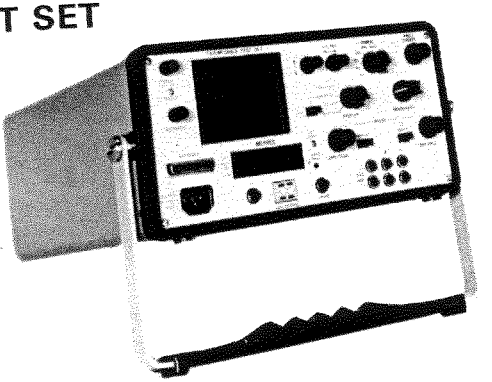
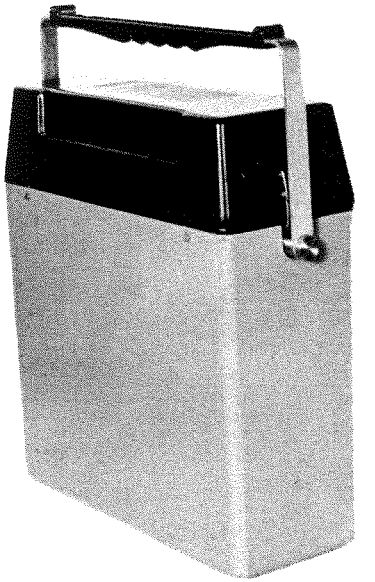
Established 1981
Advanced Test Equipment Rentals
www.atecorp.com 800-404-ATEC (2832)

BIDDLE®

A member of the THORN EMI Group THORN

MODEL 435 DIGITAL RADAR CABLE TEST SET





OPERATING INSTRUCTIONS AND APPLICATIONS GUIDE

refer to inside front cover before operating

PREFACE

IMPORTANT NOTE

This instrument is supplied with the internal battery discharged. Before use, charge the battery as described in 3.4.

Complete discharge of the internal battery is prevented by a sensing circuit which automatically disconnects the battery when its voltage falls below a pre-determined level, thus rendering the equipment inoperative. In order to restore operation depress the POWER switch and, either:

1. charge the internal battery

or 2. operate from the A.C. supply

or 3. operate from an external 12-15 volt D.C. supply

This document does not contain servicing information. A servicing manual is available as an accessory.

SAFETY PRECAUTIONS

READ CAREFULLY THE SAFETY PRECAUTIONS

ON PAGE 2.

, charge the

which
rmined level,
ess the POWER

available as an

MODELS 435F AND 435M
OPERATING INSTRUCTIONS

SAFETY PRECAUTIONS

PLEASE READ CAREFULLY BEFORE OPERATING

SAFETY IS THE RESPONSIBILITY OF THE USER

There are minimal safety problems when operating the 435 in accordance with the Instruction Manual. However, special attention should be given to the following:

- DO NOT CONNECT THE OUTPUT OF THE 435 TO ENERGIZED CONDUCTORS.
- MAKE A SEPARATE VOLTAGE TEST ON THE CONDUCTORS TO BE TESTED BEFORE CONNECTING THEM TO THE 435. (NOTE THAT THE 435 MAY NOT BE GROUNDED).
- TAKE PRECAUTIONS TO AVOID ANY IMPACT ON THE CATHODE RAY TUBE. IMPACT COULD CAUSE IMPLOSION.

Interior work on the 435 must be performed by those acquainted with the possible shock hazard of cathode ray oscilloscope circuits and with the routine precautions to be taken to avoid an accident.

Within the 435 there are voltages as high as 2 kV during operation, and such voltages can exist even after the 435 has been switched off.

Do not operate the 435 with the case removed except when following the procedures of the Service Manual.

PREFACE
SAFETY PRECAUTIONS
1 INTRODUCTION
2 DESCRIPTION OF (
3 PREPARATION FOR
3.1 Preliminary chec
3.2 Operation from a
3.3 Operation from a 12-15 V d.c. sup
3.4 Operation from t battery
3.5 'Set Zero' check
LIST OF PROPAGATION VE
4 OPERATING PROCED
4.1 Preliminary adju
4.2 Single line test
4.3 Comparison of tw the internal mem
4.4 Difference betwe
4.5 Location of cros
4.6 Propagation velo (p.v.f.) not kno

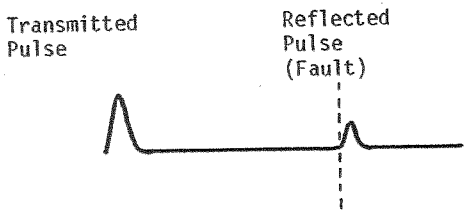
LIST OF CONTENTS

		Page
PREFACE		2
SAFETY PRECAUTIONS		5
1	INTRODUCTION	7
2	DESCRIPTION OF CONTROLS	13
3	PREPARATION FOR USE	
3.1	Preliminary check	13
3.2	Operation from an a.c. supply	13
3.3	Operation from an external 12-15 V d.c. supply	14
3.4	Operation from the internal battery	14
3.5	'Set Zero' check	15
LIST OF PROPAGATION VELOCITY FACTORS		16
4	OPERATING PROCEDURE	17
4.1	Preliminary adjustments	17
4.2	Single line testing	18
4.3	Comparison of two lines by using the internal memory	21
4.4	Difference between two lines	22
4.5	Location of crosstalk	23
4.6	Propagation velocity factor (p.v.f.) not known	24
5	APPLICATION GUIDE	29
5.1	General hints on fault locating	30
5.2	Practical examples	32
(1)	Open conductors	32
(2)	Shorted conductors	32
(3)	Joints (Splices)	33
(4)	Capacitor networks	33
(5)	Loading coils	34
(6)	Open sheath	34
(7)	Grounded sheath	35
(8)	Wet section (water ingress)	36
(9)	Crossed or split pairs	37
(10)	Taps	37
(11)	Change of cable insulation	38
5.3	Ghost reflections	39
6	SPECIFICATION	40

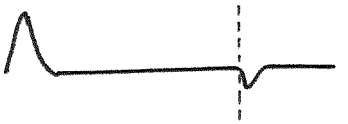
435F and 435M

The 435 has been designed primarily for testing telephone pairs. Ranges are from 30 metres (100 ft) to 15 km (50 000 ft) and measurement accuracy is ± 1% of range.

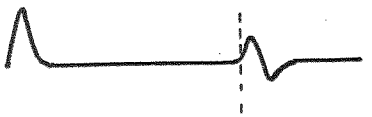
Examples of Displayed Waveforms



1. Open Circuit or Series Fault



2. Short Circuit or Shunt Fault



3. Inductive Mismatch

4. Capacitive Mismatch

Practical examples are given in Section 5

1 INTRODUCTI

The 435 is
indicatior
into a cal
medium, a
transmitt
between t
type of f
on Page 4

The 435 p

(a) Exa

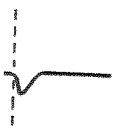
(b) Com

(c) Dif
can
or
ide

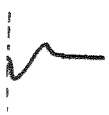
(d) Loc
on

This manu
In order
attemptin

are
± 1% of range.



Fault



1 INTRODUCTION

The 435 is a pulse-reflection (radar) cable test set, which provides a visual indication of cable faults. The principle of operation is that a pulse transmitted into a cable travels with a velocity determined by the dielectric, or insulating medium, and is reflected by discontinuities or mismatches in the cable. The transmitted and reflected pulses are displayed on a cathode ray tube, the time between them being proportional to the distance to the point of reflection. The type of fault can be determined by analysis of the displayed waveform (see examples on Page 4).

The 435 provides for:

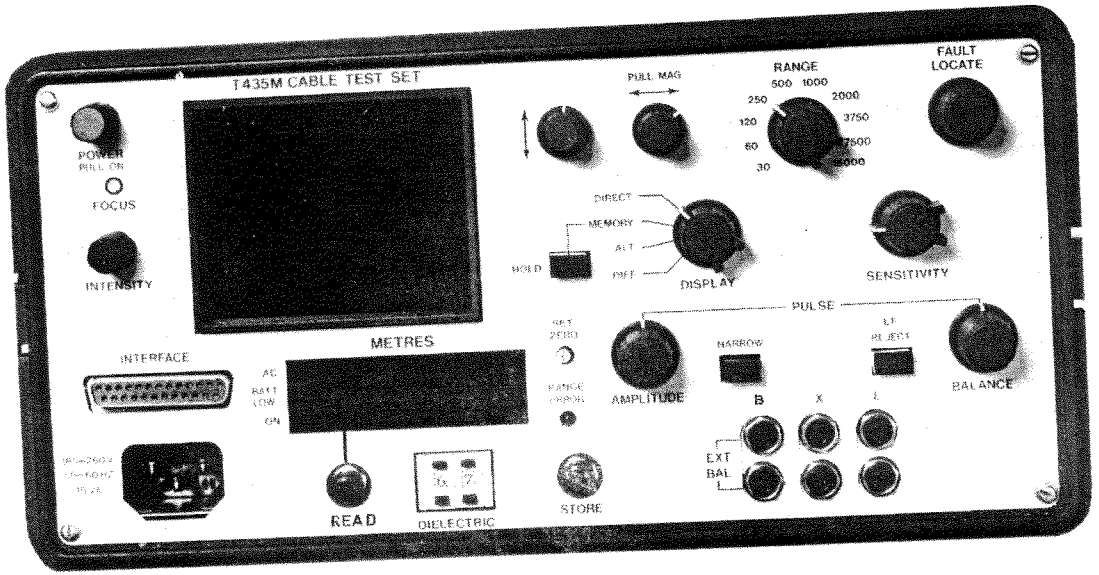
(a) Examination of a single line.

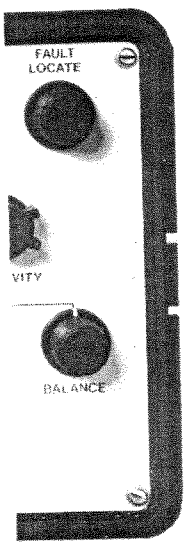
(b) Comparison between a good pair and a faulty pair.

(c) Difference between a good pair and a faulty pair, so that reflections cancel from common features such as joints and change of wire gauge or insulation, thus permitting obscure faults to be more readily identified.

(d) Location of crosstalk points, i.e. splits and resplits, by transmitting on one pair and receiving from the other.

This manual provides sufficient information for successful operation of the 435. In order to obtain maximum benefit from the 435 read through this manual before attempting to locate a cable fault.


T435M CABLE TEST SET
POWER
PULL ON
FOCUS
INTENSITY
INTERFACE
AC
BATT
LOW
ON
METRES
READ
DIELECTRIC
STORE
HOLD
DIRECT
MEMORY
ALT
REF
DISPLAY
PULL MAG
RANGE
500 1000
250
2000
120
3750
60
7500
30
15000
FAULT
LOCATE
SENSITIVITY
PULSE
AMPLITUDE
NARROW
B
X
L
EXT
BAL
BALANCE



2 DESCRIPTION OF CONTROLS

POWER	Push-pull switch for power on-off Push for OFF Pull for ON
FOCUS	Pre-set screwdriver control for optimizing the definition of the CRT display.
INTENSITY	Varies the brightness of the CRT display.
↕	Continuously variable control which adjusts the vertical position of the CRT display.
↔ / PULL MAG.	Dual control: (1) ↔ Continuously variable control which adjusts the horizontal position of the CRT display.

(2) PULL MAG: push-pull switch which, when pulled out, expands the horizontal trace about the point positioned at the centre of the CRT.

RANGE	Rotary switch which selects the displayed range.
FAULT LOCATE	Continuously variable control which adjusts the position of the bright dot cursor. For accurate measurement the cursor must be positioned at the point where the leading edge of the fault reflection just leaves the horizontal.
SENSITIVITY	Rotary switch which adjusts the gain of the vertical amplifier.
DISPLAY	Four-position rotary switch which selects the CRT display.

(1) DIRECT : Trace of line (cable) under test is displayed

(2) MEMORY : Trace stored in memory is displayed

(3) ALT.(BOTH) : DIRECT and MEMORY traces are displayed simultaneously

(4) DIFF. : Algebraic difference between DIRECT and MEMORY traces is displayed.

HOLD — Push-button switch.

IN : Secures the trace stored in memory. A back-up battery holds the trace in memory for up to 48 hours after the instrument is switched-off.

OUT : Permits a trace to be stored in memory when the STORE(WRITE) button is activated.

PULSE AMPLITUDE — Continuously variable control which adjusts the amplitude of the transmitted pulse.

PULSE BALANCE	Continuously variable control which is used to minimize the amplitude of the transmitted pulse appearing at the start of the CRT display.
LF REJECT	Push-button switch which when pushed IN connects a filter which rejects the low frequency components of the received signal.
NARROW	Push-button switch which, when pushed IN, selects an alternative pulse, narrower than that preselected by the RANGE switch, except on the two shortest ranges.
SET ZERO	Pre-set screwdriver control which is set such that the start of the CRT display coincides with the start of the transmitted pulse.
STORE(WRITE)	Push-button switch which transfers the display into memory.
RANGE ERROR	Indicates that the setting of the RANGE switch differs from that of the trace stored in memory.

DIELECT

5-DIGI

READ

INTERF

POWER

INPUT

to minimize
ring at the

ects
onents

ects an
cted by
ranges.

that
he start

y into memory.

h differs

DIELECTRIC	Thumbwheel switch which is set in accordance with the propagation velocity factor of the line under test.
5-DIGIT LED DISPLAY	Readout of fault distance (435M and 435F). Display time is two to three seconds.
READ	Push-button to activate the digital display.
INTERFACE	25-way D type socket for connecting to external accessories and applying an external 12-15 V d.c. supply.
POWER INPUT SOCKET	Input for 93 V - 130 V (optional 185 V-260 V) 45-65 Hz supply.
INPUT CONNECTORS	Three pairs of 4 mm banana sockets.

L - normal connection to line under test

X - pulse generator output for crosstalk location

B(EXT BAL) - connection for external line balance, or for a second line for displaying the difference between two lines.

AC	Indicates that the a.c. supply is present.
ON	Indicates that the instrument power is on.
BATT. LOW	Indicates that the internal battery requires to be charged.

3 PREPARA

3.1 Prelimi

Remove
The cov
leads a

NOTE

Pull th
indicat

3.2 Operati

Ensure
The con

BROWN -

3 PREPARATION FOR USE

3.1 Preliminary check

Remove the front panel cover by releasing the clips located on each side of the unit. The cover provides stowage space for the power lead, two 3 metre (10 ft) connecting leads and other accessories.

NOTE The carrying handle can be used as a tilt stand.

Pull the POWER switch ON and observe that the ON indicator is illuminated. If the ON indicator fails to light, recharge the internal battery as described in Para 3.4.

3.2 Operation from an a.c. supply

Ensure that the a.c. supply is within the range indicated on the front panel. The connections for the power plug are:

BROWN - LINE; BLUE - NEUTRAL; GREEN/YELLOW - GROUND

Connect the 435 to the a.c. supply. With the POWER control pushed to OFF observe that the AC indicator is illuminated. Pull the POWER control to ON and observe that both the AC and ON indicators are illuminated.

3.3 Operation from an external 12-15 V d.c. supply

Push the POWER control to OFF. Connect the external d.c. supply via the 24-way D type INTERFACE socket. The connections are:

Positive	-	PIN 5
Negative	-	PIN 23

NOTE Neither side is connected to ground.

3.4 Operation from the internal battery

The 435 will operate from the internal battery in the absence of the a.c. supply or external d.c. supply.

hed to OFF observe
o ON and observe

/ via the 24-way

the a.c. supply or

Complete discharge of the internal battery is prevented by a sensing circuit which disconnects the battery when its voltage falls below a predetermined value. If this should happen, operation can be restored for a short time by switching the 435 off for about 5 minutes, allowing the internal battery to recover, and then switching ON.

To recharge the battery, connect the 435 to the a.c. supply. Push the POWER control to the OFF position. Allow 14 hours for the battery to recharge fully.

3.5 'Set Zero' check

Switch to the 1000 metre (3000 ft) Range.

Adjust the 'SET ZERO' control so that the start of the leading edge of the transmitted pulse coincides with the start of the CRT trace.

Confirm that this condition is maintained for all other ranges.

LIST OF PROPAGATION VELOCITY FACTORS

DIELECTRIC SETTING FOR TYPICAL CABLES	
AIR	98
AIR SPACED COAXIAL	94
FOAM POLY	82
PTFE (TEFLON)	71
POLYETHYLENE (PIC)	67
JELLY FILLED POLY	64
PAPER (PULP .083 µF/MILE)	72
PAPER (PULP .072 µF/MILE)	88
PAPER, OIL FILLED (PILC)	50 - 56
CROSS LINKED POLY (XLPE)	52 - 58
HMW	56 - 62

DIELECTRIC SETTING FOR TYPICAL CABLES

4 OPERATING

4.1 Preliminar

(1) Conne
batte

(2) Set t

IN
PU
PU
SI
FA

PU

D

(3) Pull

OR TYPICAL CABLES

4 OPERATING PROCEDURE

4.1 Preliminary adjustments

(1) Connect the instrument to operate from the a.c. supply, d.c. supply or internal battery as required.

(2) Set the controls as follows:

INTENSITY	-	mid position
PULSE AMPLITUDE	-	fully counter-clockwise
PULSE WIDTH	-	normal, i.e. OUT
SENSITIVITY	-	fully counter-clockwise
FAULT LOCATE	-	fully counter-clockwise
↕	-	mid position
PULL MAG.	-	no expansion (i.e. pushed IN)
↔	-	mid position
DISPLAY	-	DIRECT

(3) Pull POWER switch ON and allow at least 10 seconds for the CRT trace to appear.

(4) Adjust the INTENSITY control for a well defined trace.

(5) Adjust ↔ and ↕ to position the trace in the middle of the CRT screen.

4.2 Single line testing

IMPORTANT NOTES

(a) The fault distance displayed on the readout INCLUDES the length of the connecting lead which should be subtracted from the reading obtained.

(b) A slight vertical displacement of the trace may occur when the READ button is operated. This has no effect on the accuracy of the measurement and should be ignored.

(c) The LF reject filter is provided to filter out low-frequency components. This has the effect of sharpening up the reflection on long cables. For short cables the switch should be in the OUT position.

:he CRT screen.

length of the
ng obtained.

·n the READ button
ıeasurement and

ncy components.
ng cables. For

(d) On the 2000 m (6000 ft) range and above, the trace on the CRT will flash intermittently due to the refresh time of the memory. To freeze the trace, depress the HOLD control. The HOLD control must be released should it be necessary to re-adjust any of the controls.

(1) Plug one of the 3 metre (10 ft) connecting leads into the L sockets.

(2) Set the DIELECTRIC switch to the propagation velocity factor (p.v.f.) for the cable type under test. A list is provided on Page 16 and inside the lid.

(3) If the type of cable and hence the p.v.f. is not known refer to Para. 4.6 and then continue with this procedure as appropriate.

(4) Select the RANGE to cover the full length of the cable.

(5) Rotate the SENSITIVITY control approximately a quarter turn and increase the PULSE AMPLITUDE until the fault reflection is observed.

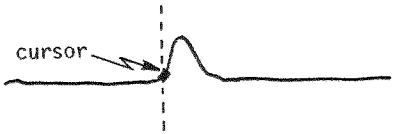
(6) Select NARROW pulse width if preferred.

(7) Adjust the BALANCE control to minimize the amplitude of the transmitted pulse at the start of the trace.

(8) Re-adjust SENSITIVITY/PULSE AMPLITUDE for optimum display.

(9) In most cases the best results are obtained with the PULSE AMPLITUDE high and the SENSITIVITY low. Some faults, for example, high-resistance joints (splices) are temporarily cleared if a high amplitude pulse is applied. In such cases use high SENSITIVITY and increase the PULSE AMPLITUDE from minimum until the fault is observed.

(10) Rotate the FAULT LOCATE control, adjusting the INTENSITY if necessary, to bring the bright-up cursor to the point where the start of the reflected pulse just leaves the horizontal, as shown below.



(11) Push the READ button. The distance to the fault will be displayed for 2 to 3 seconds on the 5-digit LED display.

The dist
bright-u

(12) For
scr
poi
ope

4.3 Comparis

(1) Co
de

(2) Sw
ST
is

(3) Sw
tr

ismitted pulse

TUDE high and
joints (splices)
n such cases
um until the

ssary, to bring
ed pulse just

d for 2 to 3

The distance displayed on the readout is always that to the start of the bright-up cursor

(12) For closer examination, position the point to be examined at the centre of the screen and operate the PULL MAG. control. The trace will expand about the point selected. The full length of the expanded trace can be observed by operating the ←→ control.

4.3 Comparison of two lines by using the internal memory

(1) Connect the test lead from the L sockets to one line and obtain a display as described in Para. 4.2.

(2) Switch the DISPLAY switch to MEMORY and with the HOLD button OUT depress the STORE(WRITE) button and observe that the trace obtained in the DIRECT position is reproduced in the MEMORY position.

(3) Switch to DIRECT, connect the test lead to the second line, and observe the trace.

IMPORTANT

Do not re-adjust any of the controls, otherwise a direct comparison is invalid.

(4) Switch the DISPLAY to ALT(BOTH) and use the ↕ control to separate the two traces for comparison.

4.4 Difference between two lines

4.4.1 Using the memory

(1) Obtain the two traces as described in Para. 4.3.

(2) Ensure that both traces are contained within the CRT display area.

(3) Switch the DISPLAY switch to DIFF and the trace displayed is the difference between the two traces.

4.4.2 Using the EXT. BAL sockets

(1) Using the second test lead connect one line to the L_1 sockets and the other line to the EXT. BAL sockets.

(2) Obtain a display as detailed in Para. 4.2 except that the BALANCE control is inoperative.

(3) The trace displayed is the difference between the two lines.

4.5 Location of crosstalk (Splits and Resplits)

Connect one line to the X sockets and the other line to the L sockets.

Obtain a display as described in Para. 4.2 except that the BALANCE control is inoperative.

Typical response

Should crosstalk result from any form of resistive or capacitive coupling, the location of the fault point is determined in the same way.

4.6 Propagation velocity factor (p.v.f) not known

If the p.v.f. is not known, it can be calculated from (a), (b), and (c) below, or alternative methods of measurement can be used as in (d) and (e) below. These calculations and measurement methods are described in sub-paras 4.6.1 to 4.6.5 below. Refer to Para. 4.2 for the general operating procedure.

(a) Velocity of propagation for the cable known

(b) Dielectric constant for the cable insulation known

(c) Short length of the same type of cable available

} DIELECTRIC setting can be calculated

(d) Route length known of a good pair in the same cable

(e) Route length known with both ends accessible.

4.6.1 Velocity of

Calculate pr

where v =

c =

4.6.2 Dielectric c

Propagation

Example :

and (c) below, or
below. These
4.6.1 to 4.6.5 below.

DIELECTRIC
setting can
be calculated

4.6.1 Velocity of propagation known

Calculate propagation velocity factor (p.v.f.): p.v.f. = $\frac{v}{c}$

where v = velocity of propagation for the cable in m/μs

c = velocity in free space 300 m/μs or 984 ft/μs.

4.6.2 Dielectric constant known

Propagation velocity factor = $\frac{1}{\sqrt{e}}$

where e = dielectric constant for the cable

Example : For Polyethylene e = 2.25: p.v.f. = $\frac{1}{\sqrt{2.25}} = \frac{1}{1.5} = 0.67$

Set DIELECTRIC control to 67.

4.6.3 Short length of same type of cable

(1) Measure the physical length of the sample cable

(2) Set the DIELECTRIC control to any value in the range 50 to 99.

(3) Obtain a reading for the apparent distance to the end of the cable.

(4) Keep the bright-up cursor at the point of reflection, and re-adjust the DIELECTRIC setting until the distance on the readout is the same as the physical length measured in (1). Note the reading of the DIELECTRIC setting, which should be recorded for later reference. This setting can be applied to ANY 435, not just the one on which the measurement was made.

4.6.4 Route length known of a good pair in the same cable

METHOD 1

(1) Connect the 435 to a good pair.

(2) Determi
length

(3) Connect

METHOD 2

(1) Connec
50-99

(2) Connec
measur

4.6.5 Route length

(1) Set t

cable.

adjust the
ame as the
LECTRIC setting,
an be applied to

(2) Determine the propagation velocity factor as previously described for a sample length and set the DIELECTRIC control.

(3) Connect to the faulty pair and measure the distance to the fault.

METHOD 2

(1) Connect the 435 to the good pair with any DIELECTRIC setting in the range 50-99 and measure the apparent distance (d_1) to the end of the cable.

(2) Connect the 435 to the faulty pair with the same DIELECTRIC setting and measure the apparent distance (d_2) to the fault position.

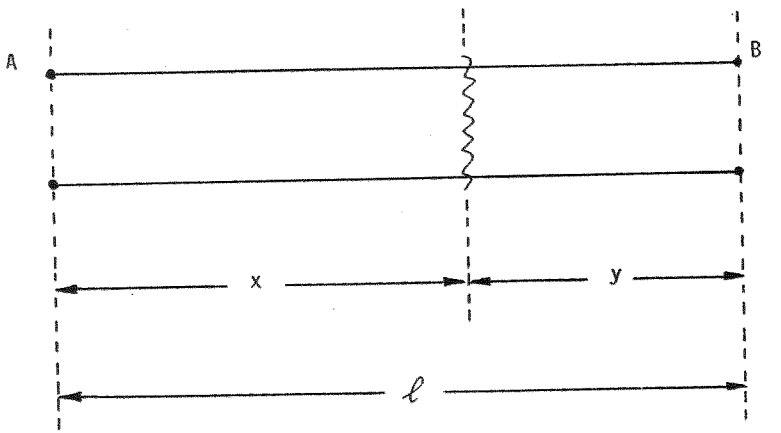
$$\text{True distance to the fault} = \frac{d_2}{d_1} \times \ell$$

where ℓ = true length of the cable

4.6.5 Route length known and both ends accessible

(1) Set the DIELECTRIC to any setting between 50 and 99.

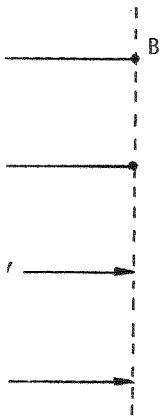
(2) Measure the apparent distance (x) to the fault from end A and the apparent distance (y) to the fault from end B.



Then distance to the fault from end A

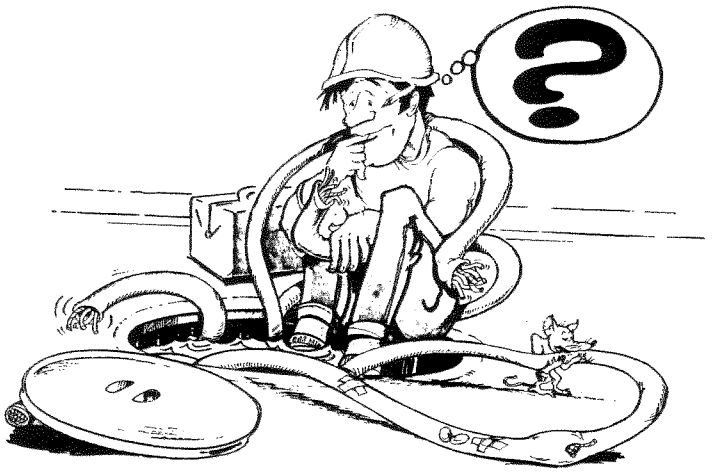
$$= \frac{x}{x + y} \cdot \ell \quad \text{where } \ell = \text{route length of the cable}$$

ı end A and the apparent



ngth of the cable

5 APPLICATION GUIDE



5.1 General hints on fault locating

The position on the trace to which the bright-up cursor is registered is the point at which the reflected pulse just leaves the horizontal.

The amplitude of the reflected pulses decreases with increase in distance because of signal loss in the cable, and the SENSITIVITY control should be adjusted accordingly.

Multiple faults may or may not be observed. If the first fault encountered is severe, most or all of the pulse energy will be reflected, disguising other possible faults. After clearing the indicated fault, check again to ensure that no other faults are present.

Telephone cables by the nature of their construction produce displays not as 'clean' as for a coaxial cable or power cable. This is why the 435 has the facility for comparing two pairs or displaying the difference between two pairs so that common reflections cancel.

Whenever possible obtain a second location of the fault from another access point.

Experienc
where the

1. Che
gr

2. If
ar

Insulati
by using
the chan

The 435
faults.

The tra
pairs b
higher

tered is the point at

distance because of
adjusted accordingly.

encountered is
ising other possible
re that no other

plays not as 'clean'
the facility for
rs so that common

ther access point.

Experience has shown that most faults occur at joints, pillars, splices, cabinets, or where the cable has been damaged.

1. Check in the area of the indicated fault position for any disturbance of the ground.

2. If the 435 shows the fault position to be close to a splice(joint), the chances are that the fault is at the splice(joint).

Insulation faults with resistance above a few kilohms are more likely to be located by using a high-resistance bridge; unless water is present, when the 435 will locate the change in capacitance caused by the water ingress.

The 435 will not 'see' through load coils, which appear as high-impedance series faults.

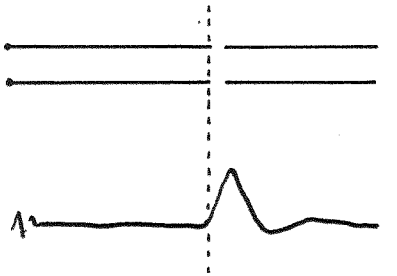
The transmitted pulse is subject to high attenuation (loss of signal) in telephone pairs because of the small-diameter conductors used. The smaller the conductor the higher the attenuation and the less the effective range.

5.2 Practical examples

(1) Open conductors

The reflection from an open conductor is a positive or upward pulse. If only one conductor is open the amplitude of the reflection will be smaller.

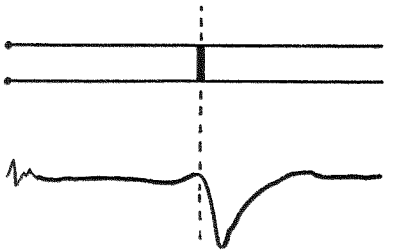
NOTE No reflection from the far end of the cable.



(2) Shorted conductors

The reflection from a shorted pair is a negative or downward pulse.

NOTE No reflection from the far end of the cable.



(3) Joints (Spl

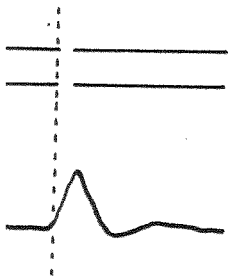
A joint (sp
reflection.

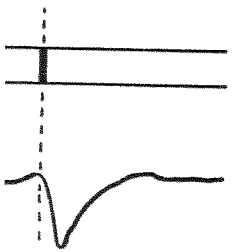
High resist

A high-resi
positive or
that of an
being deper
resistance.

(4) Capacitor r

A capacitor
shunt impe
pulse and
downward r
small posi



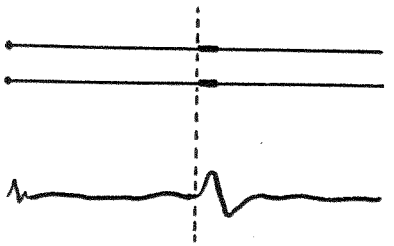


(3) Joints (Splices)

A joint (splice) produces an "S" shaped reflection.

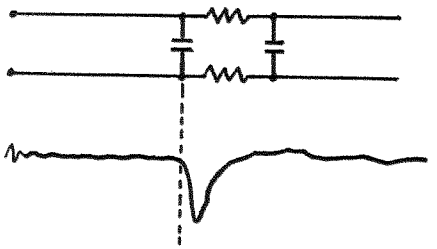
High resistance joint (splice)

A high-resistance joint produces a positive or upward pulse similar to that of an open conductor, the amplitude being dependent upon the effective resistance.



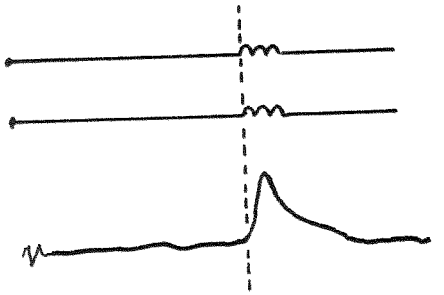
(4) Capacitor networks

A capacitor network presents a low shunt impedance to the transmitted pulse and produces a negative or downward reflection followed by a small positive overshoot.



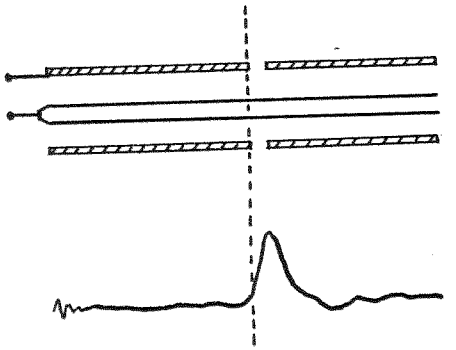
(5) Loading coils

A loading coil presents a high series impedance to the transmitted pulse and a positive or upward reflection. It is not possible to 'see' beyond the first loading coil.



(6) Open sheath

An open sheath may be located where the sheath is completely open, for example, where there is a missing strap. The sheath must be isolated in the measuring direction and the test connection made between the sheath and a shorted, twisted pair.



(7) Groundec

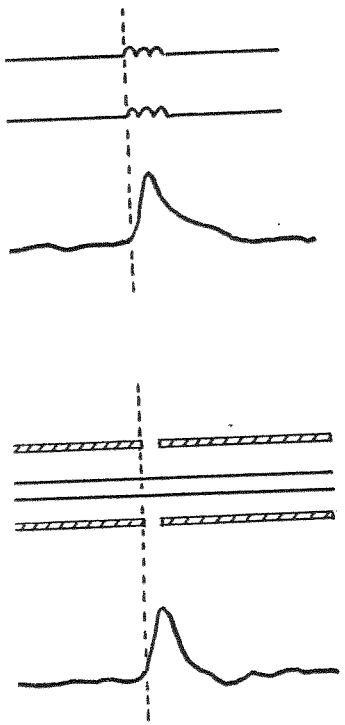
Groundec
with pu
more re
resista

However
the ear
to loca

Either:

or:

In (a)
that c
of prc
can be
lengt



(7) Grounded sheath

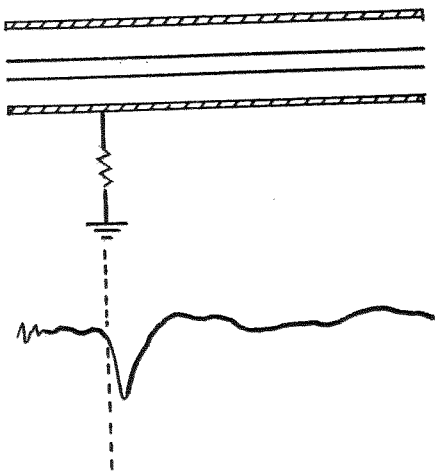
Grounded sheaths are difficult to locate with pulse echo equipment and may be more readily located by using a high-resistance bridge.

However, in some circumstances where the earth is moist, it may be possible to locate the fault.

Either: (a) connect between the sheath and a pair

or: (b) connect between the sheath and ground

In (a) the velocity of propagation is that of the cable. In (b) the velocity of propagation is unknown and the fault can be located by knowing the route length of the cable.



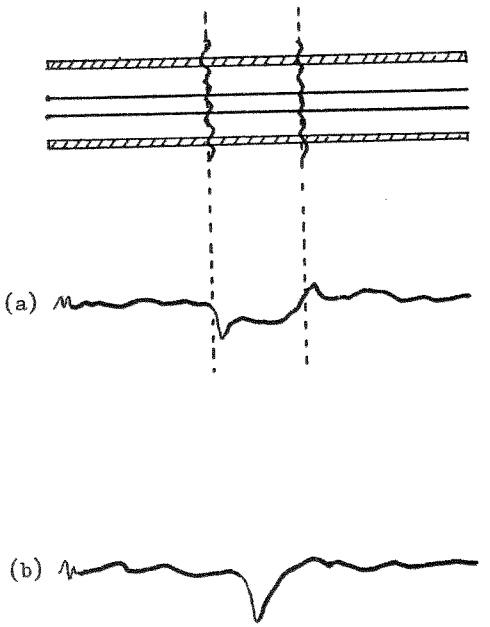
(8) Wet section (water ingress)

Water present in a cable increases the dielectric constant and hence the capacitance of the cable.

The water boundary produces a 'noisy' negative reflection, of amplitude dependent upon the degree of saturation, with a positive pulse at the end. See Waveform (a).

Because the velocity of propagation is slower in the wet section, for accurate location of the far end of the wet section repeat the test from the other end of the cable. Faults such as open-circuits will show up in the display of the wet section.

Waveform (b) shows a wet joint (splice) case.

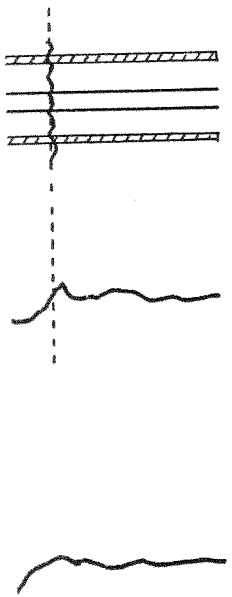


(9) Crossed

The joi
occurs
negativ
indicat
polarit
because
the spl
split,

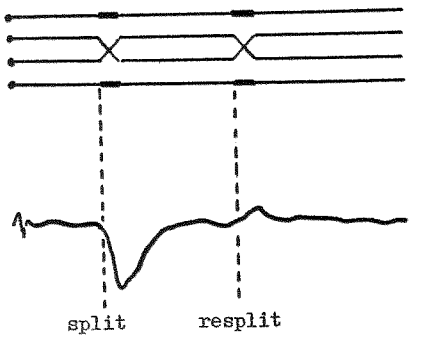
(10) Taps

The tap
followe
oversho
reflect
shoot c
taps, s
from ta



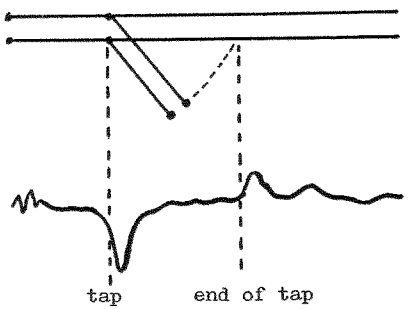
(9) Crossed or split pairs

The joint (splice) at which the split occurs is indicated by a positive or negative reflection. The resplit is indicated by a pulse of opposite polarity, but of smaller amplitude, because of the loss of pulse energy at the split. First locate and clear the split, then locate the resplit.



(10) Taps

The tap appears as a negative pulse followed immediately by a positive overshoot. Because of multiple reflections it is difficult to trouble-shoot circuits that contain several taps, so test progressively by moving from tap to tap.



(11) Change of cable insulation

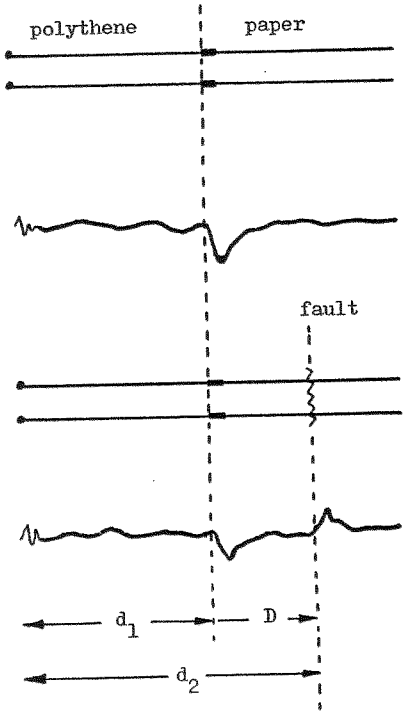
The point at which a change of cable insulation occurs results in a positive or negative reflection.

Polyethylene to Paper - negative
Paper to Polyethylene - positive

Since the velocity of propagation is different for each cable type, care should be taken to ensure that the correct value is used. In the case illustrated, first select 67 for Polyethylene for accurate fault location in the Polyethylene section, and if the fault occurs in the dry paper section select 71 (or the appropriate number for the particular type of paper insulation.)

Obtain a reading (d_1) for the apparent distance to the point of change. Then measure the apparent distance (d_2) to the fault. The accurate distance-to-fault (D) from the point of change is given by:

$$D = d_2 - d_1$$

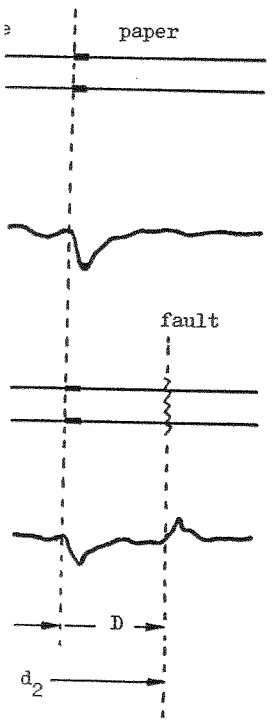


5.3 Ghost refle

It is somet
full cable
resulting f
false indic
caused by a
trace peri

To identif

NOTE ALL S
WHEN SWITC
PREVIOUSLY



5.3 Ghost reflections

It is sometimes convenient to select a range shorter than that necessary to cover the full cable length. Under these circumstances it is possible for a reflection resulting from a point beyond the range selected to appear on the display, giving a false indication of a fault. This is referred to as a "ghost reflection". It is caused by a reflection resulting from one transmitted pulse occurring during the trace period of the second or a subsequent transmitted pulse.

To identify possible ghost reflections:

NOTE ALL SIGNIFICANT REFLECTIONS ON A RANGE THAT COVERS THE FULL CABLE LENGTH. WHEN SWITCHING TO A SHORTER RANGE, ANY APPARENT REFLECTION, OTHER THAN THOSE PREVIOUSLY IDENTIFIED, IS A GHOST REFLECTION.

6 SPECIFICATION

Displayed Ranges	10 positions 435M 30 metres to 15 kilometres 435F 75 feet to 50 000 feet
Horizontal Magnification	At least 3 times, reducing the shortest displayed range to 10 metres (25 feet).
Horizontal Shift	Continuously variable control sufficient to view any part of the magnified display to be viewed.
Velocity Factor	Set by two thumb switches in the range 0.01 to 0.99.
Fault Location	Set by means of a bright dot cursor.
Readout	5 digit 0.3 inch/7.5 mm LED display. Display maintained for 2 to 3 seconds.
Accuracy	Better than ± 1% of range ± 1 digit: 0 °C to +40 °C, +32 °F to +104 °F Better than ± 2% of range ± 1 digit: -25 °C to +55 °C, -13 °F to +131 °F

ɔmetres

ɜet

ɜhortest displayed

ɪfficient to view any
ɔ be viewed.

ɜ range 0.01 to 0.99.

rsor.

play. Display

igit: 0 °C to +40 °C
+32 °F to +104 °F

igit: -25 °C to +55 °C
-13 °F to +131 °F

Resolution	435M :	0.1 metre (10 cm)
	435F :	0.5 feet (6 in)

Transmitted Pulse Characteristics

Waveform	:	sine squared approx.
Amplitude	:	continuously variable:
		X sockets 50 V peak into 100 ohms
		L sockets 30 V peak into 100 ohms
Output Impedance	:	100 ohms, L sockets
Half Height Width	:	30 ns to 1.5 μs selected by RANGE switch.

Line Connectors	:	4 mm banana sockets
X Sockets	:	pulse generator output
L Sockets	:	connection to line under test
B Sockets	:	connection for external line balance.
Internal Line Balance	:	75 ohms to 2.5 kohms

Display Modes

DIRECT	:	trace of line under test displayed
MEMORY	:	trace stored in memory displayed
ALT/BOTH	:	DIRECT and MEMORY traces displayed
DIFF	:	difference between DIRECT and MEMORY traces displayed

HOLD

Vertical Sensi

Input Filter
(LF Reject)

Cathode Ray Tu

Power Requirem

a.c.

d.c.

:r test

line balance.

: displayed

lisplayed

displayed

T and MEMORY traces displayed

HOLD	:	secures trace in memory for up to 48 hours after the instrument is switched off.
Vertical Sensitivity		A reflected signal of 5 mV produces a vertical deflection of at least 1 cm.
Input Filter (LF Reject)		Switched to provide low frequency rejection. Cut-off frequency, 150 kHz.
Cathode Ray Tube		7 x 5 cm display area
Power Requirements		
a.c.	:	93 V to 130 V or 185 V to 260 V 45 Hz to 65 Hz via I.E.C. approved connector
d.c.	:	Internal rechargeable nickel-cadmium battery provides at least five hours continuous use.

External 12 V to 15 V d.c., either polarity to ground, without the need to disconnect the internal supplies.

Dimensions and Weight

Height	:	140 mm, 5.5 inches
Width	:	290 mm, 11.5 inches
Depth	:	260 mm, 10.3 inches
Weight	:	7.5 kg, 16.5 lb including internal battery pack.

Environmental — I.E.C. 68 for field portable test equipment.

Ambient Temperature : -25 °C to +55 °C, -13 °F to +131 °F operating
-40 °C to +70 °C, -40 °F to +158 °F non-operating.