इरिसेट
गाड़ी डिटेक्शन प्रयोगशाला
प्रयोग सं : टी डी एल - 04

IRISET
TRAIN DETECTION LABORATORY
EXPERIMENT NO : TDL – 04

नाम
Name : _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

अनुक्रमांक
Roll No : _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

प्राप्तांक
Marks Awarded :

पाठ्यक्रम
Course : _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

दिनांक
Date : _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

अनुदेशक के आद्यक्षर
Instructor Initial :

Audio Frequency Track Circuit - ABB TI-21(G-1848 Hz)

(RDSO/SPN/146/2001**)**

INTRODUCTION

AFTC is a joint-less electronic track circuit, specially designed to meet the immunity level required in AC/DC electrified sections. Block joints need not be provided for straight track circuits. In this system, sensitive track relays are not required & integrity of the rails is ensured. It is a universal track circuit suitable in all type of electrified sections and non-electrified sections.

The AFTC of ABB make is designed to minimize periodic maintenance. But Periodical checks and measurements are recommended.

EQUIPMENT:

Indoor Equipment:

a) Transmitter
b) Receiver
c) Track Relay (50 V DC plug in type Relay).
d) Protection against lightning (GD/LA)
e) Power supply unit (PSU)

Outdoor Equipment:

a) Tuning Unit (TU) / End Tuning Unit (ETU) / Track Coupling Unit (TCU)
b) ‘Z’ bond
c) Impedance bond
d) Line matching unit LMU
e) Quad cable connection in between indoor and outdoor equipments

WORKING PRINCIPLE:

- ABB track circuit operates at one of 8 basic carrier frequencies. These frequencies are arranged in four pairs. Only one pair is assigned to one track/line. For 4 parallel lines allocation of frequencies are as follows
- One pair is assigned to track 1:
  - 'Track 1' frequency A = 1699 Hz
  - 'Track 1' frequency B = 2296 Hz
- One pair is assigned to track 2:
  - 'Track 2' frequency C = 1996 Hz
  - 'Track 2' frequency D = 2593 Hz
- One pair is assigned to track 3:
  - 'Track 3' frequency E = 1549 Hz
  - 'Track 3' frequency F = 2146 Hz
- One pair is assigned to track 4:
  - 'Track 4' frequency G = 1848 Hz *
  - 'Track 4' frequency H = 2445 Hz
- The TC transmitter generates a power-limited sinusoidal signal, at one of the above 8 basic frequencies:
- The basic frequency is encoded by "shifting" (FSK principle).
- "Shifting" consists of switching two frequencies with a modulation depth Δf = 17 Hz.
- (Basic frequency) ± 17 Hz
- Basic + Δf' and 'Basic – Δf' these frequencies are detected independently and a number of other checks are performed to ensure safety and against false operation.
- Modulation rate is 4.8 Hz.
- 'Modulation is included to provide greater security and to enable the information to be passed along the track without being distorted.

SYSTEM DESCRIPTION

- ABB TC is designed to detect presence of vehicle on the track.
- It is non coded AFTC
- It is used to install on straight portion of track in 'station limit'.
- Mostly installed in auto section (MUMBAI).
- It is recommended by railway board **not** to install on point zone area.*
- It is recommended by railway board remote feeding shall be within 3 km.*

* {Ref: RB's letter no. 2007/Sig/W/5/l-(AFTC) dated 26.07.2007}

- It can be configured in two types of installation
  a) Normal power mode
  - End Fed Track Circuit. {Length of track circuit (min: 200 m, max: 650 m)}
  - Centre Fed Track Circuit. {Length of track circuit (min : 450 m, max : 1200 m)}

  b) Low power mode
  - End Fed Track Circuit. {Length of track circuit (min:50 m, max : 200 m)}
- System consists of outdoor equipment at track side and indoor equipments in relay room on a special frame.

EQUIPMENT DESCRIPTION :

Transmitter (Tx) :

a) The multi-vibrator produces a square wave with a frequency of 4.8 Hz. This square wave is fed to the modulator which modulates the output of the oscillator and produces a signal that varies by ± 17 Hz about the carrier frequency at a rate of 4.8 Hz.

b) The output amplifier increases this signal to a power level suitable for transmission to the track.

c) Matching transformer matches the amplifier output to the load. The output filter isolates the unit from unwanted DC and AC voltages

d) The output signal of the transmitter is fed via a two-core cable to the associated Tuning Unit (TU) or End Termination Unit (ETU) or Track Coupling Unit (TCU).

e) No adjustments are provided on Transmitter (TX) unit.

f) Power consumption: 2.2 A max over full supply range.

g) Output power
  - a) Normal power mode 40 W to track (max.)
  - b) Low power mode 3 W to track (max.)

Receiver (Rx) :

a) The signal from the TU/ETU/TCU is fed to the input transformer, which matches the Receiver (Rx) to the TU/ETU/TCU and also provides means for setting the overall Receiver (Rx) gain.

b) The Receiver (Rx) has two parallel channels; one tuned to the higher frequency (f+17) and other to the lower frequency (f-17). In each channel, the signal is filtered amplified, filtered and finally demodulated so that a pair of anti phase square waves are applied to the 'AND' gate.

c) The 'AND' gate gives the required constant negative output only when both waves are present in anti-phase to each other. This negative output is fed to a capacitor timer which requires two seconds to reach a high potential to produce 50 V relay drive.

d) Immunity from interference is achieved, as the presence of both frequencies, correctly modulated, is necessary for a minimum of two seconds before the relay is energized.

e) Absence of Receiver (Rx) input, due to train shunt or any other reason, for a period of about '250 milliseconds' reduces the relay drive output to zero and thus the track relay drops.

f) The only adjustment available in the Receiver (Rx) is the setting of the input transformer tapping to give the required gain, as described in next Para.

g) Current consumption: 0.5A (max.) at maximum supply voltage and relay energized.

h) Relay output : Typically 50 V DC

Receiver Gain setting:

a) Initially set the gain of the Rx to 13 as shown in the table below.

b) Measure the voltage drop in mV AC, across the 1 ohm input resistor. This reading will give the input current directly in mA AC. Using the following table, select the nearest reading and set the receiver for an initial relative gain.

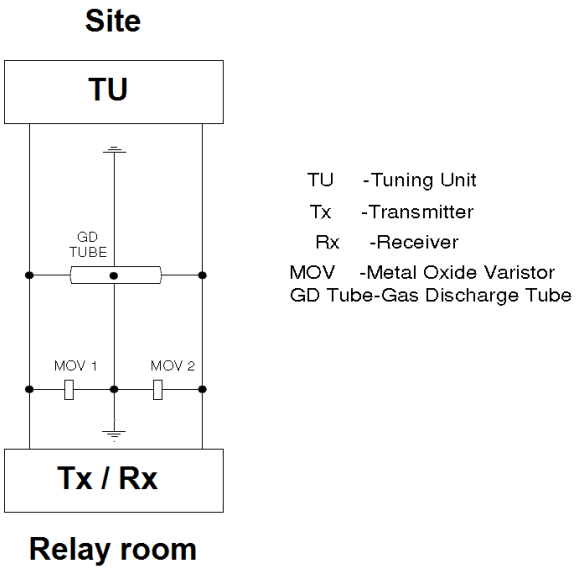
c) The final gain setting is done only after conducting test of TSR.

d) Gain = 390/V where V= the voltage across the 1 W resistor at gain setting 13 in mV.

Relative Gain	T/Circuit Length in meters.		Rx I/P current mA	Input-1	Input-2	Strap-1	Strap-2
	Normal Power Mode	Low Power Mode					
1	-	-	390	1L	1H	-	-
2	-	-	195	3L	1L	3H-1H	-
3	200-240	-	134	3L	3H	-	-
4	240-300	50-90	98	3L	1H	3H-1L	-
5	300-360	90-110	78	9L	1L	9H-3H	3L-1H
6	360-415	110-140	65	9L	3L	9H-3H	-
7	415-475	140-170	56	9L	1H	9H-3H	3L-1L
8	475-535	170-200	50	9L	1L	9H-1H	-
9	535-595	200-230	45	9L	9H	-	-
10	595-655	230-250	39	9L	1H	9H-1L	-
11	655-710	-	35.4	9L	1L	9H -3L	3H-1H
12	710-770	-	32.4	9L	3H	9H -3L	-
13	770-1200	-	30	9L	1H	9H -3L	3H-1L

- **Track Relay: (TR)**
  a) Plug -in-type
  b) Non proved type (Metal to carbon relay)
  c) Ordinary 'Q' series line Relay QN1
  d) Rated voltage is 50 V DC
  e) Maximum voltage across windings for full operation : 40.0 V DC
  f) Minimum voltage across winding for release : 7.5 V DC
  g) Minimum voltage for full release : 4.0 V DC
  h) Maximum power dissipation: 3 W.

- **Protection against lightning (LA)**
  a) In a relay room as well as in a signal location box, protection against 'Atmospheric Voltage Surges' shall be installed on each pair of conductors providing a link to the outside environment in order to limit the harmful effects of lightning on electronic equipment.
  b) This protection is provided by lightning arrester as shown in fig



- **Power supply unit**
  a) Input 110 V AC ± 9%
  b) Input tapings - 5-0-85-95-105-115-125 V AC
  c) Output 22.5 to 30.5 V DC.
  d) Output current - 0.25 to 2.0, 2.0 to 4.4 A (Depending upon the selected tapping).
  e) PSU to TX/RX - flexible copper cable
  f) 3 A fuse
  g) Maximum Ripple: 2 V peak to peak

- **Tuning unit (TU)**
  a) It is a passive device.
  b) It consists of a tuned circuit, which is used to form the 'Electronic Separation Joint'.
  c) One dedicated tuning unit to each frequency at either end of track circuit (ie: at TX end and RX end)
  d) Transmitter side tuning unit connection - For normal power mode (track circuit lengths of greater than 200 m), the transmitter is connected to the terminals 4 and 5, whilst for low power mode (track circuit length of 50 to 200 m), it is connected to terminals 1 & 2.
  e) Receiver side tuning unit connection - Receiver (RX) is always connected to the terminals 1 & 2.
- **End Termination Unit (ETU)**
  a) The end termination unit is a self contained tuned circuit for the electronic separation for track circuit isolation is not required.
  b) Such applications are:
  - End fed, or end receiver, adjacent to insulated rail joints or, (TCU's are now being used for such application instead of ETU).
  - Center fed arrangements.
- **Track Coupling Unit (TCU)**
  a) TCU is a passive device.
  b) It can be used to terminate the track circuit. It consists of a capacitor, resistor and a transformer in series. It is basically a band pass filter tuned at a particular frequency.
  c) The major applications of TCU are as follows:
    - To terminate a track circuit.
    - In the point zone track circuit.
    - In the yards where it is difficult to form the tuned zone.
  d) The advantages of using TCU as compared to ETU are as follows:
  e) The main difference between TCU and ETU is that TCU can with stand 400 V DC / 275 V AC RMS. as compared to 160 V DC / 110 V AC RMS. In case of ETU. Hence TCU can be used for Single rail application.
  f) TCU can be kept at a distance of 130 m from the rails. This feature facilitates to use of TCU in case of complex yards where there is space constraint.
  g) With TCU it is not necessary to use 35 mm sq. cable for connecting TCU to rail. Where as 2 x 2.5 sq. mm cable can be used.
  h) Impedance Bonds are not used with TCU but, they are used with ETU.

- **Line Matching Unit**
  a) Line matching unit is a transformer used to reduce the transmission losses. It is used only when distance of Transmitter to TU/ETU/TCU is greater than 30 m.
  b) Further, it is to be used with the Transmitter (TX) only and not with the Receiver (Rx).
  c) There are two types of LMUs as follows
     - LMU-Tx Side: It is connected to the Transmitter (TX) in the equipment room.
     - LMU-TU Side: It is connected to the Tuning Unit (TU) located at site.
- **Z Bonds**
  a) For balancing traction return current in both the rails a Z bond is provided in Tuned Zone.
  b) Z bond is an MS strip in 'Z' shape, which will protect the tuning units by balancing the traction return current in both the rails.
- **Electronic Separation Joint (ESJ):-**
  a) For implementation of continuous track circuits, reliable separation of audio frequencies on all continuous track circuits (common to same ESJ). This can be achieved either conventionally through the use of insulated joints which break the rail electrical continuity or through 'Electronic Separation Joint' which do not require any continuity bonds.
  b) The ESJ consists of a short track section limited at each end by a LC-type tuned circuit, known as TU.
  c) The length of tuned zone is 19.5 ± 0.5 m
  d) This is failure prone area.

READINGS

		Frequency of track circuit = 1848 Hz			
SNO	Description of readings		Terminals	Specified range	Actual readings
1	Power Supply	PSU Input V AC at tapings 5-0-85-95-105-115-125	T5 T115	95 to 120 V AC	
		PSU Output V DC	B 24 N 24	22.5 to 30.5 V DC	
		Output ripple content VAC	B 24 N 24	< 1.5 V AC	
2	TX (Transmitter unit)	TX Power Input V DC	B 24 N 24	22.5 to 30.5 V DC	
		TX signal Output V AC	OP1 OP2	10 to 18 V AC	
		Signal frequency Hz	OP1 OP2	Modulated	1848 Hz ± 17 Hz
3	TU at TX side (Tuning Unit)	TX TU Input V AC	1 & 2 or 4 & 5	10 to 18 V AC	
		TX TU Output V AC	T1 & T2	0.7 to 2.5 V AC for low Power and 3.5 to 8.5 VAC for normal power	
4	On track (TX side)	On track V AC	Tx side RAILS	0.7 to 2.5 V AC for low Power and 3.5 to 8.5 VAC for normal power	
5	On track (RX side)	On track V AC	Rx side RAILS	0.3 to 1 V AC for low Power and 0.2 to 1.8 VAC for normal power	
6	TU at RX side (Tuning Unit)	RX TU Input V AC	T1 & T2	0.3 to 1 V AC for low Power and 0.2 to 1.8 VAC for normal power	
		RX TU Output V AC	1 & 2	0.3 to 1 V AC for low Power and 0.2 to 1.8 VAC for normal power	
7	RX (Receiver unit) a)Power supply input & b)Rx Signal input from TU	RX Power supply Input V DC	B 24 N 24	22.5 to 30.5 V DC	
		RX side TU Input V AC	1 ohm resister	30 m A to 390 mA	
		RX Input signal frequency	1 ohm resister	Modulated	1848 Hz ± 17 Hz
		RX Gain by using 1-3-9 tapings	As per I/P at Rx	1 to 13	
		RX Output V DC (for TR)	R+ R -	40 to 65 V DC	
8	TR (Track Relay) 1380 Ω/50 V DC 8F/8B	TR input V DC	R1& R2	40 to 65 V DC	

Note: Refer table for suitable gain 1 to 13 as per Rx input value.

EXERCISE:

1. Draw the ABB AFTC block diagram from board?

2. Whether the common PSU can be used for TX and RX units of same(frequency) type of track circuit?

3. What is the modulating frequency used in AFTC?

4. Whether 24-volt DC supply from IPS Can be used, instead of ABB AFTC-PSU?

5. What is the length of Tuned zone (Electrical separation)?

Date: **Signature of the Trainee**