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## About This Publication

This manual details the theory of operation, the common single and double rail configurations and some basic tests for the Jeumont Schneider track circuit.

The reader will need to be familiar with the basic functionality of a track circuit.

## Document History

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# 1. Introduction

## 1.1. Scope

This manual provides the information required by field staff for the purpose of installation, maintenance and fault finding on Jeumont Schneider pulse type track circuits. These track circuits are used on sections of line where the correct shunting of the track circuit can be at risk due to rust, scale, coal dust or sand contaminating the rail surface.

There is no basic difference between these units and other types of track circuits. There is a source of power at one end (the “feed” or “transmitter”), two lengths of rail comprising the track circuit, which are electrically isolated from adjacent track circuits by block joints, and a means of detecting the presence or absence of power at the “relay” or “receiver” end. If the track is occupied, power from the feed is attenuated to such an extent that the receiver is de-energised, otherwise the receiver is energised.

The difference from other types of track circuits lies in the voltage level and waveform used within the track circuit. The transmitter at the feed end is used to generate the special waveform and at the relay end, the receiver and relay are used to detect it.

With a Jeumont Schneider track circuit the voltage on the rails consists of a series of high voltage pulses of short duration separated by relatively long intervals, the purpose being to break down semi-insulating surfaces on the rail when the track is occupied. At the same time, because the pulses occur at intervals, the power drawn from the supply by the transmitter, which produced the pulses, is much lower than the instantaneous energy fed to the track circuit.

- The voltage across the rails can be felt, but is not dangerous.
- Each track circuit is insulated from the adjacent one by insulated block joints in the normal way.

These pulse type track circuits are suitable for use on electrified lines using either single or double rail traction return as well as on non-electrified lines. In all cases the transmitting and receiving equipment is basically similar, the difference in layout being mainly confined to the matching (coupling) arrangements between the transmitter and the track, and between the receiver and the track.

On non-electrified lines and on electrified lines using single rail traction return, matching is achieved by using two transformers, one at the transmitting (feed) end and one at the receiving (relay) end.

On electrified lines using double rail traction return, matching is achieved by using an impedance bond incorporating a secondary winding at each end of the track circuit.



The track circuits are usually installed with a power supply and transmitter suitable for operation from the 120v AC Signalling busbar however, where no reliable 120v supply is available a self-contained transmitter power supply suitable for operation from a 24 or 12 volt DC battery is installed.

## **1.2. Referenced documents**

Signalling Maintenance Procedures	SMP 31
Technical Maintenance Plan	SMS 15
Jeumont Schneider Impulse Track Circuits Set up, Test and Certification	SES 03

## **1.3. Definitions**

### **Drop Shunt**

The maximum resistance in ohms which will cause the track relay contacts to drop away when this resistance is placed between the rails of the track circuit.

### **Fixed Shunt**

A predefined fixed value resistance which, when placed across the rails of the track circuit will cause the relay to de-energise.

### **Single Rail Track Circuits**

A track circuit in which one rail is used as a common rail for traction return, and the other is divided into sections by means of insulating joints

### **Double Rail Track circuit**

A track circuit in which both rails are used for traction return, and also for track circuit currents, with separation between adjacent track circuits being achieved by insulating joints in both rails.

### **Cable loop resistance**

The resistance of a cable measured in ohms when one end is short circuited.

## 2. Module Descriptions

### 2.1. Power Supply Rype NCO EAT 115CA

This power supply unit must always be used in conjunction with a transmitter type NCO.EGT.600 and is fed from a 120 volts AC 50Hz supply.

The operating limits are 103 to 127 volts AC, 48 to 51 Hz, -30 to +70C. Power consumption is approximately 45VA.

This unit produces two regulated D.C. power supplies for the transmitter, one low voltage D.C. to feed the thyristor switching circuit, the other a high voltage to charge the capacitor that delivers the output pulse.

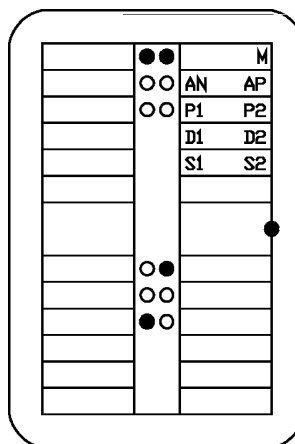


Figure 2.1 Power Type ECO.EAT.115.CA

### 2.2. Transmitter Type NCO.EGT.600

This transmitter must always be used with power supply NCO.EAT.115CA. Its output consists of the non-symmetrical pulses as shown in figure 7.1.

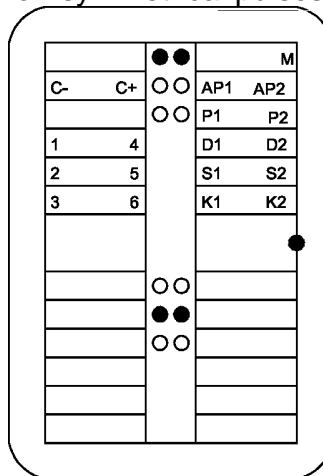


Figure 2.2 Transmitter NCO.EGT.600

### 2.3. Transmitter Type NCO.BET.24CC

This transmitter has built-in equipment to produce the high and low voltage D.C. capacitor charging and switching thyristor supplies and is connected directly to a 24 volt DC battery busbar.

The operating voltage range is 22.5 volts to 28.8 volts DC Power consumption is approx. 50 watts.

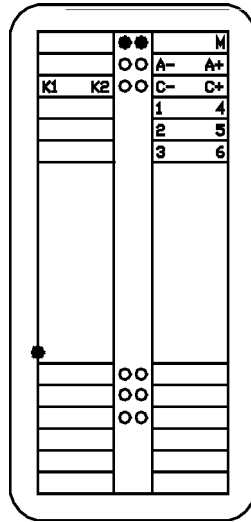


Figure 2.2 Transmitter NCO.EGT.600

### 2.4. Transmitter Type N.BET.SC-12

This transmitter has built-in equipment to produce the high and low voltage DC capacitor charging and switching thyristor supplies and is connected directly to a 120 volt AC busbar AND to a nominal 12 volt DC battery busbar.

Normally fed by the AC mains, an incorporated mains failure relay de-energises upon loss of supply, switching to the standby DC supply. When a changeover to either supply occurs the operation of the track circuit is maintained. The DC operating voltage range is 11 to 14.5 volts (nominal 12v). Power consumption when operating on the mains supply is 45VA which increases to 60 W when operating from the DC supply.

Figure 2.4

## 2.5. Receiver Type NCO.RVT.600

This receiver is used for D.C. electrified single rail and non-electrified track circuits and is also used on electrified double rail track circuits. It does not require to be connected to any power source other than the track circuit.

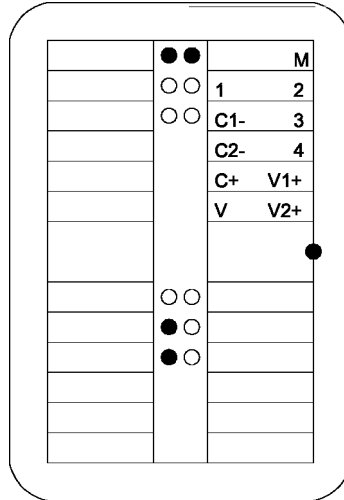


Figure 2.5 Receiver NCO.RVT.600

## 2.6. Receiver Type NCO.BRT.CA2

This receiver is used on DC electrified double rail and long non-electrified track circuits. It does not require to be connected to any power source other than the track circuit. The difference between this and the NCO.RVT.600 receiver is that it requires four wires from the receiver end matching transformer and a maximum of 2 ohms resistance or 70m between the two.

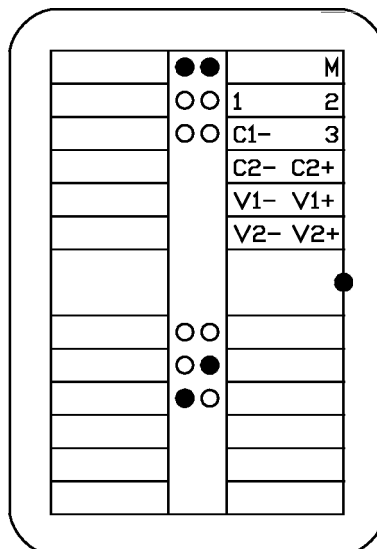


Figure 2.6 Receiver NCO.BRT.CA2

## 2.7. Relay Type NCO.CV.TH.2.404

This track relay is common to all the above track circuits and has four independent front contacts and four independent back contacts.

The resistance of the coil connected to V1+ V1- is 6700 ohms and the coil connected to V2+ V2- is 24,000 ohms.

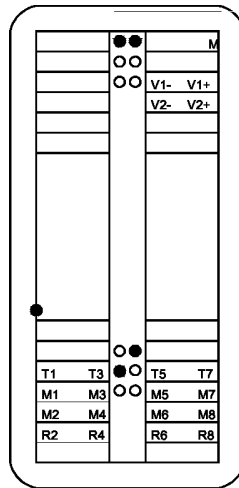


Figure 2.7 Relay NCO.CV.TH.2.404

Front contacts	Back Contacts
M 1-T1	M2-R2
M3-T3	M4-R4
M5-T5	M6-R6
M7-T7	M8-R8

## 2.8. Impedance Bond Type CIT.1400.CT1

This impedance bond is used in DC electrified double rail track circuits up to 1 km in length. The D.C. current rating of the traction winding is 1000 amps per rail continuous or a maximum of 1400 amps for 1 hour.

It has two sets of windings, the traction winding which is connected to the rails and the “fine wire” winding which is connected to the track circuit equipment.

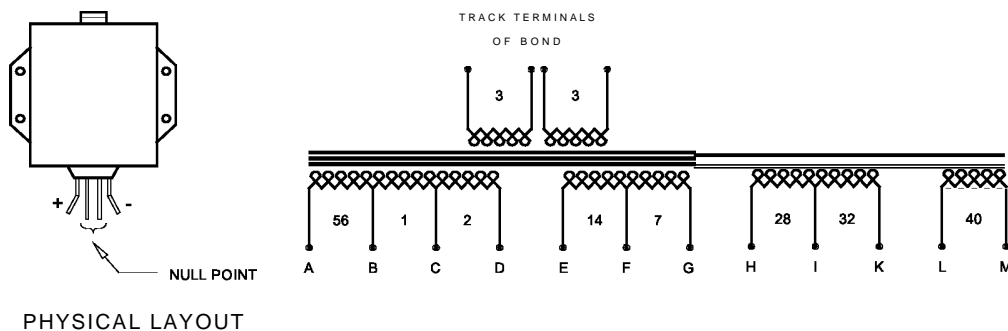


Figure 2.8 Impedance Bond CIT.1400.CT1

## 2.9. Impedance Bond Type 2000P

The 2000P impedance bond is used in areas where higher traction return currents are experienced. It too like the CIT.1400.CT1 has a secondary fine wire winding which is connected to the Transmitter / Receiver equipment in identical fashion. The DC current rating of the traction winding is 2000 amps per rail continuous or a maximum of 4000 amps per rail for 1 hour.

Note: The terminal marked 'I' in the CIT.1400.CT1 impedance bond is designated 'J' in the 2000P. All other terminal numbers are identical.

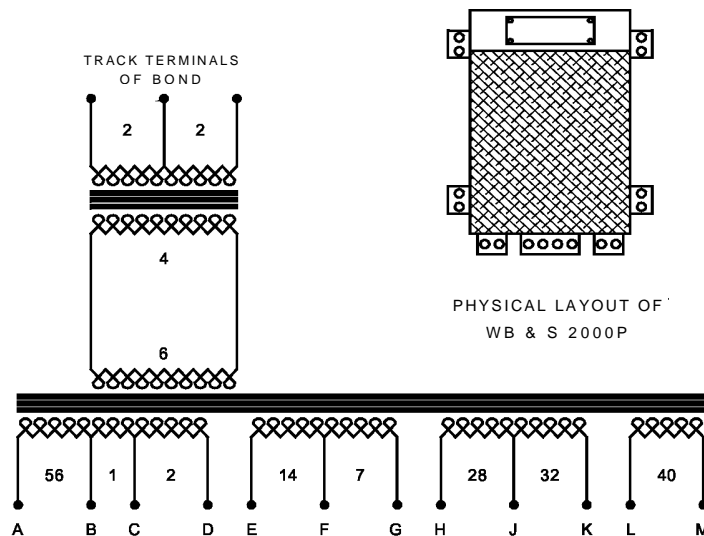


Figure 2.9 Impedance Bond 2000P

## 2.10. Matching Transformer Type TV.TH.1

This transformer is required when used on DC electrified single rail track circuits in conjunction with a resistance ER2.2. There are Teletran manufactured TV.TH.1 matching transformers also type approved for use. The Teletran transformers can be used in an identical manner to that of the Jeumont Schnieder manufactured TV.TH.1

Where used in non-electrified territory the ER2.2 resistor can be omitted.

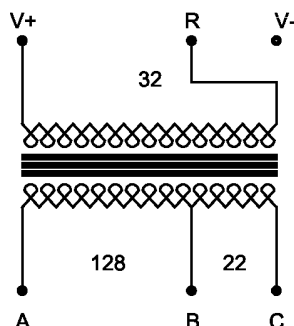


Figure 2.10 Matching Transformer TV.TH.1

## 2.11. Matching Transformer Type [TV.TH.D2](#)

This transformer is used in non-electrified areas and also where a number of track circuits are fed from a common transmitter. The TV.TH.D2.SAR transformer is used in DC electrified single rail areas in conjunction with a DC blocking capacitor. See section 3.6

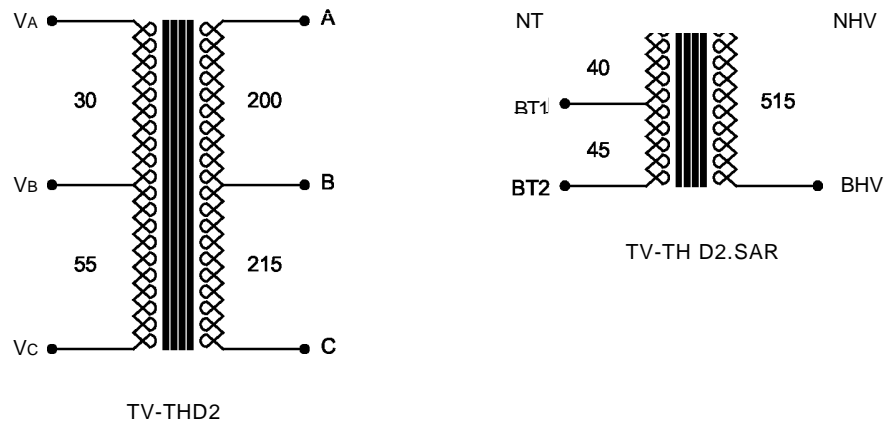


Figure 2.11 Matching Transformers [TV.TH.D2](#)

## 2.12. Matching Transformer Type [TV.LV](#)

This transformer is used on long non-electrified track circuits and is equipped with many more tapping selections than the other matching transformers. Taps are selected according to length of track circuit. Adjustment is completed according to the length of the track circuit. (See Adjustment Table in section 3.8)

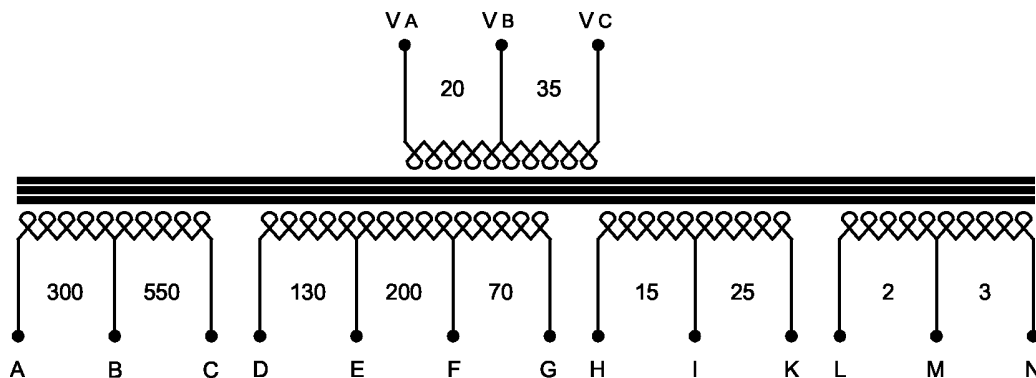


Figure 2.12 Matching Transformer [TV.LV](#)

### 2.13. Resistor ER.2.2

The resistor ER.2.2 is used only in DC electrified single rail track circuits and is connected to the matching transformer TV.TH.1 such that it forms a 2 ohm resistance in the lead between terminal R on the transformer and rail.

The purpose of this resistor is to limit the traction current flowing in the track winding of the matching transformer to prevent the saturation of the core by DC current.

Each resistor is tapped for two one-ohm sections but the full 2 ohms is normally used.

These resistors are supplied with two separate units mounted on a common board, one unit each for adjacent track circuits.

Where single rail track circuits terminate and only one resistor is required the mounting board may be cut in two.

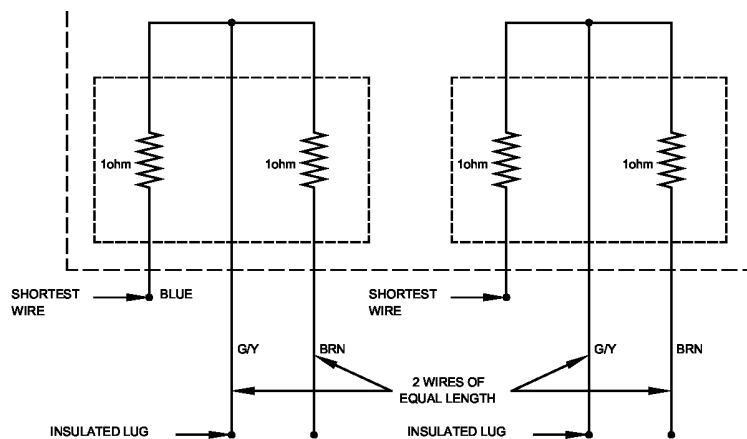


Figure 2.13 Resistor ER.2.2

### 2.14. Limitation Device Type NCO.VDR

This is a device that limits the effects of strong traction current ripple or starting current surges in the receiver of double rail track circuits under broken rail conditions.

It is connected onto the V2 coil connections from the receiver to the relay. It is plug mounted in a base type BR4 which holds two NCO.VDR units.

This device is electrically symmetrical and can be plugged into the base either way.

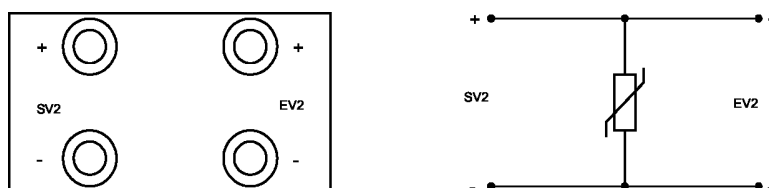


Figure 2.14 Limitation Device NCO.VDR



## 2.15. Resistor RK 40.0.07A

These are 40 ohm adjustable resistors used to adjust the resistance of the transmission loop ie. the cable loop resistance between the transmitter and the matching transformer, to the required value where a number of track circuits are fed from a common transmitter.

They are not plug-in and can be rack mounted near the outgoing cable termination.

1

3

2

Figure 2.15 Resistor RK40.0.7A

## 2.16. Integrator

The obvious need to measure the different parameters on a Jeumont Schneider track circuit cannot be achieved using a standard voltmeter due to the irregular shape of the waveform. The waveform needs to be firstly integrated before it can be measured with a standard (20kohm/volt or higher) voltmeter.

A standard integrator in it's basic form is comprised of a diode network, capacitor input and output terminals and finally a switch which is used to switch between the two halves of the pulse without having to reverse the meter leads.

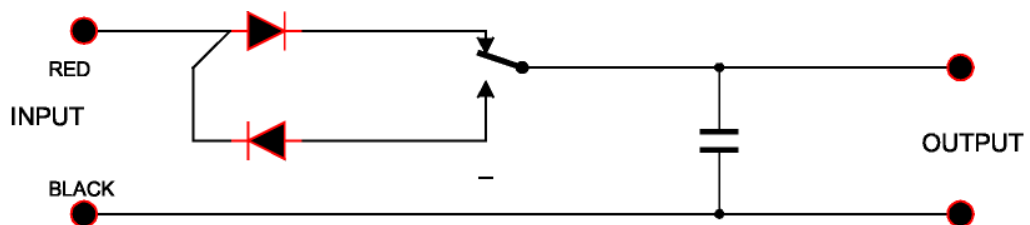


Figure 2.16 Integrator

Where series bonds are used in the track circuit arrangement, the total resistance of the series bonds must be kept below 0.15 ohm. (To achieve this twin 7/0.85mm or 7/1.7mm cable may be used for the series bond).

If it is still not possible to achieve the minimum resistance specified above the following procedure should be adopted.

- (i) Change track connecting cables at both ends for copper Hypalon. This allows the series bond resistance to be increased up to 0.3 ohms.
- (ii) If the above requirement cannot be met then the loop resistance of the track and track connection cables should be measured by connecting terminals V+ and R together at the receiver end matching transformer. Connect an Ohm meter between the track connection cable from V+ and terminal R at the transmitter end.

If the total loop resistance is over 4.5 ohms bridge out 1 ohm of the ER2-2 resistor in the series bond leg of the circuit. This is achieved by disconnecting the short lead, and connecting the lead with the insulated lug to terminal R. The short lead should be properly insulated.

### 3.1.2 Commissioning and Testing

When all wiring has been correctly terminated and resistances adjusted the power may be turned on. At no time should the transmitter or power supply be plugged or unplugged nor bridging changed while the power is on. The transmitter should not be left feeding into an open circuit for an indefinite period as this may cause it to be damaged.

Track voltages should be measured using a meter fitted with an integrator and should fall within the ranges specified in table 3.1.2.

Relay voltages should lie within the range specified in table 3.1.2.

Verify correct shunting of the track by testing the track with a 0.5 ohm non-inductive shunt. Test shunts should be done at all extremities of the track circuit including the extremities of any branch of a junction track, at the mid-point of any straight track and at both ends of any parallel-bonded section.

### 3.1.3 Non Electrified Areas

The single rail track circuit arrangement can also be used in non-electrified areas. In this case, a bridge between V- and R on the matching transformer replaces the ER2-2 resistor. The remaining setting up, adjustment, commissioning and testing data is identical.

Length of Track Circuit (in metres)	Minimum Ballast Resistance (in ohms)	Peak Voltage to Track (Volts)								Track Relay							
		Minimum Ballast Resistance				Maximum Ballast Resistance				Voltage (v)				Current (mA)			
		Transmitter		Receiver		Transmitter		Receiver		Minimum Ballast Resistance		Maximum Ballast Resistance		Minimum Ballast Resistance		Maximum Ballast Resistance	
		+	-	+	-	+	-	+	-	V1	V2	V1	V2	I1	I2	I1	I2
50	3	42	7	40	7	165	21	168	20	17	23	50	96	2.5	0.95	7.3	4
100	3	44	7	40	7	161	21	169	20	17	23	50	96	2.5	0.95	7.3	4
150	3	47	7.5	39	7	158	21	170	20	17	23	50	96	2.5	0.95	7.3	4
200	3	48	7.5	39	7	157	21	172	20	17	23	50	96	2.5	0.95	7.3	4
250	3	49	7.5	38	7	156	21	173	20	17	22	50	96	2.5	0.91	7.3	4
300	3	50	7.5	38	7	156	21	174	20	17	22	49	96	2.5	0.91	7.2	4
350	3	51	7.5	37	7	155	21	174	20	17	21	49	96	2.5	0.88	7.2	4
400	3	52	7.5	37	7	155	21	174	20	17	21	49	96	2.5	0.88	7.2	4
450	3	53	7.5	36	7	154	21	174	20	17	20	49	96	2.5	0.84	7.2	4
500	3	53	7.5	36	7	154	21	174	20	17	20	49	96	2.5	0.84	7.2	4

Table 3.1.2 Single Rail DC Electrified and Non electrified Operating Voltages and Currents

SINGLE RAIL TRACK CIRCUITS D.C. ELECTRIFIED OR NON-ELECTRIFIED  
 ADJACENT TRACKS TO BE OF ALTERNATE POLARITIES

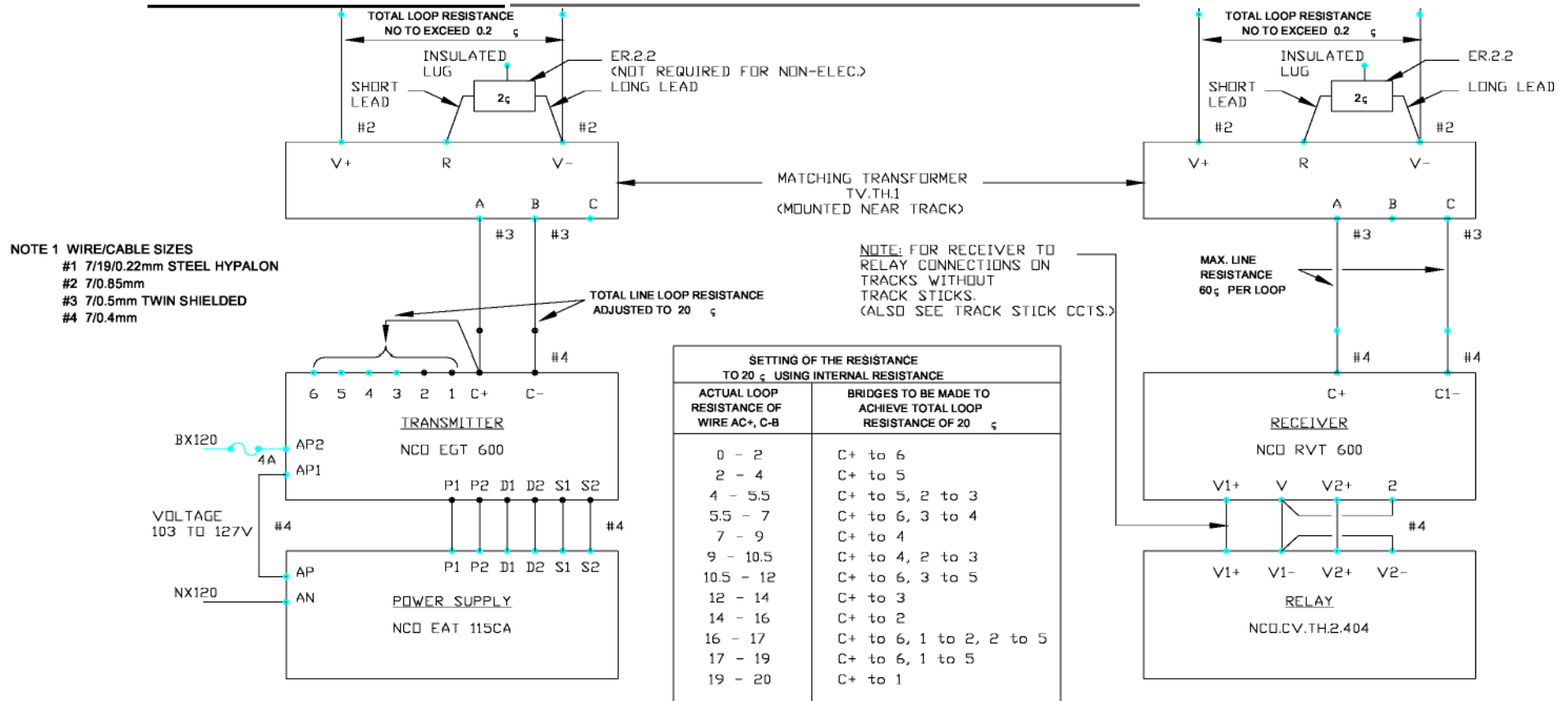


Figure 3.1.1 Single Rail DC Electrified or Non Electrified Track Circuit

### 3.2 Double Rail Track Circuits, DC Electrified – using Single NCO.BRT.CA2 - 4 wire Receiver

#### 3.2.1 Setting up and Adjustments

Connect the modules together as shown on figure 3.2.1. The termination arrangements for each module are shown in Section 2.

The following requirements should be observed in setting up the connections between units.

- (a) The transmitter cable loop resistance should be set to 10 ohms between the transmitter and the impedance bond (see below)
- (b) The connection to the transmitter end impedance bond is as follows: -

Track Length in meters	Number of turns	Connections between transmitter and impedance bond at transmitter end		Connections on the impedance bond at the transmitter end
		C+	C-	
18-1000	35	I	F	G – H

Table 3.2.1 Cable termination on transmitter end impedance Bond

- (c) The connection to the receiver end impedance bond is as per the following table:

Track Length in metres	Number of turns		Required terminations on Impedance bond at receiver end				Required bridging on the receiver end impedance bond
	S1	S2	3	C1-	C2+	C2-	
18-50	26	4	D	I	D	G	B-F;C-H
100	27	5	C	I	D	G	C-F;B-H
150	28	5	H	I	D	G	C-F
200	29	5	B	I	D	G	C-F;C-H
250	30	6	C	I	C	G	B-F;D-H
300	32	6	I	K	C	G	B-F
350	33	7	B	K	F	G	C-I
400	35	7	F	I	F	G	G-H
450	37	7	C	I	F	G	D-F;G-H
500	39	8	F	K	B	G	G-I;C-F
550	41	8	B	M	B	G	C-L;C-F
600	43	9	B	M	C	G	D-F;D-L
650	47	9	F	M	C	G	G-L;D-F
700	50	10	B	M	B	G	D-F;G-L
750	56	11	A	B	D	F	B-E
800	57	12	A	C	D	F	C-E
850	60	13	H	K	C	F	B-E
900	62	13	C	K	C	F	D-H;B-E
950	67	14	F	K	E	F	G-H
1000	72	15	I	M	B	F	K-L;C-E

Table 3.2.2 Cable termination on receiver end impedance Bond

- (d) The terminal marked 'I' in the CIT.1400.CT1 impedance bond is equivalent to terminal 'J' in the 2000P impedance bond

Verify correct shunting of the track by testing the track with a 0.25 ohm noninductive shunt. Test shunts should be done at all extremities of the track circuit including the extremities of any branch of a junction track, at the midpoint of any straight track and at both ends of any parallel-bonded section.

Length of Track Circuit (in metres)	Minimum Ballast Resistance (in ohms)	Peak Voltage to Track (Volts)								Track Relay							
		Minimum Resistance Ballast				Maximum Ballast Resistance				Voltage (v)				Current (mA)			
		Transmitter		Receiver		Transmitter		Receiver		V1		V2					
		+	-	+	-	+	-	+	-	V 1	V2	I1	I2	I1	I2		
50	3	61	11	50	10	112	21	105	21	19	26	35	53	2.8	1.08	5.2	2.2
100	3	62	11	43	10	112	21	96	21	19	25	35	52	2.8	1.04	5.2	2.16
150	3	63	12	36	10	112	21	88	20	18	24	35	50	2.7	1	5.2	2.08
200	3	63	12	34	3	112	21	83	19	18	23	35	50	2.7	0.96	5.2	2.08
250	3	63	12	31	3	113	22	77	18	18	23	35	49	2.7	0.96	5.2	2.04
300	3	64	12	28	8	113	22	72	17	18	22	35	48	2.7	0.92	5.2	2
350	3	64	12	26	8	114	22	68	17	18	22	35	48	2.7	0.92	5.2	2
400	3	64	12	25	7	114	22	64	16	18	22	35	48	2.7	0.92	5.2	2
450	3	65	12	23	7	115	22	60	15	18	22	35	48	2.7	0.92	5.2	2
500	3	66	12	22	77	115	22	55	14	18	22	35	49	2.7	0.92	5.2	2.04
550	2.73	66	12	20	6	115	22	51	13	18	23	36	49	2.7	0.96	5.3	2.04
600	2.5	67	12	19	6	115	22	47	12	18	23	36	50	2.7	0.96	5.3	2.08
650	2.31	67	12	18	6	115	22	45	12	18	22	37	50	2.7	0.96	5.5	2.08
700	2.15	67	12	16	5	116	22	43	11	19	22	37	52	2.8	0.92	5.5	2.16
750	2	67	12	15	5	116	22	41	10	19	22	38	52	2.8	0.92	5.6	2.16
800	1.88	67	12	14	5	117	22	39	10	18	22	38	52	2.7	0.92	5.6	2.16
850	1.77	67	12	14	4	117	22	37	9	18	22	38	53	2.7	0.92	5.6	2.20
900	1.67	67	12	13	4	118	22	35	9	18	22	38	53	2.7	0.92	5.6	2.20
950	1.58	67	12	12	3	118	22	34	8	18	22	39	54	2.7	0.92	5.8	2.25
1000	1.5	67	12	11	3	118	22	32	8	18	22	39	54	2.7	0.92	5.8	2.25

Table 3.2.4 Double Rail DC Electrified track circuit operating voltages and currents

ELECTRIFIED DOUBLE RAIL TRACK CIRCUIT – UP TO 1000M  
 USING IMPEDANCE BONDS (CIT1400CT1 or 2000P)  
 ADJACENT TRACKS TO BE OF ALTERNATE POLARITY

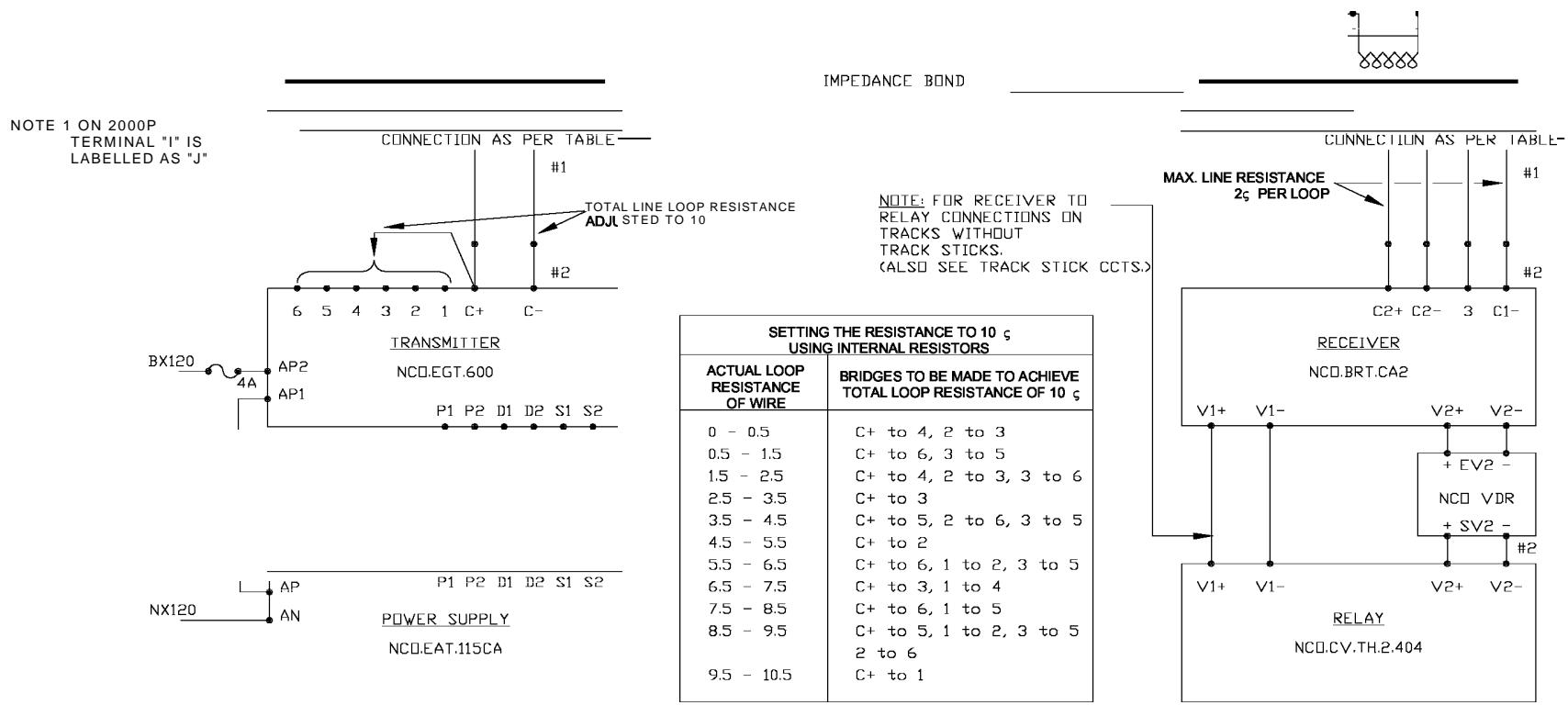


Figure 3.2.1 Double Rail DC Electrified track circuit



Length of track circuit (metres)	Minimum ballast resistance (ohms)	Peak voltage to the track (in volts)								Voltage at the relay terminals (volts)				Relay Current (mA)			
		Minimum ballast resistance				Maximum ballast resistance				Minimum ballast resistance		Maximum ballast resistance		Minimum ballast resistance		Maximum ballast resistance	
		UVA +	UVA -	UVR +	UVR -	UVA +	UVA -	UVR +	UVR -	U <sub>1</sub>	U <sub>2</sub>	U <sub>1</sub>	U <sub>2</sub>	I <sub>1</sub>	I <sub>2</sub>	I <sub>1</sub>	I <sub>2</sub>
50	3	53	7.5	44	7.5	107	16	98	16	13.5	22	34	48	2	0.91	5	2
100	3	56	7.5	37	7	109	16	90	16	13.5	22	34	48	2	0.91	5	2
150	3	59	7.5	31	6.5	110	15	83	15	14	23	34	48	2.1	0.96	5	2
200	3	59	7.5	28	6.5	111	15	77	14	14	22	34	48	2.1	0.91	5	2
250	3	60	8	25	6	112	15	71	14	14	21	35	46	2.1	0.88	5.2	1.9
300	3	61	8	24	6	113	15	66	13	14	21	35	46	2.1	0.88	5.2	1.9
350	3	61	8	22	5.5	115	15	60	13	14	22	35	46	2.1	0.91	5.2	1.9
400	3	62	8	21	5.5	117	15	54	12	15	22	34	48	2.2	0.91	5	2
450	3	62	8.5	20	5	118	15	48	12	15	23	34	48	2.2	0.96	5	2
500	3	64	8.5	19	5	118	15	46	11	15	23	34	48	2.2	0.96	5	2
550	2.73	66	8.5	17	4.5	119	15	43	11	15	22	35	48	2.2	0.91	5.2	2
600	2.5	67	8.5	15	4.5	119	15	40	10	15	21	35	48	2.2	0.88	5.2	2

Table 3.3.4 Double Rail DC Electrified track circuit operating voltages and currents

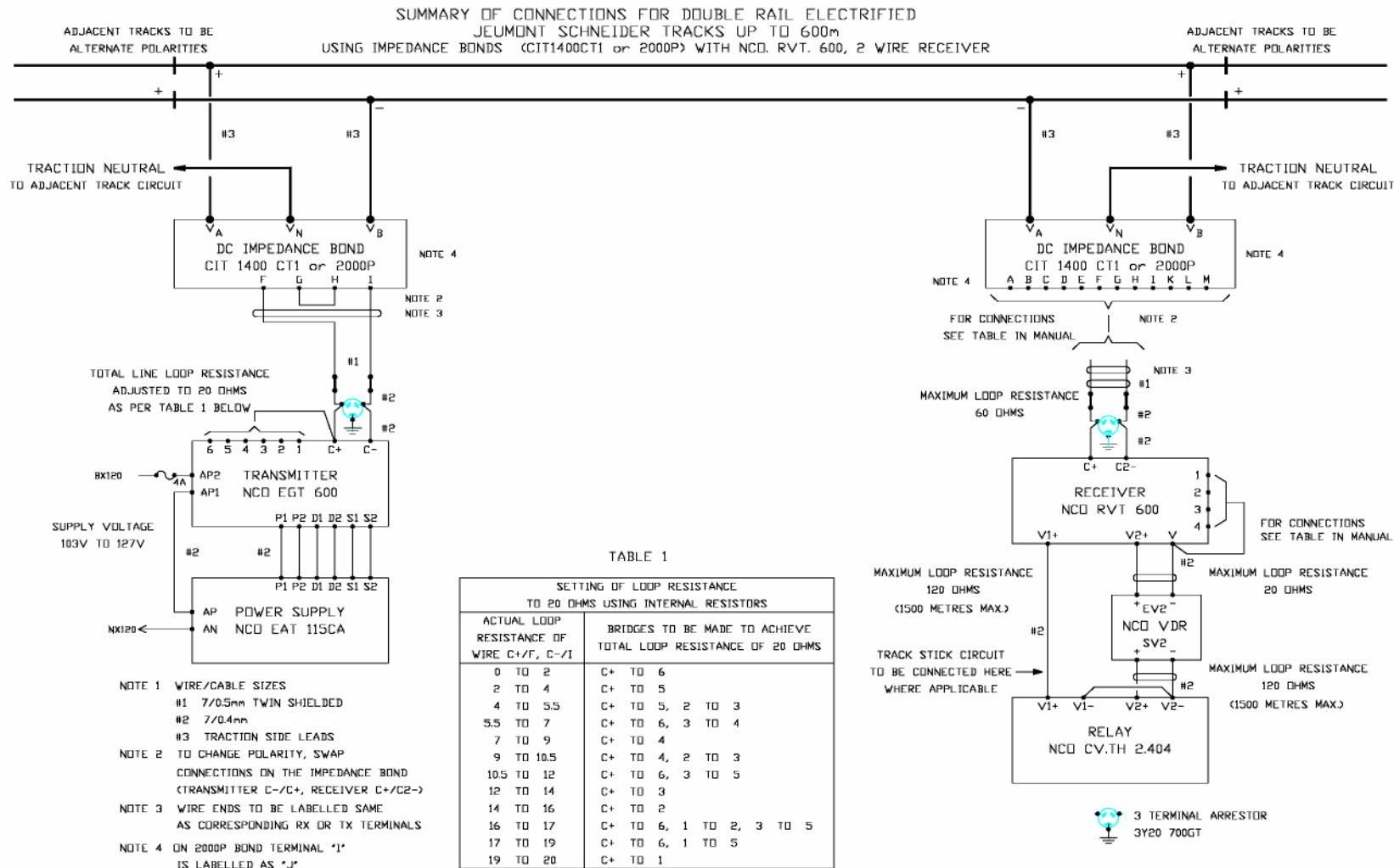


Figure 3.3.1 Double Rail DC Electrified track circuit

Length of track circuit (meters)	D	Peak voltage to the track (in volts)								Voltage at the track relay terminals (volts)				Current intensity in the relay (mA)			
		Minimum ballast resistance				Maximum ballast resistance				Minimum ballast resistance		Maximum ballast resistance		Minimum ballast resistance		Maximum ballast resistance	
		UVA	UVA	UVR	UVR	UVA	UVA	UVR	UVR	U 1	U2	U 1	U2	I1	I2	I1	I2
		+	-	+	-	+	-	+	-								
100	50	56	6	35	5.5	78	9	52	8.5	21	28	36	43	3.1	1.15	5.3	1.8
150	50 to 100	56	6	35	5.5	72	9	52	8.5	21	34	36	43	3.1	1.4	5.3	1.8
		62	7	30	5	78	9	41	8	19	28	32	39	2.8	1.15	4.7	1.6
200	50 to 150	56	6	32	5.5	74	9	49	8.5	21	32	36	41	3.1	1.3	5.3	1.7
		62	7.5	26	4.5	80	10	37	7.5	19	27	33	37	2.8	1.12	4.85	1.56
250	50 to 200	57	6.5	30	5	77	9	46	8.5	20	30	37	40	2.9	1.25	5.5	1.65
		63	8	23	4	82	10	33	7	20	25	34	37	2.9	1.04	5	1.55
300	50 to 250	58	6.5	27	5	79	9	43	8.5	20	27	37	39	2.9	1.12	5.5	1.6
		63	8.5	20	4	83	11	29	6	20	24	34	36	2.9	1	5	1.5

Table 3.4.4 Double rail DC electrified track circuit operating voltages and currents

SUMMARY OF CONNECTIONS FOR DOUBLE RAIL ELECTRIFIED  
 JEUMONT SCHNEIDER TRACKS UP TO 300m  
 USING DC IMPEDANCE BONDS WITH 2x NCO. RVT. 600, 2 WIRE RECEIVER

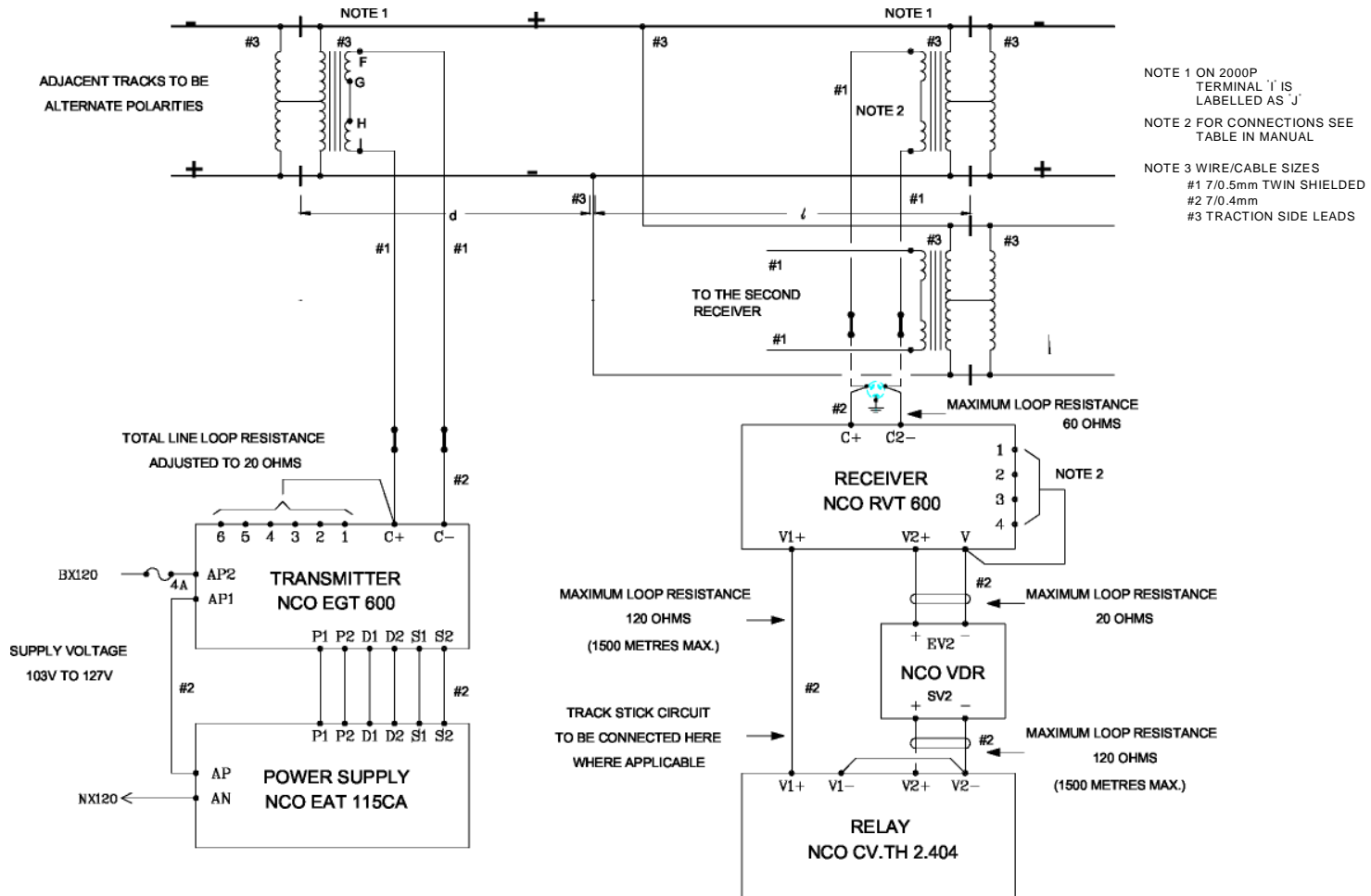


Figure 3.4.1

Double Rail DC Electrified track circuit

## 3.5 Non Electrified Single Rail Track Circuits – Common Transmitter using [TV.TH.D2](#) Matching Transformers for Level Crossings

### 3.5.1 Setting up and Adjustments.

Connect the modules together as shown on figure 3.5.1. The termination arrangements for each module are shown in Section 2.

The following requirements should be observed in setting up the connections between units.

- (a) The transmitter loop resistance should be set to 80 ohms for the crossing track and 60 ohms for each approach track by adjusting the RK 40 resistor. Check that the transmitter internal resistance strapping is connected between C+ and 1.
- (b) The maximum resistance of the cable between the receiver and the matching transformer is 60 ohms.
- (c) The maximum loop resistance between the matching transformer and the track is 0.5 ohm. Where series bonds are used in the track circuit the resistance of the bonds must be kept below 0.15 ohm. If it is not possible to achieve this minimum resistance, change the track connection cable to copper Hypalon. This allows the series bond resistance to be increased up to 0.3 ohms.
- (d) The maximum loop resistance of the cable between the receiver and the track relay is 120 ohms. The maximum length of the cable is 1500m.

Ensure that the voltage at the transmitter terminals is between 103 and 127 volts. The nominal voltage is 115 volts.

### 3.5.2 Commissioning And Testing

When all wiring has been correctly terminated and the transmitter resistances for each separate track circuit adjusted, the power may be turned on. At no time should the transmitter or power supply be plugged or unplugged nor bridging changed while the power is on. The transmitter should not be left feeding into an open circuit for an indefinite period as this may cause it to be damaged.

Each track circuit should be treated as an individual track circuit. Track voltages should be measured with a meter fitted with an integrator and should fall within the ranges specified in table 3.5.1.

Relay voltages should lie within the range specified in table 3.5.1.

Verify correct shunting of the track by testing the track with a 0.25 ohm noninductive shunt. Test shunts should be done at all extremities of the track circuit including the extremities of any branch of a junction track, at the midpoint of any straight track and at both ends of any parallel-bonded section.

Number of zones fed	Length of track circuit	Peak voltage to the track (in volts)								Voltage at the track relay terminals (volts)			
		Minimum Ballast				Maximum Ballast				Minimum Ballast		Maximum Ballast	
		UVE +	UVE -	UVR +	UVR -	UVE +	UVE -	UVR +	UVR -	U1	U2	U1	U2
3 at line clear	50	34	10	33	10	80	18	79	18	27	33	56	83
	200	38	10	32	10	83	18	79	18	26	31	56	82
	400	43	10	30	9	85	18	79	17	26	29	56	80
3 with 2 in short circuit	50	28	6	27	6	65	11	64	11	18	27	39	68
	200	33	6	25	6	72	11	64	11	18	25	39	67
	400	39	6	23	5	79	11	64	11	18	23	39	66
2 at line clear	50	34	10	33	10	80	18	79	18	27	33	55	83
	200	38	10	32	10	83	18	79	18	26	31	54	82
	400	43	10	30	10	85	18	79	17	26	29	53	80
2 with 1 short circuit	50	30	8	29	8	72	14	71	14	23	30	46	75
	200	35	8	28	8	77	14	71	14	22	28	46	74
	400	40	8	27	7	82	14	71	14	22	26	46	72
1 at line clear	50	34	10	33	10	78	17	77	17	28	33	53	80
	200	37	10	32	10	81	17	77	17	27	31	53	79
	400	42	10	30	9	84	17	77	16	27	30	53	77

Table 3.5.1 Multi feed transmitter arrangement for Level Crossings operating voltages and currents

SUMMARY OF CONNECTIONS FOR SINGLE RAIL JEUMONT TRACKS  
 FOR LEVEL CROSSINGS  
 ADJACENT TRACKS TO BE OF ALTERNATE POLARITIES

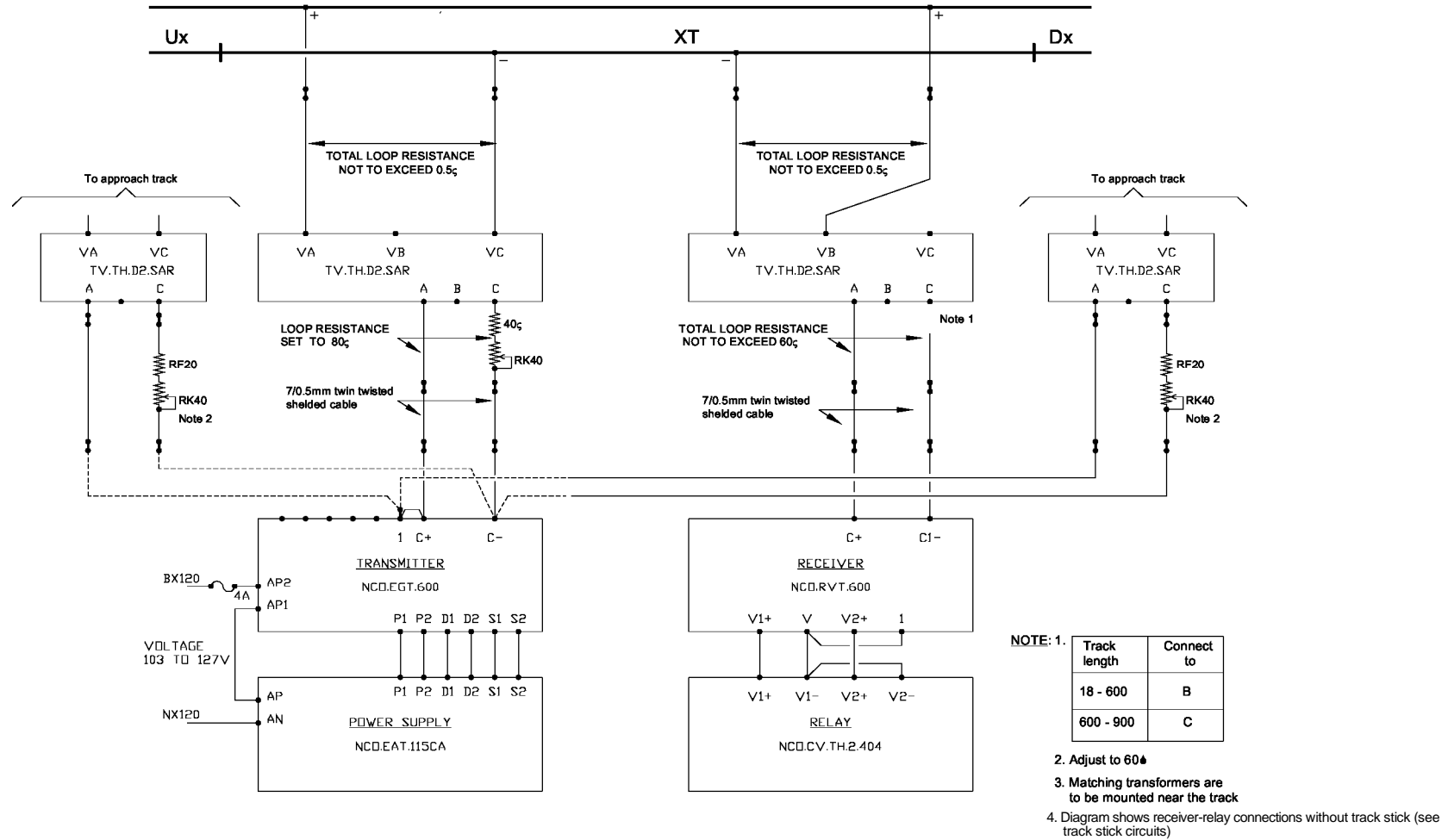


Figure 3.5.1 Multi feed transmitter arrangement for Level Crossings

## **3.6 Electrified Track Circuits – Common Transmitter using TV.TH.D2.SAR Matching Transformers (Capacitor Fed)**

### **3.6.1 Setting up and Adjustments**

Connect the modules together as shown in figure 3.6.1. The termination arrangements for each module are shown in Section 2.

The following requirements should be observed in setting up the connections between the units.

- (a) The transmitter loop resistance should be set to 60 ohms between the transmitter and each matching transformer
- (b) The maximum loop resistance between matching transformer and receiver is 60 ohms.
- (c) The maximum loop resistance between the transmitter end matching transformer and track connections is 0.5 ohms. The resistance of any series bonding used in the track circuit should be kept to a minimum.
- (d) The loop resistance between the receiver-end matching transformer and track connections must be adjusted to 2 ohms (see below).

Ensure that the AC supply voltage is between 103 and 127 volts (115 volts nominal).

#### **Transmitter loop resistance adjustment**

Isolate the power from the power supply unit and open the outgoing transmitter track terminals. Check that the transmitter internal resistance strapping is connected between C+ and 1. Open the outgoing location terminal links, and short terminals BHV and NHV on the transmitter matching transformer. Measure the loop resistance at the outgoing terminals, adjust the 40 ohm adjustable resistor in the matching unit until the loop resistance equals 60 ohms, +/- 1 ohm.

#### **Receiver loop resistance adjustment**

- (a) Disconnect the cable from terminal BT1 on the receiver end matching transformer, and apply a short circuit between the receiver end rail connections.
- (b) Measuring the loop resistance between the free wire and transformer terminal NT, adjust the 2 ohm variable resistor until the loop resistance equals 2 ohms +0.2,-0.0 ohms.

Remove the short circuit, and reconnect terminal BT1.

Note: At times this test may be very difficult to carry out, when stray DC traction currents produce reading errors in the ohm-meter. In that case, the loop resistance should be adjusted approximately by setting the adjustable resistor to between 1.8 ohms (matching unit 1-2 metres from track) and 1.5 ohms (matching unit 3-4 metres from track).



### 3.6.2 Commissioning and Testing

When all connections have been made, and the loop resistances adjusted, then power may be connected to the transmitter. At no time should the transmitter or power supply unit be plugged or unplugged, or bridging be changed while the power is on. The transmitter should not be left feeding into an open circuit for an indefinite period as this may cause it to be damaged.

Track voltages should be measured with a meter fitted with an integrator and should fall within the range specified in table 3.6.1.

Verify correct shunting of the track by testing the track with a 0.25 ohm non-inductive shunt. Test shunts should be done at all extremities of the track circuit including the extremities of any branch of a junction track, at the mid-point of any straight track and at both ends of any parallel-bonded section.

Number of zones fed	Length of track circuit	Peak voltage to the track (in volts)								Voltage at the track relay terminals (volts)			
		Minimum Ballast Resistance				Maximum Ballast Resistance				Minimum Ballast Resistance		Maximum Ballast Resistance	
		UVE +	UVE -	UVR +	UVR -	UVE +	UVE -	UVR +	UVR -	U1	U2	U1	U2
3 at line clear	50	34	10	33	10	80	18	79	18	27	33	56	83
	200	38	10	32	10	83	18	79	18	26	31	56	82
	400	43	10	30	9	85	18	79	17	26	29	56	80
3 with 2 in short circuit	50	28	6	27	6	65	11	64	11	18	27	39	68
	200	33	6	25	6	72	11	64	11	18	25	39	67
	400	39	6	23	5	79	11	64	11	18	23	39	66
2 at line clear	50	34	10	33	10	80	18	79	18	27	33	55	83
	200	38	10	32	10	83	18	79	18	26	31	54	82
	400	43	10	30	10	85	18	79	17	26	29	53	80
2 with 1 short circuit	50	30	8	29	8	72	14	71	14	23	30	46	75
	200	35	8	28	8	77	14	71	14	22	28	46	74
	400	40	8	27	7	82	14	71	14	22	26	46	72
1 at line clear	50	34	10	33	10	78	17	77	17	28	33	53	80
	200	37	10	32	10	81	17	77	17	27	31	53	79
	400	42	10	30	9	84	17	77	16	27	30	53	77

Table 3.6.1 Single Rail DC Electrified Capacitor Fed Operating voltages and currents

SUMMARY OF CONNECTIONS FOR SINGLE RAIL JEUMONT TRACKS  
 D.C. ELCTRIFIED, CAPACITOR-FED  
 ADJACENT TRACKS TO BE OF ALTERNATE POLARITIES

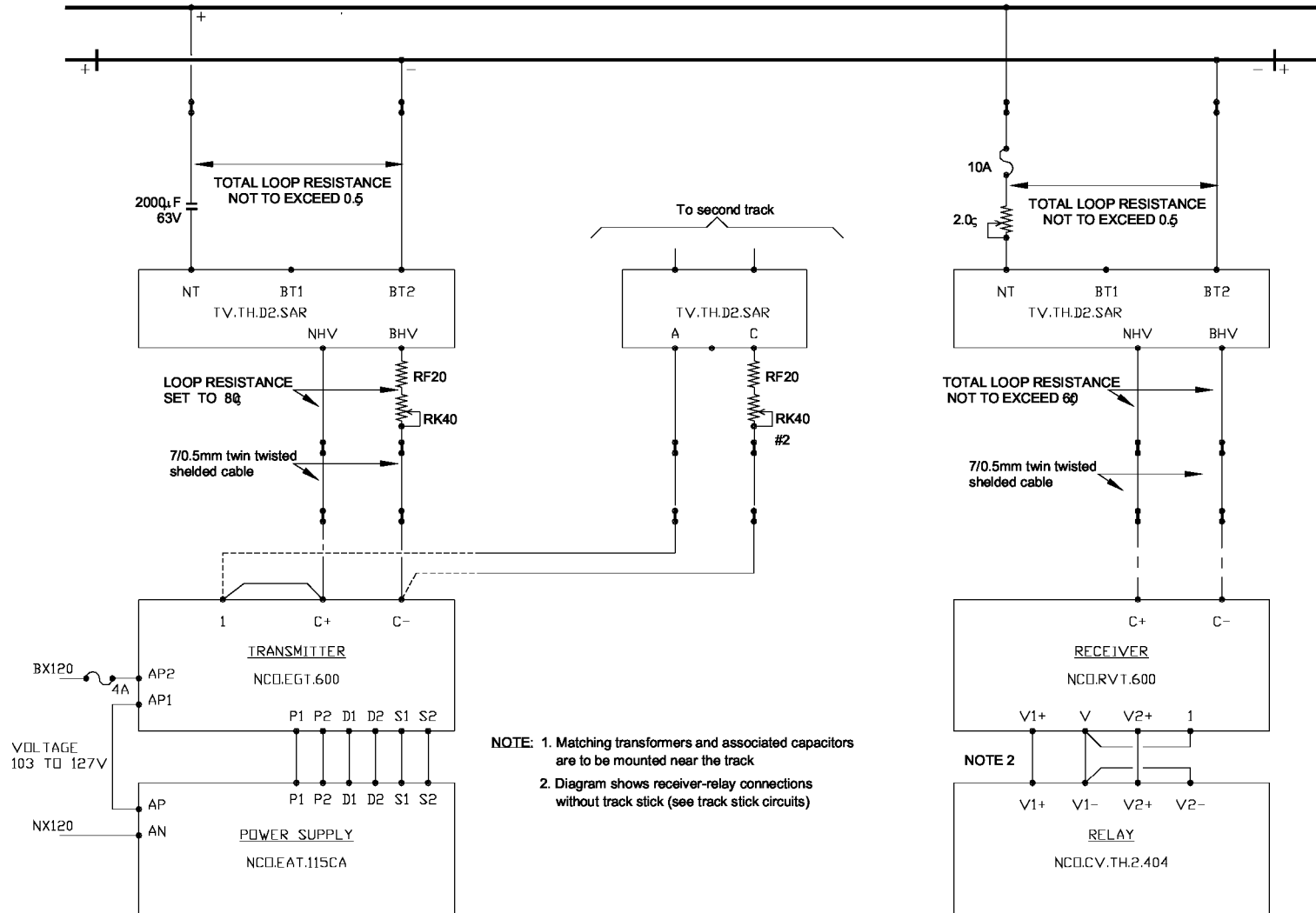


Figure 3.6.1 Single Rail DC Electrified Capacitor Fed track circuit (multi feed arrangement)

Where series bonds are used in the track circuit arrangement the resistance of the series bonds must be kept below 0.15 ohm. (To achieve this twin 7/0.85mm or 7/1.7mm cable may be used for the series bond).

If it is still not possible to achieve the minimum resistance specified above the following procedure should be adopted.

Change track connection cable to copper Hypalon. This allows the series bond resistance to be increased up to 0.3 ohms.

### 3.7.2 Commissioning and Testing

When all wiring has been correctly terminated and resistances adjusted the power may be turned on. At no time should the transmitter or power supply be plugged or unplugged nor bridging changed while the power is on. The transmitter should not be left feeding into an open circuit for an indefinite period as this may cause it to be damaged.

Track voltages should be measured with a meter fitted with an integrator and should fall within the ranges specified the table 3.7.2.

Relay voltages should lie within the range specified in table 3.7.2.

Verify correct shunting of the track by testing the track with a 0.25 ohm non-inductive shunt. Test shunts should be done at all extremities of track circuit including the extremities of any branch of a junction track, at the mid-point of any straight track and at both ends of any parallel-bonded section.

Length of Track Circuit (in metres)	Min. Ballast Resistance (in ohms)	Peak Voltage to Track								Track							
		Minimum Ballast				Maximum Ballast				Voltage (v)				Current (mA)			
		Transmitter		Receiver		Transmitter		Receiver		Minimum Ballast		Maximum		Minimum		Maximum Ballast	
		+	-	+	-	+	-	+	-	V1	V2	V1	V2	I1	I2	I1	I2
50	3	29	2.2	29	2.2	76	7	76	7	19	36	41	89	2.8	1.5	6.1	3.7
100	3	30	2.2	29	2.2	76	7	76	7	19	36	41	89	2.8	1.5	6.1	3.7
150	3	32	2.2	28	2.2	77	7	75	7	19	34	41	89	2.8	1.4	6.1	3.7
200	3	33	2.2	28	2.1	77	7	75	7	19	34	41	87	2.8	1.4	6.1	3.6
250	3	35	2.1	27	2.1	77	7	74	7	18	34	41	87	2.7	1.4	6.1	3.6
300	3	36	2.1	26	2	78	7	73	7	18	31	41	87	2.7	1.3	6.1	3.6
350	3	38	2.1	25	2	78	7	73	7	18	31	42	85	2.7	1.3	6.3	3.5
400	3	39	2.1	24	2	79	7	72	7	18	31	42	85	2.7	1.3	6.3	3.5
450	3	41	2	24	1.9	79	7	71	7	17	29	42	82	2.5	1.2	6.3	3.4
500	3	42	2	23	1.9	79	7	71	7	17	29	42	82	2.5	1.2	6.3	3.4
550	2.7	44	2	22	1.8	80	7	70	7	17	29	42	80	2.5	1.2	6.3	3.3
600	2.5	45	1.9	21	1.8	80	7	69	7	17	26	42	80	2.5	1.1	6.3	3.3
650	2.3	45	1.7	20	1.6	81	6	65	6	16	26	41	80	2.4	1.1	6.1	3.3
700	2.15	45	1.6	18	1.5	81	6	60	5.5	15	26	40	80	2.2	1.1	6	3.3
750	2	45	1.4	17	1.4	82	6	55	5	15	26	39	80	2.2	1.1	5.8	3.3
800	1.98	45	1.3	16	1.3	82	6	50	4.5	14	26	37	77	2.1	1.1	5.5	3.2
850	1.75	45	1.2	15	1.2	83	5	45	4	14	24	35	77	2.1	1	5.2	3.2
900	1.65	45	1	14	1	83	5	40	3.5	13	24	35	77	2	1	5.2	3.2
950	1.58	45	0.9	13	0.9	84	5	40	3.5	13	24	35	77	2	1	5.2	3.2
1000	1.5	46	0.9	12	0.9	84	6	39	3.5	13	24	35	75	2	1	5.2	3.1
1050	1.43	46	0.9	12	0.9	85	6	39	3.5	14	24	35	75	2.1	1	5.2	3.1
1100	1.35	46	0.9	11	0.9	85	7	38	3.5	14	24	35	75	2.1	1	5.2	3.1
1150	1.3	46	0.9	11	0.9	86	7	38	3.5	14	24	35	73	2.1	1	5.2	3
1200	1.25	46	0.9	10	0.9	86	7	37	3.5	14	23	35	73	2.1	0.95	5.2	3
1250	1.2	47	1	10	1	86	6	36	3.5	15	23	34	73	2.2	0.95	5.1	3
1300	1.15	48	1	10	1	87	6	36	3	15	23	33	73	2.2	0.95	4.9	3
1350	1.1	48	1	10	1	87	5	35	3	15	23	31	73	2.2	0.95	4.6	3
1400	1.07	49	1	10	1	87	5	35	3	16	23	30	70	2.4	0.95	4.5	2.9
1450	1.03	49	1	10	1	88	5	34	2.3	16	23	28	70	2.4	0.95	4.2	2.9
1500	1	50	1	10	1	88	4.5	34	2.2	16	23	28	70	2.4	0.95	4.2	2.9

Table 3.7.2 Non electrified track circuit operating voltages and currents

**SUMMARY OF CONNECTIONS FOR SINGLE RAIL JEUMONT TRACKS**  
 USING TV-TH-D2 MATCHING TRANSFORMERS  
 ADJACENT TRACKS TO BE OF ALTERNATE POLARITIES

FIG. 5

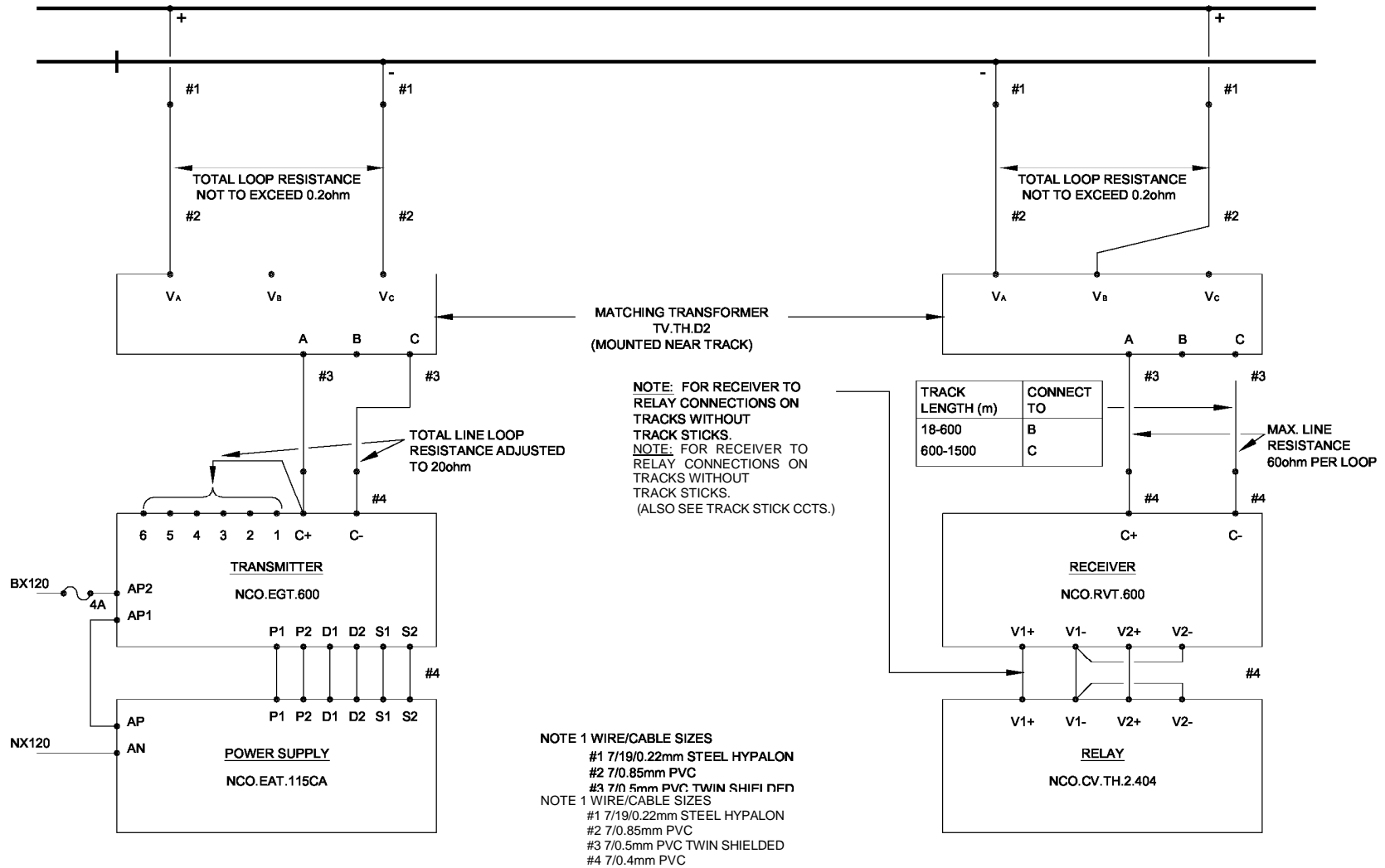


Figure 3.7.1 Non electrified track circuit

### 3.8.2 Commissioning and Testing

When all wiring has been correctly terminated and resistances adjusted the power may be turned on. At no time should the transmitter or power supply be plugged or unplugged nor bridging changed while the power is on. The transmitter should not be left feeding into an open circuit for an indefinite period as this may cause it to be damaged.

Track voltages should be measured with a meter fitted with an integrator and should fall within the ranges specified in the table 3.8.2.

Relay voltages should lie within the range specified in table 3.8.2.

Verify correct shunting of the track by testing the track with a 0.15 ohm non-inductive shunt. Test shunts should be done at all extremities of track circuit including the extremities of any branch of a junction track, at the mid-point of any straight track and at both ends of any parallel-bonded section.

Length of track (m)	No. of turns	TRANSMITTER END				RECEIVER END					
		C+	C-	Connections on TV-LV transformers	SRI		SR2		Connections on TV-LV transformer		
					No. of turns	CI - 1	No. of turns	C2- C2+			
50 to 450	225	E	K	F.I	200	E	F	27	I	M	K.L
500	225	E	K	F.I	225	E	K	28	I	N	F.I, K.M
550	225	E	K	F.I	240	E	K	30	I	N	F.H, K.L
600	225	E	K	F.I	250	A	H	32	F	H	B.K, G.L, M.K
650	225	E	K	F.I	275	A	I	33	F	H	B.K, G.M, N.K
700	225	E	K	F.I	295	A	L	33	F	H	B.N, G.M, N.K
750	225	E	K	F.I	315	A	I	35	H	L	B.H, K.N
800	225	E	K	F.I	330	D	F	37	H	M	K.N
850	225	E	K	F.I	355	D	K	38	H	L	F.I, K.M
900	225	E	K	F.I	370	A	G	40	H	K	B.F
950	225	E	K	F.I	415	D	I	43	H	N	G.H, K.M
1000	225	E	K	F.I	460	A	H	45	H	N	B.E, F.K, K.L
1050	345	D	I	F.H	200	E	F	35	H	L	K.N
1100	345	D	I	F.H	205	E	N	37	H	M	F.L, K.N
1150	345	D	I	F.H	205	E	N	38	H	L	F.L, K.M
1200	345	D	I	F.H	215	E	I	38	H	L	F.H, K.M
1250	345	D	I	F.H	225	E	K	40	H	K	F.I
1300	345	D	I	F.H	240	E	K	42	H	M	F.H, K.L
1350	345	D	I	F.H	245	E	N	42	H	M	F.H, K.L
1400	345	D	I	F.H	255	E	H	43	H	N	G.I, K.M
1450	345	D	I	F.H	265	E	L	45	H	N	G.N, K.L
1500	570	D or A	I or G	F.H or B.E	270 270	E E	G G	47 55	F F	I H	G.L, M.K G-I
1550	570	A	G	B.E	270	E	G	57	F	H	G-L, M-I
1600	570	A	G	B.E	300	A	B	58	F	H	G-M, N-I
1650	570	A	G	B.E	300	A	B	60	F	H	G-L, N-I
1700	570	A	G	B.E	300	A	B	60	F	H	G-L, N-I
1750	570	A	G	B.E	300	A	B	65	F	L	G-N
1800	570	A	G	B.E	330	D	F	65	F	L	G-N
1850	570	A	G	B.E	330	D	F	67	F	M	G-N
1900	570	A	G	B.E	330	D	F	68	F	L	G-M
1950	570	A	G	B.E	330	D	F	68	F	L	G-M
2000	570	A	G	B.E	345	D	I	70	F	G	F-H
2050	570	A	G	B.E	255	E	H	55	F	H	G-I
2100	570	A	G	B.E	255	E	H	55	F	H	G-I
2150	570	A	G	B.E	257	E	H	57	F	H	G-L, M-I
2200	570	A	G	B.E	258	E	H	58	F	H	G-M, N-I
2250	570	A	G	B.E	260	E	H	60	F	H	G-L, N-I
2300	570	A	G	B.E	265	E	L	65	F	L	G-N
2350	570	A	G	B.E	265	E	L	65	F	L	G-N
2400	570	A	G	B.E	270	E	G	67	F	M	G-N
2450	570	A	G	B.E	285	E	I	68	F	L	G-M, G-H
2500	570	A	G	B.E	295	E	K	70	F	G	G-I
2550	570	A	G	B.E	300	A	B	72	F	M	G-L
2600	570	A	G	B.E	300	A	B	73	F	N	G-M
2650	570	A	G	B.E	300	A	B	75	F	N	G-L
2700	570	A	G	B.E	300	A	B	75	F	N	G-L
2750	570	A	G	B.E	315	A	I	75	F	N	G-L, B-H
2800	570	A	G	B.E	325	A	K	80	F	L	G-H, I-N, B-I
2850	570	A	G	B.E	330	D	F	80	F	L	G-H, I-H
2900	570	A	G	B.E	330	D	F	83	F	L	G-H, I-M
2950	570	A	G	B.E	330	D	F	83	F	L	G-H, I-M
3000	570	A	G	B.E	330	D	F	85	F	I	G-H



Length of Track Circuit (in meters)	Min. Ballast Resistance (in ohms)	Peak Voltage to Track (Volts)								Track Relay							
		Ballast minimum				Ballast maximum				Voltage (v)				Current (mA)			
		Transmitter		Receiver		Transmitter		Receiver		Ballast minimum		Ballast maximum		Ballast minimum		Ballast maximum	
		+	-	+	-	+	-	+	-	V1	V2	V1	V2	I1	I2	I1	I2
50	3	72	11	71	10	198	33	200	33	17	26	61	79	2.5	1.08	9	3.3
100	3	72	11	70	10	196	33	200	33	17	25	61	79	2.5	1.04	9	3.3
150	3	72	11	70	10	193	33	201	32	17	25	61	79	2.5	1.04	9	3.3
200	3	73	11	69	10	192	33	203	32	17	25	61	79	2.5	1.04	9	3.3
250	3	73	11	68	10	191	33	205	32	17	24	61	79	2.5	1	9	3.3
300	3	74	11	67	10	190	33	207	32	17	24	61	79	2.5	1	9	3.3
350	3	75	11	66	10	189	33	208	32	17	24	61	79	2.5	1	9	3.3
400	3	75	11	65	10	188	33	208	32	17	23	61	79	2.5	0.96	9	3.3
450	3	76	11	65	10	187	33	209	32	17	23	61	79	2.5	0.96	9	3.3
500	3	75	10	62	9	187	33	209	32	17	23	66	84	2.5	0.96	9.7	3.5
550	2.73	75	9	60	9	187	32	209	31	18	24	72	84	2.7	1	10.6	3.5
600	2.5	74	8	58	8	187	32	209	31	18	24	78	89	2.7	1	11.5	3.7
650	2.31	74	8	56	8	186	32	211	31	18	24	83	91	2.7	1	12.3	3.8
700	2.15	73	7	53	7	186	32	213	31	18	23	88	96	2.7	0.96	13	4
750	2	73	7	50	7	185	31	215	30	18	23	92	101	2.7	0.96	13.6	4.2
800	1.88	73	7	47	6	184	30	216	30	17	23	96	105	2.5	0.96	14.2	4.4
850	1.77	72	6	44	6	183	30	217	29	17	23	100	110	2.5	0.96	14.8	4.6
900	1.67	72	6	41	5	182	29	218	28	17	23	103	115	2.5	0.96	15.2	4.8
950	1.58	72	5	39	5	180	28	217	27	17	23	105	122	2.5	0.96	15.5	5.1
1000	1.5	72	5	38	5	178	27	216	25	17	23	107	130	2.5	0.96	15.8	5.4

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Length of Track Circuit (in meters)	Min. Ballast Resistance (in ohms)	Peak Voltage to Track (Volts)								Track Relay							
		Ballast minimum				Ballast maximum				Voltage (v)				Current (mA)			
		Transmitter		Receiver		Transmitter		Receiver		Ballast minimum		Ballast maximum		Ballast minimum		Ballast maximum	
		+	-	+	-	+	-	+	-	V1	V2	V1	V2	I1	I2	I1	I2
1050	1.43	54	7	31	6	117	32	128	26	17	23	81	91	2.5	0.96	12	3.8
1100	1.36	54	7	30	6	117	32	127	26	17	23	83	96	2.5	0.96	12.3	4
1150	1.30	54	6	30	55	117	32	126	26	18	23	83	96	2.7	0.96	12.3	4
1200	1.25	54	6	29	5	116	32	125	26	18	23	84	101	2.7	0.96	12.4	4.2
1250	1.20	54	6	28	5	116	32	125	26	18	23	88	103	2.7	0.96	13	4.3
1300	1.15	54	6	26	5	116	32	125	26	17	23	93	108	2.5	0.96	13.8	4.5
1350	1.11	54	6	25	5	116	32	125	26	17	23	98	110	2.5	0.96	14.5	4.6
1400	1.07	54	6	24	5	115	32	123	26	17	23	100	113	2.5	0.96	14.8	4.7
1450	1.03	54	6	23	5	115	31	122	26	17	23	103	115	2.5	0.96	15.2	4.8
1500	1	54	6	22	4	114	31	121	26	17	23	105	118	2.5	0.96	15.5	4.9
1550	0.97	32	5	17	4	65	26	76	17	16	22	78	94	2.4	0.92	11.5	3.9
1600	0.94	32	5	17	4	65	26	76	17	16	22	78	96	2.4	0.92	11.5	4
1650	0.91	32	5	16	4	65	26	75	17	16	22	75	99	2.4	0.92	11	4.1
1700	0.88	32	5	16	4	65	26	75	17	16	22	75	99	2.4	0.92	11	4.1
1750	0.85	32	5	15	4	65	26	74	17	16	22	75	101	2.4	0.92	11	4.2
1800	0.83	32	5	15	4	65	26	74	17	16	22	75	103	2.4	0.92	11	4.3
1850	0.81	32	5	14	3	65	26	73	17	16	22	75	13	2.4	0.92	11	4.3
1900	0.79	32	5	14	3	65	26	73	17	15	22	75	105	2.2	0.92	11	4.4
1950	0.77	32	5	13	3	65	26	72	17	15	21	75	105	2.2	0.88	11	4.4
2000	0.75	32	5	13	3	65	26	71	17	15	21	71	108	2.2	0.88	10.5	4.5

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Length of Track Circuit (in meters)	Min. Ballast Resistance (in ohms)	Peak Voltage to Track (Volts)								Track				Relay			
		Ballast minimum				Ballast maximum				Voltage (v)				Current (mA)			
		Transmitter		Receiver		Transmitter		Receiver		Ballast minimum		Ballast maximum		Ballast minimum		Ballast maximum	
		+	-	+	-	+	-	+	-	V1	V2	V1	V2	I1	I2	I1	I2
2050	0.73	32	4	12	3	65	26	50	13	15	21	68	101	2.2	0.88	10.9	4.2
2100	0.71	32	4	10	2	65	26	47	12	15	21	63	94	2.2	0.88	9.4	3.9
2150	0.69	32	4	9	2	65	26	46	12	15	21	63	94	2.2	0.88	9.4	3.9
2200	0.68	32	4	9	2	65	26	44	12	15	21	63	96	2.2	0.88	9.4	4
2250	0.66	32	4	8	2	65	26	42	11	15	21	63	96	2.2	0.88	9.4	4
2300	0.65	32	4	8	2	65	26	41	11	15	21	63	96	2.2	0.88	9.2	4
2350	0.64	32	4	8	2	65	26	41	11	15	21	62	99	2.2	0.88	9.2	4.1
2400	0.62	32	4	7	2	65	26	40	11	15	21	62	101	2.2	0.88	9.2	4.2
2450	0.61	32	4	7	2	65	26	40	11	15	21	62	103	2.2	0.88	9.2	4.3
2500	0.60	32	4	7	2	65	26	39	11	15	21	62	105	2.2	0.88	9.2	4.4
2550	0.59	32	4	7	2	65	26	38	10	15	21	62	108	2.2	0.88	9.2	4.5
2600	0.57	32	4	6	2	65	26	38	10	15	21	62	108	2.2	0.88	9	4.5
2650	0.56	32	4	6	2	65	26	38	10	15	21	61	108	2.2	0.88	9	4.5
2700	0.55	32	4	6	1	65	27	37	10	15	21	61	108	2.2	0.88	9.2	4.5
2750	0.54	32	4	6	1	65	27	37	10	15	21	62	110	2.2	0.88	9.2	4.6
2800	0.53	32	4	6	1	65	27	37	10	15	21	62	110	2.2	0.88	9.4	4.6
2850	0.52	32	4	5	1	65	27	36	10	15	21	63	110	2.2	0.88	9.4	4.6
2900	0.515	32	4	5	1	65	28	36	9	15	21	63	113	2.2	0.88	9.4	4.7
2950	0.51	32	4	5	1	65	28	36	9	14	21	63	113	2.1	0.88	9.4	4.7
3000	0.50	32	4	5	1	65	28	36	9	14	21	63	113	2.1	0.88	9.4	4.7

Table 3.8.2 Non electrified long track circuit operating voltages and currents

NON-ELECTRIFIED DOUBLE RAIL TRACK CIRCUIT – UP TO 3000M  
 USING TV-LV MATCHING TRANSFORMERS  
 ADJACENT TRACKS TO BE OF ALTERNATE POLARITIES

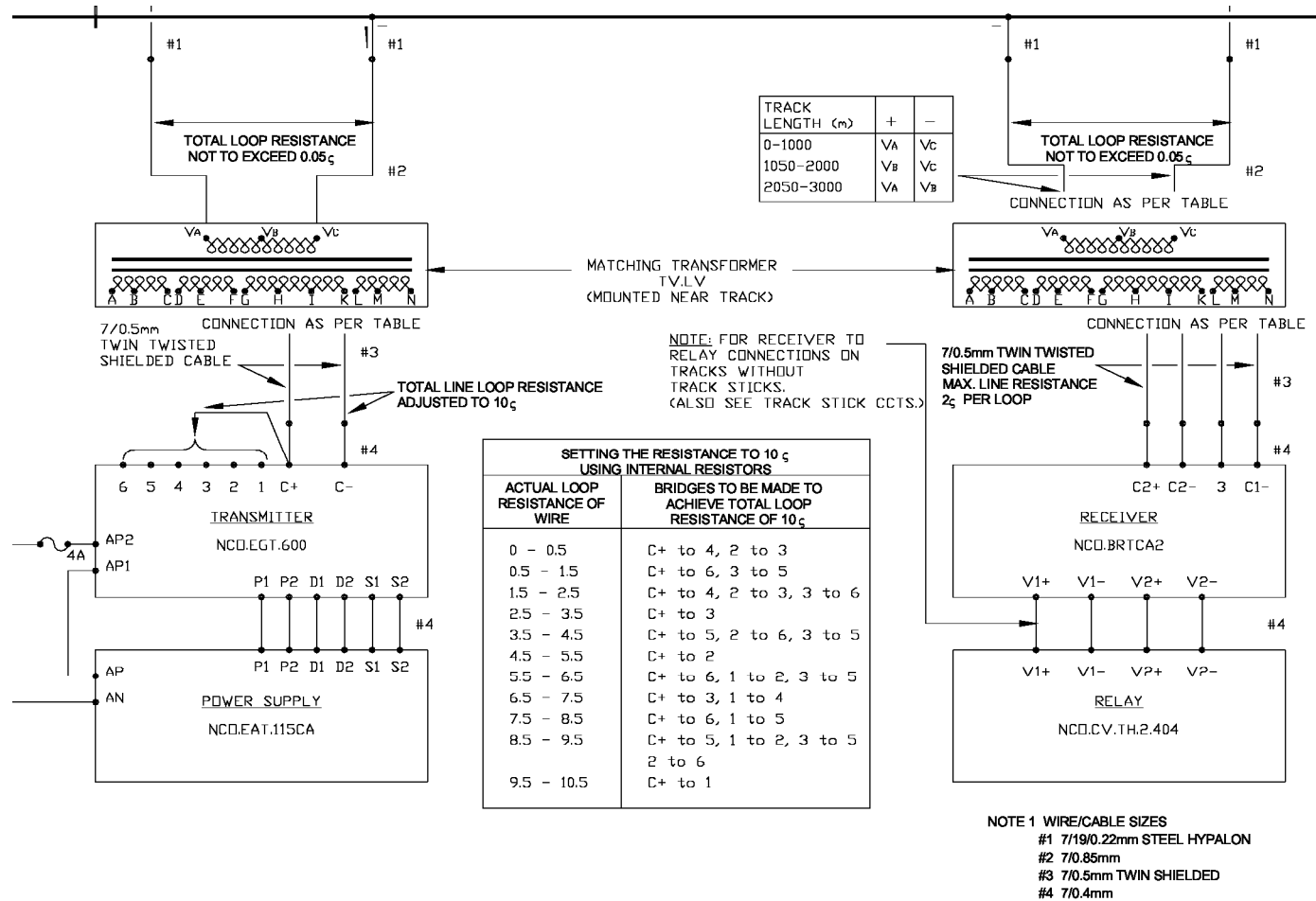


Figure 3.8.1 Non electrified long track circuit

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## 4. Track Polarities

### 4.1 Polarities – ‘On track’ measurements

The polarities of adjacent track circuits should be adjusted so that they are opposite with respect to any adjoining track and that each track circuit is wired so its positive rail is in accordance with the track insulation plan. This guarantees failsafe operation under a block joint failure condition.

The positive rail is a term associated to the rail which when measured records the higher (positive) of the two waveforms which exist in a single Jeumont pulse (see diagram 7.1 for a diagram of the waveform).

To measure the polarity of a track circuit, it is first important to correctly orientate the meter / integrator. To do this position the meter / integrator in the four foot with the integrator switch, switched to positive. Place the red (+ve) meter lead which is on the right hand side of the integrator onto the nearest rail (it should be the rail to the right hand side of the meter / integrator). Now take a voltage measurement across the rails. The resulting measured voltage will be either a high or low voltage depending on the existing polarity of the track. If a high voltage was measured then the rail to which the positive lead was connected is considered the positive rail. Conversely if the lower voltage was measured with the switch in this position the other rail (to the left of the meter) is considered the positive rail. Confirm this is correct to the track insulation plan. Perform the same test on the adjacent track to prove that the positive rail is opposite to the previous track and that it too also corresponds to the track insulation plan.

Where a yard layout is such that it is impossible to achieve a polarity reversal at every blockjoint, then the blockjoint with point of like polarities shall be one where transmitters are installed on either side.

As a quick test short circuiting the block joint and noting that either or both relays drop verifies the polarities of adjacent track circuits are opposite. Note that this does not confirm that the polarity of the track circuit is in accordance with the track Insulation Plan. Should this fail to occur the polarity should be checked and adjusted as necessary by swapping the leads from both the receiver and transmitter of one of the tracks concerned.

### 4.2 Polarity - Transmitter to Receiver

The Jeumont Schneider receiver and relay are polarity sensitive, and will only pick up when the energisation is of both the correct voltage and polarity. When certifying the track circuit, it is possible that the receiver end has been connected with opposite polarity to the transmitter. In this case, when the power is connected, the relay will energise momentarily, then immediately drop. To correct the problem, reverse the track connection leads at either the receiver or transmitter matching unit - the choice will depend on the track's polarity relative to the adjacent tracks and the track insulation plan.

If a track fails to pick when first energised, a quick check for wrong polarity is to momentarily pull and replace the track pins at the receiver (or transmitter) end, while watching the relay for the momentary pick-and-drop.

If any non-reversal is found, this should be corrected by swapping the track connection leads on the matching units at both either the transmitter or receiver end of the track. Note that swapping the transmitter will correct the polarity to the Receiver but will alter the polarity of the track circuit.

### 4.3 Changing Polarity on NCO.BRT.CA2 Receivers

The NCO.BRT.CA2 is a four-wire receiver and as a result there are 16 different combinations in the way they can be terminated of which only one is correct. If incorrect polarity on the receiver is detected (see above) then to reverse the polarity it is simply a matter swapping the termination of the cable cores within each cable for example:

	Cable 1		Cable 2	
	Terminated on		Terminated on	
Incorrect polarity on Rx	A	B	C	D
Correct polarity on Rx	B	A	D	C

Note: Under no circumstances are cores between cables to be swapped.

## 5. Mounting Details

### 5.1 Plug in Componentes

Plug-in mounting hardware should be fitted to the 30-module type NS1 aluminium mounting channel as follows: -

1. Plug Board type PFC-12 should be fixed by two screws into module holes corresponding to the base termination arrangements of the unit located in that position.
2. Remaining unused module holes under unit should be covered with Obturation Fittings type NS1 PFO.
3. Indexing holes in centre of channel should be plugged with Coding Plugs to correspond to the code pin requirement of the unit mounted in that position. The coding pin arrangements for each type of unit are shown on the base termination detail drawings as blacked out holes.

Whenever possible a one module space should be left between units on the mounting channel for ventilation. However where the quantity of equipment to be mounted makes this difficult without substantially increasing the size of the rack, the units may be butted together.

The mounting channel should always be run vertically and a space of at least 50mm should always be maintained between mounting channels.

#### 120v AC Fed Tracks

TOP	Receiver	Track Relay <a href="#">NCO.CV.TH.2-404</a>	Transmitter NCO.EGT.600	Power Supply NCO.EAT.115CA	BOTTOM
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#### 24v D.C. Battery Fed Tracks

TOP	Receiver <a href="#">NCO.CV.TH.2-404</a>	Track Relay	Transmitter Nco.BET.24CC	BOTTOM
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### 5.2 Fixed Mounted Track Side Components

The matching transformers should be located as close as practical to the rail connection consistent with rail connecting lead resistance requirements.

These should be mounted in weatherproof boxes above ground level and the rail leads terminated on RSA terminals in the Box.

One box can house two transformers, one for each adjacent track circuit where these occur.

## 7. Operating Principles

A transmitter produces the high voltage pulses and these are fed to the track by either a track transformer or by an impedance bond incorporating a secondary winding. The pulses then pass along the track and are fed to the receiver, which in turn operates a special relay.

The output is produced in the transmitter by the charging of a capacitor to a high voltage. This charge is discharged as a sharp high pulse through an output transformer approximately three times per second via a thyristor (silicon controlled rectifier) triggered by an oscillator. After each discharge pulse the magnetic energy stored in the transformer core collapses inducing a long negative voltage pulse, which is delivered to the track. Refer to Figure 7.1.

The transmitter output has to be transformed down to a level more suitable for connection to the rails to prevent variations in ballast resistance causing excessive changes in track voltage.

This is achieved by using matching transformers or impedance bonds with track and input windings and selecting transformation ratio connections appropriate to the situation.

At the relay end the reverse situation occurs where the track voltage is stepped up through the matching transformer or impedance bond to a level suitable for the receiver.

The voltage pulses as received from the track are unsuitable for the operation of a relay. The high sharp positive pulses are of short duration and there are long pauses (approximately 300 mS) between these so the relay would drop away after each pulse.

The receiver modifies and stores the energy from the track and this is connected to the relay as two separate D.C. voltages.

The energy from the high positive and low negative pulses is smoothed and stored separately in capacitors. The discrimination between positive and negative pulse is achieved by diodes.

The relay is specially constructed with two separate operating winding. Only when the magnetic fields produced by these windings are substantially the same will the relay pick up. Since the energy available from the positive and negative pulses is different the number of turns on each winding must be different for them to produce a similar ampere turns value.

Any appreciable interference with the magnetic fields produced by the windings will cause the relay to de-energise. For this reason the relay will not energise with the track polarity reversed.



Track circuits should be installed with reverse polarities on adjacent track circuits so that in the event of the insulated joint breaking down the reversed voltage pulses reaching the receiver from the adjacent track circuit will interfere with the balance of the magnetic field and relay will de-energise.

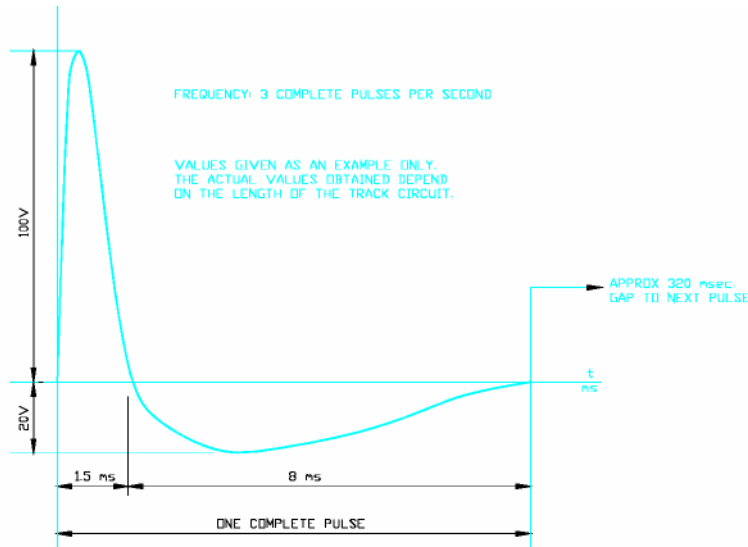


Figure 7.1 Details of a Jeumont Schneider pulse

## 8. Maintenance

The Jeumont Schneider track circuit has a long history of reliability and there is very little pro-active maintenance which can be performed.

A typical maintenance regime is centred around inspection and the recording of applicable values on a track circuit history card. The criteria for inspection shall include all points of connection, the modules and the ballast conditions.

Maintenance schedules and frequencies are detailed in the applicable technical maintenance plans.

## 9. Fault Finding

The same troubles that affect all track circuits, eg broken bonds, defective insulated joints, poor ballast, will cause failure of Jeumont Schneider tracks. Due to the non-symmetrical wave form it is not possible to measure current to and from the rails but peak voltage can be measured by using the integrator and can be compared to readings previously noted on the record card.

### 9.1 Track Problems

- (a) Short Circuit - A short circuit may usually be detected by taking voltages at various points through the track. A sudden drop in the peak voltage level indicates the location of a short circuit has been passed.
- (b) Broken Rail - This problem may be detected by taking voltage readings at regular intervals along the track. A discontinuity of the voltage (i.e. sudden drop or absence) indicates a break.
- (c) Defective Block Joint - This condition should cause one or both relays to drop. If the joint is in a deteriorated condition a lower peak voltage will be noted across the track than that measured previously.
- (d) Ballast Resistance - The peak voltage in the track will fall as ballast resistance drops. If poor ballast is suspected as the reason for intermittent track failure the ballast resistance should be measured.

### 9.2 Testing Transmitter

The transmitter can be tested of correct operation by:

- (1) Disconnecting terminal C- and C+ from the track.
- (2) Remove the bridge that is on C+ and reconnect it between C- and 6.
- (3) Power up the transmitter on its own supply or a known serviceable unit nearby.
- (4) Measure the voltage between terminals 1 and 3 using a meter fitted with an integrator. The voltage reading should be around 150 volts if the transmitter is healthy.

### 9.3 Important Notes

- (1) Do not plug or unplug units nor change any bridging without removing power.
- (2) If measuring the voltage at the output of the transmitter, the integrator should not be left connected for long periods. A reading of 300-350 volts is sufficient to verify correct operation of the transmitter.
- (3) Relay voltages should be checked with a moving coil meter or a "Fluke" meter, and the average value of the readings estimated. An integrator is not required for this measurement.

- (4) Measurements where applicable should always be taken with a meter fitted with an integrator. Meters which have min. /max functions should not be used for measurements as experience has shown that the Jeumont Schneider pulse is of sufficient energy to damage the meter.

## **9.4 Repair of Faulty Units**

Faulty units should be sent for repair or forwarded to Jeumont Schneider. A tag stating the suspected cause of failure, where it was installed, and who it is to be returned to, should accompany each unit. Failure to supply this information could lead to an increase in repair turn around time, and /or loss of equipment.

Under no circumstances should field staff attempt to repair any Jeumont Schneider track circuit equipment.