Radio Test System
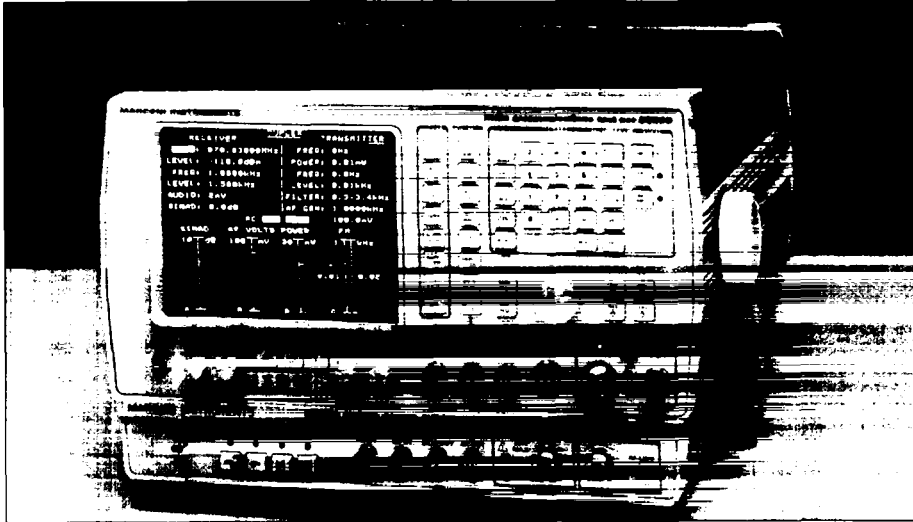
- ■ **Analog and Digital Tests in one Package with 2957D (800 and 450 MHz)**

- ■ **Combined Base Station Simulation and Mobile Radio Test Set in one Portable Package**

- ■ **GO/NO-GO, Full Auto and Manual Test Modes for Rapid Radio Testing and Fault Location**

- ■ **Non-Volatile Storage and Recall of System Set-ups**

- ■ **Detailed Data Displays for Tracing Protocol Errors**

- ■ **Serial, GPIB, Parallel Interfaces for Control and Results Printing**

- ■ **Disk Interface for User Program Storage**

- ■ **User System Definition for Future System Variants**

TEST SYSTEM DESCRIPTION

The testing of a cellular radio is not as straightforward as say a traditional two-way mobile radio. It is not possible to press a button and make it transmit, nor is it possible to receive just any signal. This is an intentional part of the telephone design to avoid the need of a private operating licence. While many cellular phones have test modes, these are not all the same nor are they necessarily well known to the service technician. Furthermore using a test mode does not guarantee correct normal operation.

To overcome these problems the 2957B/2957D simulates the signalling protocol that the radio would see from the real system. It is then possible to place and receive calls, thereby enabling the receiver and transmitter, so that normal parametric measurements can be made. As a by-product of this approach the signalling may also be verified permitting faults and errors to be traced before releasing a phone on to the network.

Automatic Operation

By using the cellular signalling protocol to control the functions of the radio, it is possible to largely automate the testing process. Apart from operating the controls of the radio when prompted on the instrument screen, a complete series of tests can be conducted without further intervention by the operator. The display will then show each test as it progresses, indicate a pass or fail and then summarize the results. If required the results may be simultaneously recorded on virtually any printer via one of the three printer ports.

The instrument contains four different sequences of tests to suit different test requirements and in general these satisfy most applications. In addition users may program the instrument with test sequences to suit their own specific needs. This sequence remains in non-volatile memory and includes which tests are performed, what limits are applied, how the results are displayed, and the format of the printout.
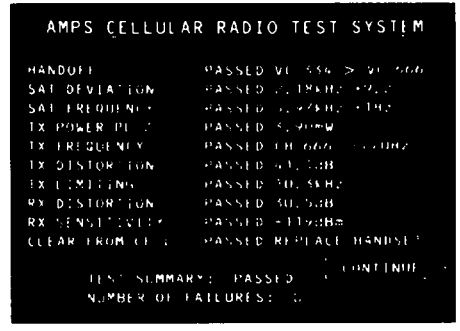
GO/NO-GO or Full Auto

The 2957B/2957D offers the operator two ways to perform the automatic test sequences. The GO/NO-GO selection will run the test sequence so that only summary results are displayed. As each test is completed, so the results scroll down the screen. Any failures are prevented from scrolling off the top of the screen so that even when unattended the important results can be seen.

The Full Auto selection allows the user to choose the display format and also when and if the test sequence should

INTRODUCTION

Since the early 1980s the AMPS cellular radio system has flourished in the Americas and Far East where there are now many millions of subscribers. To increase capacity, more channels have been added giving rise to expanded spectrum AMPS. Recently it has been further augmented by the use of narrower channels known as N-AMPS and the D-AMPS digital format. The 2957B and 2957D Radio Test Systems are designed specifically for testing AMPS in North America and now incorporate facilities to address all of the new system enhancements as well as offering a number of facilities particularly aimed at system trouble shooting, such as: Single Word Paging, Directed Retry, New Access Channels and Overload Class information. Future variations are catered for by a user system definition capability. Any set-up or definition may also be stored in non-volatile memory for instant recall.

The 2957 series now allows virtually any system arrangement to be configured and then used as normal, this is particularly useful for manufacturers who may be switching production lines on a daily or even hourly basis. Recently the capability

to address 450 MHz systems has been added. Additional software functions have also been included. These now allow the setting of System Parameter Word 3 for Private Systems. The date and time can now be entered from the front panel in various country formats. The RF power (Test 28) checks power levels including PL8-10.

The 2957B and 2957D Radio Test Systems are based around the very popular 2955B Radio Communications Test Set. It consists of a 2955B and an adapter unit which is fitted to the underside forming a single integrated test system. The instrument may be purchased complete or as separate units allowing upgrading to cellular as and when needed. The adapter units are compatible with all versions of 2955, although for Digital AMPS, we would recommend that the 2955 is brought up to current modification state.

These instruments offer a high performance, cost effective package ideal for service shops, distributors, manufacturers and system providers. The 2957 combines ease of use and flexibility making it equally at home on the production line and in the workshop.

pause to allow inspection. In this way failures can be investigated at the point where they occurred and when the signalling data is available for inspection. The screen may also be set-up to indicate the 2955B normal duplex settings and readings, the test limits and any additional information.


```
AMPS CELLULAR RADIO TEST SYSTEM

HANDOFF              PASSED VL 554 > VL 566
SAT DEVIATION        PASSED 2.1kHz +2.2
SAT FREQUENCY        PASSED 5.975Hz +1Hz
TX POWER PL 2        PASSED 5.900W
TX FREQUENCY         PASSED CH 666   20Hz
TX DISTORTION        PASSED 41.5dB
TX LIMITING          PASSED 10.5kHz
RX DISTORTION        PASSED 50.5dB
RX SENSITIVITY       PASSED -119dBm
CLEAR FROM CELL      PASSED REPLACE HANDSET

     TEST SUMMARY: PASSED        CONTINUE
     NUMBER OF FAILURES: 0
```

Non-volatile Storage
The 2957B/2957D offers a series of 6 non-volatile stores for complete system set-ups. This is particularly useful where instruments are used in workshops or on production lines where a number of radio types are tested.

Any user defined test sequence or program is automatically held in non-volatile memory and appears as part of the normal test sequence selection menu. If a number of user defined test sequences are required, they may be saved on an external disk drive. Up to 10 programs and their associated set-up memories may be stored on one diskette making it a reliable, transportable and cost effective storage medium.
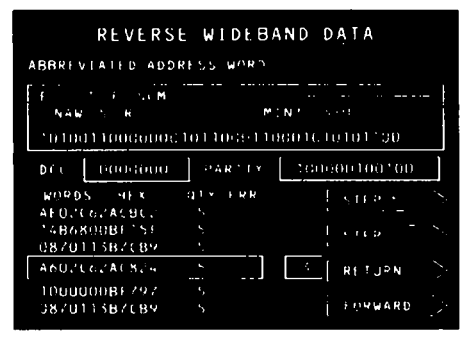
Custom Test Software Package
To simplify the creation of customized test sequences a special software package is available called PATSIE (Program and Test Sequence Instruction Editor). This package provides an environment for developing 2957 series test sequences on virtually any IBM compatible PC and features built-in help text and menu selection. As programs are created, they can be viewed, edited, printed, saved on the PC media and transferred to the 2957 via the RS232 interface.

MANUAL TESTING
Although automatic testing offers a quick and simple solution to routine radio testing, it is not suitable for trouble shooting. For this reason the 2957 series offers a manual testing mode as well. Here all of the call processing functions can be exercised at the request of the user enabling the area in question to be studied in detail repeatedly and hence isolating the fault. Many functions respond automatically when signalling

is initiated by the mobile to improve operator convenience.

Manual testing includes full control of signalling and supervisory levels and frequencies. This allows weaknesses to be shown up in receiver performance in a number of ways. It is this flexibility which makes the 2957 series attractive to both service technicians and designers alike.

As well as call processing, the 2957 series manual testing mode offers access to comprehensive data displays and the duplex testing portion of the 2955B. This means that all of the normal parametric measurements can be made while the mobile is maintained in a conversation or 'in-service' state.


```
REVERSE WIDEBAND DATA
ABBREVIATED ADDRESS WORD

F          M
NAWC   R              MIN1   SCC
10110011000000001011100011000010101010130

DCC 00000000  PARITY 30000010010000

WORDS  HEX    QTY ERR     STEP
AF0200CACBCC          X
54B68000BF T55        X
087011SB7CBV          X

A60200CACBCH          X  RETURN
1000000BF792          X
387011SB7CBV          X     FORWARD
```

DATA DISPLAYS
All of the data transmitted between the radio and the test system can be viewed in a user friendly format on a series of data displays. The displays themselves are based as closely as possible on the air specification and use the same nomenclature. Where single errors may be corrected, the bit errors are indicated in reverse video and where not, an overall error indicator identifies corrupted words. To simplify the display, repetitions of words are shown as a single message and a repeat count.

The data displays may also be copied to any suitable printer, making it easy to report problems back.

INTERFACES
The 2957 series supports a number of interfaces enabling virtually any combination of controller and printer to be used.

Serial Interface
The serial interface can be used for connection to a printer for hardcopy results, to a computer for remote control and programming applications, or to a telephone modem for long distance remote operation. A set-up command string may be defined to initialize the modem or to configure a printer prior to use.

A range of baud rates are available from 75 to 9600 with a comprehensive choice of

parity and stop bits allowing it to be used in virtually any situation.

Parallel Interface
The parallel interface allows the connection of a centronics style printer for fast hard copies. The interface also permits custom accessories to be connected and controlled. This can further speed up and automate the process of testing by removing the need for a user to operate the radio's controls.

GPIB
An IEEE488 interface is provided for both remote control and printing with a listen only printer. For remote control applications, the 2955 may be accessed directly or indirectly through the user-defined program facilities.

SPECIFICATION

ANALOG AMPS CELLULAR SOFTWARE

COUNTRY VARIANTS INCLUDED IN SCREEN MENU

AMPS
E – AMPS
N – AMPS

Channel Plan
1–333 System A
334–666 System B
667–716 System A'
717–799 System B'
800–990 Reserved
991–1023 System A''
(User defined country variants may be defined and stored for systems not mentioned above.)

MOBILE NUMBER

MIN Format:
XXX-XXX-XXXX

ESN Format:
Hexadecimal, Octal, Decimal, Standard 1 & Standard 2.

DIAGNOSTIC MANUAL TEST MODES
Data Off (SAT measurement enabled).
Dotting (5 kHz).
Signal tone (10 kHz).
DSAT generation.

DIGITAL AMPS CELLULAR SOFTWARE
The Digital AMPS software includes all features of Analog AMPS with the following additions.

Tests are for TDMA or D-AMPS dual standard mobiles, as defined in TIA documents IS-54B.

DIGITAL TRANSMITTER TESTS

CARRIER FREQUENCY

Frequency Range
824.010 MHz to 848.970 MHz and 869.010 MHz to 893.970 MHz 440.010 MHz to 449.970 MHz in 30 kHz steps ±1 kHz.

Measurement range
±500 Hz from channel center.

Accuracy
±20 Hz relative to the instrument's frequency reference.

Resolution
±10 Hz.

2957B/2957D

Modulation tolerance
Any data pattern of π/4DQPSK, as defined in TIA IS-54B.

Measurement sample
156 symbols (6.4 ms).

CARRIER POWER

Input Impedance
50 Ω Nominal.

VSWR
<1.35.

Max Input Power
100 W.

Power Reading Correction
0 to 20 dB offset.

Range
−15 dBm to +35 dBm.

Accuracy
±0.7 dB.

Measurement sample
156 symbols (6.4 ms) (Digital Traffic Channel only).

BURST TIMING

Range
±30 symbols relative to the Standard Offset Reference, IS-54B.

Accuracy
1/8 Symbol, 5 µs.

MODULATION ERROR

Modulation type
Any data pattern π/4DQPSK (α 0.35) as defined in IS-54B (Digital Traffic Channel only).

Reading format
RMS vector error for 1 burst, Averaged RMS vector error for 10 bursts over 60 s period and RMS vector error for first 10 symbols relative to averaged reading.

Accuracy

Total residual error
3% max.

DIGITAL RECEIVER TESTS

SIGNAL GENERATOR

Level Range
−50 dBm to −120 dBm.

Accuracy
±2 dB.

Resolution
0.1 dB.

Frequency Range
824.010 MHz to 848.970 MHz and 869.010 MHz to 893.970 MHz 485.010 MHz to 494.970 MHz in 30 kHz steps ±1 kHz.

Accuracy
As reference frequency.

Duplex offset from TX Measurements
45 MHz.

MODULATION GENERATOR

Modulation type
π/4DQPSK as defined in IS-54B.

RMS Vector error
<3.2% typical, <4.0% maximum.

Fading simulation
Two ray, equal amplitude, delay 40 µs.

User Channel Data
Psuedo random data, 'talk-back' speech or encoded speech with encoder option.

RECEIVER SENSITIVITY TEST
This test is performed with the use of the 'Test Interface' to command the unit under test into the 'TDMAON' mode. Psuedo random user data is then sent to the mobile on the forward channel and the returned data on the reverse channel is compared for bit errors. Two RF conditions are available – static or simple fading.

Bit Error Rate
0 to 100%.

BER Reporting Test
A call is established on a digital traffic channel in the normal way. Maintaining a high RF level, to reduce the likelihood of errors introduced by the RF link, deliberate bit errors are then inserted into the forward channel. The mobiles reporting of these errors is then monitored and correlated.

Reading
BER reporting error after 10 s.

RSSI Characteristics
A call is established on a digital traffic channel in the normal way. The RF level is then varied and the corresponding RSSI measurement reported by the mobile is recorded. The monotonicity is checked and the relative readings and levels are compared.

Reading
Relative error between −105 dBm and − 75 dBm/−85 dBm.

Talk-back Test
For general confidence, a talk-back test enables speech transmitted by the mobile to be returned to the receiver after a 5 second delay.

INTERFACES

Test Interface
For connection to a mobile test interface adapter to enable special test features within the radio.

FREQUENCY STANDARD

Temperature stability
<5 parts in 10⁸, 5°C to 55°C.

Ageing rate
<2 parts in 10⁷ per year.

GENERAL SPECIFICATION

TEST PROGRAM DISPLAY MODES

TEST MODES
Full Auto Test.
GO/NO-GO Test.
Manual Test.

TEST MODE FACILITIES
Pause Manual Only.
Pause On Failure.
Pause Always.

TEST SEQUENCES
Brief Testing.
Call and RF Testing.
Comprehensive Testing.
Call Processing Only.
(User Defined Test Sequence*.)
* Non Volatile area, can be used for custom programs, custom limits and subroutines for the above programs.

TESTS ROUTINES AVAILABLE
(where applicable)
Test 1 – Tx Power.
Test 2 – Tx Frequency.
Test 3 – Tx Distortion, SINAD, Noise.
Test 4 – Tx Limiting.
Test 5 – Tx Compression.
Test 6 – Rx Distortion, SINAD.
Test 7 – Rx Sensitivity.
Test 8 – Rx Expansion.
Test 9 – DC Power.

Test 20 – Registration.
Test 21 – Call Reception by mobile.
Test 22 – Call Placement by mobile.
Test 23 – Handoff.
Test 24 – Multiple Handoff.
Test 25 – SAT, DSAT or DVCC Transponding.
Test 26 – Clear down from base station.
Test 27 – Clear down from mobile.
Test 28 – Mobile Tx Power.
Test 29 – Data performance/BER report.
Test 30 – DTMF tones.
Test 31 – Hook Flash.
Test 32 – Data Deviation.
Test 33 – ST Deviation.
Test 34 – ST Duration.
Test 35 – Digital modulation error, rms vector error, 1st 10 symbols, origin offset, burst envelope.
Test 36 – Digital RF sensitivity (BER).
Test 37 – Digital speech loopback quality.
Test 38 – Digital RSSI.

DC power meter
Voltage range: 1 to 25 V.
Accuracy: ±5% ±100 mV.
Current range: 0 to 10 A.
Accuracy: ±5% ±200 mA.

Power accuracy:
±10% ±20 mW from 100 mW to 200 W.

AF input to AF output
Gain: As 2955B except AC coupling only and x 20 amplifier for <100 mV.

External modulation input
Gain: 0.5 V peak-to-peak for 5 kHz deviation ±10% at 1 kHz.

AF Measurement de-emphasis
Frequency response
6 dB/octave from 300 Hz to 3.4 kHz.

Psophometric (C-message) filter
C-message filter selectable for psophometric audio measurements.

SAT Generation
Frequency range
3 kHz to 8 kHz in 5 Hz steps nominally 6 kHz.

Accuracy
Crystal derived, accuracy better than ±1 Hz at SAT frequency.

Output level accuracy
±10%, 300 Hz to 2.5 kHz at system frequencies, i.e. 5.970 kHz to 6.030 kHz.

Distortion
<3%, <2% at 6 kHz ±30 Hz.

SAT Measurement
Accuracy
±10% at nominal system SAT frequencies and levels.

ST Measurement
Measurement deviation
±10%, 5 kHz to 10 kHz.

Tone duration
±10 ms, 40 ms to 5 s.

FSK Data (wideband)
Manchester encoded NRZ data.

Generated data deviation
±10%, 1 kHz to 10 kHz.

Bit rate
±1 bit/s, 8 or 10 kbit/s.

Measurement deviation
±10%, 1 kHz to 10 kHz.

Digital SAT/ST Generation
Sub audible FSK data, Manchester encoded and bandwidth limited.

Data range: 200 bit/s.
Accuracy: 0.01 bit/s.

Deviation range: 0 to 1 kHz.
Accuracy: ±10% at 700 Hz.

Digital SAT/ST Measurement
Deviation accuracy
±10% at nominal system level (700 Hz).

DTMF TONE GENERATION
Frequency Accuracy: +1 Hz.
Deviation: +10%, 1 to 5 kHz high tone, low tone = high tone +2 dB.
Distortion: Less than 3% (individual tones).

INTERFACES

PRINTER INTERFACES
RS-232, GPIB, Centronics.

Print menu facilities.
Print on PASS.
Print on FAIL.
Print ALWAYS.

CONTROL INTERFACES

GPIB
IEEE-488 (1978) subset SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E1.

RS-232
Baud rates 75 to 9600. Length/parity 8/even, odd or none. 7/even, odd or none. Stop bits 1 or 2.

Parallel

Parallel printer (Centronics type). 8-way bi-directional port, 48 mA sink. 4 TTL outputs (unprotected), 4 TTL inputs (unprotected). +5 V DC supply at 100 mA accessory power (unprotected).

DISK INTERFACE

Compatible with 5.25 or 3.5 inch, 40/80 track, single/double sided, single density disk drive with industry standard S.400 (Shugart) controller drive interface. Track to track step time selectable 6 or 12 ms. 34-way IDC male socket.

GENERAL

Power requirements (Adapter only)

AC operation
Rated supply voltage
115 or 230 V nominal AC.

Supply voltage range
95 to 130 V or 190 to 264 V AC.

Supply frequency range
50 to 400 Hz ±10%.

Maximum consumption
30 VA.

DC operation
±11 V to 32 V (consumption 30 W maximum). The DC supply is connected to the DC power meter input terminals.

DIMENSIONS AND WEIGHT

Height	Width	Depth	Weight
231 mm	345 mm	490 mm	20.0 kg
9.1 in	13.6 in	19.3 in	44 lb

SAFETY

Complies with IEC 348 safety requirements.

RATED RANGE OF USE

0 to 50°C.

LIMIT RANGE OF OPERATION

0 to 55°C.

CONDITIONS OF STORAGE AND TRANSPORT

Temperature
−40 to +70°C.

Humidity
Up to 90% RH.

Altitude
Up to 2500 m (pressurized freight at 27 kPa differential, i.e. 3.9 lbf/in²).

RADIO FREQUENCY INTERFERENCE

Conforms to the requirements of EEC Directive 76/889 as to limits of RF interference.

VERSIONS AND ACCESSORIES

When ordering please quote eight digit code numbers.

Ordering numbers	
2957B	AMPS Cellular Test System (Analog).
Option 001	Sensitive receiver.
Option 006	DC Kit & Stowage cover.
	Supplied with Cables and Fixing Kit. Front Stowage cover. Operating Manuals. Introductory Guide. DC Supply Lead (with option 006). BNC Telescopic Antenna (with option 001). Operating Summary Card.
54415-018W	**Selected Accessories** Analog Amps Adapter (converts a 2955 with GPIB to 2957 to allow Analog AMPS Cellular).
44991-064D	PATSIE Test Software for 2960 or 2957 series.
43137-886D	9-way D type connection lead PC to 2960B or 2957B.
43137-887T	25-way D type connection lead PC to 2960B or 2957B.

Ordering numbers	
2957D	AMPS Cellular Test System (Digital & Analog).
Option 001	Sensitive receiver.
Option 006	DC Kit & Stowage cover.
Option 21	450 MHz & 800 MHz D-AMPS capability.
	Supplied with Cables and Fixing Kit. Front Stowage cover. Operating Manuals. Introductory Guide. DC Supply Lead (with option 006). BNC Telescopic Antenna (with option 001). Operating Summary Card.
54415-019D	**Selected Accessories** Digital Amps Adapter (converts a 2955 with GPIB to 2957 to allow Analog & Digital AMPS 800 MHz Cellular).
54415-022D	As 54415-019D with 450 MHz and 800 MHz D-AMPS capability.
44991-064D	PATSIE Test Software for 2960 or 2957 series.
43138-206E	9-way D type connection lead PC to 2960D or 2957D.
43138-207U	25-way D type connection lead PC to 2960D or 2957D.
43138-208Y	TIA interface cable.

Ordering numbers	General Accessories
54433-022Y	GPIB interface for 2955 series.
43129-189U	GPIB lead.
43130-596E	N type to TNC double screened cable.
46662-192W	Hard transit case for either 2955 or 2957 series.
46881-982C	Service manual for 2957B.
46882-140T	Service manual for 2957D.
46883-408K	GPIB adapter, IEEE male/IEC female.
43883-907V	DC supply cable kit, connects mobile to test system and comprises: 4 mm to 4 pole AMP cable (1 m), 4 mm to open end (1 m).
43130-592K	Parallel Control port to centronics printer cable.

Refer to separate data sheet for full range of 2955 series accessories.