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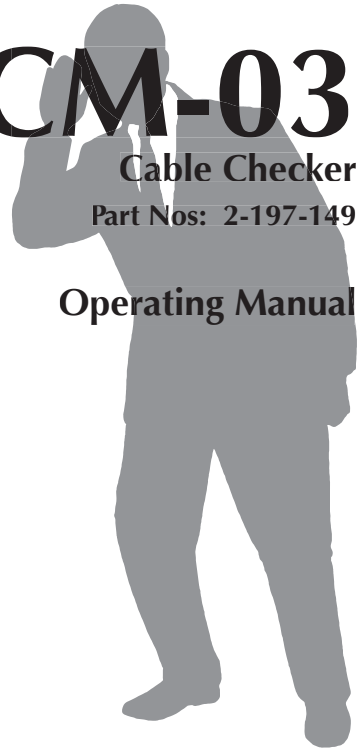
TCM-03

Cable Checker

Part Nos: 2-197-149

Operating Manual



TCM-03 Operating manual - Part No: 2-197-246

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Notes

Warning **DO NOT ALLOW ANY METAL TOOLS OR PARTS TO COME INTO CONTACT WITH THE LARGE RECHARGABLE BATTERY TERMINALS as this may cause a short circuit of the battery which could result in a fire.**

Changing the Internal Fuses

If the unit has been connected to an excessive voltage then the internal fuses may rupture and will require replacement. ENSURE THAT THE REASON FOR THE FUSE(S) RUPTURING HAS BEEN IDENTIFIED AND THE CAUSE ISOLATED. If you are unable to determine the reason then contact the manufacturer or your local supplier of the TCM unit before changing any fuse.

Fuses can be levered out gently using a screwdriver or other suitable tool. Lifting the rear panel out may make this easier. Ensure that the correct replacement fuse is fitted. Fuses must be:

20mm x 5mm, 250 V rated 100 mA Fast Blow

The spare fuses are marked "F100 mA 250V'

If the fuse appears to be loose in the older, remove the fuse and squeeze the fuse holder contacts together a little.

Adjusting Tone Cut-out Threshold

NOTE This requires a power supply to be connected to the input and set to the new threshold voltage. Turn unit on, SELECT AUTO and listen via headphones for switching of the tone. Adjust the yellow trimmer control marked '64 W 1M' which is located on the circuit board approximately 50 mm from the right hand corner of the rechargable battery nearest to the front panel.

Contents

APPENDIX B

Access to Inside of Unit

Unless the unit requires servicing - which should only be carried out by the manufacturer or qualified personnel - the only reasons for gaining access to the inside of the unit are:

* To replace a ruptured input fuse

* To adjust the automatic tone cut-out threshold setting

WARNING - LIVE PARTS INSIDE - Before removing any covers or loosening any screws you must:

Disconnect AC Mains

Disconnect Input lead from any cable

Switch unit off

Removing Cover

The top cover of the unit is held by 4 long screws which also hold the rubber feet. Turn the unit over, remove the 4 screws from the feet, turn the unit back over whilst holding the top and bottom covers in place then lift off the top cover. DO NOT ATTEMPT TO LOOSEN ANY OTHER FASTENER.

You can also lift out the 2 sides and carrying handle if required. The front and back panels can be lifted out of their retaining slots but take great care not to strain any connecting leads.

Fitting of the covers is the reverse of the above instructions.

Tone Generator

Frequency range	typically 200 Hz - 8 kHz triangle-wave output
Level	nominally 30 mV rms at 1kHz into 600 ohms
DC output:	Nominal 10 VDC source limited by 6 kohm resistor.

Line Load

Switchable nominal 250 ohm and 1 kohm resistors may be connected across input.

Meter

Digital Liquid Crystal Display type.

2 settings - 1.999 VDC and 199.9 VDC (corresponding to 1.999 mA with 1 kohm load selected)

Power Requirements

Internal 6 V Lead acid rechargable battery and charger powered from AC mains (selectable 85 - 130 and 185 - 260 VAC 50/60 Hz supply). Current limited charger. Battery provides approximately 15 hours of continuous operation.

Alkaline PP3 for Voltmeter - Battery provides in excess of 1000 hours of operation.

INTRODUCTION

Unpacking

The TCM-03 is supplied as a system comprising:

- TCM-03 Unit
- Input lead assembly
- AC power lead
- Test Microphone
- Spare fuse set - 2 pieces 100mA 250V anti-surge fuses
- 4 pieces 100mA 250V fast-blow fuses
- 9V MN1604 Battery
- Carrying Case
- BT socket breakout adaptor
- BT socket doubler
- US Telephone double adaptor
- UK-USA Teleadaptor
- Operating manual

In the event of items being missing or damaged in transit please contact your supplier immediately.

Safety Precautions

To help ensure the safety of the user (and to protect the cable system and other personnel) no attempt should be made to access cables, disturb cables or connect equipment to cables which are carrying an excessive voltage.

An excessive voltage is defined to be a combination of AC and DC components such that:

U(dc) & 3U (ac) is less than 150 volts

Where U(dc) is the value of the DC voltage and U(ac) is the rms value of the Ac voltage in volts. For fuller definition see BSI BS 6301: 1987.

Do not attempt to access to or disturb any cables unless you are absolutely sure that it is safe to do so

If there is any doubt about the use and function of a cable seek qualified assistance. Always seek a safe connecting point and ensure that the cable under test is not accidentally short-circuited or connected to another cable. Do not touch any bare wires or other conducting parts (such as the ends of crocodile clips on the input lead supplied) unless you know it is safe to do so.

The function of some cables may be impaired by connection of the unit.

Always plug the input lead to the unit before connection to the cable to ensure that the pins of the connecting plug cannot be touched accidentally.

Should you need to gain access to the inside of the TCM-03 then ensure that both the AC mains and input leads are disconnected. Switch the unit off and do not allow the battery terminals to be short-circuited. Full instructions for removal of the cover of the unit are contained in appendix B.

The unit is for indoor use only. Do not use in damp conditions.

APPENDIX A

Specifications

Audio Amplifier

Sensitivity	typically 30 uV for 10dB S/N output. 600 ohm source at 1kHz
Input impedance	nominally 5 Kohm at 1kHz
Audio Band width	nominally 300 Hz -15 kHz
Automatic Gain Control	Output held to typically +/- 6dB for input signals from 20uV to 2 V rms at 1 kHz (100 dB AGC). Unit has automatically switched dual gain stage with hysterisis of typically 6 dB.

Tuneable receiver

Frequency coverage	typically 15 kHz - 400 kHz. Source selectable between Line and Mains Live-Neutral and Live, Neutral combined to Earth combinations.
Sensitivity	typically 100 uV for 10 dB S/N at 100 kHz. 2.5 kHz deviation at 1kHz modulation frequency
Selectivity	typically 50 dB rejection at +/- 10 kHz
IF rejection	(455 kHz) better than 50 dB
Image rejection	typically 30 dB
Outputs	AM and FM selectable

Set 'LOAD' switch to '1' and note new (off-hook) voltage - call this V2

The line resistance RL is calculated according to:

RL = 250 x (V1 -V2)/V2

If V1 = 50 V and VC2 = 10 V then RL is calculated to be:

RL = 250 x 40/10 = 1,000 ohms

The meter can resolve 0.1V and the smallest change in line resistance that can accordingly be measured is the order of 25 ohms.

Connection to the AC mains cable for the purpose of charging the internal battery or for testing for the presence of carrier transmissions on AC mains cabling must be made via the AC lead supplied connected to the 3-pin IEC type socket on the rear of the unit only. The unit must be earthed via this lead when connecting the AC mains.

Warning

The unit is intended for testing a variety of cable types provided that the cable does not carry an excessive voltage or current. This unit may not be connected whether directly or indirectly to a telecommunications network except by the authorised person. Where reference is made in this manual to a telecommunications network (eg. telephone line) it is on the understanding that connection is made only by an authorised person. Depending on the country of use it may be an offence to connect this equipment to a telecommunication network.

Power

The TCM-03 has an internal rechargeable lead-acid type battery pack for powering up the majority of the circuitry. Charging occurs whenever AC power is connected. Remember to set the local AC mains voltage. There are two fuses adjacent to the voltage selector. In the unlikely event that these should need changing use the following type only:

20mm x 5 mm
100mA anti-surge or slow-blow rated at 250 V

Spare fuses are provided and the value is marked on each fuse. Take care not to confuse the mains type fuse with the internal protection fuses which are also rated at 100mA. The spare fuses for the 2 mains fuse holders have the following marking '250V S (orT) 100mA' (the other fuses have an 'F' instead of 'S' or 'T')

Charging an exhausted battery takes about 16 hours provided the unit is switched off (if it is switched on charging takes much longer). It is safe to leave the unit charging for several days. In use the battery should not be allowed to discharge completely as this, if repeated, reduces the capacity of the battery. If the front panel 'low' light illuminates then it is advisable to recharge the battery although the unit will function normally for a further hour or so.

Under normal use (with moderate headphone value setting) a full charged battery will give approximately 15 hours of continuous operation at normal room temperatures.

A PP3 alkaline type battery is also required which provides power to the liquid crystal display meter. The battery which is disconnected when the unit is switched off will provide approximately 1000 hours or more of operation. The battery compartment is located on the base of the unit and the battery should be changed when the battery symbol shows on the liquid crystal display. Always use a quality alkaline type.

If the tap had an impedance of 1,000,000 ohms (1 Mohm, typical of a better quality tap) then the current would be 50 uA and the voltage 49.95 VDC. This change in voltage could not be resolved by the TCM-03 but the current could be measured.

So, a poorer tap could be detected by measuring the line voltage over a period (assuming that the line was free of taps) and checking for a significant change.

A better method which is more sensitive and is not affected by any innocent change in the voltage from the exchange, is to break one of the wires between the exchange and any likely connection point for a tap and checking for any current flow. You can confirm that the telephone is not the cause of the current flow by either checking between the telephone and the line for current flow or by disconnecting the telephone during the test.

To perform this measurement - disconnect one of the telephone wires and connect one Green clip to the wire and the other to where the wire was connected. Set the meter to the Up position and set the rear panel 'LOAD' switch to '2'. The meter will now read current flowing in mA. Any current flow should be investigated further by firstly subtracting any current drawn by the telephone (disconnecting the telephone is the easiest way of doing this).

Series Tap

A series tap will introduce some extra resistance along the telephone line. The line resistance can be measured in the following way:

Connect Green clips across the line at the telephone end

Set the meter to the Up position and note voltage reading (on-hook) - call this V1

Voice Activated types of tap would not normally cause any change in the DC characteristics unless they draw power from a telephone line in order to charge a battery or are a series connection type where AC signals are detected by measuring the AC voltage across a series resistor.

Remember that a tap connected to a radio transmitter may be detected (using other equipment) through the presence of a radio transmission whilst the telephone is in use.

Having understood the types of taps that cause a DC change the next question is to what degree will the DC voltage or current be changed by the presence of such a device on the line under test?

Parallel Tap

Consider a parallel type of tap that introduces a resistance of 100,000 ohms across a telephone line. This is typical of cheaper taps. If the On-hook voltage is 50 VDC without a tap connected then adding the tap causes a current to flow from the exchange to the tap (but not from the tap to the telephone irrespective of line resistance):

50 / 100,000 = 0.000500 Amp or 500 uA

The drop in the line voltage measured at the telephone end of the line would be assuming the telephone line has an effective resistance of 1,000 ohms (a reasonable figure for a telephone line) then the voltage is:

50 x 100,000/(1,000 + 100,000) = 49.5 volts

The meter set in the Down position resolves measurement to 0.1 volt and so is a measurable change.

FACILITIES

Elements

The unit has:

A sensitive audio frequency amplifier with automatic gain control to detect the presence of illicit signals from microphones and other sources at signal levels ranging from micro-volts to volts.

An isolated DC power output that can be used to provide power to FET or Electret type microphones.

Tunable, low frequency radio receiver with AM and FM demodulators to detect the presence of signals from carrier type transmitters on AC power and other cables at frequencies from approximately 20 kHz to 400kHz.

Turnable tone generator with automatic cut-out to activate single tone remotely controlled devices.

Digital display meter for measurement of voltage and low level current to detect the presence of DC power on a cable and to measure significant changes to the normal voltage/ current conditions on a cable caused by the addition of an eavesdropping device.

Switchable cable loads to enable line resistance test and to mimic use of a telephone.

Operation is simple to ensure fast and effective use.

Control & Indicators

Front Panel

Headphone & Volume Control

The headphone connection socket is under the 'volume' control. Once set the volume control should not have to be adjusted further since signals are automatically levelled within the unit. You will notice the automatic gain control operating particularly when adjusting the select tune or source control. Do not wear the headphone when switching the unit on as the audio level can be high before the internal circuits have become fully operational. There may also be transient high volume levels when altering switch settings.

'Select' switch

The 'select' switch sets the operating mode:

AM - enables amplitude modulated signals tuned to be heard

FM - enables frequency modulated signals tuned to be heard

AF - audio frequency, enables normal audio frequency signals to be heard

(TONE) Auto - The unit impresses an audio frequency (set by the tune control) tone onto the cable under test provided the voltage across the cable is greater than about 25 volts (an internal control enables this threshold to be changed). 'AF' is selected automatically so you can hear the tone.

(Tone) On - The unit impresses an audio frequency (set by the tune control) tone onto the cable under test whatever the voltage across the cable. 'AF" is automatically selected so you can hear the tone.

Detect presence of DC current flow corresponding to Off-hook condition.

Detect the presence of ringing, dialling speech etc. signals by detecting variations in voltage, current electric or magnetic fields associated with the telephone line - often called a Voice Activated or VOX tap.

Picking-Up

This is achieved by:

Detecting variations in voltage, current, electric or magnetic fields associated with conversation on the telephone line.

Also, taps are connected in one of three possible ways:

Parallel - 2 leads from the taps are connected across the pair of wires comprising the telephone line

Series - one of the telephone wires is broken and each end connected to the 2 leads of the tap (so current passes through the tap)

'Contactless' - the device has a sensing head (sensing either magnetic or electric fields) that is placed very close to the telephone line but no leads are connected to the metal parts of the wires comprising the telephone line.

Types of tap detectable using the TCM-03

The TCM-03 has a basic set of DC measurement functions. The types of tap that will cause a change in the DC electrical characteristics are:

Parallel connection types that detect the change in On-hook to Off-hook voltage

Series connection types that detect the change in DC current flowing

Telephone Taps

Firstly, a brief review of operation of a telephone line. Any external telephone line (at least within the UK) and within some older types of private exchange (PABX) DC current flows along the telephone line when the handset is lifted (line goes from On-hook to Off-hook state). Consequently the On-hook voltage of typically 50 VDC (the actual value depends on the telephone line, the telephone and the voltage generated by the exchange). When ringing signals, dialling tones or signals corresponding to conversation are present then the voltage and current vary in sympathy with the signal (that is, there is an AC signal superimposed on the DC signal).

Newer PABX's do not necessarily use this system of On-hook and Off-hook current/voltage relationships. However, when a conversation is taking place on an extension there is an AC signal corresponding to the conversation. An exception to this is the 'digital' type of PABX where digital signals pass between the handset and the PABX which are converted to analogue signals within the PABX handset.

A telephone tap performs 2 basic functions:

It DETECTS use of the telephone line and so activates a tape recorder or radio transmitter used to store or relay respectively the subsequent conversation.

It PICKS UP the signals from the telephone line corresponding to conversation and conditions it to a form suitable for recording or transmission.

Detecting

There are different ways of detecting use of a telephone line some of which are only relevant to some types of line:

Detect change in DC voltage from On-hook to Off-hook - many taps are of this type.

'Tune' Control

If 'auto' or 'on' is selected then the 'tune' control sets the tone frequency. Set fully clockwise the frequency is at its maximum,

If either AM or FM is set then you can tune across the range of frequencies by adjusting the 'tune' control. Set fully anti-clockwise then the received frequency is at its minimum (20 kHz).

'Source' switch

If either AM or FM is set then the 'source' control determines whether the tune to signal is taken from:

the 'line' (that is through the input socket)

or, the live and neutral - L-N conductors on the AC power cable connected

or, the live and earth or neutral and earth - L/N-E conductors on the AC power cable connected via the mains lead

'Meter Set' switch

The lever switch under the meter display sets the sensitivity of the meter.

Switch Down - meter reads 0.0 to 199.9 VDC

Switch Up - meter reads 0.000 to 1.999 VDC

For voltage measurements on telephone lines the switch should be set in the Down position.

For the normal current measuring mode (see below) the switch should be in the Up position. When used with the rear panel 'load input' switch set to '2' the meter reads current from 0.000 to 1.999mA.

Should a battery symbol be shown on the display during normal use of the TCM-03 unit then the PP3 battery requires changing.

If during use the meter reads '1' (with blanks for other digits) then this indicates that the voltage measured is greater than the range setting. Please note that the meter will not register AC voltages.

'low indicator'

This illuminates when the main battery voltage has fallen below approximately 6 volts. You can continue to use the unit although at very low battery the internal circuits will not function correctly resulting in poor performance. The battery should be re-charged - immediately if the unit has been allowed to discharge almost completely as this will, if repeated too often, reduce the storage capacity of the battery. Do not store the unit with a discharged battery.

'Charge' indicator

This illuminates when the unit is on charge. If AC power is connected and the indicator is not lit then this indicates to fault condition. Check the fuses adjacent to the AC voltage selector switch on the rear panel.

Rear Panel

'On' switch

Connects the internal batteries to the circuitry. When the unit is connected the mains battery charging occurs regardless of the setting of the 'on' switch but charging is fastest if the unit is switched off.

'load input' switch

This is a spring loaded switch with a centre position - off. When pushed to '1' to '2' the switch connects a resistor across the signal input connections. The resistor values are:

Any 3 wires from 4 = 4 sets

Any combination of 3 to get power connected correctly = 6

Total number of combinations = 4 x 6 = 24

If there are 6 wires then the number of combinations is 240

Taps

The detection of a device (typically a telephone tap) by checking for any significant change in the normal voltage and current conditions associated with a cable is not straightforward, and it must be understood that some devices cannot be detected by use of electronic countermeasures equipment because the effect they have on the electrical characteristics is so negligible that any change cannot be distinguished from the effects of electrical noise.

The TCM-03 provides a basic set of electrical measurement functions that are reasonably easy to implement and give a useful level of detection capability. There are more complex measurement systems available.

To understand the problem, it is useful to look at various types of eavesdropping devices and consider how voltage and current is affected if the device is connected to a cable. A useful example is the telephone tap.

FURTHER OPERATING STEPS

Scope

Following the operating steps given in the *Basic Operating Steps* section ensures that a reasonable level of countermeasures have been implemented. Any unusual signal condition or corresponding to the presence of an active eavesdropping device manifests itself in an unambiguous way (ie room audio is heard).

This section describes further steps which are more time consuming to implement and less unambiguous. Two complications are considered:

A microphone is present that has three connections

A tap is present

3 Wire Microphones

A 3 wire microphone's connections are:

1 - +ve voltage for power

2 - Output of audio signal

3 - Common for -ve volts and audio signal

If only 2 connections are made, then the microphone will not work properly and therefore no (significant) audio will be heard.

3 connections are required which increases the number of combinations that have to be checked on a cable comprising many wires. For example, if the cable comprises 4 wires then the number of possible combinations of connection of the 2 green clips and the red and black clips from the input lead are:

'1' - nominally 250 ohms. 2 W rating

'2' - nominally 1000 ohms. 1 W rating

Setting '1' is suitable for mimicking the effect of telephone in use (that is off hook) on typical current operated telephone line.

Setting '2' is suitable for measuring small currents flowing along, for example, a telephone line, caused by connection of a resistive parallel connection telephone tap.

'Input' socket

Connection to the cable under test, except when testing the AC mains for carrier transmissions is made through this socket. Although termed an input socket it actually has 2 input pins and 2 output pins.

The red and black connections on the input lead assembly provide DC power suitable for activating dormant microphones that require a few volts for operation. These are the power outputs. The green connections are for inputs.

If, assuming no connection is made to any cable, the input pins are short-circuited (eg by joining the crocodile clips together on the input lead assembly) no damage will result and no internal fuses will rupture.

In the event that the internal fuses rupture through accidental connection of a high voltage or other cause then refer to *Appendix B* for further instructions.

Mains socket

Connection of AC power for charging the main battery and for testing for the presence of mains carrier transmissions is made to this socket. The connection lead (there is one provided) must make an earth connection. When wiring a plug to the AC mains lead observe the following connections:

Live - brown wire

Neutral - blue wire

Green/yellow - earth

If the plug has a fuse ensure it is rated at 5 Amps or less

AC Fuses

The live and neutral connections are fused inside the TCM-03 unit. See section 1.4 for correct fuse types. Do not fit any other fuses, holders are adjacent to the AC voltage selector switch and can be changed without removing any cover of the TCM-03 unit.

AC Voltage Selector

Set the switch to show a value (115 or 230 VAC) nearest the value of the local AC mains supply. The unit will operate normally over the following voltage ranges:

90 - 130 VAC for 115 VAC switch setting

185 - 260 VAC for 230 VAC switch setting

Test Microphone

A test microphone assembly with 10 cm red and black connecting leads is provided. You can use this to listen to room audio. The microphone needs a few volts to operate. To work, power needs to be connected the correct way round. The microphone is similar to those found in eavesdropping devices and will give you a good idea of what to expect when checking for real devices.

7 If the measured voltage is less than 1V, then connect the DC output Red and Black connectors. Set 'Mode' to 'AF' and listen. Repeat test after swapping the Red and Black connections. This test activates any microphone requiring power for operation in a 2-wire configuration.

Select next pair and repeat the steps above.

AC Mains

Connect the TCM-03 by means of its AC power lead to a Mains socket

1 Set 'SOURCE' to 'L/N'

2 Set 'Mode' to 'AM' and tune listening for room audio, turn 'TUNE' from one extreme to the other.

3 Set 'Mode' to 'FM' and repeat

4 Set 'SOURCE' to 'L.N/E' and repeat steps 2 & 3 above

Operating Steps - not for AC Mains

The following tests are quick to perform and cover a reasonable number of eavesdropping configurations. Other tests are described in the *Further Operating Steps* Section later.

1 Connect green clips to the selected wire pair

2 Set 'Mode' to 'AF' and listen for room or area audio (an innocent sound source may be helpful)

3 Set 'Mode' to 'AM' and turn TUNE control from one extreme to the other slowly listening for room audio, ensuring that 'SOURCE' is set to 'LINE'

4 Set 'Mode' to 'FM' and repeat step 3 above

5 If the cable is not a telephone line then set 'Mode' to 'TONE' and turn 'TUNE' control from one extreme to the other slowly. Then set 'Mode' to 'AF' and listen for audio.

If the cable is a telephone line and no call is in progress and the meter indicates a voltage of greater than approximately 25 volts, then set 'Mode' to 'AUTO' and turn 'TUNE' slowly from one extreme to the other. If a device such as an Infinity Tap is activated, the telephone line voltage will drop and the tone will be automatically disengaged allowing you to hear audio. If no tone is heard during this test, then the threshold set within the TCM-03 is incorrectly set (see appendix B), in this instance 'TONE' not 'AUTO'.

6 Record any voltage reading and compare with previous readings. Any significant difference should be investigated further.

BASIC OPERATING STEPS

The Threat

Operation is best described by considering the types of eavesdropping threat associated with cables.

A cable comprising 2 or more individual wires may be:

Used to relay audio from a microphone, microphone-like device (eg loudspeaker) or piece of equipment modified to act like a microphone (eg modified telephone).

Used to relay a signal carrying intelligence from a low frequency transmitter. Eg as a mains carrier transmitter connected to the AC mains.

Tapped, enabling otherwise private communications to be recorded directly or transmitted onwards to listening equipment.

Detection

The essence of detection is:

1 To listen in the cables to ensure that no illicit signals from microphones or carrier transmitters are present.

2 To check that the normal voltage and current conditions on the cable have not deviated significantly from normal levels due to the connection of a tap or other eavesdropping device.

'Listening in' (step 1 above), usually gives unambiguous results since you hear room audio or other recognisable sounds which could only originate from an eavesdropping device.

Checking voltage and current conditions. Step 2 above, is not necessarily straight forward since voltage and current may change on a cable for innocent reasons and, in any event, well designed eavesdropping devices result in a negligible change (there are however many brands of device particularly telephone taps, which do result in significant changes and so there is a value in carrying out test). An example of an eavesdropping device which results in an unambiguous change is:

A few volts are measured across a pair of wires carrying power to a recently installed eavesdropping device. In previous tests zero was measured.

Checking for the presence of taps by measurement of voltage and current is described in more detail in the *Further Operating Steps* section later.

In this section voltage/current tests are restricted to measuring voltage only since this can be done anywhere along a cable and measure current flowing along a wire.

Practical Considerations

The first step is to locate and identify cables in the area to be checked. This as described in the *Facilities* section above may require the assistance of a qualified person to ensure that no dangerous cables are accessed, disturbed or connected to.

To simplify subsequent checks (assuming that the area is checked on a regular basis) you may find it useful to have convenient connection sockets installed on cables so that connection is speeded up.

Test Scheme

With the exception of AC mains, cables are subjected to the following tests:

- Listen for the presence of room/area audio
- Listen for the presence of AM or FM transmissions from eavesdropping transmitters
- Attempt to activate a remotely-controlled dormant device
- Measure and record for future comparison the voltage and current levels
- For AC mains cables the test is:
- Listen for the presence of AM or FM transmissions on the live/neutral and live, neutral/earth wire
- combinations.

Permutation and Combinations

If a cable comprises more than 2 separate wires then tests must be repeated to cover all permutations and combinations.

For example, if a cable comprises 6 wires then there are 15 possible wire pairs and every pair should be checked. The calculation is:

6 x 5 x 4 x 3 x 2 divided by (2 x 4 x 3 x 2) = 15

in this example, if DC power is connected to each pair then there are 2 ways (2 polarities) of connection giving 30 possible combinations.