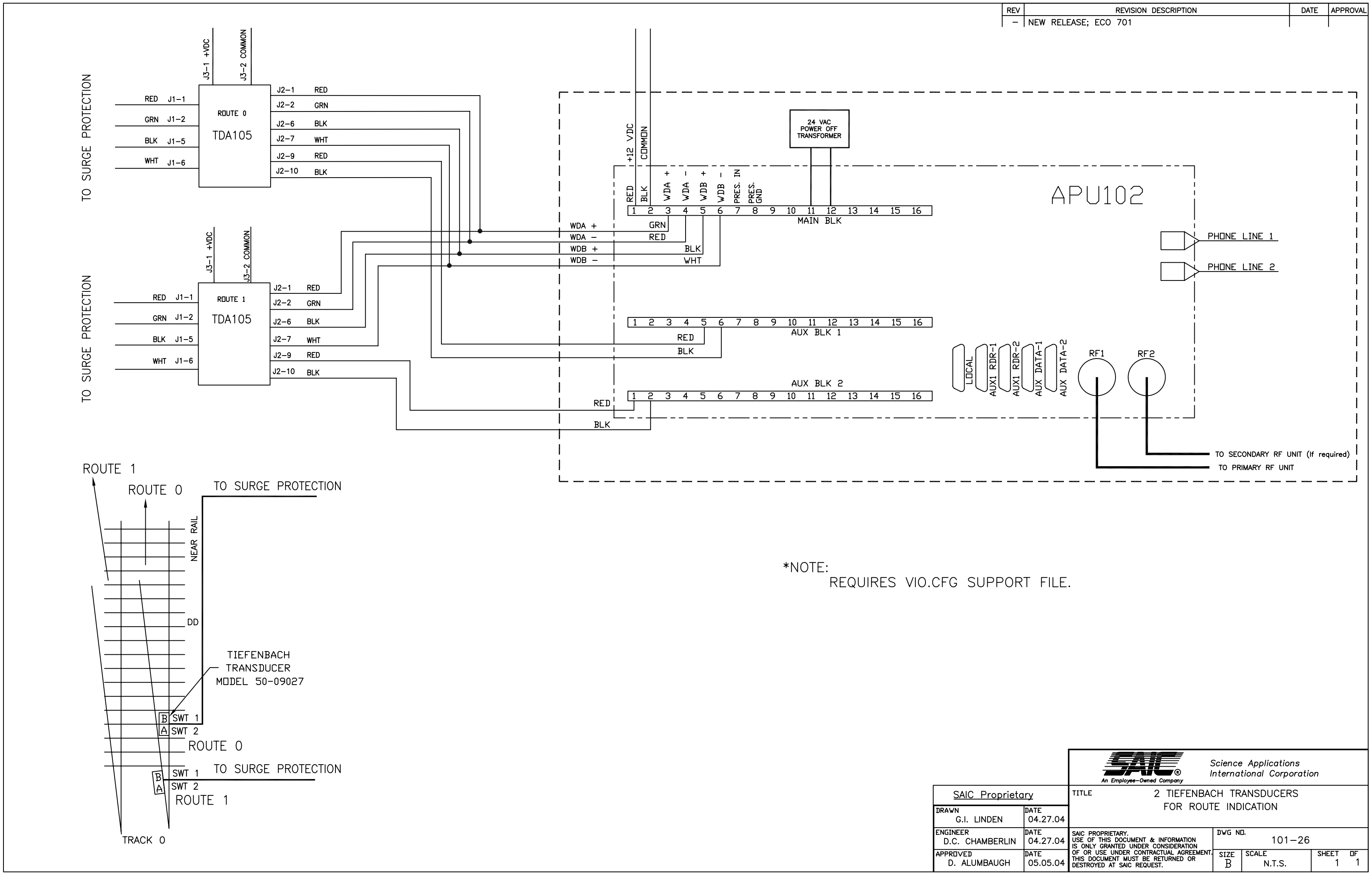

Figure C.26: SLU/SHU AEI System Flow – Tiefenbach Transducers for Route indication Drawing Number: 101-26

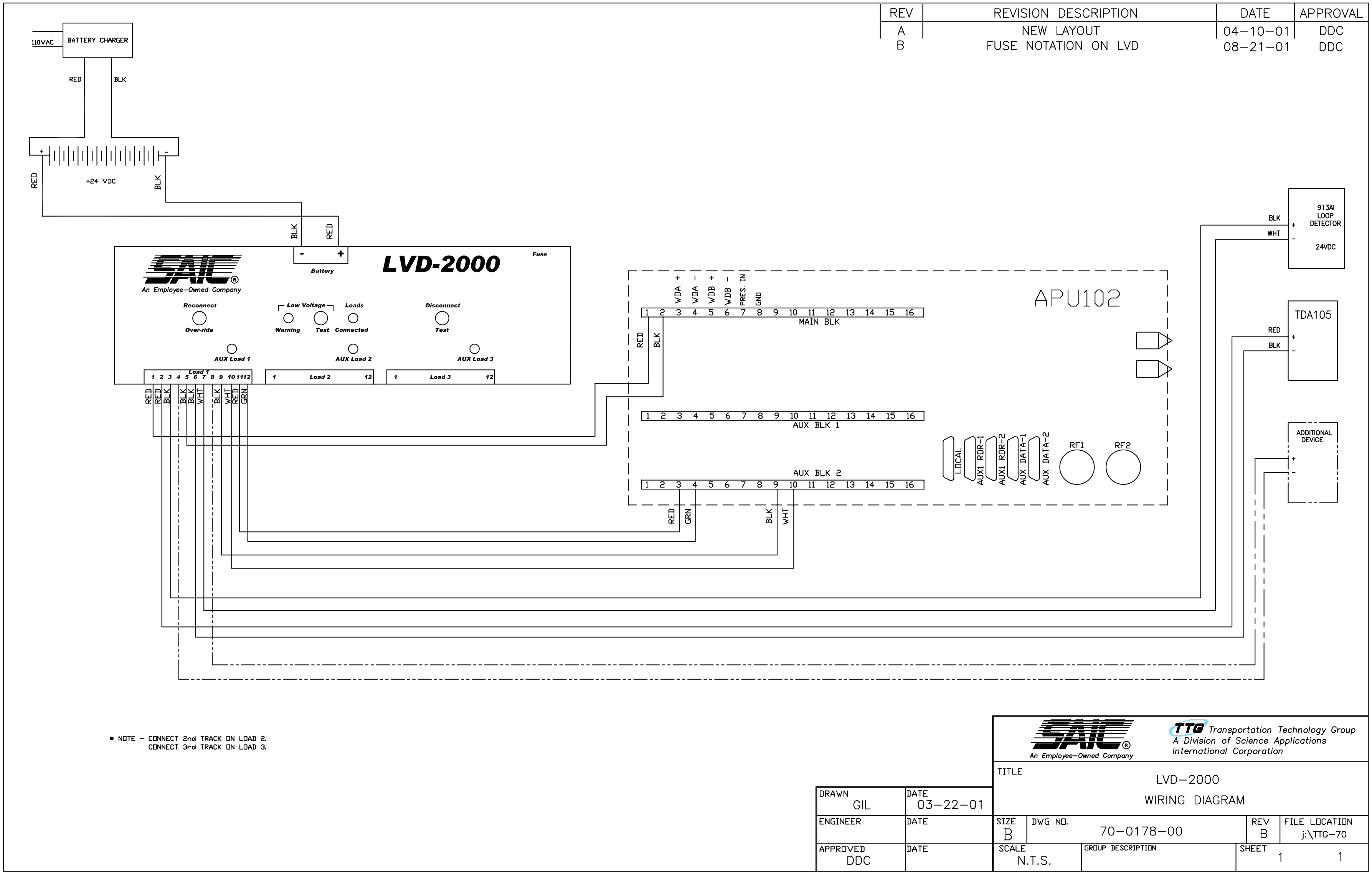

Figure C.27: LVD-2000 Wiring Diagram Drawing Number: 70-0178-00

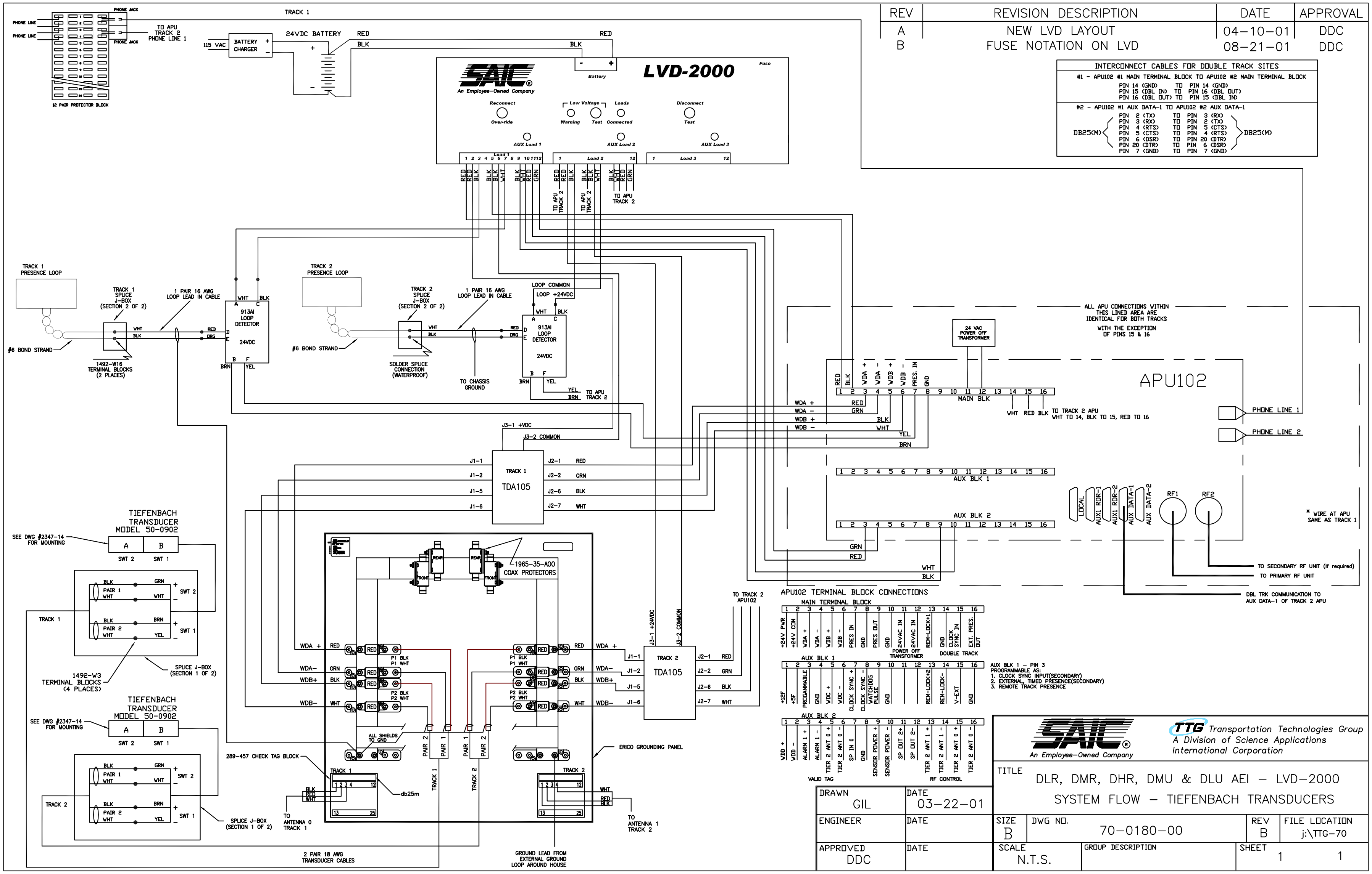

Figure C.28: DLR, DMR, DHR, DMU and DLU AEI – LVD-2000 System Flow Drawing Number: 70-0180-00

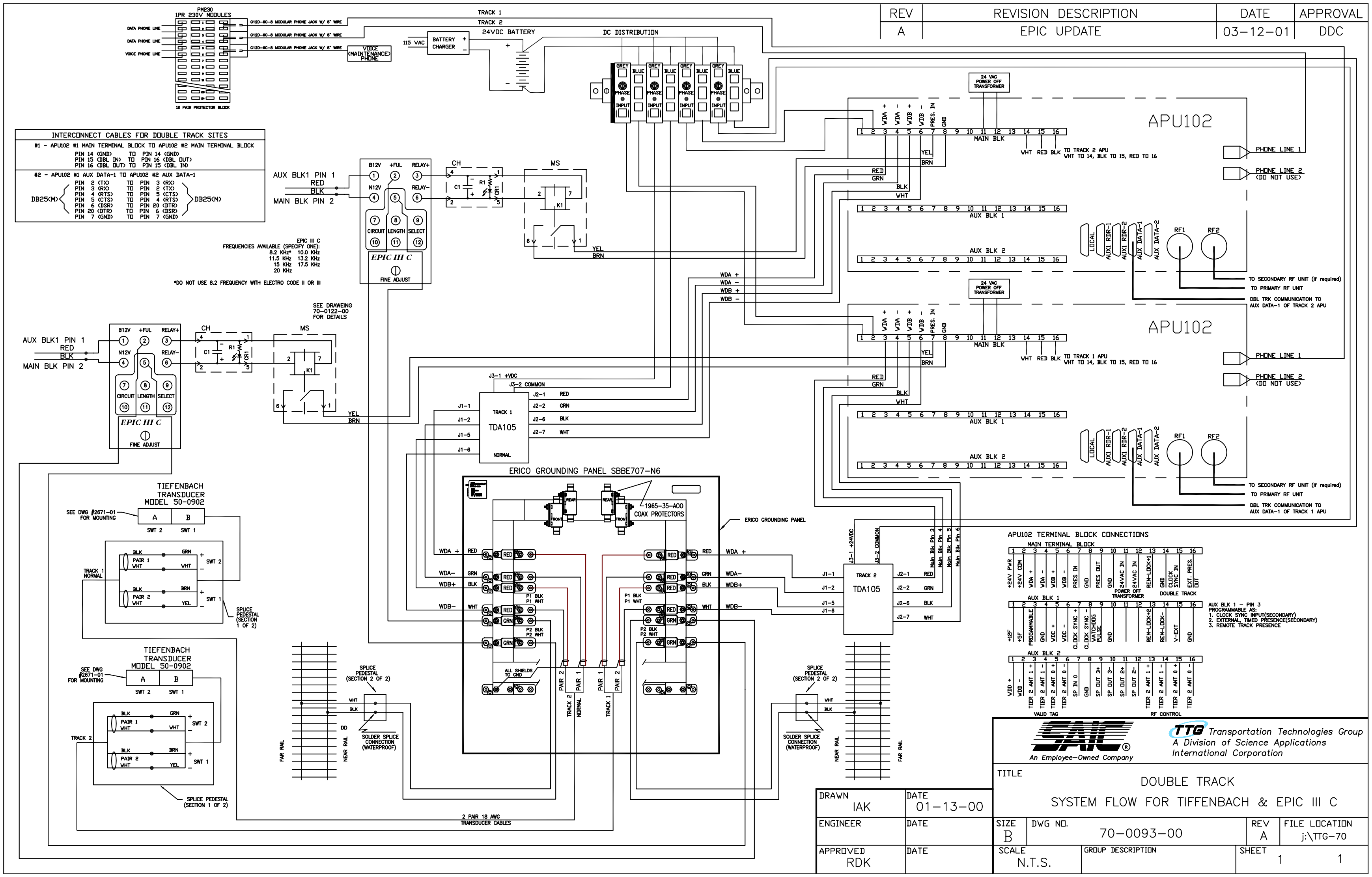

Figure C.29: DLR, DMR, DHR AEI System Flow – Tiefenbach Transducers and Epic III Presence Circuit   Drawing Number: 70-0093-00

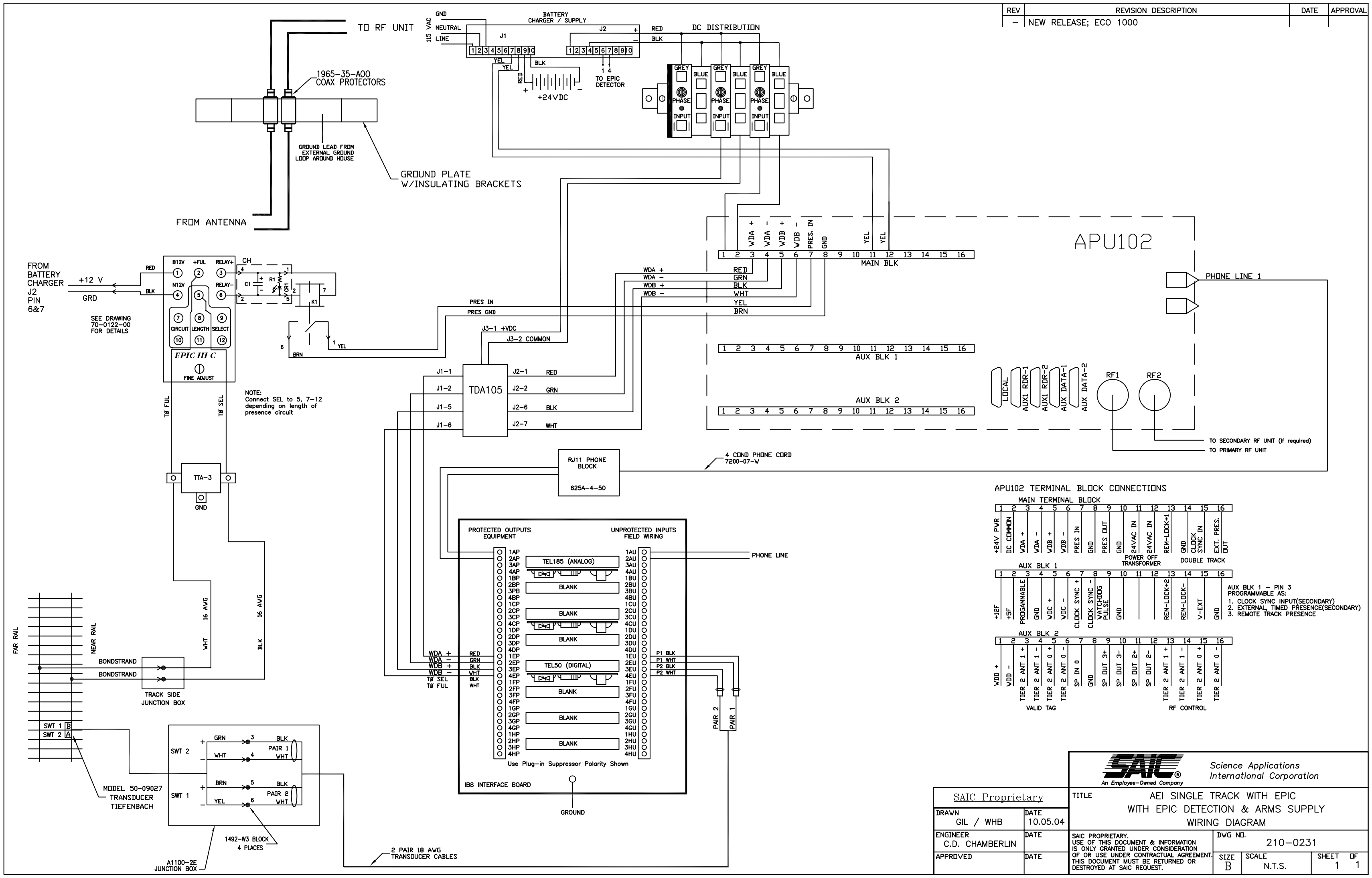

Figure C.30: SLU/SHU AEI System Flow – Tiefenbach Transducer, ARMS Power Supply, SuppressSurge Protection Panel, and Epic III Presence Circuit

Drawing Number: 210-0231-00

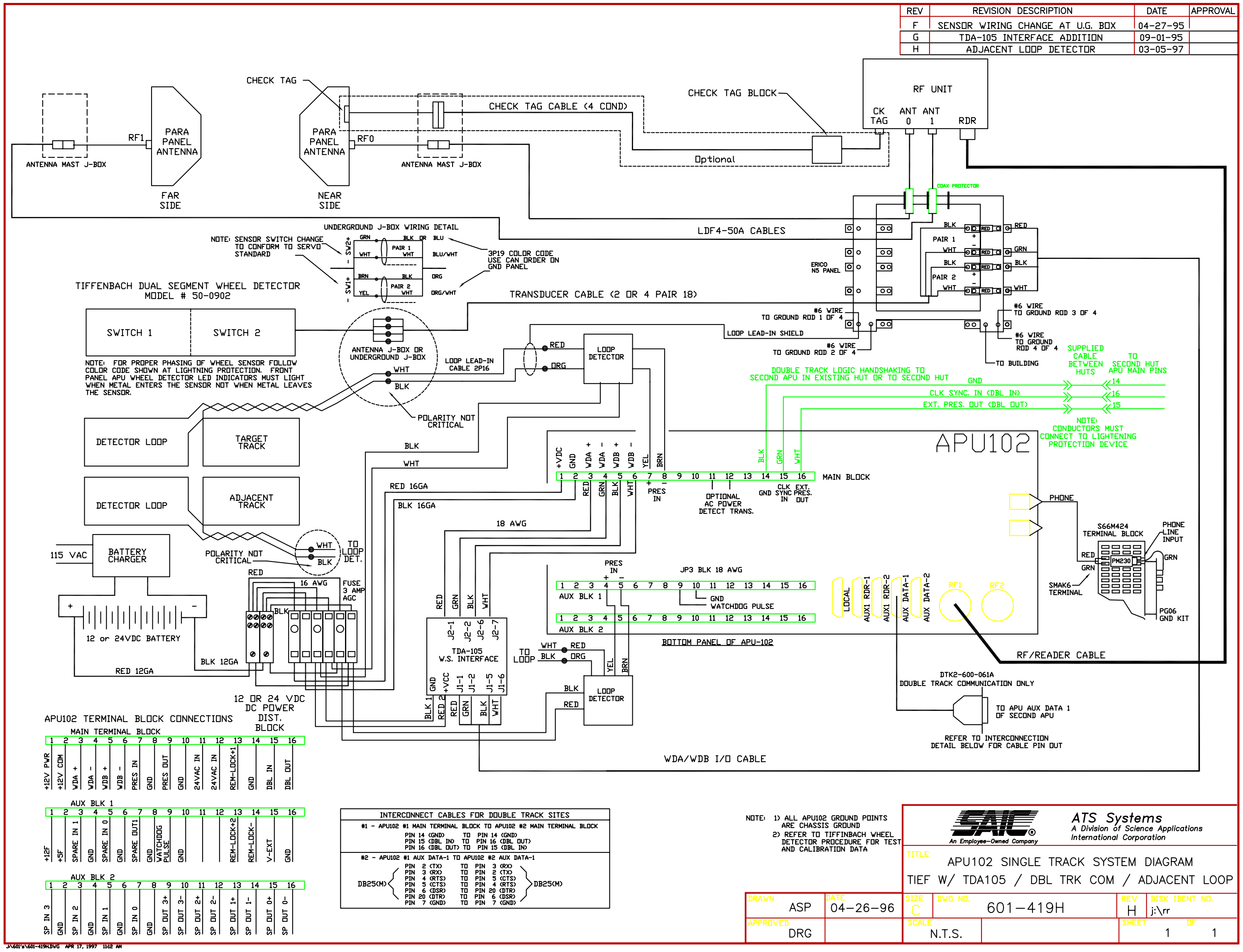

Figure C.31: APU102 Single Track System Diagram

Drawing Number: 601-419H

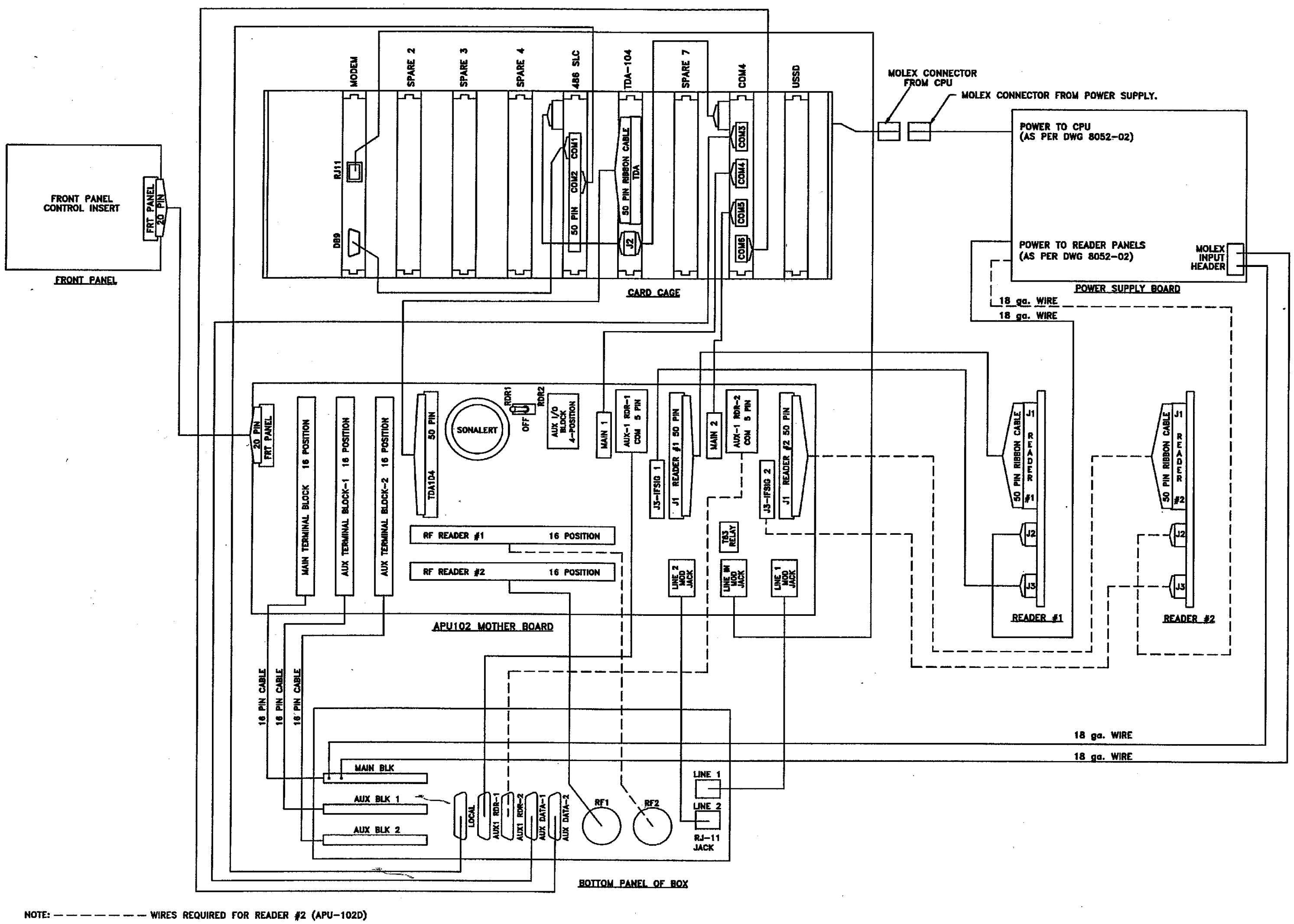

Figure C.32: APU-102 Interconnect Drawing

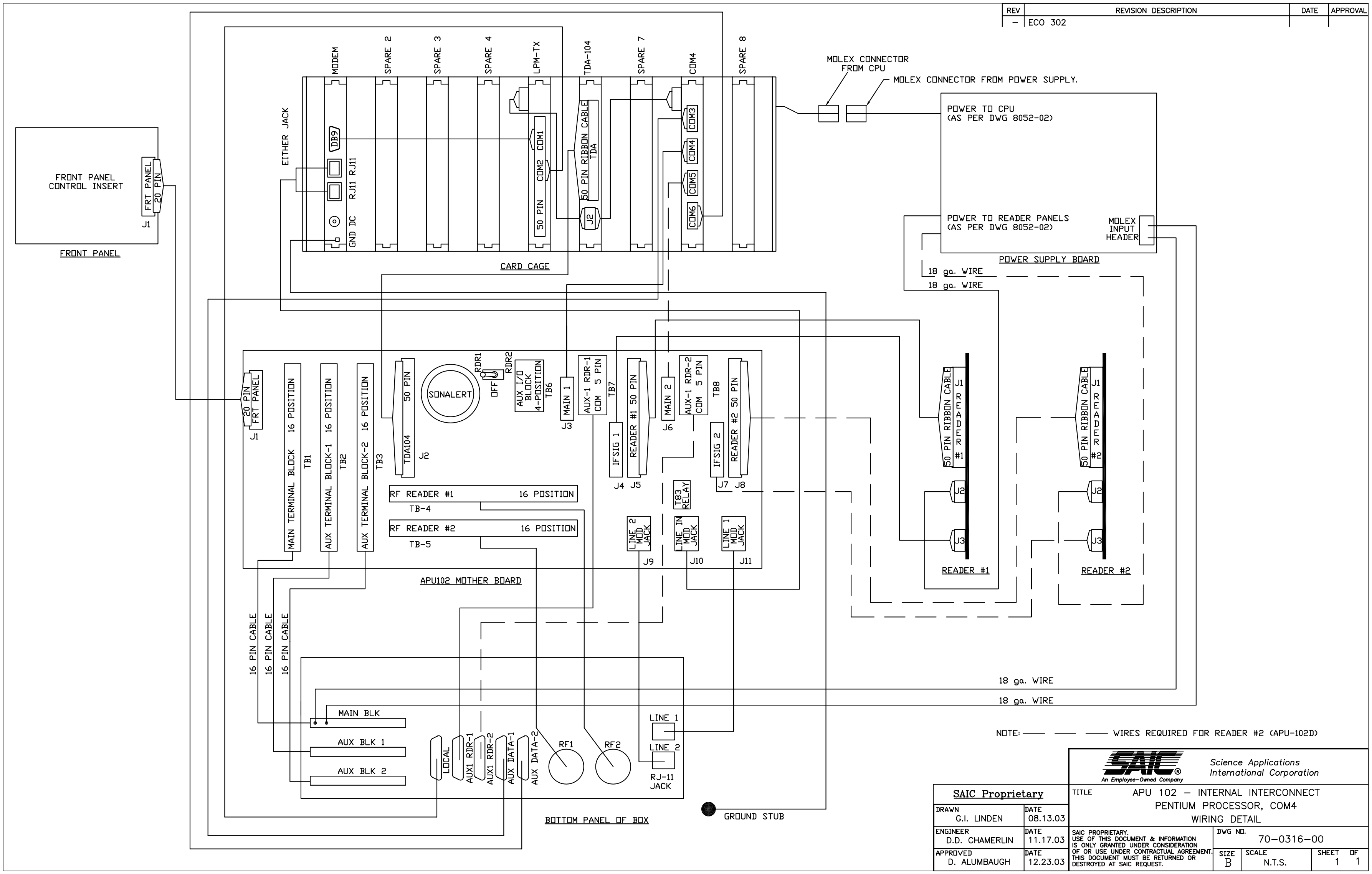

Figure C.33: APU-102 Interconnect Drawing, TX (Pentium) Computer

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