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Rear-End Collision
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Signals & Train Control Group
Attachment 4

WMATA, Technical Procedures Manual
T181 – Track Circuit Adjustments

Introduction
Audio Frequency Track Circuits (**H**igh **F**requency) are used on the mainline for detection of trains and to transmit speed commands. The two brands of **HF** Track Circuits are the US&S AF-800/800W and the GRS/Alstom Track circuits.
Power Frequency (60 Hz **AC**) Track Circuits are used in interlockings for Train Detection. The two basic brands of AC Track Circuits are GRS/Alstom and US&S.
The GRS/Alstom AC Track Circuits are retrofitted with Safetran AC Vane Relays. These Relays have comparable electrical characteristics to the GRS/Alstom AC Vane Relays that they replaced. Testing and Adjustments of AC Track Circuits with Safetran Vane Relays or GRS/ Alstom Vane Relays are the same.
Series AC track Circuits are used in Yards to indicate train occupancy of storage tracks.

Purpose
Adjust Audio Frequency Track Circuits, Power Frequency track Circuits and Yard Storage Series Track Circuits after corrective maintenance or after any equipment modification or change-out that affects the electrical characteristics of the applicable track circuit.

Reference Documents
Will be determined in each Procedure for the brands and types of track circuit that is to be adjusted.

Responsibility
Will be determined in each Procedure for the brands and types of track circuit that is to be adjusted.

Frequency
After any corrective maintenance or disarrangement that affects the electrical characteristics of the track circuit.

Crew Size
Three.

Time
Will be determined in each Procedure for the brand of track circuit that is to be adjusted.

Prerequisites
None.

Special Tools and Test Equipment
Will be determined in each Procedure for the brands of track circuits

Records
See Records requirements outlined in each Procedure

Process

For US&S Audio Frequency Track (HF) Circuits, perform Procedure T18A
For GRS/Alstom Audio Frequency (HF) Track Circuits, perform Procedure T18B
For All Power Frequency (AC) Track Circuits, perform Procedure T18C
For Yard Storage Series Track Circuits, perform Procedure T18D

Pass/Fail Criteria
Refer to the Procedure for each track circuit type to determine Pass/Fail Criteria for that particular type of track circuit.

Remedial Action
Refer to the Procedure for each track circuit type to determine what remedial actions will be necessary when tests fail for that particular type of track circuit.

Revision History:

Rev	Description	Date	By
A	Original (draft)	October 29, 2008	ID

Introduction
These Adjustment Procedures are for the US&S AF-800 and AF-800W Track Circuits. On the AF-800 ATP Module, Track Circuit Detection Signal Level Adjustments will be done on the Power Amplifier PCB only. There is an adjustable resistor (R18) on this PCB to provide a "fine" adjustment for track circuit detection signal level. The Power Amplifier PCB for the AF-800W ATP Module does not have this adjustable resistor. So the "fine" adjustment for track circuit detection signal level must be done on the Receiver Input PCB.
All US&S AF track circuit detection signal level adjustments will be done using a shunt strap.

Purpose
To Adjust US&S Audio Frequency Track Circuits so that the associated track relays will drop when the track circuit is shunted with a .06Ω shunt strap simulating track circuit occupancy by a train.

Reference Documents
US&S Service Manual 6420-1 (AF-800), US&S System Field Maintenance Manual TM 9091 (AF-800W), WTP 2.1, US&S AF-800 Wave Shaping Board Installation and Test Procedure.

Responsibility
ATC A Mechanic or above

Frequency
After any corrective maintenance or disarrangement that affects the electrical characteristics of the track circuit.

Crew Size
Three: At least one trained on US&S Audio Frequency Track Circuits.

Time
Half hour per track circuit.

Prerequisites
None.

Special Tools and Test Equipment
Oscilloscope, VOM, shunt strap.

Records
Form T18A**:** File one copy in the TCR and submit the original to your supervisor.

Process

1 AF-800/AF-800W Transmitter Power Output Transistor Bias Adjustment

Note: Power Amplifier Transistor bias is done when the Power Amplifier Transistors or the Power Amplifier PCB is changed, or when a Wave Shaper PCB is installed or replaced on an ATP AF-800 module. Bias voltage will drift as the transistors' temperature dynamics change. Transistors will become hotter than normal when transmitting both Cab and Track frequencies. Perform bias adjustments when transistors cool down sufficiently.
A Wave Shaper modification to the AF-800 transmitter is designed to minimize the ringing of the Receiver Input Filter (which can falsely pick the track relay) when the mini bond is disconnected from the circuit transmitter.

CAUTION: When removing or installing PCBs on US&S AF-800/AF-800W ATP Modules, always turn power to the applicable card file OFF.

1.1 Disengage the oscillator PCB for the AF-800/W track circuit from the card file.

1.2 Place the Power Amplifier PCB on extender board and install into the module. Turn Power to the card file ON and adjust the Transmitter Power Output Transistor bias level as follows:

For AF-800 modules, refer to Service Manual 6420-1, Section 3.2.2 for additional information if needed.
Adjust R32 on the Power Amplifier PCB for a voltage reading between 90 millivolts dc and 100 millivolts dc between TP9 and TP6 (GND) on the Power Amplifier PCB.
Then verify that the voltage reading between TP10 and TP6 is within ± 50 millivolts from the reading between TP9 and TP6.

For AF-800W modules, refer to TM 9091 Section 5.2.5, and WTP 2.1 for additional information if needed.
Adjust R3 on the Power Amplifier PCB for a voltage reading between 90 millivolts dc and 100 millivolts dc between TP4 and TJ2 on the Power Amplifier PCB.
Then verify that the voltage reading between TP5 and TJ2 is within ± 50 millivolts from the reading between TP4 and TJ2.

1.3 Re-install the oscillator PCB into the ATP module and restore the track circuit to normal operation.

2 AF-800/AF-800W Track Circuit Detection Signal Level Adjustments

Note: For a track circuit that does not have its receiver bond next to IJs, a **hard shunt** will be placed 20' outside the receiver bond. For a track circuit that has its receiver bond adjacent to IJs, a **soft shunt** will be placed 2' inside the track circuit at the receiver bond.

2.1 Check that the Power Amplifier Transmitter indication (LED D3 on AF-800, LED 1 on AF-800W) is flashing to indicate that the transmitter is operational and supplying the necessary condition to energize the track relay.

2.2 Turn pot (R22,) on Receiver PCB fully CCW.

2.3 Install The Power Amplifier PCB on an extender board and install into the module. Set SW3 (Track Power Level Switch) on the Power Amplifier PCB to its lowest level.

2.4 On AF-800 Power Amplifier PCB, turn R18 fully CCW. (There is no R18 equivalent on AF-800W).

2.5 Turn Power to the card file ON.

2.6 If the receive bond for the track circuit is **NOT adjacent to IJs**, install a **hard shunt 20' (twenty feet) outside** the track circuit receive bond.

If the Receive bond for the track circuit **is adjacent** to IJs, install a **soft shunt 2' (two feet) inside** the track circuit receive bond.

2.7 Advance SW3 on the Power Amplifier PCB gradually until the track circuit picks. Decrease SW3 one step and verify that the track circuit drops. (On AF-800W, it may occasionally be necessary to decrease SW3 by two or more steps).

2.8 On AF-800 modules, **advance R18 on the Power Amplifier PCB** until the track circuit picks. Then decrease R18 until the track circuit drops.

On AF-800W modules, **advance R22 on the Receiver PCB** until the track circuit picks. Then decrease R22 until the track circuit drops.

2.9 Remove the shunt strap and restore the track circuit back to operational status and verify that the track circuit is up.

2.10 Measure and record the transmit and receive data for the track circuit according to PMI T121 (T12A).

2.11 **Perform a shunt verification of the track circuit according to PMI T111.**

Pass/Fail Criteria:
Transmit and receive signals must be distortion free. The track circuit must show occupancy when the shunt verification tests are done according to PMI T111.

Remedial Action
Troubleshoot and repair the ATP module, bond/loop or cables and connections.

Revision History:

Rev	Description	Date	By
A	Original (draft)	October 29, 2008	ID

Automatic Train Control Technical Procedures Manual			
T18A	US&S AF Track Circuit Adjustments Data Sheet	Loc:_____	Date_____/_____/_____

Track Circuit	Power Amp Bias Adjustment			Transmit Signal (p-p)		Receive Signal (p-p)		Power Level	Reason for Adjust
	AF-800 or AF-800W	TP 9-TP6 (mV)	TP10-TP6 (mV)	AF-800 J5-J6 (YEL-YEL)	AF-800W TJ3-TJ4 (YEL-YEL)	TP1-TP2 (GRN-GRN)	TP3-TP4 (WHT-BLK)	(SW3)	

Remarks:_____

Signatures: _____ _____

Technician Reviewing Supervisor

Introduction
These Adjustment Procedures are for GRS AF Track Circuits with ATP Modules 31038-56, Gr 1,2 or 3, and Alstom Track Circuits with ATP Module 31038-253-04. Refer to the GRS O&M Manual-Wayside Equipment Appendices Volume 3, and Alstom Field Maintainer's Manual P5004B volume II for additional information on adjustments of these track circuits.
A track circuit must show occupancy when a train is within its prescribed limits and must not show occupancy if not occupied or otherwise shunted.

Purpose
To Adjust GRS/Alstom Audio Frequency Track Circuits so that the associated track relays will show occupancy when the track circuit is shunted with a .06Ω shunt strap simulating track circuit occupancy by a train.

Reference Documents
GRS O&M Manuals, Alstom Field Maintainer's Manual P5004B Volume II.

Responsibility
ATC A Mechanic or above.

Frequency
After any corrective maintenance or disarrangement that affects the electrical characteristics of the track circuit.

Crew Size
Three: At least one trained on GRS/Alstom Audio Frequency Track Circuits.

Time
Half hour per track circuit

Prerequisites
None.

Special Tools and Test Equipment
Oscilloscope, VOM, shunt strap.

Records
Form T18B**:** File one copy in the TCR and submit the original to your supervisor.

Process

1 **Transmitter Power Output Transistor Bias Adjustment** (For GRS ATP Module 31038-56, Gr 1, 2 or 3 only).

Note: ATP Transmitter Power Output Transistor Bias Adjustment is necessary after Corrective Maintenance associated with the Power Output stage of an ATP Module.

CAUTION: Do not remove or insert the B25 (Power Amplifier Bias) card on the ATP Module while power to the module is ON.

1.1 Refer to GRS O&M Manual Volume III, Test Procedure 5.2.1 for supplementary information on Bias Adjustments if needed.

1.1.1 Remove the B28G fuse for the track circuit ATP Module.

1.1.2 Remove the Track Carrier Filter (A19) and Train Carrier Filter (A24) PCBs from the ATP Module.

1.1.3 Place the Power Amplifier Bias PCB (B31) on an extender board, and turn both of the potentiometers on the Bias Board fully CCW.

1.1.4 Connect an ammeter (VOM) set on the 1 Amp scale across the terminals of the B28G fuse holder for the ATP Module (fuse removed in step 1.1.1 above).

1.1.5 Note the current Reading on the ammeter (normally between 200 ma and 250 ma).

1.1.6 Adjust one of the potentiometer on the Power Amplifier Bias Board clockwise to increase the reading of the ammeter by 50 ma..

1.1.7 Adjust the other potentiometer on the Power Amplifier Bias Board clockwise to increase the reading on the ammeter another 50 ma.

1.1.8 Remove the ammeter and extender board. Re-install all PCBs to the ATP module and restore the track circuit to operational status.

1.2 Alstom ATP Module 31038-253-04– No Bias Adjustments

2 GRS/Alstom Track Circuit Detection Signal Level Adjustments

These adjustments are clearly explained in the appropriate O&M Manuals listed below.

2.1 For GRS ATP Module 31038-56 Gr 1, 2, 3, Refer to GRS O&M Manual–Wayside Equipment– Appendices Volume 3 and follow the applicable steps outlined in GTP 1.2 section 3 to adjust the Track Transmit and Receive Signal Levels.

2.2 For Alstom ATP Module 31038-253-04, Refer to Alstom Field Maintainer's Manual P5004B, Volume II and follow the steps outlined in Table 6-6 for Track Transmit Power Level Adjustment; and Table 6-8 for Track Receive Level Adjustment.

2.3 Measure and record the data for the track circuit according to PMI T121.

2.4 **Perform a shunt verification of the track circuit according to PMI** T111.

Pass/Fail Criteria:
Transmit and receive signals must be distortion free. Shunt verification tests in step 2.11 must be successful.

Remedial Action
Troubleshoot and repair the ATP module, bond/loop or cables and connections.

Revision History:

Rev	Description	Date	By
A	Original (draft)	October 29, 2008	ID

Automatic Train Control Technical Procedures Manual			
T18B	GRS/Alstom AF Track Circuit Adjustments Data Sheet	Loc:_____	Date_____/_____/_____

Track Circuit	Power Amp Bias Adjustment			Transmit Signal (p-p)		Receive Signal (p-p)		Power Level	Reason for Adjust
	ATP Module Group	**Step 1.1.6** POT 1 Bias Current (mA)	**Step 1.1.6** POT 2 Bias Current (mA)	GRS Line (+)-Line (-)	Alstom J4-J5	RX AMP IN	RX AMP OUT (GRS SW1or Alstom SW2 down	From PCZ2 configuration	

Remarks:_____

Signatures: _____ _____

Technician Reviewing Supervisor

Introduction
Power Frequency (60 Hz **AC**) Track Circuits are used in interlockings for Train Detection. The two basic brands of AC Track Circuits are GRS/Alstom and US&S.
The GRS/Alstom AC Track Circuits are retrofitted with Safetran AC Vane Relays. These Relays have comparable electrical characteristics to the GRS/Alstom AC Vane Relays that they replaced. Testing and Adjustments of AC Track Circuits with Safetran Vane Relays or GRS/ Alstom Vane Relays are the same.

Purpose
To Adjust the electrical characteristics of GRS/Alstom Power Frequency Track Circuits *(* with GRS or Safetran AC Vane Relay*)* or US&S Power Frequency Track Circuits, so that the shunting sensitivity of the track circuit is optimized for train detection.

Reference Documents
Safetran, GRS/Alstom O&M Manuals, US&S SM 6087, Location BOP.

Responsibility
ATC C Mechanic or above

Frequency
After performance of any corrective maintenance or disarrangement that affects the electrical characteristics of the track circuit.

Crew Size
Three: At least one trained on the applicable Type of Power Frequency Track Circuit.

Time
One hour per track circuit

Prerequisites
None.

Special Tools and Test Equipment
VOM, shunt strap.

Records
Form T12C**:** Power Frequency (AC) Track Circuit Signal Level Tests Data Sheet. File one copy in the TCR and send the original to your supervisor.

Process

1 **Feed End Adjustments**

1.1 Open the feed end supply voltage to the track circuit at terminals TB and TN on the secondary of the track transformer. Verify that there is no stray energy present at the terminals of the open wires connected to the tracks..

1.2 Place a hard shunt across the running rails at the feed end of the track circuit.

1.3 For Track Circuits with Safetran Vane Relays, measure and record the feed end track and cable resistance in series with the 3 Ω feed end resistor between TB and TN of the open cable. Adjust the feed end resistor for a total value of between 2.5 Ω to 3 Ω.

For US&S Track Circuits, verify that the feed end resistor is set at maximum 5 Ω. Measure and record the feed end track and cable resistance in series with the 5 Ω feed end resistor between TB and TN of the open cable.
Do not adjust the feed end resistor!

1.4 Reconnect TB and TN to the track transformer.

1.5 For Track Circuits with Safetran Vane Relays, verify that the feed end current through the 8 amp fuse is 6.6 ± 1 Amps (ac). Adjust the output voltage tap settings of the track transformer to achieve the required current. This current may have to be readjusted in step 2.1 below if the relay does not operate correctly.

For US&S track circuit, do not measure the feed end current at this time.

1.6 Remove the hard shunt from the running rails at the feed end of the track circuit.

2 **Relay End Adjustments**

2.1 For Track Circuits with Safetran Vane Relays, adjust the 25 Ω Relay End Resistor to allow the track circuit Vane Relay to pick, without bouncing or pounding, and make its front contact stops firmly.

For US&S Track Circuits, the Vane Relay must pick firmly, but not all the way. Adjust the Track Transformer Secondary Tap Settings for the proper voltage to pick the Vane Relay without bouncing or pounding.

3 Measure and Record all data for the track circuit according to PMI T121: Procedure T12C for US&S Power frequency Track Circuit or Procedure T12D for Safetran Equipped Vane Relay (GRS/Alstom replacements) Power frequency Track Circuit.

4 **Perform a shunt verification of the AC Track Circuit according to PMI T111.**

Pass/Fail Criteria

In step 2.1 above, the AC Track circuit Vane Relay should pick up firmly without bouncing or pounding.

The track circuit must show occupancy when the shunting tests in PMI T111 are done in step 4.

Remedial Action

Verify that tap settings on the track transformer are correct for the length of the track circuit. Troubleshoot and repair/replace defective components in the track circuit.

Revision History:

Rev	Description	Date	By
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Automatic Train Control Technical Procedures Manual			
T12C	Power Frequency (AC) Track Circuit Signal Level Tests Data Sheet	Loc:_____	Date___/___/___

Perform PMI T121 (Procedure T12C For US&S Power Frequency (AC) Track Circuit or Procedure T12D for GRS/Alstom Power Frequency (AC) Track Circuit (with Safetran Vane Relay replacement) and enter the Data below for each Track Circuit tested.

Track Circuit	Feed End						Relay End					
	Transformer output voltage (ac)		Feed End Resistor Value		Feed End Current (ac)		Relay Coil Voltage (ac)		Relay End Resistor Value		Relay End Current (ac)	
	Previous	Present	Previous	Present	Previous	Present	Previous	Present	Previous	Present	Previous	Present

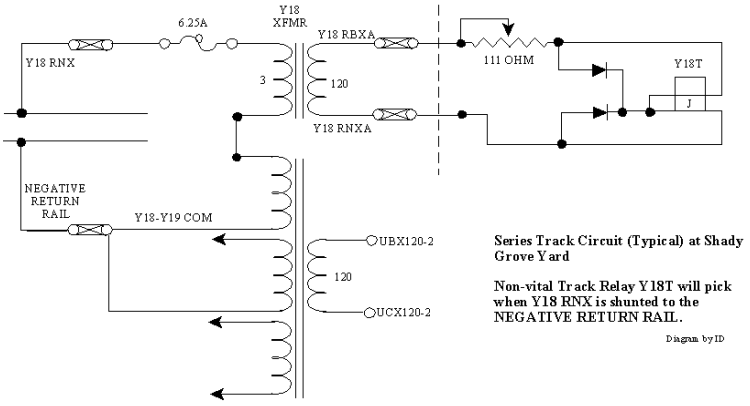
Remarks:_____

Signatures: _____ _____

Technician Reviewing Supervisor

Introduction
The different types of Series Track Circuits installed in storage yards are non-vital circuits that are used for train detection. When the circuit is occupied, the axles of the train complete an ac circuit through a track transformer winding. The induced ac voltage in the other winding of the transformer is rectified and adjusted by a variable resistor to pick the track relay.

At right is a typical Series ac track circuit found at Shady Grove Yard. Note that in this circuit, the voltage to the track is low and it is not directly adjustable. In other installations (e.g., Glenmont) , there may be a small, high-wattage variable current limiting resistor in series with the 6.25A fuse. These Track Circuits will be functionally similar. Components will vary slightly.



Refer to the location BOP and applicable O&M manual for the circuit description of each type of series track circuit.

Purpose
To adjust the Yard Storage Series Track Circuit to ensure that it will show occupancy (the track relay picks) when shunted and do not show occupancy (the track relay drops) when not shunted.

Reference Documents
BOP, O&M Manual for the type of the Yard Storage Series track circuits.

Responsibility
ATC C mechanic or above.

Frequency
After any corrective maintenance or disarrangement on a Yard Storage Series Track Circuit.

Crew Size
Three (at least one ATC mechanic trained on the applicable brand of track circuit).

Time
30 minutes per track circuit.

Prerequisites
None

Special Tools and Test Equipment
VOM.), shunt strap, oscilloscope.

Records
Form T12E (Yard Storage Series Track Circuit Test Data Sheet)**.** File one copy in the TCR and submit the original to your supervisor.

Process

1 Adjustments

1.1 With the track circuit unoccupied, measure the ac voltage going to the rails.

1.2 Remove the feed fuse, and measure the resistance of the wires (open circuit) to the rails.

1.3 Install a hard shunt across the tracks at the far end (from the feed) of the circuit.

1.4 Apply ohm's law and verify that the feed fuse is adequate.

1.4.1 If there is an adjustable resistor in series with the wires, make adjustment on the resistor to keep the current through the feed fuse below its limit. Various tap settings may also be present on the track transformer to adjust the output voltage.

1.5 Replace the hard shunt with a soft (0.06 Ω) shunt.

1.6 Adjust the relay end resistor so that the relay just pick, then reduce the value of the resistor slightly to keep the relay picked.

1.7 Remove the shunt and verify that the track relay drops.

2 Perform Procedure T12E - Yard Storage Series Track Circuit Tests

Pass/Fail Criteria
The track relay must pick firmly when a soft shunt is installed across the rails at the far end from the feed connections. The track relay must be down when the track circuit is not shunted.

Remedial Action

If the track relay does not energize when the track circuit is shunted, check the fuse(s) of the track circuit. Verify that the correct ac voltage is going to the rails. Check the wires to the rails. Inspect the rails for a crack.

Check that the correct ac voltage is going to the rectifier. Check the dc output of the rectifier. Test the relay.

Note: If the relay chatters, suspect a defective rectifier diode or low voltage.

Revision History:

Rev	Description	Date	By
A	Original (draft)	October 29, 2008	ID

Automatic Train Control Technical Procedures Manual			
T12E	Yard Storage Series Tests Data Sheet	Yard:_____	Date___/___/___

Track Circuit	AC Voltage to rails		Wire resistance to rails		Transformer AC Voltage to relay rectifier		Reason for Test
	No shunt on track	Shunt on track	No shunt on track	Shunt on track	No shunt on track	Shunt on track	

Remarks:_____

_____

Signatures: _____ _____

Technician Reviewing Supervisor