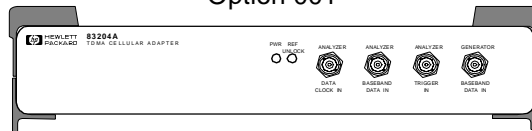


# HP 83204A Cellular Adapter User's Guide

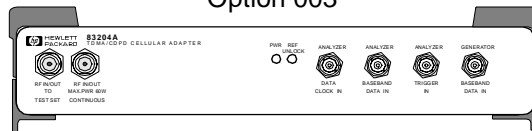
for use with  
HP 8921A Cell Site Test Set - Firmware Version A.16.00 and above

This manual applies directly to the following instruments:  
HP 83204A TDMA Cellular Adapter (Option 001)  
HP 83204A TDMA/CDPD Cellular Adapter (Option 003)

Option 001



Option 003



**HP Part No. 83204-90009**  
**Printed in U. S. A.**  
**August 1996**

**Rev. B**

Copyright © Hewlett-Packard Company 1996

**Notice**

Information contained in this document is subject to change without notice.

All Rights Reserved. Reproduction, adaptation, or translation without prior written permission is prohibited, except as allowed under the copyright laws.

This material may be reproduced by or for the U.S. Government pursuant to the Copyright License under the clause at DFARS 52.227-7013 (APR 1988).

Hewlett-Packard Company  
Learning Products Department  
24001 E. Mission  
Liberty Lake, WA 99019-9599  
U.S.A.

**Manufacturer's Declaration**

This statement is provided to comply with the requirements of the German Sound Emission Directive, from 18 January 1991.

This product has a sound pressure emission (at the operator position) < 70 dB(A).

- Sound Pressure  $L_p < 70$  dB(A).
- At Operator Position.
- Normal Operation.
- According to ISO 7779:1988/EN 27779:1991 (Type Test).

**Herstellerbescheinigung**

Diese Information steht im Zusammenhang mit den Anforderungen der Maschinenlärminformationsverordnung vom 18 Januar 1991.

- Schalldruckpegel  $L_p < 70$  dB(A).
- Am Arbeitsplatz.
- Normaler Betrieb.
- Nach ISO 7779:1988/EN 27779:1991 (Typprüfung).

## Safety Considerations

### GENERAL

This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

This product has been designed and tested in accordance with *IEC Publication 1010*, "Safety Requirements for Electronic Measuring Apparatus," and has been supplied in a safe condition. This instruction documentation contains information and warnings which must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

### SAFETY EARTH GROUND

A uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set.

### CHASSIS GROUND TERMINAL

To prevent a potential shock hazard, always connect the rear-panel chassis ground terminal to earth ground when operating this instrument from a dc power source.

### SAFETY SYMBOLS



Indicates instrument damage can occur if indicated operating limits are exceeded. Refer to instruction in this guide.

Indicates hazardous voltages.

Indicates earth (ground) terminal

---

### WARNING

**A WARNING note denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.**

---

### CAUTION

A CAUTION note denotes a hazard. It calls attention to an operation procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond an CAUTION note until the indicated conditions are fully understood and met.

## Safety Considerations for this Instrument

---

### **WARNING**

**This product is a Safety Class I instrument (provided with a protective earthing ground incorporated in the power cord). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor inside or outside of the product is likely to make the product dangerous. Intentional interruption is prohibited..**

**Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.**

**If this instrument is to be energized via an autotransformer (for voltage reduction), make sure the common terminal is connected to the earth terminal of the power source.**

**If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protection are intact) only.**

**No operator serviceable parts in this product. Refer servicing to qualified personnel. To prevent electrical shock, do not remove covers.**

**Servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing unless you are qualified to do so.**

**The opening of covers or removal of parts is likely to expose dangerous voltages. Disconnect the product from all voltage sources while it is being opened.**

**Adjustments described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.**

**The power cord is connected to internal capacitors that may remain live for 5 seconds after disconnecting the plug from its power supply.**

**For Continued protection against fire hazard, replace the line fuse(s) only with 250 V fuse(s) or the same current rating and type (for example, normal blow or time delay). Do not use repaired fuses or short circuited fuseholders.**

---

---

**CAUTION:**

Always use the three-prong ac power cord supplied with this product. Failure to ensure adequate earth grounding by not using this cord may cause product damage.

This product is designed for use in Installation Category II and Pollution Degree 2 per *IEC 1010* and *IEC 664* respectively. For indoor use only.

This product has autoranging line voltage input, be sure the supply voltage is within the specified range.

Ventilation Requirements: When installing the product in a cabinet, the convection into and out of the product must not be restricted. The ambient temperature (outside the cabinet) must be less than the maximum operating temperature of the product by 4° C for every 100 watts dissipated in the cabinet. If the total power dissipated in the cabinet is greater than 800 watts, then forced convection must be used.

**Product Markings**

CE - the CE mark is a registered trademark of the European Community. A CE mark accompanied by a year indicated the year the design was proven.

CSA - the CSA mark is a registered trademark of the Canadian Standards Association.

---

**WARNING**

**To prevent electrical shock, disconnect the HP 83205A from mains before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally**

**CERTIFICATION**

*Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members*

**WARRANTY**

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firms are designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

**LIMITATION OF WARRANTY**

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

**NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.**

**EXCLUSIVE REMEDIES**

**THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASE ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.**

**ASSISTANCE**

*Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products. For any assistance, contact your nearest Hewlett-Packard Sales and Service Office.*

## In this Book

*Chapter 1, Digital Modulation Concepts*, describes the benefits of using TDMA (time division multiple access) digital modulation, the similarities and differences between analog and digital systems, and the basics for understanding digital modulation systems.

*Chapter 2, Making TDMA Measurements*, describes the basic TDMA measurements and how to use the Cellular Adapter and the Test Set to make them.

*Chapter 3, TDMA Dual Mode Cellular Test Screen*, contains information about each control and measurement on the Test Set's TDMA test screen.

*Chapter 4, Connector Descriptions*, describes the functions and operating characteristics of the Cellular Adapter's connectors.

*Chapter 5, HP-IB Syntax Diagrams for TDMA Test*, contains syntax diagrams for remote programming reference. This chapter also contains an example of a simple HP-IB program.

*Chapter 6, Specifications*, lists specification for the test system's TDMA generator and TDMA analyzer. (The test system is the Test Set and Cellular Adapter together.)

## CDPD Operation

This cellular adapter may be configured three different ways:

Option 001 - provides TDMA base station testing.

Option 002 - provides Cellular Digital Packet Data (CDPD) base station testing, and may be retrofitted to also provide TDMA base station testing.

Option 003 - provides testing for both TDMA and CDPD base stations.

CDPD base stations are tested using the Mobile Data Base Station (MDBS) Cell Site Test Software. The software, and its manual, are shipped with every option 002 or option 003 Cellular Adapter. All CDPD testing is done using the software; there is no manual testing. Although a screen titled "CDPD SCREEN" can be accessed, it is only used by the factory software for CDPD testing.



---

## Contents

### **1 Digital Modulation Concepts**

Why Use Digital Modulation? 18

Increased System Capacity 18

Traditional Analog Systems 19

TDMA Digital Systems 21

Assigning Calls to Channels 23

Formatting Calls Into a TDMA Frame 25

Modulating the Carrier 27

Understanding QPSK (Quadrature Phase Shift Keying) 28

Understanding Pi/4 DQPSK 29

Understanding IQ Patterns and Constellation Diagrams 30

Need More Details on TDMA Systems? 32

### **2 Making TDMA Measurements**

Comparing Analog and Digital Tests 34

Test System Overview 36

Reference Connections 40

Using Channel Tuning 44

Measuring Error Vector Magnitude (EVM) 46

Performing an Error Vector Magnitude Self-test 50

Measuring Bit Error Rate 51

Performing a Bit Error Rate Self-test 56

Measuring Adjacent Channel Power 57

Performing an Adjacent Channel Power Self-test 61

Measuring Power 62

TDMA Tests Using HP-IB 66

---

## Contents

### 3 Screen and Field Descriptions

TDMA DUAL MODE CELLULAR TEST Screen 70

---

## Contents

### **4 Connector Descriptions**

Cellular Adapter Connector Descriptions 98

---

## Contents

### **5 HP-IB Syntax Diagrams for TDMA Test**

HP-IB Syntax Diagram Listing 114

---

## Contents

### 6 Specifications

TDMA Signal Generator Specifications 125

TDMA Analyzer Specifications 125

---

## Contents

### 7 Installation

---

## Contents



---

## Digital Modulation Concepts

This chapter provides an overview of digital cellular radio systems, Time Division Multiple Access (TDMA) communications theory, and Pi/4 DQPSK modulation. Specific frequencies and data structures given in this document refer to the NADC (North American Dual-Mode Cellular) system.

## Why Use Digital Modulation?

---

### **Increased System Capacity**

Most cellular phone systems only allow one conversation to be assigned to a radio channel at one time. The TDMA format allows up to six people to use the same channel at the same time; greatly increasing the number of people that can be serviced from a cell site.

### **More Secure Communications**

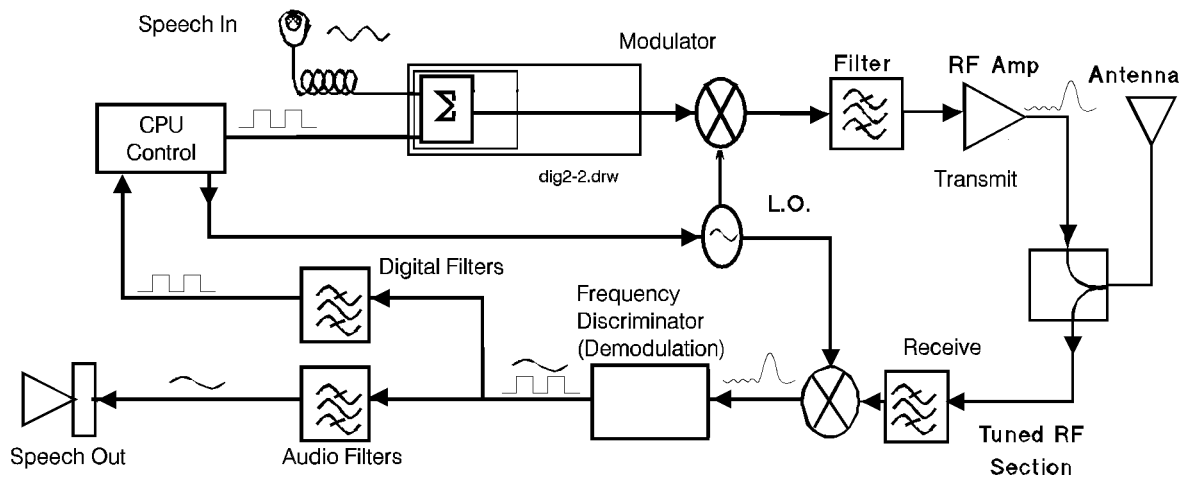
Any time an un-scrambled analog signal is transmitted, anyone with a suitable receiver can listen to it by tuning to the appropriate channel frequency. Systems using all digital modulation encode the message, and may add special encryption information to provide additional security.

---

## Traditional Analog Systems

Early cellular phone systems combine analog voice modulation with digital control data. The widely-used AMPS format is an example of this type of system. The control data identifies the mobile unit, and provides the necessary call setup information to the telephone company's switching operation.

The drawing below illustrates the main functional blocks of an analog cellular phone.



**Figure 1** An Analog Cellular Radio Transceiver

## Transmitting

In the Modulator, analog speech is converted to standard FM, and digital data is converted to FSK modulation. FSK (Frequency Shift Keying) uses the 1 and 0 logic states of the data to cause specific frequency shifts in the carrier. The combined modulating signal is mixed with the Local Oscillator (LO) to up-convert the signal to the cellular frequency band. The modulated carrier is filtered, amplified, and then sent to the antenna.

## Receiving

The incoming signal is filtered and down-converted to an intermediate frequency (IF). The Frequency Discriminator then demodulates the IF to strip off the modulating signal. The modulating signal is then fed into filters to separate the speech and digital control data.

The CPU Control coordinates transmit and receive channel timing and frequencies between the mobile (phone) and the base station.

---

## TDMA Digital Systems

Systems using the TDMA format use sophisticated Digital Signal Processing (DSP) encoders and decoders to digitize speech and add call processing information. The drawing below illustrates the main functional blocks in a digital cellular phone. The upper half of the drawing illustrates the transmitter portion of the phone; the lower part illustrates the receiver section.

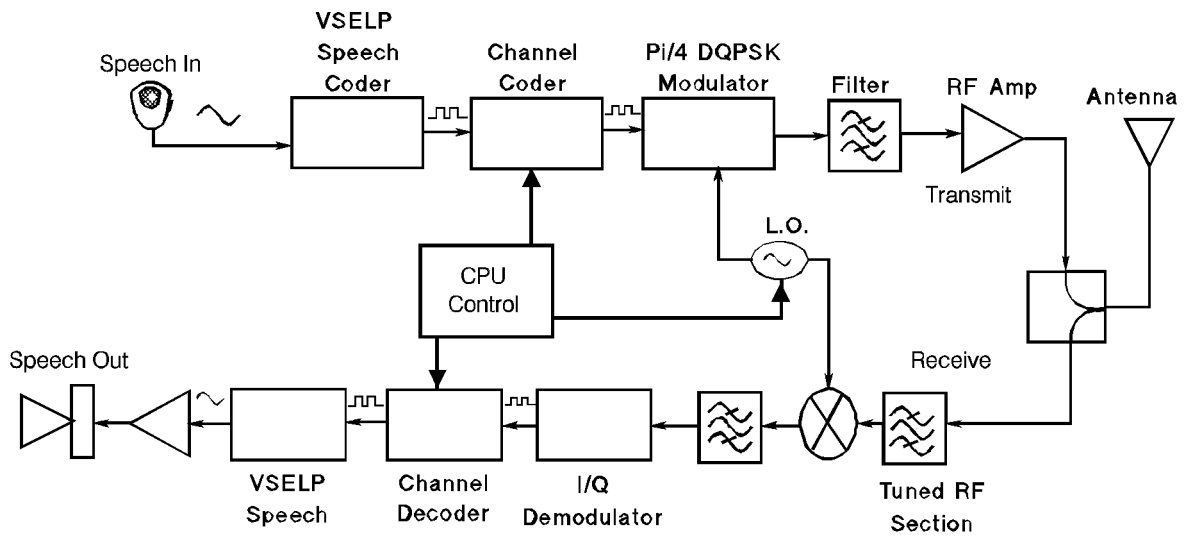


Figure 2 An All Digital Transceiver

## Transmitting

The VSELP Speech Coder uses Vector Sum Excited Linear Predictive coding to digitize speech, using complex algorithms to minimize the amount of data needed to represent the voice information. The Channel Coder adds the TDMA data for channel coding; such as the phone's subscriber number, the channel (frequencies) to use, the 'timeslot' to transmit on, the base station to use,..etc. The Pi/4 DQPSK Modulator provides Pi/4 Differential Quadrature Phase Shift Keying modulation, using the Local Oscillator (LO) to up-convert the signal to the cellular frequency band. The modulated carrier is filtered, amplified, and sent to the antenna for transmission.

The CPU Control block coordinates transmit and receive channel timing and frequencies between the mobile (phone) and the base station.

## Receiving

When received, the signal is filtered, down-converted to an intermediate frequency (IF), filtered again, and input to the IQ Demodulator. The demodulated data enters the Channel Decoder to remove the channel information. The VSELP Speech Decoder reconstructs the remaining data into speech.

---

## Assigning Calls to Channels

### Channel Assignments for Analog Systems

In analog systems, every cellular phone call uses an individual *channel*. A channel refers to the pair of frequencies used to transmit and receive a call. No other phones can use that channel while a call is present. Simultaneous transmission and reception of a call (called 'duplex') is provided using a frequency offset between the transmit and receive frequencies (typically 45 MHz for cellular phone systems).

In the illustration below, TX1 and RX1 represent the transmit and receive frequencies (channel) used by one conversation. TX2 and RX2 represent another conversation happening at the same time using a different channel. TX1 and TX2 are typically spaced 30 kHz apart.

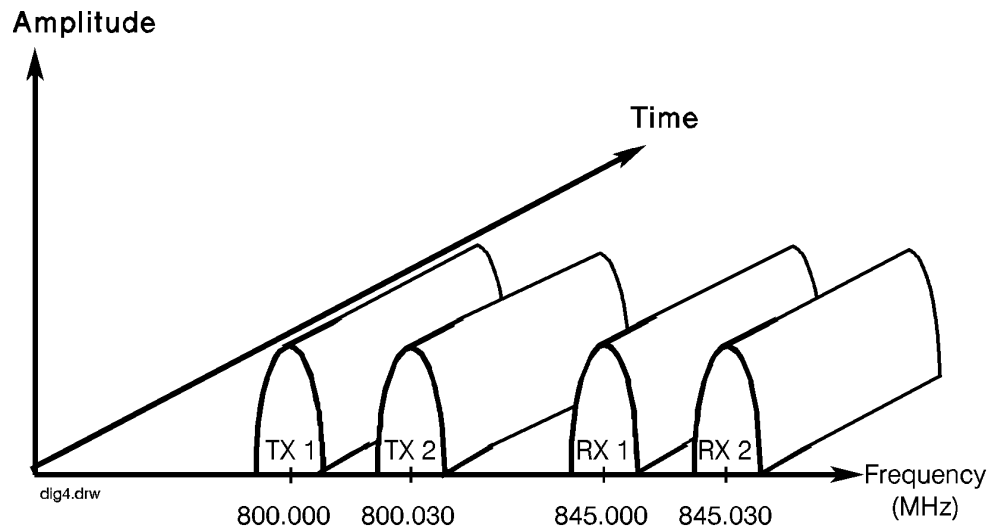
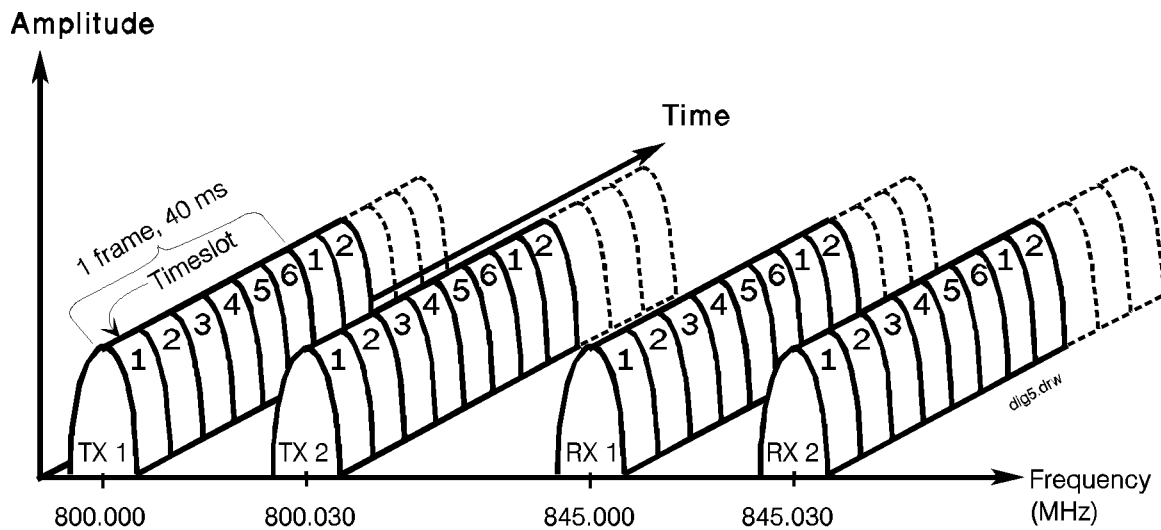


Figure 3 Assigning One Call Per Channel

**Channel Assignments for TDMA Systems**

In a TDMA system, channel capacity is increased by allowing up to six phone calls to share a channel. By ‘time-sharing’ the channel, only one conversation is being transmitted by the base station at a time.

In the illustration below, TX1 and RX1 represent the transmit and receive frequencies (channel) used for one group of six calls. The group is called a *frame*, with each call in the frame occupying one *timeslot*. TX2 and RX2 represent another frame of calls happening at the same time on a different channel.



**Figure 4** Assigning Six Calls Per Channel Using TDMA

When a base station transmits a frame, the six timeslots in the frame are sequentially transmitted and received on one channel. Although the base station is continually transmitting and receiving frames, each mobile is only allowed to transmit and receive data during its assigned timeslot in the frame.

A mobile user cannot tell that their radio only listens to every 6th timeslot because of the digital processing techniques used. Speech data is compressed when sent, and expanded when received, filling the gaps in reception with speech while their timeslot is not being received.

---

**NOTE:** Current TDMA systems actually use two slots per frame for each call. Consequently, a maximum of 3 calls are carried on each channel. The timeslots assigned to each call are staggered, so caller #1 actually uses slots 1 and 4, caller #2 uses slots 2 and 5, and caller #3 uses slots 3 and 6. In the future, when higher-performance digital coding techniques are implemented, each call will occupy only one timeslot; allowing the system to perform at the maximum capacity of six calls per frame.

---



---

## Formatting Calls Into a TDMA Frame

Each timeslot in the frame has 324 bits of information, containing the data needed to identify the phone (mobile) being used, the information needed to setup and transfer calls, and the digitally-encoded speech of the user. The bits are grouped into pairs by the Channel Coder to create 162 *symbols*.

Each timeslot is transmitted for 6.667 milliseconds; taking 40 milliseconds to send the entire frame at a rate of 48.6 Kbits per second (24.3 Ksymbols/second).

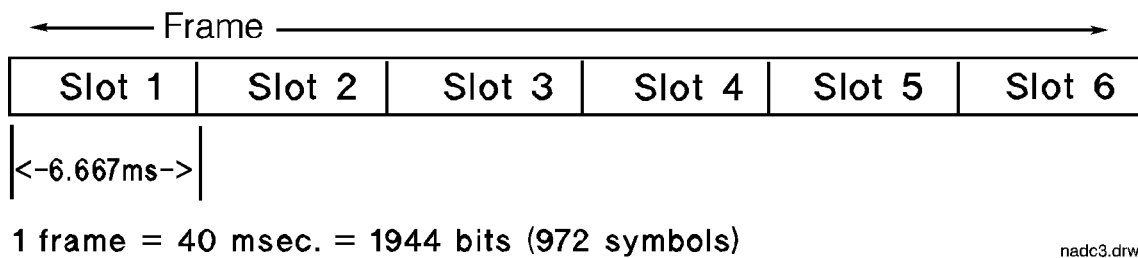
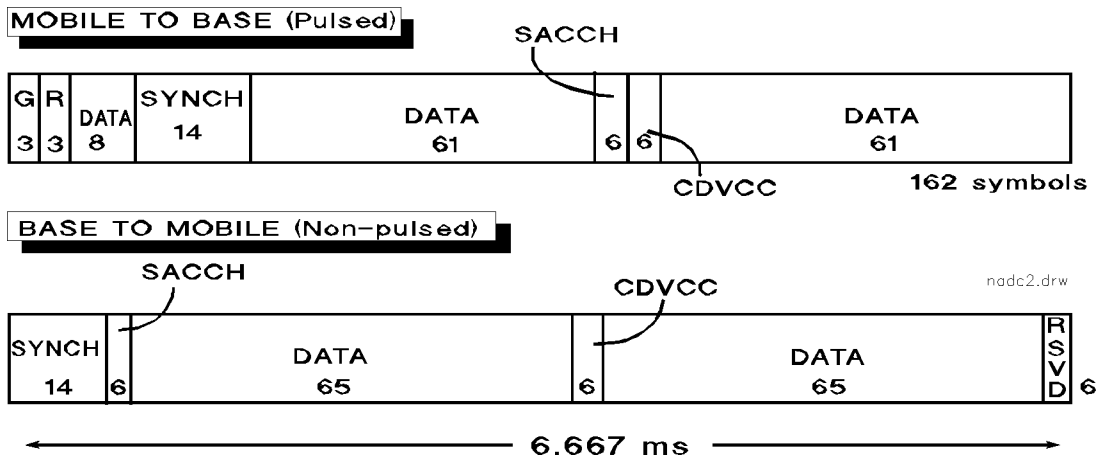


Figure 5 TDMA Frame Format for North American Dual-Mode Cellular Systems

**What Each Type of Data Does**

- Guard and Ramp allow the mobile to pulse its carrier on and stabilize before transmitting further data.
- SYNCH (synchronization) data is used for slot synchronization, equalizer training, and timeslot identification.
- SACCH (Slow Associated Control Channel) data provides signaling message (supervisory and control) exchange between the base station and mobile.
- FACCH (Fast Associated Control Channel) data is used when SACCH information is too slow, or some change in control of the mobile needs to be implemented immediately. To do this, the base station “steals” speech data to send the control or supervisory message to the mobile.
- CDVCC (Coded Digital Verification Color Code) is used to identify which base station a mobile is currently using - no two adjacent base stations have the same CDVCC.
- RSVD (Reserved) data provides additional base station data space for future system improvements.
- DATA is the information (usually digitized speech) that the phone user wants to communicate to another user. (See also FACCH listed above.)



**Figure 6 Contents of Each Timeslot in the Frame**

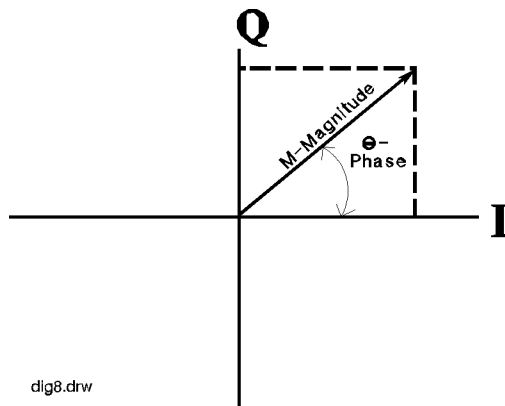
The numbers shown in each section of the timeslot represent the number of symbols used to convey that information. The type and arrangement of the data in the slot is different for mobiles and base stations.

---

## Modulating the Carrier

After the digitized speech and control data are grouped into symbols, the symbols are sent to the IQ Modulator to change the carrier's amplitude and phase. This change is expressed in polar notation as a vector, whose length ( $M$ ) represents the amplitude of the carrier, and whose angle ( $\theta$ ) represents the phase in degrees. If the carrier amplitude is kept constant, and the phase is swept from  $0^\circ$  to  $360^\circ$ , the tip of the vector would form a perfect circle.

The signal can also be described in rectangular coordinates. The I and Q scales are used as the two axes for describing the coordinates.



### CARRIER PHASE & AMPLITUDE:

Described by Rectangular:

$$\Theta = \text{Arctan } Q/I$$

$$M = \sqrt{I^2 + Q^2}$$

Described by Polar:

$$M \angle \Theta$$

Figure 7 Mathematical Definitions and Illustration of IQ Modulation

---

## Understanding QPSK (Quadrature Phase Shift Keying)

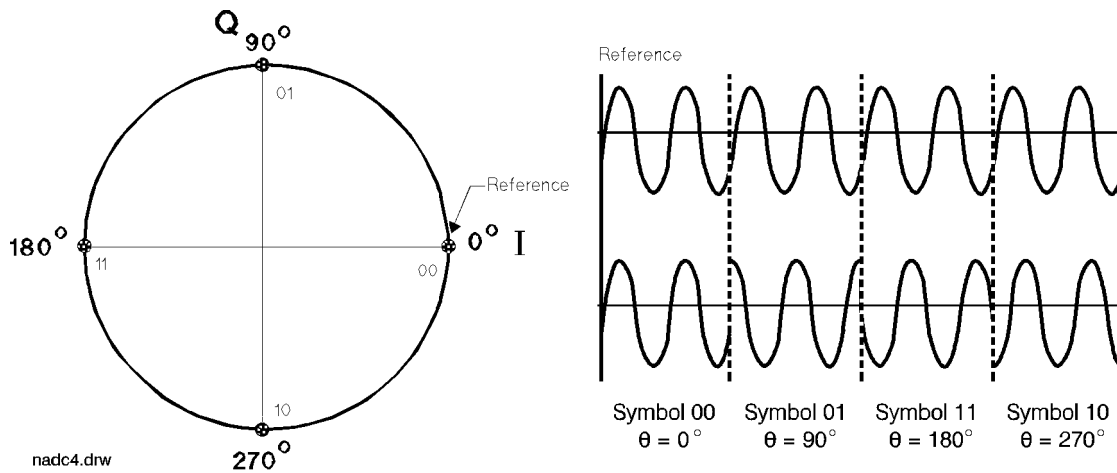
QPSK modulation converts 2-bit symbols into discrete changes in phase, *relative to a fixed reference signal*.

The symbols are used to modulate the carrier for transmission, and then to reconstruct the decoded data when received. Since each bit in the data is either a logic 1 or 0, there are four possible symbols: 00, 01, 10, and 11.

- Symbol 00 results in  $0^\circ$  of phase shift.
- Symbol 01 results in  $90^\circ$  of phase shift.
- Symbol 11 results in  $180^\circ$  of phase shift.
- Symbol 10 results in  $270^\circ$  of phase shift.

The amplitude (magnitude) of the carrier is kept constant.

The illustration below indicates the change in phase states for each received symbol, and the resulting change in the modulated carrier relative to the reference.



## Understanding Pi/4 DQPSK

TDMA systems use Pi/4 DQPSK (Pi/4 Differential Quadrature Phase Shift Keying) modulation. In this system, *phase changes are referenced to the last known phase state of the carrier*, eliminating the need for a fixed reference signal.

Using Pi/4 DQPSK, symbols input to the IQ modulator result in the following phase changes:

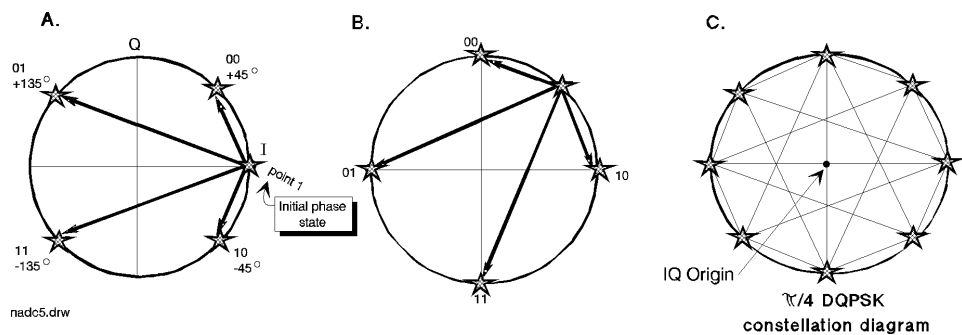
- A 00 results in  $+45^\circ$  of phase shift.
- A 01 results in  $+135^\circ$  of phase shift.
- A 10 results in  $-45^\circ$  of phase shift.
- A 11 results in  $-135^\circ$  of phase shift.

Looking at the illustration below,

Drawing A shows a starting point for the phase and amplitude of a received signal, and the four possible vectors that can result when the next I/Q shift occurs.

Drawing B assumes that a 00 symbol was transmitted, shifting the initial reference point by  $+45^\circ$ . The four possible vectors that could follow when the next symbol is transmitted are indicated.

Drawing C indicates every possible vector that can occur. This is referred to as a Constellation Diagram.



**Figure 8** Possible Phase Transitions Using Pi/4 DQPSK

The point where the I and Q axes cross is referred to as the *IQ origin*. The farther a point on the vector is from the origin, the greater the amplitude of the carrier at that time.

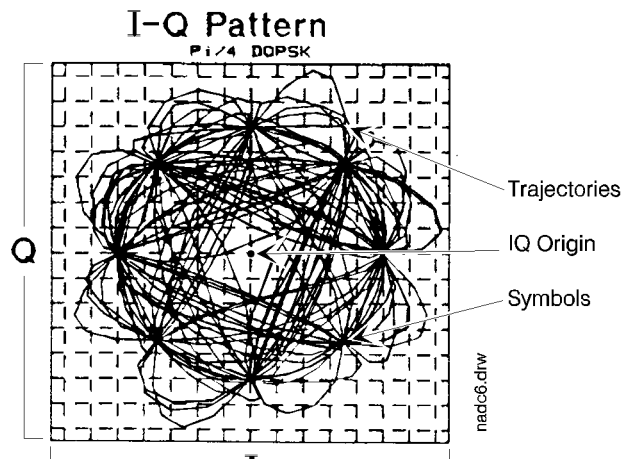
---

## Understanding IQ Patterns and Constellation Diagrams

An IQ Pattern traces the phase and amplitude changes of the carrier. In an actual system, the vectors do not form straight lines, they arc through the symbol transition points as I and Q change. Because of this arcing effect, the measured IQ paths are also referred to as *trajectories* when displayed.

There are two characteristics that are important to notice -

1. The amplitude of the carrier is not constant. You can see in **figure 9** below that some trajectories pass close to the IQ origin when moving between symbol points, indicating a loss of amplitude between symbols. Notice that a vector never passes through the IQ origin (although one comes very close in this case). Passing through the origin would indicate the carrier's amplitude is at zero at that point, causing the receiver to lose the signal (and possibly lose the phone call if it happens very often).
2. Although the trajectory of the carrier is changing widely, it always crosses through one of the eight symbol locations. Transmitted data is sampled and recovered at the time the carrier phase is at one of the symbol points. The actual trajectory between symbol locations is unimportant (unless it passes through the IQ origin), since we are only interested in the phase and amplitude of the carrier at precise points in time.



**Figure 9** An Actual IQ Pattern From a TDMA Transmitter

### Measuring IQ Modulation Quality

How close the carrier is to the correct phase and amplitude when the receiver samples the data is called Error Vector Magnitude (EVM). If EVM is too large, the receiver has a hard time determining the intended phase change. If data is incorrectly demodulated or decoded by the receiver, the phone call may be lost, or will fail to be established at all.

The illustration below shows the phase and amplitude of the carrier at the points when the receiver sampled the data. By looking at this type of constellation display, it is easier to see the EVM at each of the eight symbol points. Since several frames of mobile data was measured, there are several error vectors for each symbol. This diagram is for a transmitter with  $\approx 15\%$  EVM.

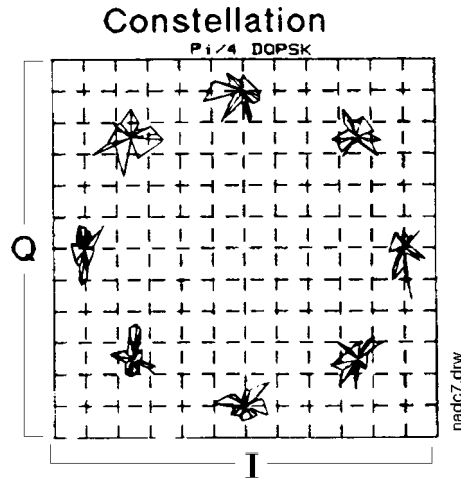


Figure 10

An Actual Constellation Pattern From a TDMA Transmitter

---

## Need More Details on TDMA Systems?

This chapter has provided a very *basic* overview on TDMA systems. The sophisticated process of initiating a call, call hand-off between cells, cell site operation, and the complex interaction between the cellular system and telephone switching system is beyond the scope of this manual.

For more details on TDMA data structure and standards, refer to the following EIA/TIA standards:

- IS-54 for system information.
- IS-55 for mobile radio information.
- IS-56 for base station information.

Specific, detailed system operation information can only be provided by the manufacturer of the equipment you are using: each manufacturer has their own operating systems for testing their equipment.



---

## Making TDMA Measurements

This chapter is an overview of how TDMA measurements are made using the TDMA Test System (Test Set and Cellular Adapter). The measurement procedures are provided as *generic* test routines. You must know how to get your transceiver to transmit. Refer to your transceiver's documentation, or call the manufacturer, for specific operating information.

You must understand how to access the necessary test screens and alter control settings of the Test Set to use procedures in this chapter. If you are not familiar with the operation of the Test Set, refer to its User's Guide.

## Comparing Analog and Digital Tests

Most of the basic tests performed on analog radios have a digital radio test equivalent. The main difference is that digital radios use Pi/4 DQPSK modulation instead of standard FM.

### Receiver Tests

#### Sensitivity and BER

The Sensitivity measurement for an analog FM receiver involves reducing the level of a modulated carrier until the receiver's demodulated signal gets noisy. The carrier's level at the point where the receiver's signal gets too noisy is its sensitivity.

The Bit Error Rate test for a digital receiver compares the transmitted data sent over a Pi/4 DQPSK-modulated carrier to the resulting demodulated data out of the receiver. The carrier level is reduced until the receiver starts incorrectly translating the received data from the generator. The percentage of misinterpreted bits at a specific carrier amplitude is the Bit Error Rate.

## Transmitter Tests

### Modulation Accuracy and EVM

Measuring Modulation Accuracy of an analog FM transmitter involves modulating the transmitter with a sinewave and measuring the resulting deviation of the carrier. If the transmitter's modulation circuits are aligned correctly, the total deviation for the modulation level input should be within specifications, and the positive and negative deviations of the carrier should be equal.

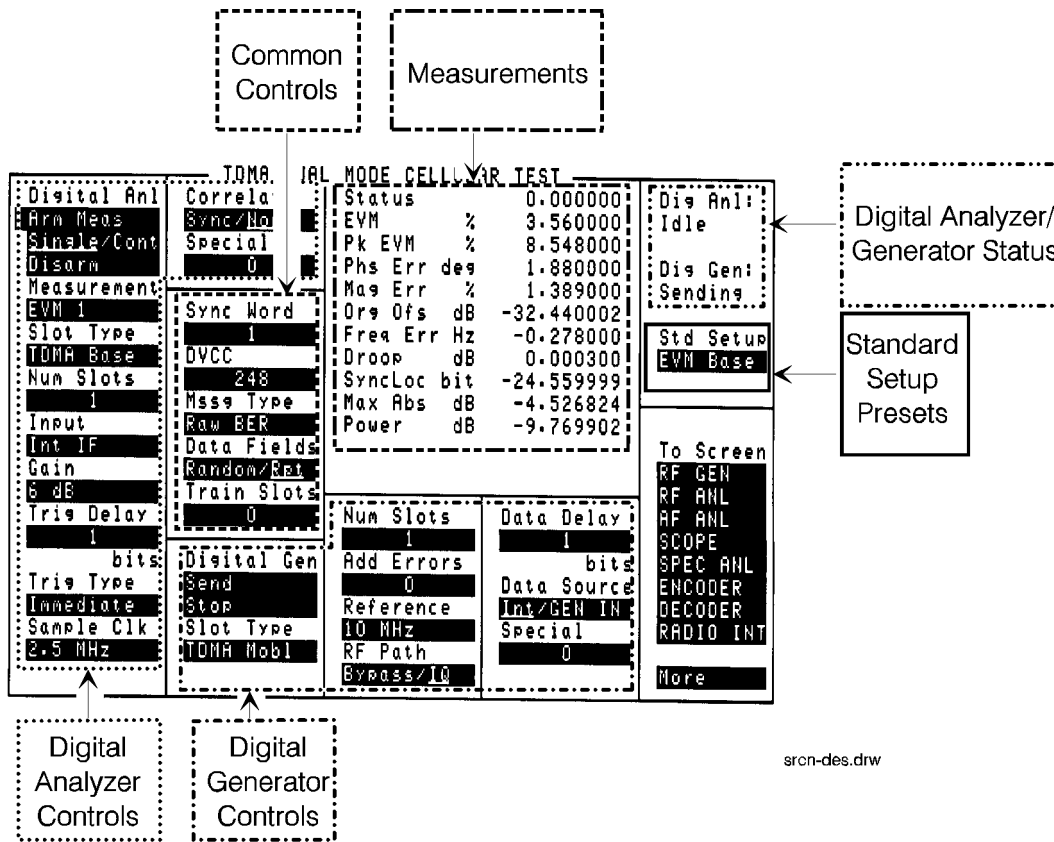
Measuring Error Vector Magnitude (EVM) of a TDMA digital transmitter involves modulating the transmitter with TDMA data and analyzing the resulting phase and amplitude changes. If the IQ Modulator and supporting DSP (Digital Signal Processing) circuits of the transmitter are working correctly, the correct phase and amplitude shifts are present in the carrier when the analyzer's clock samples the decoded data.

### Adjacent Channel Power

The Adjacent Channel Power measurement looks at how much unwanted transmitter power is broadcast into the channels above and below the transmitter's intended carrier frequency. This measurement is basically the same for Analog FM and Digital systems; the difference is a special receiver filter used with digital signals before being measured. The measurement looks at the power levels three channel-spacings above and below the carrier.

## Test System Overview

All controls and measurements for the Digital Test Systems are displayed on the TDMA DUAL MODE CELLULAR TEST screen of the Test Set. This screen is accessed by selecting the **More** field in the bottom-right corner of the displayed screen and selecting **TDMA TEST**.



srch-des.drw

Figure 11 The TDMA DUAL MODE CELLULAR TEST Screen

## Generating and Analyzing TDMA Signals

- The Digital Analyzer controls are used to prepare the analyzer to make Pi/4 DQPSK transmitter measurements.
- The Digital Generator controls are used to generate a Pi/4 DQPSK signal to test TDMA digital cellular receivers. They are also used to specify the Cellular Adapter's reference frequency.
- The Common controls are used to specify information that the Digital Analyzer and Digital Generator share for tests.
- The Standard Setup field is used to automatically configure controls on the TDMA DUAL MODE CELLULAR TEST screen for specific tests.
- Displaying TDMA Measurements and Instrument Status
- The Measurements area displays measurement results. The type of measurements displayed depends on the Digital Analyzer's **Measurement** field setting.
- The Digital Analyzer/ Generator Status area tells what the Digital Analyzer and Digital Generator are doing:
  - The Digital Analyzer is either **Idle** (not making a measurement) or **Armed** (ready to be triggered by the signal indicated in the Digital Analyzer's **Trig Type** field).
  - The Digital Generator is either **Idle** or **Sending**. When idle, the Digital Generator outputs a constant stream of 00 symbols. When sending, the data stream containing the information defined in the Common and RF Generator controls is output until the generator is at Idle again.

Digital modulation is only output when the **RF Path** field is set to **IQ**. To output an un-modulated RF carrier, set the **RF PATH** field to **Bypass**.

### Configuring the Cellular Adapter

Figure 12 and figure 13 illustrate the functions contained in the Cellular Adapter, and the field(s) used to control them.

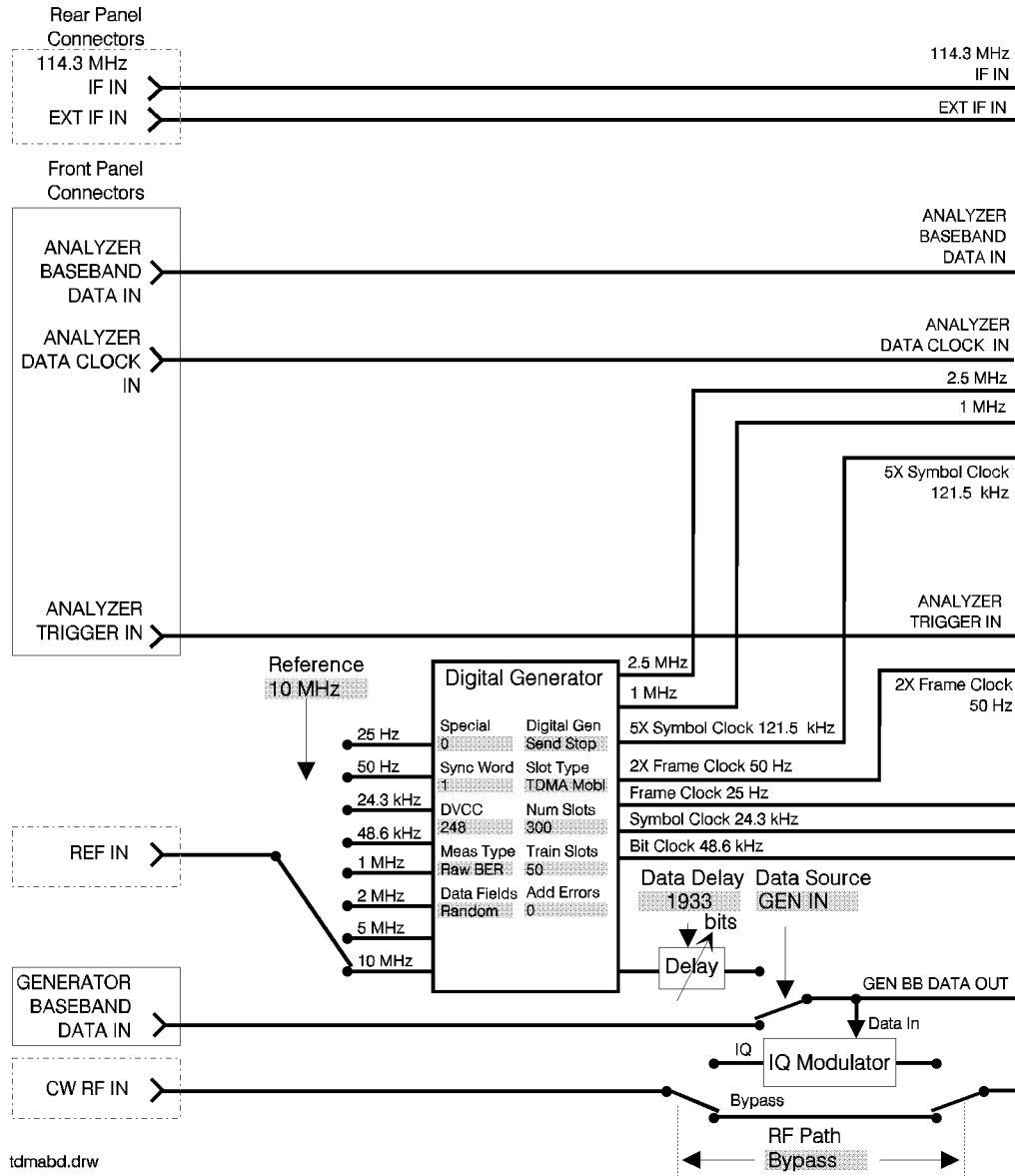


Figure 12 Digital Analyzer Inputs and the Digital Generator

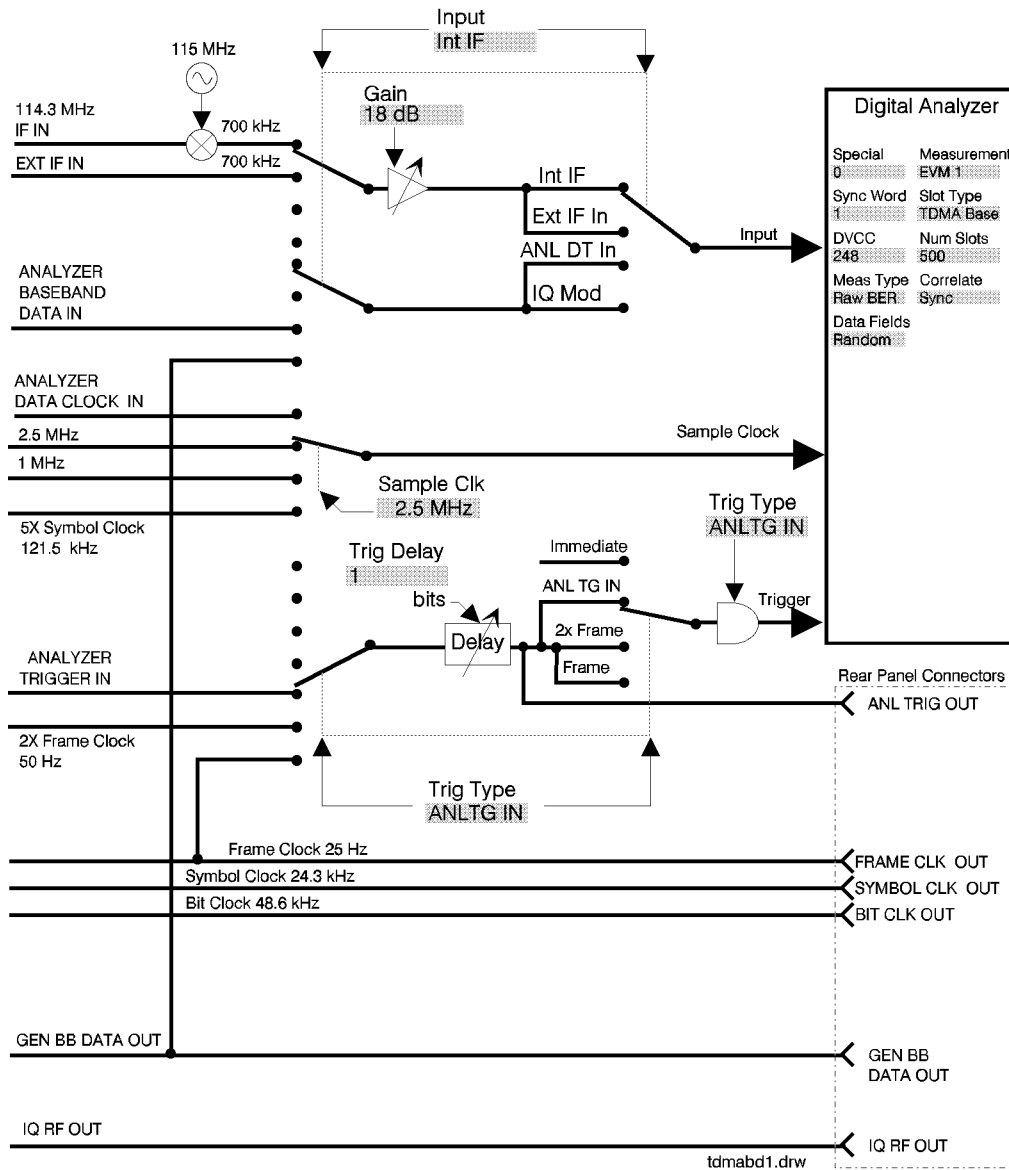


Figure 13 Digital Generator Outputs and the Digital Analyzer

## Reference Connections

Base station receiver tests require the HP 83204A Dual Mode Cellular Adapter, an HP 8921 Test Set, and the base station being tested to be phase-locked together. The reference source may be Test Set's reference output, or an external system reference source.

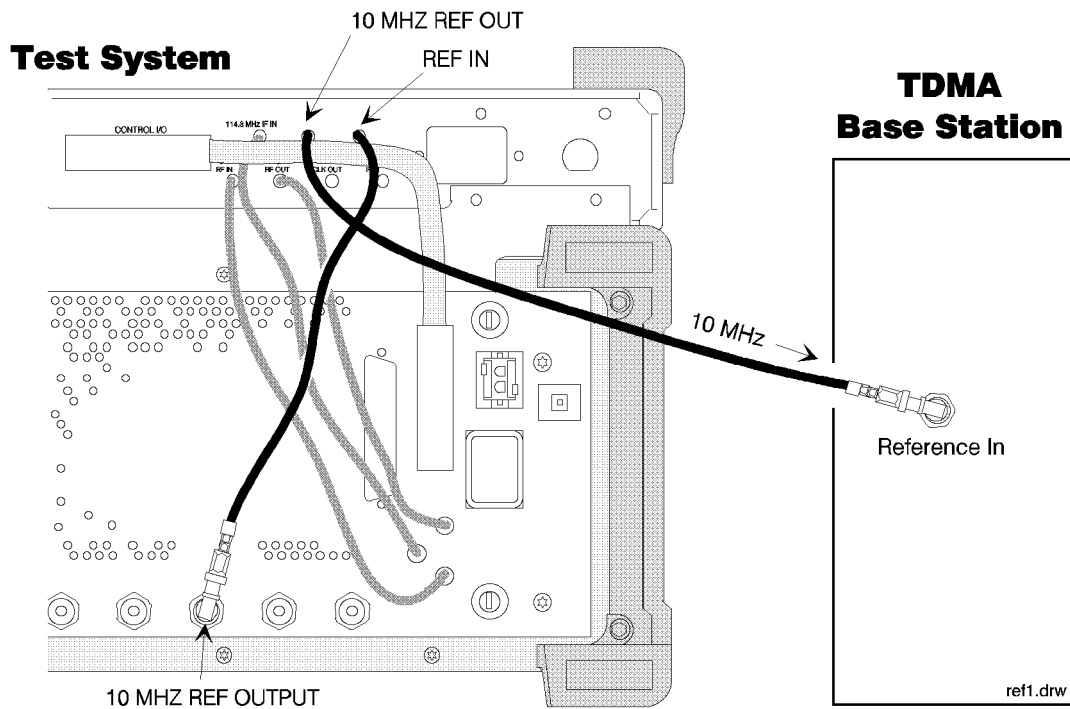
Base station transmitter measurements do not require the transmitter to be phase-locked to the Test System. However, the Test System (HP 83204A and HP 8921) should always be phase locked together.

Mobile radios are designed to phase lock to the base station's carrier and do not require an external reference connection.



**Phase Locking to the Test System's Reference**

If your base station can phase lock to a 10 MHz external reference, we recommend you use the Test System's high-stability timebase as the reference source. Set the **Reference** field of the TDMA DUAL MODE CELLULAR TEST screen to **10 MHz**. Also, make sure the REF UNLOCK indicator on the Adapter is off before making measurements.



**Figure 14** Phase Locking the Base Station to the Test System's Reference

### Phase Locking to the Base Station's Reference

To use your base station's reference, connect the reference from your base station as shown below, and then select one of the available **Reference** field choices.

It takes several seconds for the test system to phase lock to a 25 or 50 Hz signal; wait for the REF UNLOCK light to turn off before making measurements. Also, always connect the reference signal to the test system before selecting the **Reference** field choice; this re-initiates the phase-lock routine needed for these low frequencies.

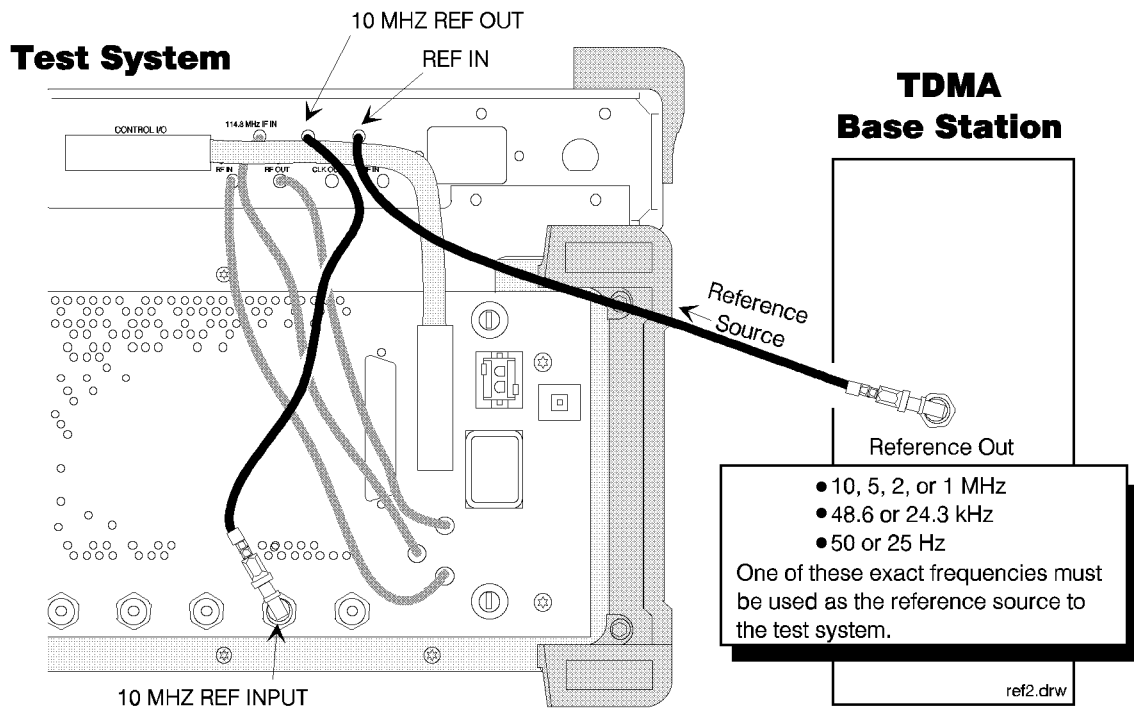


Figure 15 Phase Locking the Base Station's Reference

### Improperly Connecting References

No matter which device you use for a reference source, *do not* loop the reference signal back to the reference's input. If looped-back, each reference will try to lock to the previous instrument's output, and consequently alter its own reference output to the next instrument; continuing around the loop - they will never be phase locked.

In **figure 16**, the connection from the base station's Reference Output to the Test Set's 10 MHz REF INPUT should be omitted; allowing the Test System's 10 MHz REF OUTPUT to be used as the reference source.

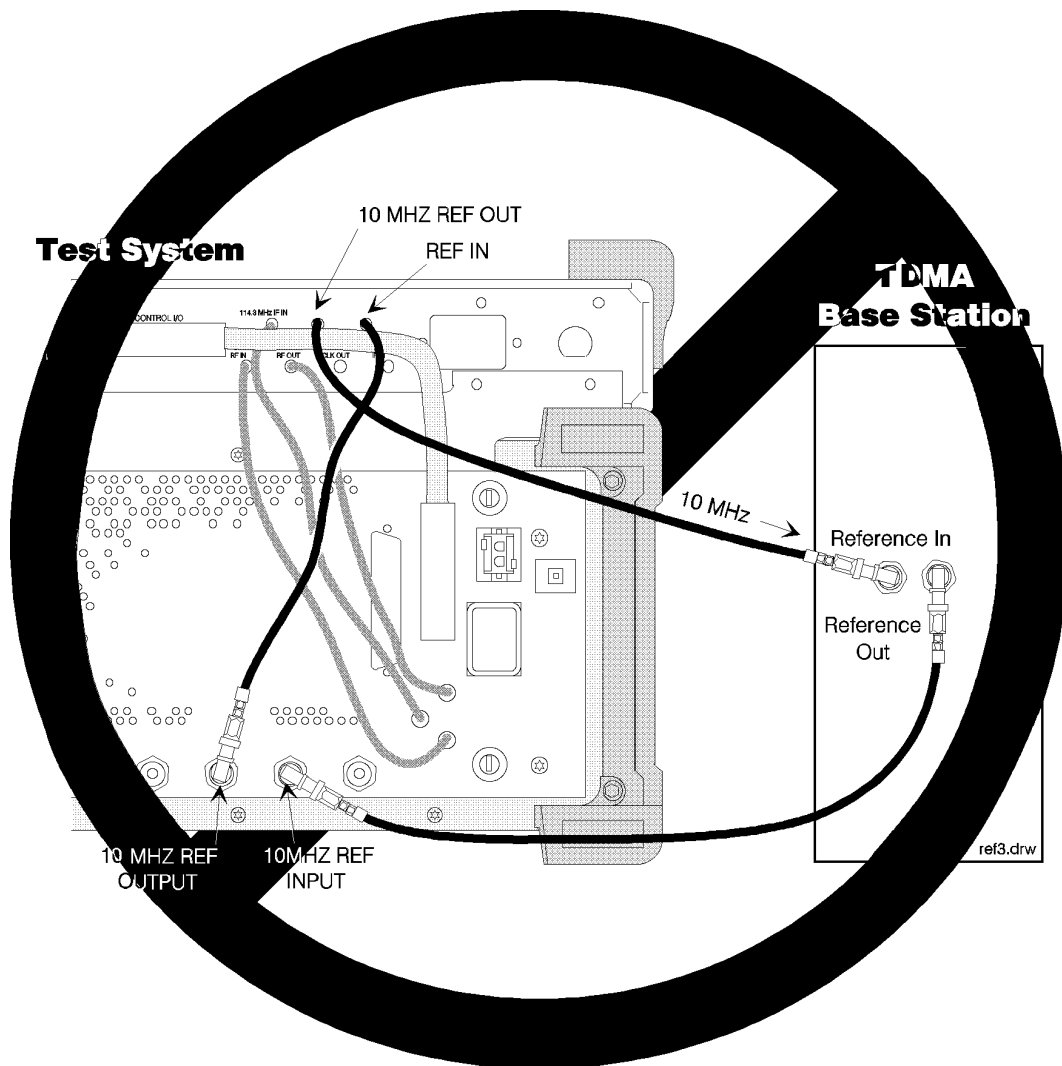


Figure 16

Improper Looping of References

## Using Channel Tuning

The test procedures on the following pages instruct you to enter the transmit and receive frequencies for your transceiver. If you would prefer to enter the channel number directly to set up the RF Analyzer and RF Generator, you can use the Channel Tuning function on the Test Set.

When channel tuning is used, the RF Analyzer's **Tune Mode** and **Tune Freq** fields, and the RF Generator's **RF Gen Freq** field, are replaced by a single field called **RF Channel**.

CONFIGURE				
RX/TX Cntl Auto/Manual Carrier/PLI	Intensity 8	RF Display Freq/Chan	RF Level Offset On/Off	Firmware A.08.06
RF Offset On/Off (Gen)-(Anl) 45.000000 MHz	Beeper Quiet	RF Chan Std: MS AMPS	RF In/Out 0.0	To Screen RF GEN RF ANL RF ANL SCOPE SPEC ANL ENCODER DECODER RADIO INT SERVICE More
RFGen Volts 50 ohm/enf	Low Battery 10 min	User Def Base Freq 800.000000 MHz	Duplex Out 0.0	
Range Hold Auto All Hold All State: Mixed	Date 32593 MMDDYY	Chan Space 30.0000 kHz	Antenna In 0.0 dB	
	Time 12.24 HH.MM	(Gen)-(Anl) 45.000000 MHz		

Figure 17 Channel Tuning is Turned On and Off On the CONFIGURE Screen

**Procedure Changes Using Channel Tuning** If you do use channel tuning when performing the following test procedures, ignore steps that tell you to *set the Tune Mode to Manual*. Also, when told to enter the **Tune Freq** or **RF Gen Freq**, enter the **RF Channel** number instead.

---

**NOTE:** You cannot use channel tuning for the self-tests at the end of each procedure. The self-tests require the RF Generator and RF Analyzer to be tuned to the *same frequencies*; channel tuning automatically sets a 45 MHz difference between these frequencies.

---

1. Access the CONFIGURE screen.
2. Set the **RF Display** field to underline **Chan**.
3. Select the **RF Chan Std** field to match the type of transceiver you are testing.
  - a. Select **MS AMPS** when testing an AMPS/TDMA Mobile Station (mobile).
  - b. Select **LS AMPS** when testing an AMPS/TDMA Land Station (base).

**To Disable Channel Tuning**

1. Access the CONFIGURE screen.
2. Set the **RF Display** field to underline **Freq**.
3. Set the **RF Offset** field to **Off** to disable the 45 MHz Generator-Analyzer offset. Leaving this field **On** causes the RF Generator and RF Analyzer to always be offset by the value in the **(Gen) - (An1)** field (45 MHz in this case).

## Measuring Error Vector Magnitude (EVM)

For a description of the EVM 1 and EVM 10 measurements, refer to the [Measurement field description, on page 81](#).

Before proceeding, press the PRESET key on the Test Set to establish a known instrument state.

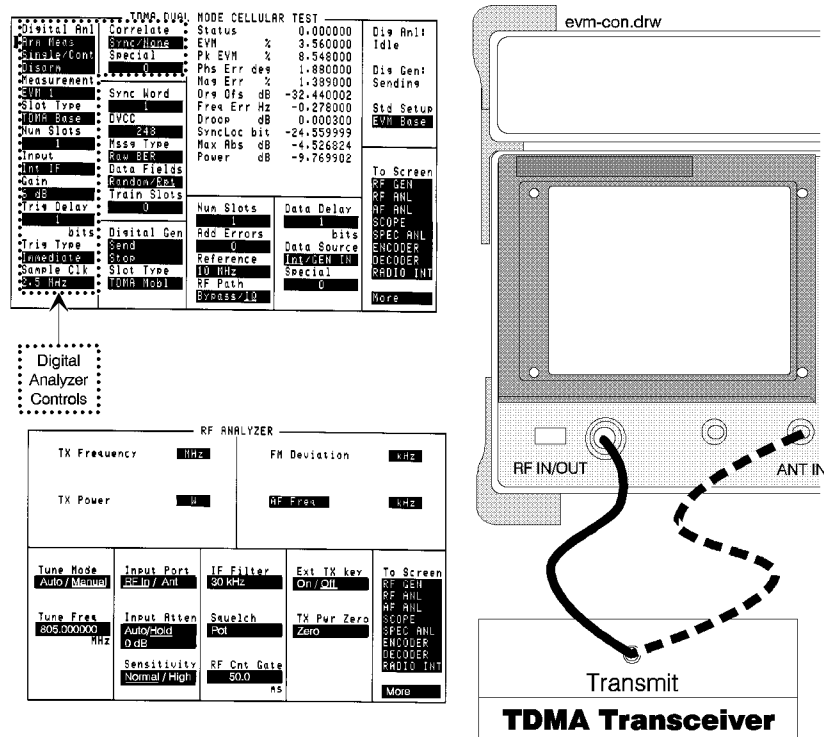


Figure 18 Basic Setup to Test Error Vector Magnitude

The measurement example above indicates an EVM of 3.56 %. Several other parameters are also displayed, including **status**. These parameters are discussed in ["Measurement" on page 81](#).

## Test System Connections

1. Connect the output of your transmitter to one of the front-panel RF inputs on the Test Set:
  - If the peak transmitted power is greater than 200 mW, but less than 60 W, or if you are testing a mobile, connect the signal to the RF IN/OUT port.
  - If the peak transmitted power is *not* greater than 200 mW, and you are testing a base station, connect the signal to the ANT IN port.
  - Test Set Configuration

### Prepare the RF Analyzer

1. Access the RF ANALYZER screen.
2. Set the **Tune Mode** to **Manual**.
3. Set the **Tune Freq** to match the transmitter's carrier frequency.
4. Set the **Input Port** to match the front-panel RF input port you are using.
5. For mobile radios transmitting a pulsed carrier, the input attenuator auto-ranging function should be turned off and a fixed attenuation should be specified:
  - a. Key the transmitter and observe the *maximum* displayed attenuator setting for the **Input Atten** field.
  - b. De-key the transmitter.
  - c. Set the **Input Atten** field to **Hold**.
  - d. Select the maximum attenuator level observed while the transmitter was keyed (0 dB, 20 dB, or 40 dB).<sup>1</sup>
6. Access the RF GENERATOR screen.
7. Set the **RF Gen Freq** field to match the transceiver's *receive* channel frequency.
8. Set the **Output Port** to **RF Out**.
9. Turn off AF Generator 1 by positioning the cursor in front of the lower of the two **AFGen1 To** field entries and pressing the ON/OFF key.

1. Refer to the [Max Abs field description, on page 79](#), for information on setting the correct attenuator level for the input port you are using and the transmitter power level you are measuring.

### Prepare the Digital Analyzer

1. Access the TDMA DUAL MODE CELLULAR TEST screen.
2. Select the appropriate **Std Setup** field setting.
  - Select **EVM Base** to test a base station.
  - Select **EVM Mob1** to test a mobile radio.
  - Select **EVM 10** to perform the EVM 10 measurement on a mobile.

### Start the Digital Generator (Mobile Test Only)

1. Put the mobile in the TDMA receive mode to expect data on a digital channel. This usually requires using a TIA test adapter or some other means of sending program codes to the mobile.
2. When testing mobiles in the pulsed-output mode, select the Digital Generator **Send** function. The generator provides the signaling necessary to keep your mobile transmitting correctly during the test.
3. Make the Measurement

At this point, the Test Set's RF Analyzer should be ready to accept your transmitter's signal, and the Digital Analyzer should be setup to make the measurement.

1. Key your transmitter
2. With the transmitter keyed, select **Arm Meas** (under **Digital An1**). The EVM Base measurement takes  $\approx .5$  second; it takes a few more seconds to perform the EVM 10 measurement.
3. De-key your transmitter after the measurement is displayed.



## Are You Finished?

If the displayed **status** value is 0.000000, the measurement results are valid and you are finished with this test. If the Status is not 0.000000, a measurement error exists. Refer to the [Status field description, on page 89](#), for help.

### Is The Test Set Receiving Your Transmitted Signal?

If a test fails, and you suspect your transmitter is not transmitting, or its output is too low, you can verify the presence (or lack) of the carrier using the Spectrum Analyzer.

1. Access the SPECTRUM ANALYZER screen.
2. Verify that the **Center Freq** is set to your transmitter's channel frequency.
3. Key your transmitter. You should see a modulated carrier appear at the center of the screen.
4. If you don't see the carrier -
  - Gradually decrease the **Ref Level**. If you still don't see the carrier, the RF Analyzer is not receiving the transmitted signal.
  - Verify that the port you connected your transmitter to is the same port selected for the RF ANALYZER screen's **Input Port** field.

## Performing an Error Vector Magnitude Self-test

You can perform an Error Vector Magnitude test on the Test System itself. This allows you to experiment with the Test System to understand more about EVM tests without using a transceiver.

To perform an EVM self-test, use the previous test procedure, making the following changes to the sections shown below in *italics*.

1. *Test System Connections* - Connect a cable between the DUPLEX OUT and ANT IN ports.
2. *Prepare the RF Analyzer* -
  - a. In step 3, set the **Tune Freq** to **850.000000** MHz.
  - b. In step 4, set the **Input Port** to **Ant**.
  - c. Ignore step 5.
3. *Prepare the RF Generator* -
  - a. In step 2, set the **RF Gen Freq** to **850.000000** MHz.
  - b. In step 3, set the **Output Port** to **Dupl**.
  - c. Set the **Amplitude** to **-40.0 dBm**.
4. *Prepare the Digital Analyzer* -
  - a. In step 2, set the **Std Setup** to **EVM Mobl**.
  - b. Change the Digital Analyzer **Trig Delay** to **1** or **0**.
5. *Start the Digital Generator* - (Ignore the original instructions.)
  - a. Set the **Slot Type** to **TDMA Mobl** (to match the Digital Analyzer's Slot Type).
  - b. Select the **Send** function.
6. Ignore the *Make the Measurement* instructions.
7. Select the Digital Analyzer **Arm Meas** function to make and display the measurement.

---

## Measuring Bit Error Rate

For a description of the Bit Error Rate Test (BERT), refer to [Measurement field description, on page 81](#).

Most base station manufacturers perform internal BER tests. This requires a Pi/4 DQPSK generator to send a signal into the receiver port of the base station. The base station control software then displays BERT results. Although the following procedure can be used for testing base stations that can be put in a loop-back test mode, it is primarily intended for testing mobile radios.

Before proceeding, press the PRESET key on the Test Set to establish a known instrument state.

Chapter 2, Making TDMA Measurements  
 Measuring Bit Error Rate

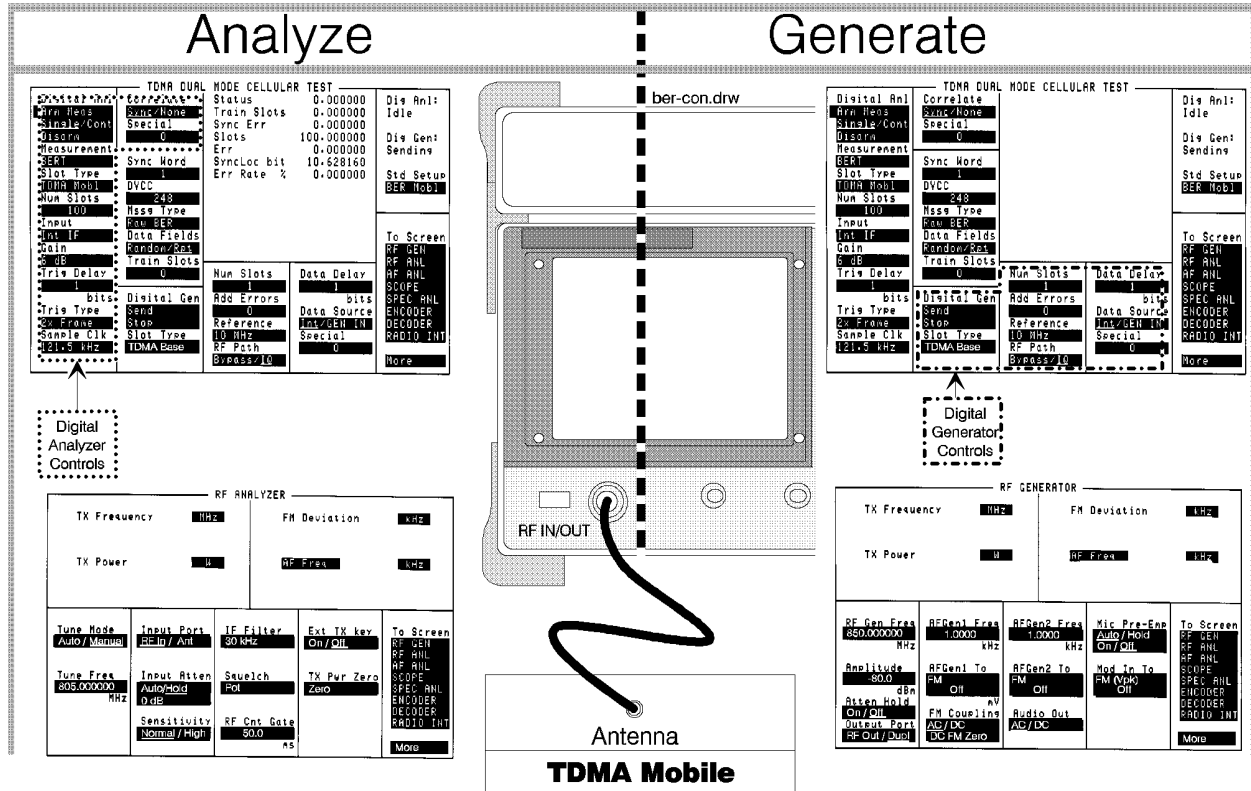


Figure 19 Basic Setup to Test Error Vector Magnitude

## Test System Connections

### For a Mobile Radio

1. Connect the antenna port of your mobile to the Test Set's RF IN/OUT port.

### For a Base Station

1. Connect the DUPLEX OUT port of the Test Set to the receiver's input port.
2. Connect the RF IN/OUT port of the Test Set to the transmitter's output port.
3. Connect the base station's reference to the test system as shown in [figure 14 on page 41](#) or [figure 15 on page 42](#). Do not proceed to the next step until the REF UNLOCK indicator on the Cellular Adapter is off.
4. Test Set Configuration

### Prepare the RF Analyzer

1. Access the RF ANALYZER screen.
2. Set the **Tune Mode** to **Manual**.
3. Set the **Tune Freq** to match the transmitter's carrier frequency.
4. Set the **Input Port** to match the front-panel RF input port you connected to your transceiver's output.
5. For mobile radios transmitting a pulsed carrier, the input attenuator auto-ranging function should be turned off, and a fixed attenuation should be specified:
  - a. Key the transmitter and observe the *maximum* displayed attenuator setting for the **Input Atten** field.
  - b. De-key the transmitter.
  - c. Set the **Input Atten** field to **Hold**.
  - d. Select the maximum attenuator level observed while the transmitter was keyed (0 dB, 20 dB, or 40 dB).<sup>1</sup>

1. Refer to the [Max Abs field description, on page 79](#), for information on setting the correct attenuator level for the input port you are using and the transmitter power level you are measuring.

### Prepare the RF Generator

1. Access the RF GENERATOR screen.
2. Set the **RF Gen Freq** field to match your *receiver's* tune frequency.
3. Assign USER key k1' to the **Amplitude** field.
  - a. Position the cursor next to the **Amplitude** field.
  - b. Press SHIFT, k4 (to initiate the ASSIGN function)
  - c. Press SHIFT, k1 (to enable the k1' USER key).

**Global User key 1 assigned.** should appear at the top of the screen.
4. Select the **Output Port**:
  - Select **Dupl** for testing base stations.
  - Select **RF OUT** for testing mobiles.
5. Turn off AF Generator 1 by positioning the cursor in front of the lower of the two **AFGen1 To** field entries and pressing the ON/OFF key.

### Prepare the Digital Analyzer

1. Access the TDMA DUAL MODE CELLULAR TEST screen.
2. Select the appropriate **Std Setup** field entry:
  - Select **BER Mob1** to test a mobile.
  - Select **Eric Base** if you are testing an Ericsson base station.<sup>1</sup>

### Start the Digital Generator

1. Select the **Digital Gen** field **Send** function. The **Dig Gen:** status indicates **Sending**.

The Digital Generator should now be sending a repetitive Pi/4 DQPSK modulated carrier out of the Test Set and into your receiver.

1. At the time this was written, Ericsson was the only manufacturer known to support BER tests on base stations.

## Radio Operation

1. Put your transceiver into a TDMA transmit loop-back mode to re-transmit the received TDMA data. (Refer to the manufacturer's diagnostic procedures or maintenance mode.)

## Making Measurements

At this point, the Digital Generator is sending a signal into your receiver, and your transmitter is re-transmitting the signal back into the Digital Analyzer.

1. Set the the **Digital An1** control to **Cont**. The analyzer starts displaying measurements.
2. Press SHIFT, k1 to display the **RF Gen Amplitude** at the top of the screen.
3. Press the CURSOR CONTROL knob to highlight the amplitude setting.
4. Slowly turn the knob counterclockwise to decrease the RF Generator amplitude to your transceiver's specified BER test carrier level.

The **Err Rate %** measurement indicates the Bit Error Rate through your transceiver at the present carrier level.

## Are You Finished?

If the displayed **status** value is 0.000000, the measurement results are valid and you are finished with this test. If the Status is not 0.000000, a measurement error exists. Refer to the [status field description, on page 89](#), for help.

### Is The Test Set Receiving Your Transmitted Signal?

If a test fails, and you suspect your transmitter is not transmitting or its output is too low, you can verify the presence (or lack) of the carrier using the Spectrum Analyzer.

1. Access the SPECTRUM ANALYZER screen.
2. Verify that the **Center Freq** is set to your transmitter's channel frequency.
3. Key your transmitter. You should see a modulated carrier appear at the center of the screen.
4. If you don't see the carrier -
  - a. Gradually reduce the **Ref Level**. If you still don't see the carrier, the RF Analyzer is not receiving the transmitted signal.
  - b. Verify that the port you connected your transmitter to is the same port selected for the RF ANALYZER screen's **Input Port** field.

## Performing a Bit Error Rate Self-test

You can perform a Bit Error Rate test on the Test System itself. This allows you to experiment with the Test System to understand more about BER tests without using a transceiver.

To perform a BER self-test, use the previous test procedure, making the following changes to the sections shown below in *italics*.

1. *Test System Connections* - Connect a cable between the DUPLEX OUT and ANT IN ports.
2. *Prepare the RF Analyzer* -
  - a. In step 3, set the **Tune Freq** to 850.000000 MHz.
  - b. In step 4, set the **Input Port** to **Ant**.
  - c. Ignore step 5.
3. *Prepare the RF Generator* -
  - a. In step 2, set the **RF Gen Freq** to 850.000000 MHz.
  - b. Set the initial **Amplitude** to -40.0 dBm.
  - c. In step 4, set the **Output Port** to **Dupl**.
4. *Prepare the Digital Analyzer* -
  - a. In step 2, set the **Std Setup** to **BER Mobl**.
  - b. Set the **Trig Delay** to 0. (The default of 565 bits represents the normal delay between the time a base transmits and a mobile responds.)
5. *Start the Digital Generator* - (Ignore the original instructions.)
  - a. Set the **Slot Type** to **TDMA Mobl** (to match the Digital Analyzer's Slot Type).
  - b. Select the **Send** function.
6. Ignore the *Radio Operation* instructions.

Perform the *Making Measurements* procedure as listed in the original instructions.



## Measuring Adjacent Channel Power

For a description of the Adjacent Channel Power measurement, refer to the [Measurement field description, on page 81](#).

Before proceeding, press the PRESET key on the Test Set to establish a known instrument state.

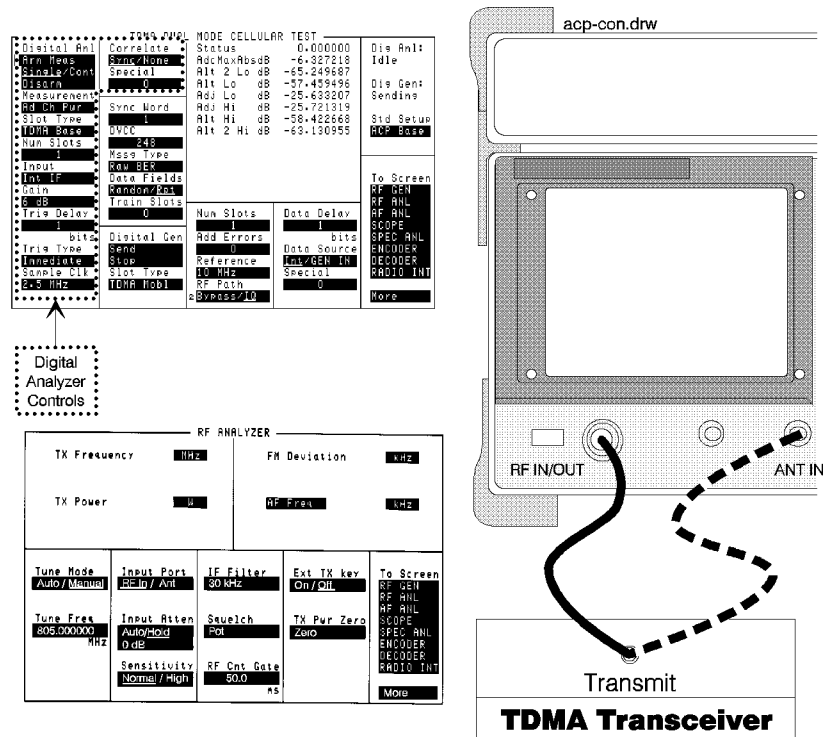


Figure 20 Basic Setup to Test Adjacent Channel Power

## Test System Connections

1. Connect the output of your transmitter to one of the front-panel RF inputs on the Test Set.
  - If the peak transmitted power is greater than 200 mW, but less than 60 W, or if you are testing a mobile, connect the signal to the RF IN/OUT port.
  - If the peak transmitted power is *not* greater than 200 mW, and you are testing a base station, connect the signal to the ANT IN port.

## Test Set Configuration

### Prepare the RF Analyzer

1. Access the RF ANALYZER screen.
2. Set the **Tune Mode** to **Manual**.
3. Set the **Tune Freq** to match the transceiver's *transmit* channel frequency.
4. Set the **Input Port** to match the front-panel port you connected your transmitter to.
5. For mobile radios transmitting a pulsed carrier, the input attenuator auto-ranging function should be turned off, and a fixed attenuation specified:
  - a. Key the transmitter and observe the *maximum* displayed attenuator setting for the **Input Atten** field.
  - b. De-key the transmitter.
  - c. Set the **Input Atten** field to **Hold**.
  - d. Select the maximum attenuator level observed while the transmitter was keyed (0 dB, 20 dB, or 40 dB).<sup>1</sup>

### Prepare the RF Generator (Mobile Test Only)

1. Access the RF GENERATOR screen.
2. Set the **RF Gen Freq** field to match the transceiver's *receive* channel frequency.
3. Set the **Output Port** to **RF Out**.
4. Turn off AF Generator 1 by positioning the cursor in front of the lower of the two **AFGen1 To** field entries and pressing the ON/OFF key.

1. Refer to the [Max Abs field description, on page 79](#), for information on setting the correct attenuator level for the input port you are using and the transmitter power level you are measuring.

### Prepare the Digital Analyzer

1. Access the TDMA DUAL MODE CELLULAR TEST screen.
2. Select the appropriate **Std Setup** field setting.
  - Select **ACP Base** to test a base station, or to test a mobile that can be put in a continuous transmit mode.
  - Select **ACP Mob1** to test a mobile radio in the normal pulsed-output mode.

### Start the Digital Generator (Mobile Test Only)

1. When testing mobiles in the pulsed-output mode, select the Digital Generator **Send** function. The generator provides the signaling necessary to keep your mobile transmitting correctly during the test.

### Make the Measurement

1. Key the transmitter.
2. With the transmitter keyed, select the **Arm Meas** function of the **Digital An1** control. The measurement is displayed about two seconds later.
3. De-key the transmitter after the measurement is displayed.

## Are You Finished?

If the displayed **status** value is 0.000000, and you are testing a base station, the measurement results are valid and you are finished with this test.

If you are testing a mobile, it is possible that the **status** value is 0.000000, but a valid measurement was not made (this may be indicated by test results that are quite different than expected). This can happen if the Digital Analyzer is not triggering at the proper time during the mobile's pulsed output. If you suspect this is the case, verify proper triggering by making a valid mobile EVM measurement. Once EVM is correctly measured, change the **Measurement** field entry to **Power**. Key your mobile and select **Arm Meas** to make the Power measurement.

If the Status is not 0.000000 when testing either base stations or mobiles, a measurement error exists. Refer to the [status field description, on page 89](#), for help.

### Is The Test Set Receiving Your Transmitted Signal?

If a test fails, and you suspect your transmitter is not transmitting or its output is too low, you can verify the presence (or lack) of the carrier using the Spectrum Analyzer.

1. Access the SPECTRUM ANALYZER screen.
2. Verify that the **Center Freq** is set to your transmitter's channel frequency.
3. Key your transmitter. You should see a modulated carrier appear at the center of the screen.
4. If you don't see the carrier -
  - a. Gradually reduce the **Ref Level**. If you still don't see the carrier, the RF Analyzer is not receiving the transmitted signal.
  - b. Verify that the port you connected your transmitter to is the same port selected for the RF ANALYZER screen's **Input Port** field.

---

## Performing an Adjacent Channel Power Self-test

You can perform an Adjacent Channel Power test on the Test System itself. This allows you to experiment with the Test System to understand more about ACP tests without using a transceiver.

To perform an ACP self-test, use the previous test procedure, making the following changes to the sections shown in *italics*.

1. *Test System Connections* - Connect a cable between the DUPLEX OUT and ANT IN ports.
2. *Prepare the RF Analyzer* -
  - a. In step 3, set the **Tune Freq** to **850.000000** MHz.
  - b. In step 4, set the **Input Port** to **Ant**.
  - c. Ignore step 5.
3. *Prepare the RF Generator* -
  - a. In step 2, set the **RF Gen Freq** to **850.000000** MHz.
  - b. In step 3, set the **Output Port** to **Dupl**.
  - c. Set the **Amplitude** to **-40.0 dBm**.
4. *Prepare the Digital Analyzer* -
  - a. In step 2, set the **Std Setup** to **ACP Base**.
5. *Start the Digital Generator* - (Ignore the original instructions.)
  - a. Set the **Slot Type** to **TDMA Base** (to match the Digital Analyzer's Slot Type).
  - b. Select the **Send** function.
6. Select the Digital Analyzer **Arm Meas** to make and display the measurement.

## Measuring Power

The Power measurement indicates the RMS power of a Pi/4 DQPSK carrier, relative to a known power level. Since it is a relative measurement, the power is expressed in dB, and not in absolute units such as dBm or Watts.

Before proceeding, press the PRESET key on the Test Set to establish a known instrument state.

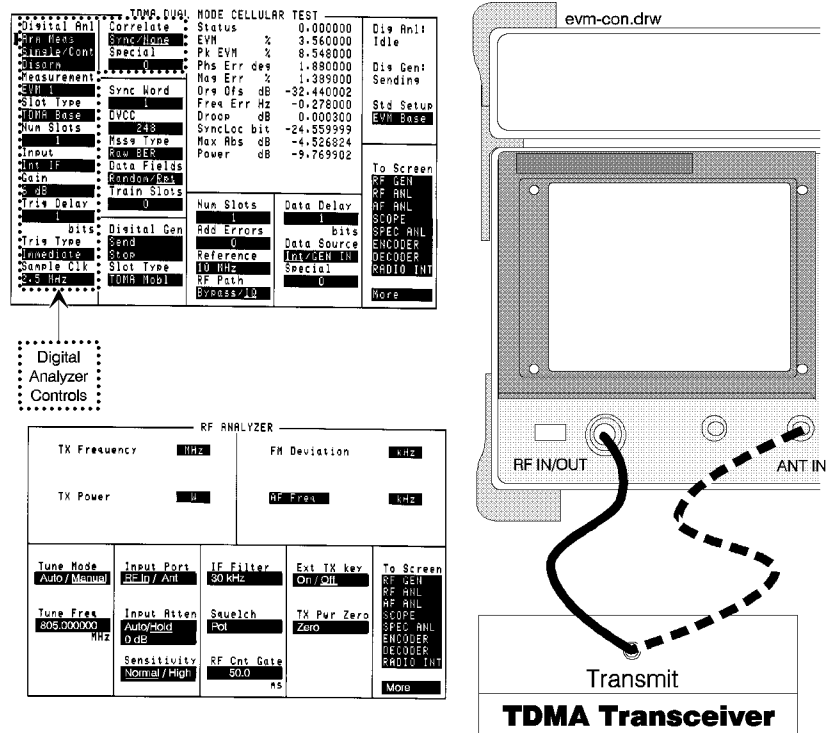


Figure 21 Basic Setup to Test Error Vector Magnitude

## Test Overview

The Test Set's standard TX Power measurement uses a peak detector to measure power. This type of detector does not work well with some TDMA signals (especially pulsed mobiles). The Digital Analyzer measures RMS power, but the RF path through the Test System is not calibrated. To make an RMS power measurement on pulsed or noisy TDMA signals, you must first measure an unmodulated RF carrier with the Test Set's standard power meter, and then use that measurement as a calibration factor for measuring TDMA signals on the Digital Analyzer.

Transmitter power should be at least 0 dBm (1 mW) for accurate measurements.

## Making a Base Station Power Measurement

You can test base station TDMA power directly on the TX TEST screen (although the reading is 2.95 dB high due to the peak power detector). To do this, your transmitter must be set up to send pseudo-random data, and the transmitter must have relatively low Error Vector Magnitude.

If you cannot transmit pseudo-random data, or if your base station has high Error Vector Magnitude, use the Mobile power test procedure.

1. Connect your transmitter to the RF IN/OUT port.
2. Access the TX TEST screen.
3. Set the **Tune Mode** field to **Manual**.
4. Set the **Tune Freq** field to your transmitter's frequency.
5. Key your transmitter.
6. Read the **TX Power** measurement.
7. Subtract 2.95 dB from this measurement to arrive at the RMS power level.

## Making a Mobile Power Measurement

Use this procedure anytime you are testing a mobile in the TDMA mode, or if you are testing a base station with high Error Vector Magnitude or cannot output pseudo-random data.

### Test System Connection

1. Connect your transmitter to the RF IN/OUT port.

### Prepare the RF Generator (Mobile Test Only)

1. Access the RF GENERATOR screen.
2. Set the **RF Gen Freq** field to match the transceiver's *receive* channel frequency.
3. Turn off AF Generator 1 by positioning the cursor in front of the lower of the two **AFGen1 To** field entries and pressing the ON/OFF key.

### Make a Standard Analog Power Measurement

1. Access the RF ANALYZER screen.
2. Position the cursor in front of the **W** field for the **TX Power** measurement.
3. Press the GHz/dBm key to change the unit of measure to dBm.
4. Set the **Tune Mode** to **Manual**.
5. Enter the transmitter's frequency in the **Tune Freq** field.
6. Put your transmitter in the ANALOG mode (not TDMA) to produce a continuous wave (CW) signal.
7. Key the transmitter.
8. Set the **Input Atten** field to **Hold**. This 'locks-in' the input attenuator setting for the power level being measured.
9. Write down the **TX Power** measurement value.

### Make a TDMA Screen Analog Power Measurement

1. Access the TDMA DUAL MODE CELLULAR TEST screen.
2. Set the **Std Setup** field to **EVM Mob1** (select EVM Base if you're testing a base station).
3. Select the Digital Generator **Send** function.
4. Set the Digital Analyzer **Gain** field to **18 dB**.
5. Set the Digital Analyzer **Measurement** field to **Power**.
6. With the transmitter still keyed, select the **Arm Meas** function to make the measurement.
7. De-key the transmitter.
8. If the **Max Abs dB** value is  $\geq 0$  dB (indicating the ADC is overdriven), reduce the **Gain** value and re-measure. Continue to reduce gain and re-measure until the **Max Abs dB** value is  $< 0$  dB.
9. Record the **Power dB** measurement value (displayed at the end of the measurements).



### Determine the Calibration Factor

Subtract the TDMA DUAL MODE CELLULAR TEST screen's power measurement value from the RF ANALYZER screen's measurement to determine the calibration factor.

For example, if the RF Analyzer's measurement is  $-2.00$  dBm, and the TDMA screen's power measurement is  $-18.45$  dB, the calibration factor is  $(-2.00) - (-18.45) = 16.45$  dB

### Make a TDMA Power Measurements

After the power calibration factor is calculated, you can measure TDMA signals of the same frequency and approximate power level used to calculate the calibration factor.

For example, if the TDMA Power measurement for the new radio you test is  $-5$  dB, and the calibration factor determined using the first radio is  $16.45$  dB, the RMS power of the new radio is

$$(-5) + (16.45) = 11.45 \text{ dBm}$$

To convert dBm to Watts, use the formula:

$$10^{\frac{\text{dBm}}{10}} \times 0.001 = \text{Watts}$$

---

**NOTE:**

The calculated calibration factor is only accurate for signals of the same frequency, and for amplitudes that are the same or no less than  $\approx 10$  dB below the same power level. If you measure signals of a different frequency, or signals of a much lower or greater power level, you need to calculate a new calibration factor for those signals.

---

## TDMA Tests Using HP-IB

The following program example performs an EVM Base measurement on the Test Set's Digital Generator. Other than a BNC-to-Type 'N' cable, no external equipment is required.

After connecting the RF IN/OUT port to the DUPLEX OUT port and pressing 'Continue' on your controller, the program continues until all the measurements displayed on the TDMA DUAL MODE CELLULAR TEST screen are read back into your controller.

This program was written to run using the Test Set's internal IBASIC controller. To run this program on an external controller, change the bus select code in line 10 to match your controller (usually 7).

```

10 Bus=8 !Define the Bus Select Code (8=Test Set's internal controller).
20 Dut=100*Bus+14 !Define the HP-IB address of the Test Set.
30 CLEAR SCREEN
40 Print "Connect the RF IN/OUT port to the DUPLEX OUT port."
50 Print "Press 'Continue' to perform the test."
60 PAUSE
70 CLEAR SCREEN
80 OUTPUT Dut;"*RST" !PRESET the Test System.
90 OUTPUT Dut;"DISP RFG" !Display the RG Generator screen.
100 OUTPUT Dut;"RFG:FREQ 850 MHZ" !Create an 850 MHz carrier.
110 OUTPUT Dut;"RFG:OUTP 'DUPL'" !Send carrier out the DUPLEX OUT port.
120 OUTPUT Dut;"RFG:AMPL 5 DBM" !Set the carrier amplitude.
130 OUTPUT Dut;"AFG1:FM:STAT OFF" !Turn the default 3 kHz mod signal off.
140 OUTPUT Dut;"DISP RFAN" !Display the RF ANALYZER screen.
150 OUTPUT Dut;"RFAN:TMODE 'MANUAL'" !Set RF Analyzer Tune Mode to Manual.
160 OUTPUT Dut;"RFAN:FREQ 850 MHZ" !Set Tune Frequency to 850 MHz.
170 OUTPUT Dut;"RFAN:INP 'RF IN'" !Set the Input Port to RF In.
180 OUTPUT Dut;"RFAN:ATT:MODE 'HOLD'" !Set Input Atten ranging to Hold.
190 OUTPUT Dut;"TRIG:MODE:RETR SING" !Set trigger to make one measurement.
200 OUTPUT Dut;"DISP TDMA" !Display the TDMA Dual Mode Test screen.
210 OUTPUT Dut;"DGCommon:SETup 'EVM Base'" !Select the EVM Base Std Setup.
220 OUTPUT Dut;"DGG:SEND" !Modulate carrier with Digital Gen's TDMA data.
230 OUTPUT Dut;"TRIG" !Trigger the measurement.
240 DIM Values(30),Label$(30)[20] ! Dimension measurement arrays
250 ON TIMEOUT Bus,10 GOTO Timeout ! Set a 10 second timeout in case a
260 ! valid measurement cannot be made and the bus gets 'hung'.
270 OUTPUT Dut;"MEAS:DGAN:VAL?" ! Query measurement values.
280 Num_values=FNRead(Dut,Values(*)) ! Enter measurement values into the
290 ! Values array, and read the number of values returned.
300 FOR I=1 TO Num_values ! Define number of measurement labels.
310 OUTPUT Dut;"MEAS:DGAN:LAB? ";I-1 ! Query measurement labels.
320 ENTER Dut;Label$(I) ! Enter returned labels in the 'Label' array.
330 NEXT I
340 OFF TIMEOUT Bus ! Disable timeout after measurement
350 !
360 FOR I=1 TO Num_values ! Echo the results sent to
370 PRINT Label$(I),Values(I) ! the screen on the controller.
380 NEXT I
390 PRINT
400 !
410 ! Print selected results. The FNSearch function is used to
420 ! return the index into the previously read Values array to
430 ! to find the values to be printed. The following example
440 ! shows that the entire label doesn't need to be passed in as a
450 ! search string, and that the searches allow the program to
460 ! print out the values in any order. If a label is not found
470 ! then the value MAXREAL is returned.
480 !
490 Values(0)=MAXREAL ! Error indicator, if string not found
500 PRINT "Error Vector Mag = ";Values(FNSearch(Num_values,Label$(*),"EVM"))
510 PRINT "Origin Offset = ";Values(FNSearch(Num_values,Label$(*),"Org Ofs"))
520 PRINT "Status = ";Values(FNSearch(Num_values,Label$(*),"Status"))
530 PRINT "Error Example= ";Values(FNSearch(Num_values,Label$(*),"No String"))
540 !
550 STOP
560 !
570 Timeout: ! Specify what to do if a measurement timeout occurs.
580 PRINT
590 PRINT "Measurement timed out."
600 CLEAR Bus

```

## Chapter 2, Making TDMA Measurements

### TDMA Tests Using HP-IB

```
610     STOP
620     !
630     END
640     !
650     ! Search elements 1 through Array_size (inclusive) of String_array$
660     ! for an element that includes Search_string$. Return the index
670     ! of the first element containing it, or 0 if not found. Array_size
680     ! must be >= 1.
690     !
700     DEF FNSearch(Array_size,String_array$(*),Search_string$)
710     N=1
720     WHILE N <=Array_size AND NOT POS(String_array$(N),Search_string$)
730     N=N+1
740     END WHILE
750     IF (N>Array_size) THEN N=0
760     RETURN N
770     FNEND
780     !

790     ! Read a comma-separated list of floating-point values from Addr
800     ! into Array, and return the number read. Array must be
810     ! dimensioned large enough to accept the maximum number of
820     ! returned values.
830     !
840     DEF FNRead(Addr,Array(*))
850     I=1
860     ON ERROR GOTO End_loop
870     REPEAT
880     ENTER Addr USING "%,16D,B";Array(I),Separator
890     I=I+1
900     UNTIL Separator=10! New-line
910 End_loop:      !
920     OFF ERROR
930     N=I-1
940     RETURN N
950     FNEND
```

---

## Screen and Field Descriptions

**TDMA DUAL MODE CELLULAR TEST Screen**

TDMA DUAL MODE CELLULAR TEST			
Digital Anl Arm Meas Single/Cont Disarm Measurement EVM 1 Slot Type TDMA Base Num Slots 500 Input Int IF Gain 18 dB Trig Delay 1 bits Trig Type Frame Clk Sample Clk 2.5 MHz	Correlate Sync/None Special 0 Sync Word 1 DVCC 248 Mssg Type Raw BER Data Fields Random/Rpt Train Slots 50 Digital Gen Send Stop Slot Type TDMA Mobil	Status 13.000000 EVM % 99.084999 Pk EVM % 110.463005 Phs Err deg 89.736000 Mag Err % 95.389000 Ora Ofs dB -100.000000 Frea Err Hz 0.000000 Droop dB 0.000000 SyncLoc bit 0.000000 Max Abs dB -53.726650 Power dB -64.418243	Dig Anl: Armed Dig Gen: Idle Std Setup Preset To Screen RF GEN RF ANL RF ANL SCOPE SPEC ANL ENCODER DECODER RADIO INT More
		Num Slots 300 Add Errors 0 Reference 10 MHz RF Path Bypass/IQ	Data Delay 1933 bits Data Source Int/GEN IN Special 0

**AdcMaxAbs**

This measurement field indicates the absolute value of the peak sample at the input of the Digital Analyzer for Adjacent Channel Power measurements.

See Also

[Max Abs field description, on page 79](#)

### **Add Errors**

This field specifies the number of bit errors the Digital Generator includes in the data pattern each time it sends its output data.

The errors can be used to validate a bit error measurement. The number of errors detected by the analyzer can be compared to the number of errors specified to verify that a valid measurement has been made.

Up to 15 errors can be added.

#### **Other Considerations**

Adding a known number of errors to the data can be useful for verifying that the measurement results reflect the actual conditions of the input signal.

### **Adj Lo Adj Hi**

These measurement fields indicate the power levels measured (in dB) for the adjacent channels below and above the carrier channel.

### **Alt Lo Alt Hi**

These measurement fields indicate the power levels measured (in dB) for the first alternate channels (two channel spacings below and two channel spacings above the carrier channel).

### **Alt2 Lo Alt2 Hi**

These measurement fields indicate the power levels measured (in dB) for the second alternate channels (three channel spacings below and three channel spacings above the carrier channel).

## BERT

This measurement field specifies the difference between the bit stream demodulated by the Digital Analyzer and the actual bit pattern output by the Digital Generator (or by a mobile radio when it is set up to loop-back to the Test Set).

This parameter indicates the receiver's ability to correctly demodulate data. The EIA standard specifies  $\leq 3\%$  error at  $-110$  dBm.

## Correlate

This field determines whether the data measured by the Digital Analyzer will be aligned with the sync word in the time slot or not.

Selecting **sync** enables the Digital Analyzer to identify the beginning of the time slot from the total data captured.

Selecting **None** causes base station measurements to be made beginning at an arbitrary point within the captured data. If **TDMA Mob1** in the analyzer's **Slot Type** field, the analyzer will not be able to make a valid measurement. An error condition will be indicated in the measurement **status** field when a measurement is attempted.

### Other Considerations

**sync** should be selected for all measurements where specific data must be measured, such as bit error measurements. It should be selected for all measurements on mobile radios.

The Digital Analyzer will make accurate transmitter measurements on a base station where a continuous stream of data is present with **None** selected.



## Data Delay

This field specifies the number of bits that the Digital Generator will wait to send its baseband data after **send** has been selected in the Digital Gen field and the frame clock goes high. This delay is valid only for internal data; external data is not affected. The range of acceptable settings for this field is from 0 to 1943 bits.

When **Int** is selected in the Data Source field, the delay affects the baseband signal sent to the instrument's IQ Modulator, Digital Analyzer, and GEN BB DATA OUT connector located on the rear panel.

### Other Considerations

The data delay setting is important when you are trying to align the Test Set's data pattern to a base station that requires proper time alignment.

The appropriate amount of delay depends on the particular base station that you are testing.

Mobile radios will adjust to the Test Set, so the delay is not required for a mobile radio test.

## Data Fields

This field determines whether the data output by the Digital Generator and measured by the Digital Analyzer will be a random or repeating sequence of data.

Selecting **Random** causes the Digital Generator to output a random data pattern over the number of bursts selected. It also causes the Digital Analyzer to use the same data pattern output by the generator for measuring BER.

Selecting **Rpt** causes the data pattern selected in the **MSSG Type** field to be repeated in each slot.

### Other Considerations

**Random** is generally the best solution for making BERT measurements.

**Rpt** (Repeat) is useful when you want a stable data pattern for troubleshooting, for repeatable power measurements, or for error vector magnitude (EVM) measurements using the Test Set's generator.

## Data Source

This field selects which baseband data source is sent to the instrument's IQ Modulator, Digital Analyzer, and GEN BB DATA OUT connector located on the rear panel. **Int** selects the baseband signal provided by the instrument's Digital Generator. **GEN IN** selects the GENERATOR BASEBAND DATA IN connector located on the front panel.

## Digital Anl

This field determines whether the Digital Analyzer is armed to make a measurement or not.

Selecting **Arm** sets the analyzer to make a measurement as soon as it is triggered. **Arm** must be selected once the analyzer fields have been set up to begin a measurement. Making changes to any field setting after **Arm** has been selected will cause the Digital Analyzer to terminate the current measurement and re-arm to begin another measurement using the new setting. However, if the Digital Generator is also being used, changing field settings will cause the generator to stop sending data. **Send** must be selected in the **Digital Gen** field to begin sending data again.

Selecting **Single** causes the analyzer to make a single measurement each time it is armed. When **Cont** is selected, the analyzer continuously repeats the measurement and updates the displayed results as the measurement data becomes available.

Selecting **Disarm** affects operation only when the analyzer has been armed but measurements have not been displayed yet.

### Other Considerations

When making measurements on the instrument's Digital Generator, it is generally best to select **Send** in the **Digital Gen** field, then select **Arm**.

Selecting **Arm** while the Digital Analyzer is making a measurement will cause it to re-arm for another measurement.

## Digital Gen

This field causes the Digital Generator to begin sending or stop sending data.

Selecting **send** causes the Digital Generator to begin sending its output data immediately unless a delay value greater than 0 has been specified in the **Data Delay** field.

Selecting **stop** causes the generator to stop sending its output data. Making changes to field settings on the display can also cause the generator to stop sending its data.

### Other Considerations

When using the Digital Analyzer to measure the output of the Digital Generator during a BERT measurement, it is generally best to select **send** in the **Digital Gen** field, then select **Arm** in the **Digital An1** field. It is only necessary to select **send** once when making EVM measurements. When making BERT measurements, **send** should be selected just prior to selecting **Arm** to align the training slots and transmitted data with the analyzer.

## Droop

This measurement field specifies the difference, in dB-per-symbol, between the level of the first symbol and the level of the last symbol captured by the Digital Analyzer.

This parameter is most significant for pulsed signals. A high number would indicate a problem with the pulse modulation process.

For battery powered mobiles, output power can drop over the burst when the battery is low.

## DVCC

This field specifies the Digital Verification Color Code to be used by the Digital Analyzer and Digital Generator. The range of acceptable values is 0 to 255.

### Other Considerations

The appropriate setting is determined by the unit-under-test.

It should be set when performing BERT measurements on mobile or base stations that require a particular DVCC.

## Err

This field indicates the number of bit errors detected during the BERT measurement.

## Err Rate

This field indicates the number of bit errors detected per slot as a percentage of the number of data bits transmitted per slot (260). This value is calculated as follows:

$$(\text{number of errors} \times 100) \div (\text{number of slots} \times 260)$$

## EVM

This measurement field specifies the magnitude of the error vector which connects the ideal signal trajectory on the unity circle to the measured signal trajectory at the detection decision point. The RMS value of the error vector is calculated by taking the square root of the sum of the squares of the individual error vector magnitudes at each detection decision point over the measured burst. The magnitude error and the phase error are the two components which determine the over-all error vector magnitude.

## EVM Peak

This measurement field specifies the worst case EVM measured for a symbol over the measurement burst.

## Freq Err

This measurement field specifies the frequency error between the measured RF signal and the RF frequency that the Test Set is tuned to.

This measurement can be affected by timebase errors in the unit-under-test or in the Test Set.

## Gain

This field sets the gain of the Digital Analyzer's RF input path.

This setting affects the signals connected to the analyzer via the 114.3 MHz IF IN and the EXT IF IN connectors located on the instrument's rear panel.

### Other Considerations

This setting affects all Digital Analyzer measurements except when digital data is being measured using the ANALYZER BASEBAND DATA IN connector, such as for a receiver looped-back to the Test Set for bit error rate testing.

Use as much gain as possible without overdriving the (indicated (in dB) by the **Max Abs** measurement field for the EVM measurement).

### See Also

[Max Abs field description, on page 79](#)

## Input

This field selects the input path for the Digital Analyzer.

**Int IF** selects the input path for using the RF IN/OUT connector on the front panel of the Test Set. The RF input signal is converted to an IF and sent from the 114.3 MHz IF OUT connector to the 114.3 MHz IF IN connector on the Test Set's rear panel.

**EXT IF IN** selects the EXT IF IN connector on the rear panel. This connector provides a path for connecting an external 700 kHz or 220 kHz IF signal (30 to 40 mV peak) to the analyzer.

**ANL DT IN** selects the ANALYZER BASEBAND DATA IN connector located on the front panel of the Test Set. This connector provides a path for connecting a demodulated TDMA data stream (TTL) to the analyzer.

**IQ Mod** selects an internal path that connects the output of the Test Set's Digital Generator to the data input on the Digital Analyzer. The output of the Digital Generator is also available at the GEN BB DATA OUT connector on the Test Set's rear panel.

## Mag Err

This measurement field specifies the difference in amplitude at the detection decision point between the received signal and an ideal signal generated with the same data pattern. The difference in amplitude is referenced to the amplitude of the ideal signal on the unity circle to obtain the percent difference.

Magnitude Error is an indicator of the quality of the amplitude component of the p/4 DQPSK signal. For example, a very high magnitude error might indicate high incidental AM modulation on the signal. This error can also be caused by a faulty linear power amplifier or modulator, or when data is not aligned with the RF burst on a mobile radio.

The magnitude error, when converted to a phasor, is one of the components of the error vector magnitude.

## Max Abs

This measurement field specifies the absolute value of the peak sample from the middle 145 symbols of a timeslot after IF digital filtering. The measured level is affected by the RF input signal level, the input attenuator setting, and the level set in the **Gain** field.

### Other Considerations

When a measurement is made, difference between the maximum signal level seen at the Digital Analyzer's input and the full-scale level needed for the measurement is displayed (in dB) in the **Max Abs** measurement field. For valid measurements, this value should be between 0 and -23 dB. (The closer to 0 dB (full-scale) the better, as long as the level never reaches 0.) This level is affected by three values:

- The amplitude of the TDMA signal connected to the Test Set.
- The RF ANALYZER screen's **Input Atten** setting.
- The TDMA DUAL MODE CELLULAR TEST screen's **Gain** setting.

**Table 1 on page 80** lists the recommended **Input Atten** and **Gain** settings for measuring input signals < 17 dBm at the ANT IN port.

For measuring signals > +17 dBm, use the RF IN/OUT port. When using the RF IN/OUT port, subtract 36 dB from the input signal level to determine the input level to use in the table. For example, if the signal level at the RF IN/OUT port is +35 dBm, use -1 dBm as the Input Level in the table.

**Table 1** Recommended Input Atten and Gain Settings

<b>Input Level at Ant In (RMS)</b>	<b>Digital Anl Gain Setting</b>	<b>Input Atten Setting</b>
+17 dBm	0 dB	40 dB
+11 dBm	6 dB	40 dB
+5 dBm	12 dB	40 dB
-1 dBm	18 dB	40 dB
-3 dBm	0 dB	20 dB
-9 dBm	6 dB	20 dB
-15 dBm	12 dB	20 dB
-21 dBm	18 dB	20 dB
-23 dBm	0 dB	0 dB
-29 dBm	6 dB	0 dB
-35 dBm	12 dB	0 dB
-41 dBm	18 dB	0 dB



## Measurement

This field selects the measurement mode for the Digital Analyzer.

**EVM1** sets the analyzer to make its measurements on 1 timeslot after it is triggered. The analyzer is set up to make the following measurements.

- Status
- Error Vector Magnitude (%)
- Peak Error Vector Magnitude (%)
- Phase Error (Degrees)
- Magnitude Error (%)
- Origin Offset (dB)
- Frequency Error (Hz)
- Droop (dB)
- SyncLoc (Sym)
- Maximum Absolute Power (dB)
- Power (dB)

---

**NOTE:**

The **Status** field does not provide measurement results. It indicates the operating status of the analyzer for the measurement. For additional information, see the [Status field description, on page 89](#).

**EVM10** sets up the analyzer to make the same measurements listed for **EVM1**. However, the first three measurements shown in the list are made using the first ten symbols from the first ten time slots used by the analyzer for its measurements. The remaining measurements are made using data from the tenth time slot only.

**BERT** sets the analyzer to make the following measurements for Bit Error Rate Testing:

- Status
- Training Slots
- Sync Word Errors
- Slots
- Errors
- Sync Loc
- Error Rate (%)

**Ad Ch Pwr** sets the analyzer to make the following adjacent channel power measurements:

- ADC Maximum Absolute Power (dB)
- Second Low-Side Alternative Channel Power (dB)
- First Low-Side Alternative Channel Power (dB)
- Low-Side Adjacent Channel Power (dB)
- High-Side Adjacent Channel Power (dB)
- First High-Side Alternative Channel Power (dB)
- Second High-Side Alternative Channel Power (dB)

**Sync Srch** sets the analyzer to measure the number of symbols between when the analyzer is triggered and when the code specified in the DVCC field occurs in the slot.

#### Other Considerations

Select **EVM10** to make the ten burst average measurement for mobile stations as specified in IS55 3.3.2.1.3.

**MAHO** (Mobile Assisted Hand-Off) prepares the Digital Analyzer to receive and report SACCH channel quality measurements (BER and RSSI) from a mobile. Measurements are reported for the *current channel only*.

Before the measurements are returned, you must first request the channel quality values from your mobile by sending a Measurement Order Message command (or by some other means available with your mobile). Refer to the EIA/TIA IS-54 standard, paragraphs 2.4.5.1, 2.4.5.4.1.1.1, 2.4.5.4.1.2.1, and 3.7.3.1.3.2.2, and tables 2.4.5.1-1 and 2.4.5.1-2.

The values for BER and RSSI are returned as integer numbers representing the bit pattern defined in the IS-54 standard.

When using this measurement setup, the **Mssg Type** should be set to **SACCH**, the two **Num Slots** fields should have the same values, the **Data Fields** field should be set to **Random**, the **Train Slots** field should be **0**, and the rest of the fields should be set as they would for a BERT measurement.

The measurements returned from the mobile are labeled:

- BerRange
- RssiRange

## Mssg Type

This field specifies the type of data the Digital Generator will transmit. It also specifies the type of data the Digital Analyzer will expect to receive for a BERT measurement.

**Raw BERT** selects uncoded (non-convolutional encoded) data.

**FACCH** selects a Fast Associated Control Channel data pattern.

**SACCH** selects a Slow Associated Control Channel data pattern.

**Speech** selects encoded speech.

**Call Proc** selects a FACCH data pattern, supplied by the user, and outputs it on a specified slot number. This FACCH pattern and the slot number must be defined via HP-IB.

**Talk Back** selects a mode in which the instrument echoes back what is spoken into the radio.

**Ericsson** selects the data pattern for making a bit error rate measurement on Ericsson base station transceivers.

**Custom 1-3** are provided for selecting other custom data patterns that have been installed.

## Num Slots

Two **Num slots** fields are provided; one for the Digital Analyzer and one for the Digital Generator. The **Num slots** field in the first column on the left side of the screen specifies the number of slots from which the Digital Analyzer will calculate its measurement. The **Num slots** field in the second column from the left specifies the total number of slots of data (not including training slots) that the Digital Generator will output when **Send**, in the **Digital Gen** field, is selected.

### Other Considerations

**Num slots** for the Digital Analyzer is used only for BERT measurements.

For the Digital Generator, the number of slots determines the number of bits over which a BERT measurement is made and, as a result, the length of time it takes to compute data before it is sent.

## Org Ofs

This measurement field (origin offset) specifies the magnitude of RF carrier feed-through relative to the magnitude of the modulated carrier at the detection decision points (data clock edges).

Carrier feed-through is an indication of the balance of the I-Q modulator. If the modulator is balanced, the carrier is nulled in the RF spectrum. Imbalance in the I-Q modulator will result in carrier feed-through and will appear as a dc offset on the demodulated I-Q signal.

## Phase Error

This measurement field specifies the difference in phase, at the detection decision points, between the received signal and an ideal signal generated from the same data pattern.

The magnitude of this error is an indicator of the quality of the phase component of the p/4 DQPSK signal. For example, a very high phase error might indicate high incidental FM modulation on the signal.

The phase error, when converted to a phasor, is one of the components of the error vector magnitude measurement.

## Power

This measurement field specifies the rms power level (in dB) seen by the Digital Analyzer. The measured level is affected by the RF input signal level, the input attenuator setting, and the vernier (gain) adjustment.

This is not a calibrated measurement. To calibrate the RF path to the digitizer, make an initial power level measurement on a known power source using the Digital Analyzer. Determine the difference between the known source and the measured level. Apply the difference as the calibration factor for subsequent power measurements made with the Digital Analyzer.

## Reference

This field specifies which reference frequency is to be used by the Digital Generator. This setting should be selected to match the frequency of the signal connected to the REF IN connector on the rear panel of the Test Set.

### Other Considerations

For testing mobile radios, the REF IN connector is normally connected to the Test Set's 10 MHz output connector.

When making BERT measurements on base stations, the Test Set may be locked to a data clock (such as a bit, frame, or slot clock) provided by of the unit-under-test.

## RF Path

This field determines whether the input signal connected to the CW RF IN connector on the rear panel is IQ modulated by the Test Set before it is sent to the IQ RF OUT connector (also on the rear panel).

If **IQ** is selected when **send** is selected in the Digital Gen field, the signal will be IQ modulated.

If **Bypass** is selected, the signal will be sent directly from the CW RF IN connector to the IQ RF OUT connector without being modulated.

## Sample Clk

This field sets the sample clock rate for the Digital Analyzer.

**121.5 kHz**, **1 MHz**, and **2.5 MHz** select internal clock sources provided by the Digital Generator.

**ANL CLK IN** selects the ANALYZER DATA CLOCK IN connector on the instrument's front panel for connecting an external sample clock source. The frequency range for this signal is dc to 48.6 kHz at TTL levels.

### Other Considerations

The primary considerations for selecting the sample clock rate are the type of measurement being made and the input selection in the **Input** field.

**121.5 kHz** should be selected when BERT is selected in the **Measurement** field for making real time demodulated measurements such as bit error rate.

**1 MHz** is the appropriate selection when EXT IF IN is selected in the **Input** field and the external RF signal is 220 kHz. **1 MHz** is also appropriate for compatibility with the HP 11847A/B or HP 8953DT 220 kHz IF for EVM measurements.

**2.5 MHz** is appropriate for making EVM measurements using the front panel connectors or when EXT IF IN is selected in the **Input** field and the signal connected to the EXT IF IN connector is 700 kHz.

**ANL CLK IN** should be selected when BERT is selected in the **Measurement** field and **ANL DT IN** or **IQ MOD** is selected in the **Input** field. The hold time of the data after the rising edge of the clock must be 5  $\mu$ s.

## Slots

This measurement field indicates the number of slots used for a BERT measurement. The value returned when the BERT measurement is complete should match the number specified in the **Num Slots** field.

## Slot Type

Two **slot Type** fields are provided; one for the Digital Analyzer and one for the Digital Generator. The **slot Type** field in the first column on the left side of the screen specifies the type of TDMA slot (mobile or base station) that the Digital Analyzer is to measure. The **slot Type** field in the second column from the left specifies the slot type to be output by the Digital Generator.

### Other Considerations

Selecting the appropriate **slot Type** is necessary when making BERT or EVM measurements when you are synchronizing to a sync word.

## Special

Two **special** fields are provided; one for the Digital Analyzer and one for the Digital Generator. The **special** field in the second column from the left selects special operating modes available for the Digital Analyzer. The **special** field in the fourth column from the left selects special operating modes available for the Digital Generator.

The special operating modes are not yet determined.



**Status**

This field indicates the status of the Digital Analyzer when making its measurements. The status result encodes any errors that might have occurred during the measurement. The status is a bit-mapped collection of the error conditions. A status of 0 means that no errors were reported.

**EVM Measurement Status Codes**

[Table 2 on page 90](#) defines the status codes for EVM measurements.

**Example**

A status of 22 would be decoded as follows:

$$\begin{array}{r} 22 = 16 + 4 + 2 \\ | \quad | \quad | \text{ Sync even} \\ | \quad | \text{ Weak clock} \\ | \text{ ADC overdriven} \end{array}$$

**Table 2 EVM Measurement Status Codes**

Decimal	Bit	Description
1	0	Sync Error. The sync word contained an error or was not found. A measurement was made and results were returned.
2	1	Sync Even. The sync word began on the second bit of the symbol. A measurement was made and results were returned.
4	2	Weak Clock. The Test Set had difficulty to finding the data clock's phase, for example, when all zeros are transmitted. A measurement was made and results were returned, however, performance may be degraded.
8	3	ADC Under-driven. The absolute value of the peak sample was less than 30 dB below full scale of the ADC. A measurement was made and results were returned.
16	4	ADC Overdriven. The absolute value of the peak sample was at ADC full scale. A measurement was made and results were returned.
32	5	No Trigger or Clock Present. Not implemented.
64	6	Memory Overflow. The memory of the RX DSP board was exceeded. The measurement was aborted and zeros returned.
128	7	Sync Early. The sync word occurred too soon in the burst. The measurement is invalid and aborted, and zeros are returned.
256	8	Sync Late. The sync word occurred too late in the burst. The measurement is invalid and aborted, and zeros are returned.
512	9	Converge Error. The parameter estimator does not converge. The measurement is aborted and zeros are returned.
1024	10	Parameter Error. The user selected incompatible pass parameters in the analyzer fields. No hardware is set and all zeros are returned. Only EVM cases are coded at this time.
2147483648	31	Default. Specific error information is not available.

**Table 3** defines the status codes for BERT measurements.

**Table 3** BERT Measurement Status Codes

Decimal	Bit	Description
1	0	Sync Error. Synchronization of the slots received with the first expected slot did not occur. All other measurement fields except SyncLoc are invalid.
2	1	Sync Even. The sync word began on the second bit of the symbol. A measurement was made and results were returned.
4	2	Weak Clock. The Test Set had difficulty finding the data clock's phase, for example, when all zeros are transmitted. A measurement was made and results were returned, however, performance may be degraded.
64	6	Memory Overflow. The memory of the RX DSP board was exceeded. The measurement was aborted.
1024	10	Parameter Error. The user selected incompatible pass parameters in the analyzer fields. No hardware is set and all zeros are returned.
2048	11	FIFO abort. The measurement was aborted due to communication with the DSP board while a measurement was armed. If the measurement is aborted due to communication with the DSP, the host will swallow the measurement and automatically re-arm another measurement. This error is only seen by the host firmware and is not reported to the <b>status</b> field for the user.
4096	12	SyncLoc bad. An error-free sync word was not found. The SyncLoc result is not valid.

**Table 4** defines the status codes for Adjacent Channel Power measurements.

**Table 4 Adjacent Channel Power Measurement Status Codes**

Decimal	Bit	Description
8	3	ADC under-driven. The absolute value of the peak sample is less than 30 dB below full scale of the ADC. A measurement is made and results are returned. (30 dB applies only to EVM measurements.)
16	4	ADC Overdriven. The absolute value of the peak sample was at ADC full scale. A measurement was made and results were returned.
64	6	Memory Overflow. The memory of the RX DSP board was exceeded. The measurement was aborted.
1024	10	Parameter Error. The user selected incompatible pass parameters in the analyzer fields. No hardware is set and all zeros are returned.
2048	11	FIFO abort. The measurement was aborted due to communication with the DSP board while a measurement was armed. If the measurement is aborted due to communication with the DSP, the host will swallow the measurement and automatically re-arm another measurement. This error is only seen by the host firmware and is not reported to the <b>Status</b> field for the user.
2147483648	31	Default. Specific error information is not available.

Mobile Assisted Hand-Off (MAHO) Status Codes

**Table 5 MAHO Measurement Status Codes**

Decimal	Bit	Description
16384	14	No channel quality message type was received from the mobile.
32768	15	No stable BER measurement was made; the last measured BER value is reported. Two identical successive measurements must be returned for a valid measurement to be recognized (200 to 300 slots are typically needed).

## Sync Err

This measurement field indicates the number of times the sync word errors were detected during the BERT measurement. When the Digital Analyzer detects a sync-word error, it finds a best match and continues the measurement.

## SyncLoc

This measurement field indicates the time in bit periods from when the Digital Analyzer was triggered to the beginning of the first sync word symbol detected for a base station. For a mobile radio measurement, it is the time from the trigger to the beginning of the first data symbol.

### Other Considerations

This value can be useful for determining the position of the trigger relative to the designated timeslot positions.

## Sync Word

This field specifies which sync word the Digital Generator will output as part of its time slot data when **Send** is selected in the **Digital Gen** field.

This field also specifies which sync word the Digital Analyzer will use to align its measurement with the appropriate time slots. For EVM measurements, the Digital Analyzer uses the sync word only if **Sync** is selected in the **Correlate** field. When **BERT** or **Sync Search** is selected in the **Measurement** field, the Digital Analyzer always uses the sync word to align its measurement.

- 1 specifies time slots 1 and 4
- 2 specifies time slots 2 and 5
- 3 specifies time slots 3 and 6
- 4, 5, and 6 are defined as specified in IS 54.

### Other Considerations

The correct sync word should be specified for all bit error measurements. It should also be specified for all error vector magnitude measurements made on mobile radios.

Only slot 1, 2, or 3 should be specified for the Digital Generator.

## Train Slots

This field specifies the number of training slots the Digital Generator outputs before outputting the data to be measured. The training slots contain a pre-determined data pattern. Training slots are necessary to enable the analyzer to align its demodulated measurements such as BERT. From 0 to 500 slots can be specified.

When a BERT measurement has been made, a measurement field is displayed that indicates the number of training slots received before synchronization occurred.

### Other Considerations

A sufficient number of training slots should be specified to allow the mobile radio to lock-up and start transmitting valid loopback data.

## Trig Delay

The **Trig Delay** field specifies the number of bits that the trigger signal will be delayed before it is sent to the Digital Analyzer's trigger input. This delay is applied only when **ANL TG IN** or **Dig Gen** is selected as the trigger source in the **Trig Type** field.

The range of acceptable settings is from 1 to 1943 bits.

### Other Considerations

Delaying the trigger can be useful when you need to capture a timeslot of data that is delayed relative to an external trigger.

## Trig Type

This field specifies the trigger conditions for the Digital Analyzer.

Selecting **Immediate** causes the analyzer to be triggered immediately when **Arm** is selected in the of the **Digital An1** field.

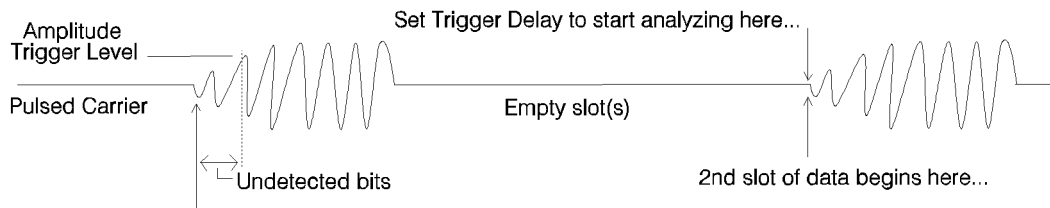
Selecting **ANL TG IN** causes the analyzer to be triggered by the signal at its ANALYZER TRIGGER IN connector.

Selecting **2 × Frame** causes the analyzer to be triggered by the 50 Hz, 2 × frame clock provided by the Test Set's Digital Generator.

Selecting **Frame** causes the analyzer to be triggered by the 2.5 Hz frame clock provided by the Test Set's Digital Generator.

Amplitude triggering uses low-to-high amplitude transitions in pulsed carriers as the trigger source. Trigger thresholds are at -6 dB (**Amptd Hi**), -12 dB (**Amptd Mid**), and -18 dB (**AmptdLow**) from the maximum **AdcMaxAbs** level. The **Input** field must be set to either **Int IF** or **Ext IF IN**.

If the initial amplitude of the carrier pulse is not high enough, the trigger will occur too late to analyze the first few bits, causing EVM or BERT errors. In that case, use the Trigger Delay field to capture the next full transmitted data pulse.



### Other Considerations

Selecting the appropriate trigger is necessary when making BERT measurements and aligning the Digital Analyzer to timeslots for Power, Adjacent Channel Power, or EVM measurements.





---

## Connector Descriptions

## Cellular Adapter Connector Descriptions

In the following descriptions, *Cellular Adapter* refers to the HP 83204A. *Test Set* indicates the HP 8921.

### 10 MHz REF OUT

This rear-panel port outputs a 10 MHz reference. This signal is phase locked to the signal applied to the REF IN port. All clocks (Bit, Symbol, and Frame) are derived from or phase locked to this signal.

If the REF UNLOCK indicator is lit, the output frequency may not be accurate.

#### Operating Considerations

Nominal output level:  $>+5$  dBm

Output impedance =  $50 \Omega$

Frequency stability = the same as the signal applied to the REF IN connector (typically needs to be within  $\pm 5$  ppm of the selected **Reference** frequency).

#### See Also

["REF UNLOCK Indicator" on page 110](#)

[Reference field description, on page 86](#)

["REF IN" on page 109](#)

## 114.3 MHz IF IN

This rear-panel port is where the Cellular Adapter receives the 114.3 MHz IF from the Test Set's receiver section. It is usually connected to the Test Set's 114.3 MHz IF OUT port.

### Operating Considerations

Input impedance = 50  $\Omega$

Input level range = -53 to -30 dBm

Input Bandwidth = the incoming signal goes through a 114.3 MHz bandpass filter with  $\approx$ 400 kHz 3dB bandwidth before down-conversion to 700 kHz. A 20 MHz LPF (Low Pass Filter) and 3 MHz LPF provide additional filtering before being analyzed.

### See Also

["EXT IF IN" on page 103.](#)

## ANALYZER BASEBAND DATA IN

This front-panel port provides a direct input to the Digital Analyzer section for analyzing TDMA data streams. This port is enabled by selecting the **Input** field and choosing **ANL DT IN**.

### Operating Considerations

The rising edge of the ANALYZER DATA CLOCK IN signal is used to trigger the Digital Analyzer to read the data.

The data must be present on the input for  $\geq$ 100 ns before the rising edge of the clock. The data must be stable on this input for  $\geq$ 1.3  $\mu$  s after being triggered by the Data Clock to correctly read the data.

Input level = TTL

Input impedance = 100 k  $\Omega$

Data Rates = 48.6 kHz

## ANALYZER DATA CLOCK IN

The rising edge of the signal applied to this front-panel port causes the data on the ANALYZER BASEBAND DATA IN connector to be sampled by the Digital Analyzer. This port is enabled by selecting the **sample clk** field and choosing **ANL CK IN**.

### Operating Considerations

Input level = TTL  
Input impedance = 100 k  $\Omega$   
Expected Clock Frequency = 48.6 kHz

## ANALYZER TRIGGER IN

This front-panel port allows external signals to trigger the Digital Analyzer section to begin sampling the selected input. This port is enabled by selecting the **Trig Type** field and choosing **ANL TG IN**.

### Operating Considerations

This signal is affected by the **Trig Delay** setting. If the **Trig Delay** setting is too large, the delay time overlaps the period of the triggering signal, preventing the analyzer from being triggered. Reduce the **Trig Delay** setting to prevent this overlap and allow the analyzer to be triggered. The minimum delay setting is 0 bits, resulting in a delay of  $\approx 0.5$  bit.

The normally used trigger frequency is 50 Hz.  
Input impedance = 100 k  $\Omega$   
Input level = TTL (rising edge)

## ANL TRIG OUT

The rear-panel Analyzer Trigger Output port outputs the signal used to synchronize external equipment to the Digital Analyzer. A rising edge indicates the Digital Analyzer was triggered.

The **Trig Type** field selects the desired signal.

A +5 VDC level is present if **Immediate** is selected in the **Trig Type** field.

### Operating Considerations

This signal is affected by the **Trig Delay** field setting. The minimum delay (**Trig Delay** set to 0 bits) is  $\approx 1/2$  bit time. Although you can enter fractional delay values, the actual delay will be rounded off to the nearest full bit.

Output level = CMOS

Output impedance =  $50\Omega$

## BIT CLK OUT

This rear-panel port outputs a square wave from the Digital Generator section's Bit Clock. This allows you to synchronize external equipment to the Digital Generator.

### Operating Considerations

When using internally generated data, the GEN BB DATA OUT signal is stable before the rising edge of the BIT CLK OUT, allowing the Bit Clock to be used to strobe this data into your external equipment.

Output frequencies = 48.6 kHz

Output level = CMOS

Output impedance =  $50\Omega$

## CW RF IN

This rear-panel port is the RF carrier input to the Cellular Adapter. This signal is normally connected to the Test Set's CW RF Out port. Although not normally used when testing TDMA signals, the Test Set can use AFGen1 or AFGen2 to provide AM or FM before being connected to this port.

### Operating Considerations

If the **RF Path** field is set to **IQ**, the signal gets  $\pi/4$  DQPSK modulated before being routed to the rear-panel IQ RF OUT connector. If this field is set to **Bypass**, this signal is routed directly to the IQ RF OUT connector without being modulated.

Nominal input level = 0 dBm,  $\pm 4$  dB

Maximum input level = +12 dBm

Input impedance = 50  $\Omega$

Frequency range:

- 500 to 1000 MHz without IQ modulation (may use AM or FM from the Test Set).
- 810 to 956 MHz with IQ modulation.

### See Also

["IQ RF OUT" on page 107.](#)

## CONTROL I/O

This connector provides data communication between the Test Set and the Cellular Adapter. The Cellular Adapter cannot be turned on without this cable attached to an operating Test Set.

## DIAG OUT

This port provides various signals used to service the Cellular Adapter.

When servicing the Cellular Adapter, this port is connected directly to the Test Set's AUDIO IN (HI) connector. Diagnostic routines are then run using the Test Set's internal IBASIC computer to locate the faulty module.

## EXT IF IN

This rear-panel port allows an external IF signal to be used in place of the 114.3 MHz IF that comes from the Test Set. This allows you to provide your own external down-conversion of the modulated carrier, bypassing the Test Set's receiver down conversion to 114.3 MHz and Cellular Adapter's down conversion to 700 kHz.

### Operating Considerations

Input Frequency = 700 kHz or 220 kHz,  $\pm 1$  kHz

Input level range = 30 to 1000 mV peak Input impedance: The input impedance has changed due to design improvements. The first four numbers (serial prefix) of your Cellular Adapter's serial number indicate the version you have. (Example: **3315A1234**)

- Serial prefix 3315 and below  $\approx 2$  k  $\Omega$
- Serial prefix 3333 and above  $\approx 1$  k  $\Omega$

When testing NADC radios using the TDMA DUAL MODE CELLULAR TEST screen, set the **sample clk** to 2.5 MHz for a 700 kHz IF, and 1 MHz for a 220 kHz IF.

## FRAME CLK OUT

This rear-panel port outputs a square wave from the Digital Generator section's Frame Clock. This allows you to synchronize external equipment to the Digital Generator.

### Operating Considerations

Nominal output frequency = 25  
Hz Output level = CMOS  
Output impedance = 50  $\Omega$

## FUSE

This fuse provides over-current protection for the Cellular Adapter.

### Operating Considerations

Rating: 2.0 Amp, 250 V  
Size: AGC Type: normal blow

---

**WARNING:** Replacing a fuse with a different type, size, or rating than is supplied with the instrument can cause an electrical shock and/or fire hazard.

---



## GEN BB DATA OUT

The rear-panel Generator BaseBand Data Output port monitors the digital signal applied to the Pre-modulation Filter/IQ Modulator. This signal is selected using the **Data Source** field, and comes from either of two sources:

- The internal Digital Generator section (**Int**).
- The front-panel GENERATOR BASEBAND DATA IN connector (**GEN IN**).

### Operating Considerations

Modulation data consists of two-bit symbols (00, 01, 10, or 11) that are sent to a Pre-Modulation filter. The Pre-Modulation filter is just ahead of the IQ Modulator to properly shape the modulating waveform.

This signal is affected by the **Data Delay** field setting. If the Data Delay is '0', the first data of a valid time slot lines up with the rising edge of the frame clock. The nominal delay from the first data bit in a two-bit symbol to its peak RF response (decision point) after  $\Omega/4$  DQPSK modulation is 12 bits (6 symbols).

Output level = CMOS

Output impedance = 50  $\Omega$

Nominal Data Rate = 48.3 kbits/sec

### See Also

["GENERATOR BASEBAND DATA IN" on page 106](#)

## GENERATOR BASEBAND DATA IN

This front-panel port allows you to send external data to the Pre-modulation Filter/IQ Modulator. This port is enabled by selecting the **Data Source** field and choosing **GEN IN**.

### Operating Considerations

When using an external reference, the same reference used to generate the Baseband data must also be connected to the Cellular Adapter's REF IN port to correctly clock-in the data.

Modulation data consists of two-bit symbols (00, 01, 10, or 11) that are sent to a Pre-Modulation filter. The Pre-Modulation filter is just ahead of the IQ Modulator to properly shape the modulating waveform. External data is clocked in on the rising edge of the Bit Clock. The first bit of a symbol is clocked in on the rising edge of the Symbol Clock, and the second bit of the symbol is clocked in on the falling edge of the Symbol Clock. Care must be taken to properly align the Baseband Data being input with the Symbol Clock to correctly modulate the Digital Generator.

This signal is not affected by the **Data Delay** field setting. The nominal delay from the first data bit in a two-bit symbol to its peak RF response (decision point) after  $\Omega/4$  DQPSK modulation is 12 bits (6 symbols).

Input level range = TTL  
Data rate = 48.6 kbits/sec  
Input impedance = 100 k  $\Omega$

### See Also

[RF Path field description, on page 86.](#)  
["SYMBOL CLK OUT" on page 111](#)

## **IQ RF OUT**

This rear-panel port outputs the carrier applied to the rear-panel CW RF IN connector. The carrier may or may not be IQ modulated, depending on the **RF Path** field setting.

Although not normally used when testing TDMA signals, the Test Set can use AFGen1 or AFGen2 to provide AM or FM before being connected to the CW RF IN port and routed to this port.

This port is normally connected to the Test Set's rear-panel IQ RF IN connector.

### **Operating Considerations**

When the **RF Path** field is set to **IQ**, the carrier is **always** IQ modulated. Even when the Digital Generator is not actively sending a message, the IQ Modulator still receives symbol data.

Output impedance = 50  $\Omega$

Nominal output level:

- -9.5 dBm ( $\pm 1.5$  dB) when IQ modulated.
- 0 dBm un-modulated (CW).

Frequency range:

- 500 to 1000 MHz without IQ modulation (may have AM or FM from the Test Set).
- 810 to 956 MHz with IQ modulation.

## MAINS (LINE)

This connection furnishes AC Line power to the Cellular Adapter; however, the instrument is not turned on until the connected Test Set is turned on.

### Operating Considerations

Line Voltage range: 100 V to 240 V

Line Frequency range: 50 Hz to 60 Hz

Typical power consumption: <80 VA over the entire range of line voltages and frequencies.

---

**WARNING:** Using line voltages and/or frequencies other than those listed can cause an electrical shock and/or fire hazard.

---

**NOTE:** The Test Set can be operated without the Cellular Adapter turned on if the I/O CONTROL and RF cables are still connected between the two instruments. If the I/O CONTROL cable is not connected, a cable must be connected between the Test Set's CW RF OUT and IQ RF IN ports to allow the Test Set to function by itself.

---

### See Also

Refer to the *Power Cable and Mains Plug Part Numbers* table in the Test Set's User's Guide for a list of available power cords.

## PWR Indicator

This indicator lights when the Test Set is turned on. There is no separate POWER switch for the Cellular Adapter. After mains (line) power is supplied, the Cellular Adapter is turned on when the connected Test Set is turned on.

## REF IN

This rear-panel connector provides a timing reference for the Digital Generator and Digital Analyzer sections. One of these frequencies must be used:

- 25 Hz,
- 50 Hz,
- 24.3 kHz,
- 48.6 kHz,
- 1 MHz,
- 2 MHz,
- 5 MHz,
- 10 MHz.

The Test Set's 10 MHz REF OUTPUT is normally used.

### Operating Considerations

The reference frequency must be specified in the **Reference** field. The REF UNLOCK indicator is lit if the reference signal's frequency does not match this field setting.

Using a Frame or 2X Frame Reference

---

#### **NOTE:**

#### **Using a Frame or 2X Frame Reference**

It takes about 30 seconds to lock to a 25 or 50 Hz reference after connecting the reference signal and selecting the correct setting in the **Reference** field. (The 200 and 400 Hz selections are a little faster.) If the reference signal is disconnected and then reconnected, you must re-select the reference frequency in the **Reference** field to start the phase-locking process over again. If you do not re-select the reference frequency, it can take **hours** to re-establish phase lock with these very low frequency references.

All Cellular Adapters require a 50% duty cycle when using a frame clock for the REF IN signal.

---

#### **REF IN Operating Considerations (continued)**

If a signal other than the Test Set's 10 MHz REF OUT is used as the system reference, the Cellular Adapter's 10 MHz REF OUTPUT should be connected to the Test Set's 10 MHz REF INPUT to phase lock the Test Set to the same external reference. Any external reference must be spectrally pure (very low noise) to provide a noise-free 10 MHz REF OUT signal and allow the Cellular Adapter to achieve phase lock.

Frequency accuracy typically needed for phase lock:  $\pm 1$  ppm

Input impedance:

- For 1 to 10 MHz signals:  $50 \Omega$
- For  $< 1$  MHz signals:  $100 \text{ k} \Omega$

Input level:

- For 1 to 10 MHz signals:  $-2.5 \text{ dBm}$  to  $+23 \text{ dBm}$
- For  $< 1$  MHz signals: TTL

#### **REF UNLOCK Indicator**

This indicator lights when the Digital Generator cannot phase lock to the reference signal from the rear-panel REF IN connector. This condition exists when the frequency of the reference signal does not match the setting for the **Reference** field, or when the reference signal level is incompatible.

**See Also**

**"REF IN" on page 109**

## RF IN/OUT

This type-N connector is only present on cellular adapters with option 002 or 003, and is only used for CDPD testing. This port is sampled by the cellular adapter's Digital Signal Processor, and is connected to the base station's RF output to measure signals up to 60 W. Refer to the *CDPD MDBS Software User's Guide* for more information.

## RF IN/OUT TO TEST SET

This type-N connector is only present on cellular adapters with option 002 or 003, and is only used for CDPD testing. This port is connected to the Test Sets RF IN/OUT port to provide RF measurements on the CDPD signal. Refer to the *CDPD MDBS Software User's Guide* for more information.

## SYMBOL CLK OUT

This port provides an output for the Symbol Clock of the Digital Generator. This allows you to synchronize external equipment to the Digital Generator.

### Operating Considerations

When using internally-generated data, and the **Data Delay** value is an even number, the first bit of a symbol is present on the rising edge of the Symbol Clock. If the delay is an odd number, the second bit of the symbol is present on the rising edge of the Symbol Clock.

When using externally-supplied data through the GENERATOR BASEBAND DATA IN port, the first bit of a symbol is always clocked in on the rising edge of the Symbol clock.

Nominal output frequency = 24.3 kHz

Nominal output level = CMOS

Output impedance = 50  $\Omega$

### See Also

[Data Delay field description, on page 73](#)





---

## HP-IB Syntax Diagrams for TDMA Test

---

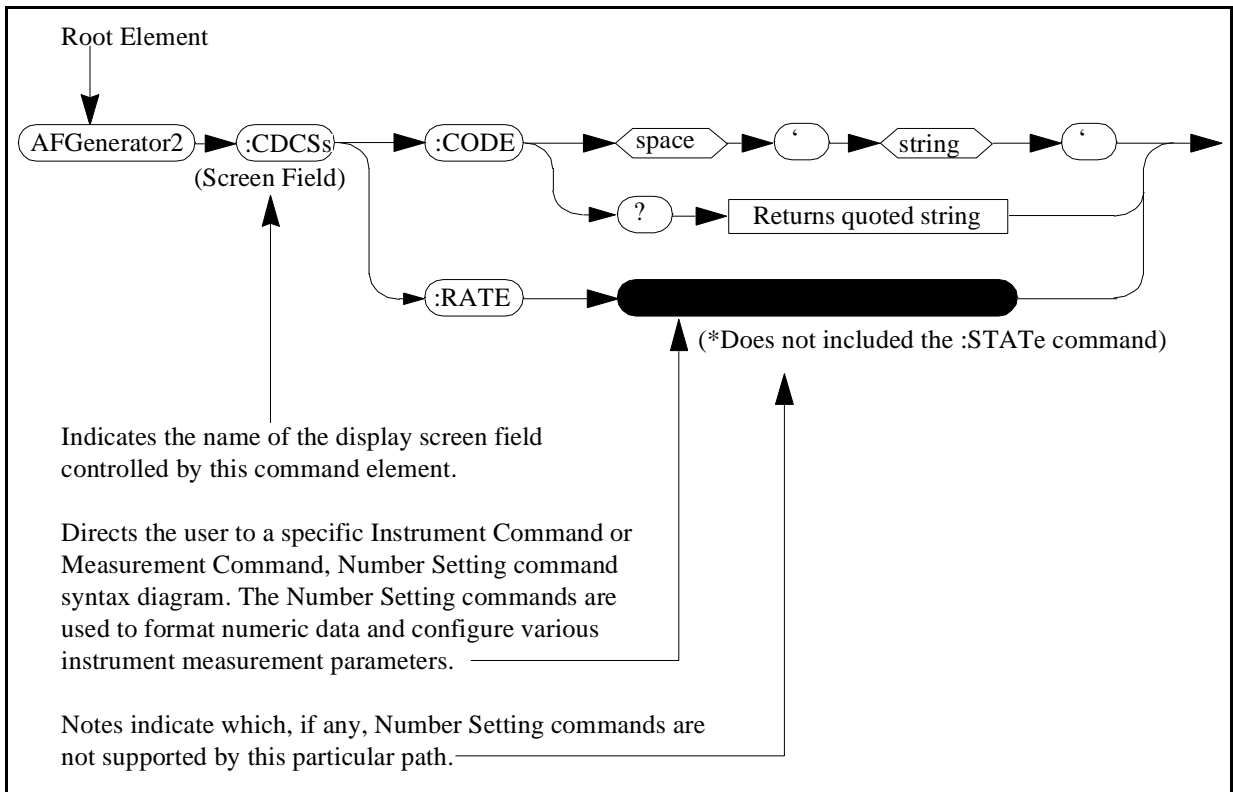
## HP-IB Syntax Diagram Listing

- "Digital Analyzer" on page 116
- "Digital Common" on page 118
- "Digital Generator" on page 119
- "Sending FACCH Messages" on page 120
- "Measure Commands" on page 121
- "Integer Number Setting Syntax" on page 122

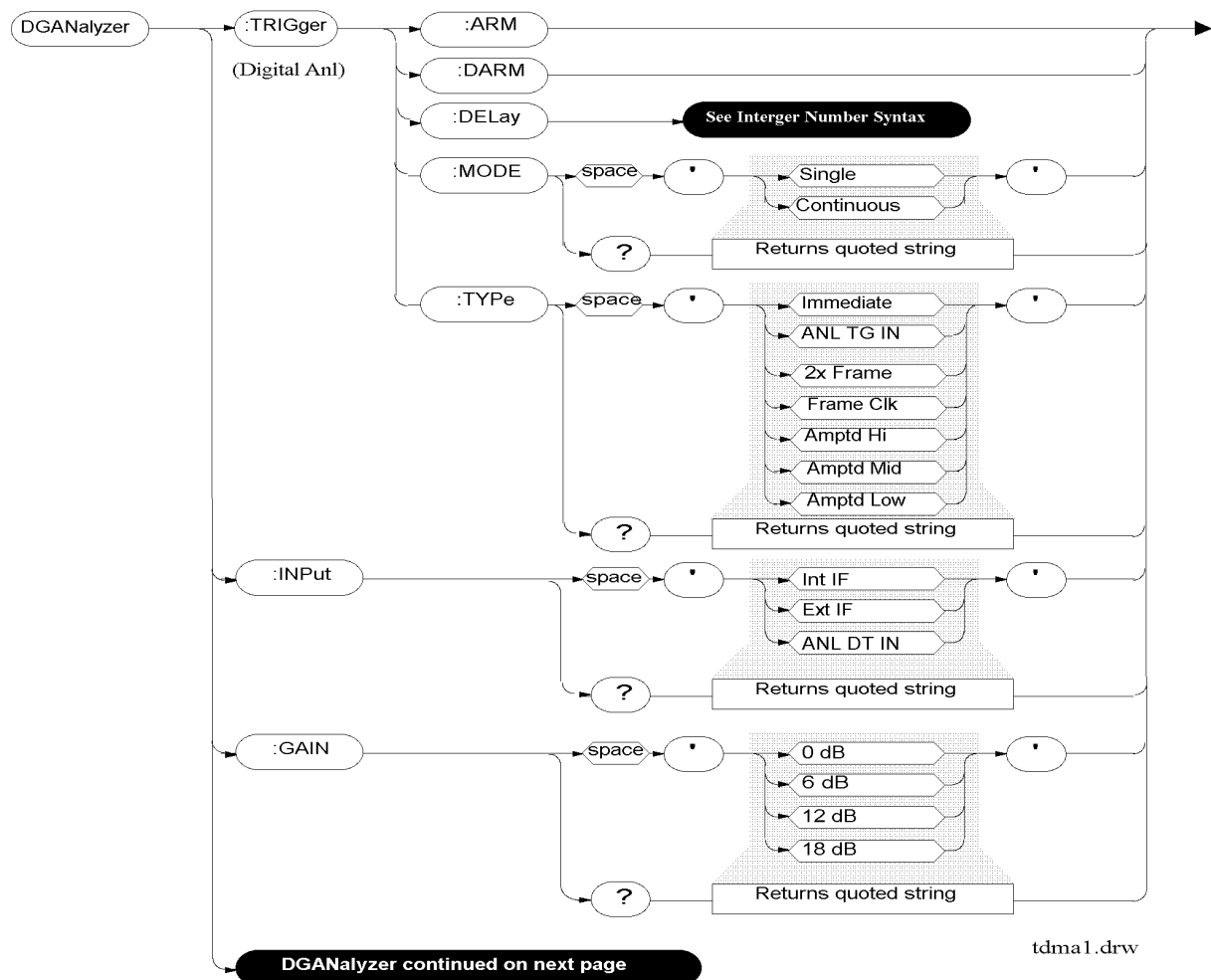
### Diagram Conventions

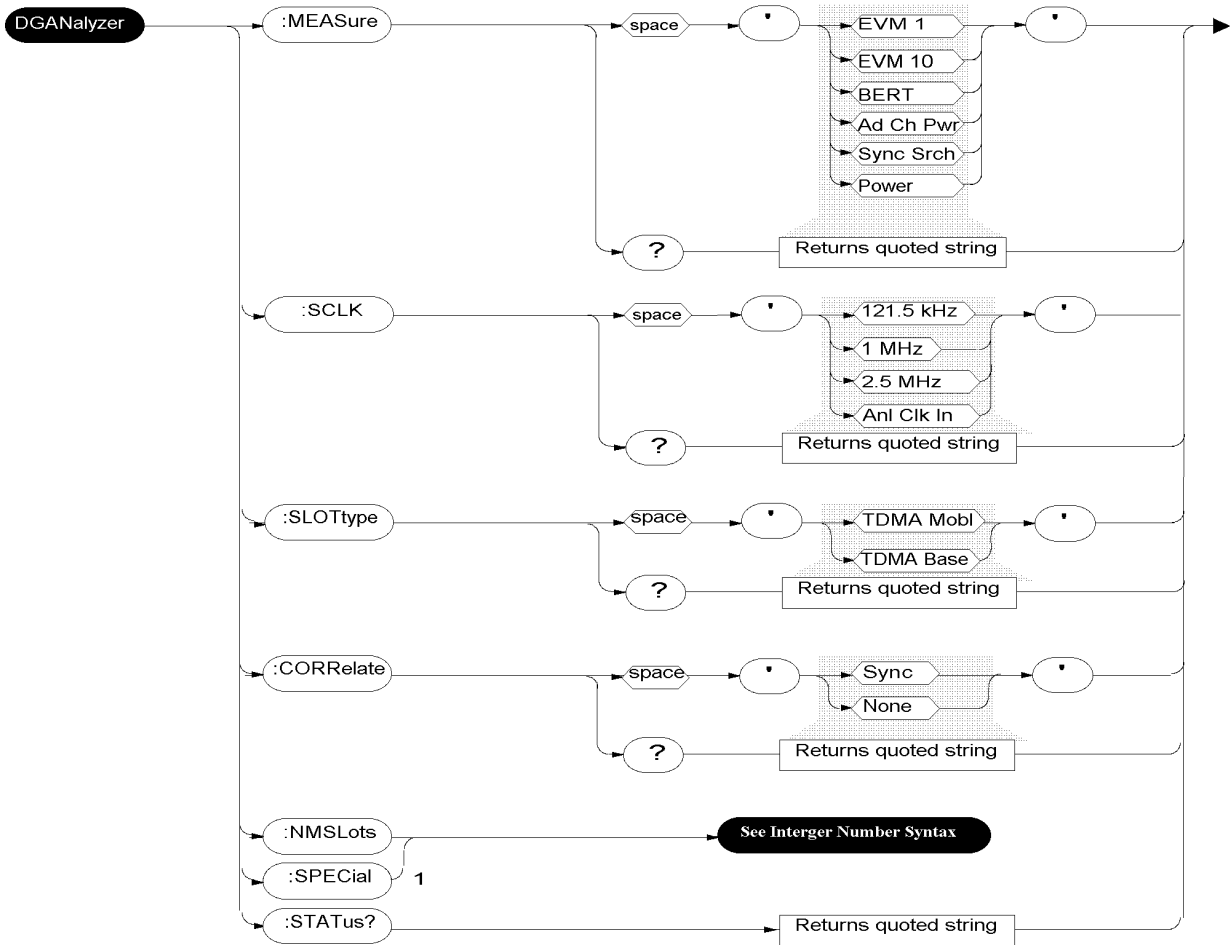
Use the following diagram to assist in the understanding of the conventions used in the syntax diagrams.

Statement elements are connected by lines. Each line can be followed in only one direction, as indicated by the arrow at the end of the line. Any combination of statement elements that can be generated by starting at the root element and following the line the proper direction is syntactically correct. An element is optional if there is a path around it. The drawings deal properly with the use of spaces. Where spaces are required they are indicated by a box with the word “space” in it, otherwise no spaces are allowed between command elements.



### Digital Analyzer





1. For future use-must be set to 0 at this time for the instrument to function correctly.

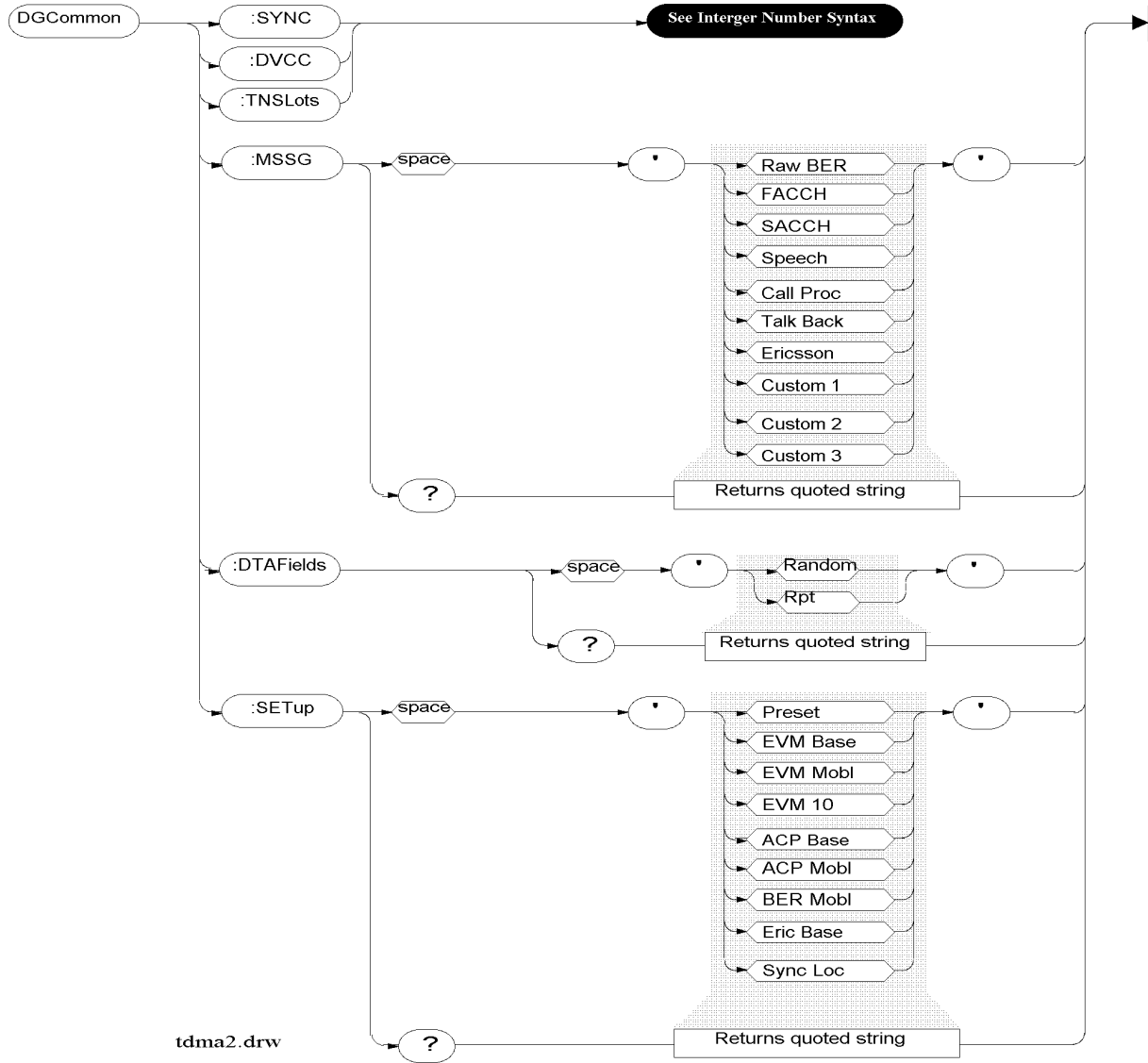
To read the HP 83201A REF UNLOCK indicator status:

Select the Latch = SERVICE: LATCH: SElect 'ref\_rx\_o0l\_int\_sense'  
 Read the status = SERVICE: LATCH: VALue? Returns +0 (phase locked)  
 +1 (unlocked)

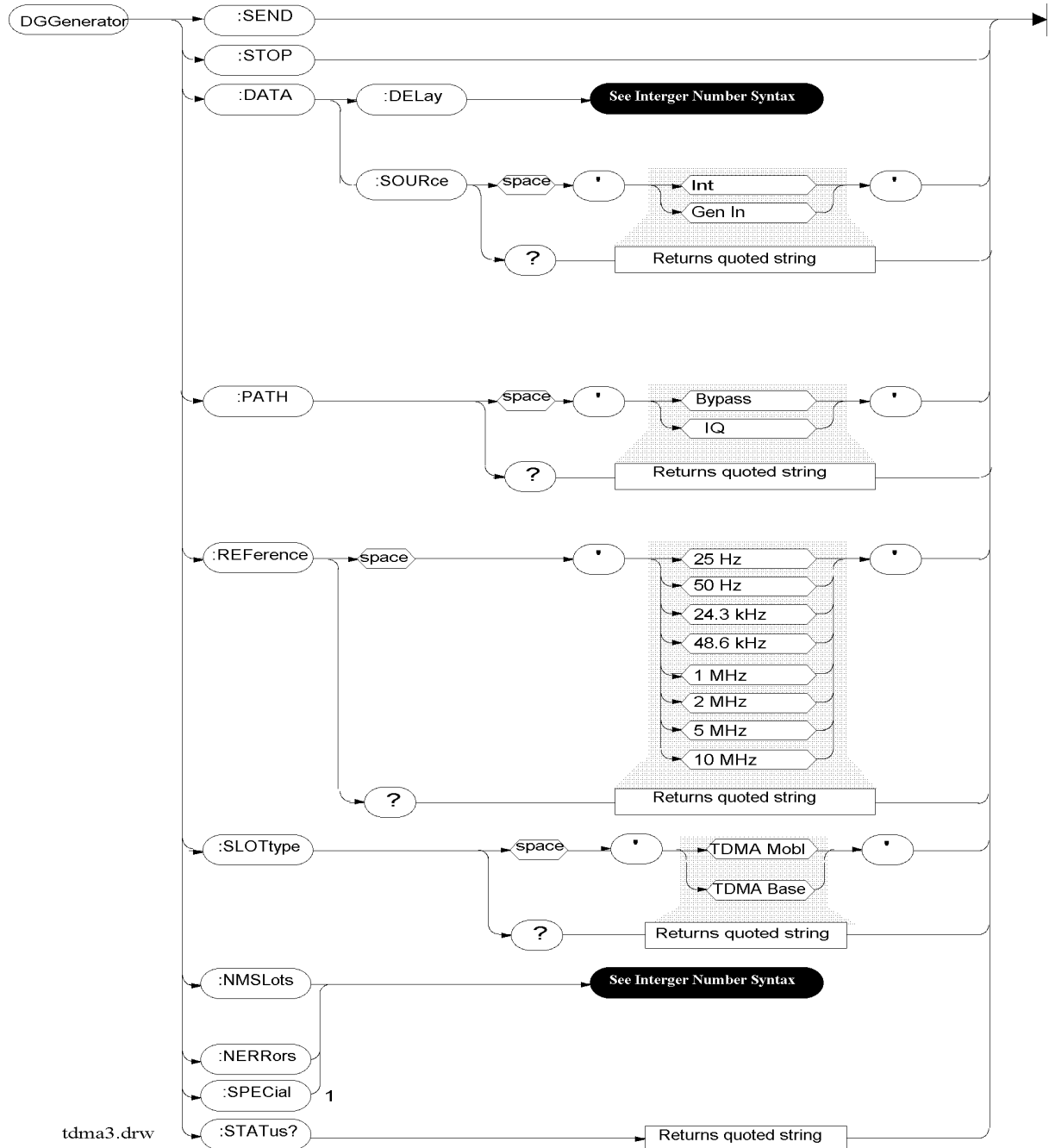
The Latch must be selected everytime the status is queried.

tdma4.drw

**Digital Common**



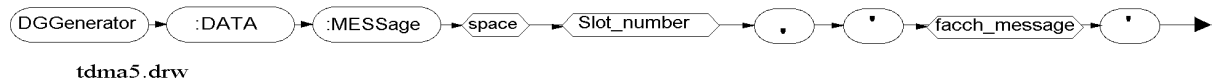
## Digital Generator



1. For future use-must be set to 0 at this time for the instrument to function correctly.

## Sending FACCH Messages

FACCH messages can be pre-loaded into the Digital Generator for call processing before they are sent.



The first 12-digit hexadecimal message must be preceded by a zero (0). For example, to have the Digital Generator output the FACCH message 3c8230400383 in slot 200, send the command:

```
DGGenerator:DATA:MESSAge 200,'03c8230400383'
```

Up to four messages can be included in one command string. The second, third, and fourth messages must be preceded by a one (1). For example to output these three FACCH messages 0c50104050c0 000303233343 5363738393a0 starting at slot 250, send the command:

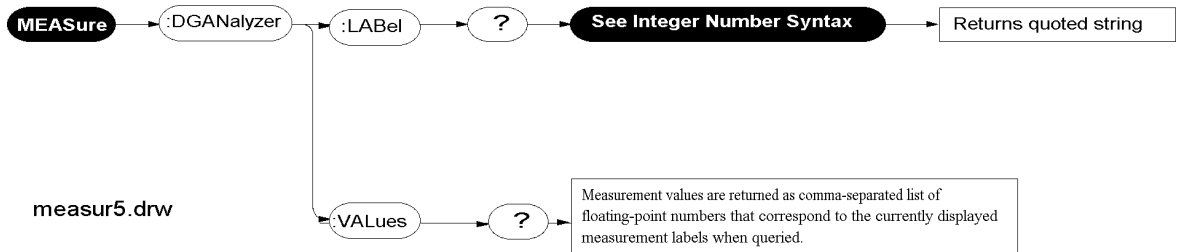
```
DGG:DATA:MESS 250,'00c50104050c0100030323334315363738393a0'
```

When multiple slots are pre-loaded, the slots must be sent in ascending order, or previous messages will be erased.



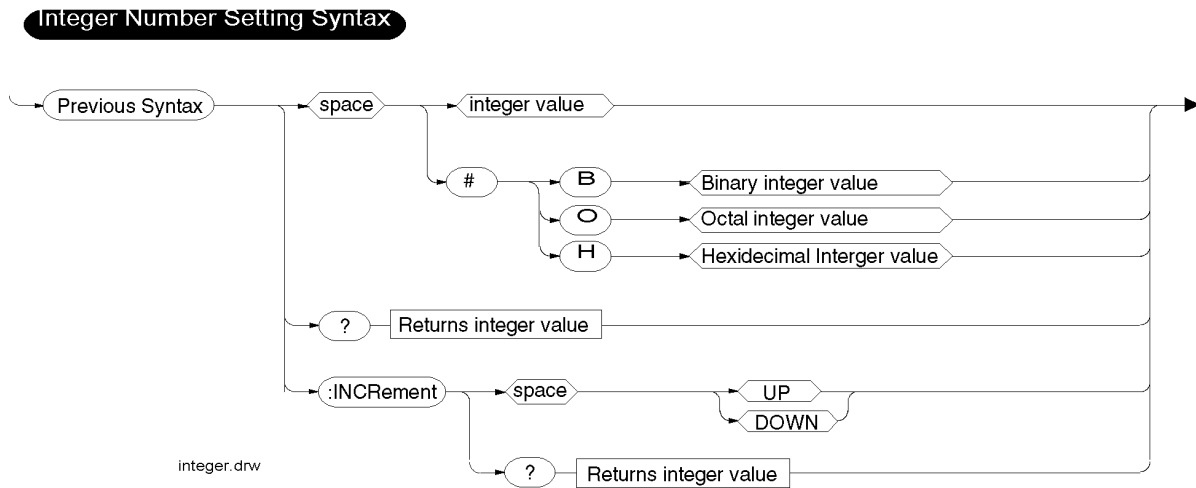
## Measure Commands

Part of Test Set's MEASure.



## Integer Number Setting Syntax

Same as Test Set's Integer Setting Syntax.



---

**Specifications**

Specifications describe the instrument's warranted performance and are valid over the entire operating/environmental range unless otherwise noted.

Supplemental Characteristics are intended to provide additional information useful in applying the instrument by giving typical, but non-warranted performance parameters. These characteristics are shown in *Italics* or labeled as "typical", "usable to", or "nominal".

The following specifications are for the Test System (Test Set plus the Cellular Adapter). Other specifications for the Test Set are given in the Test Set's documentation.

---

## TDMA Signal Generator Specifications

**Output Level Range:**

**RF In/Out:** -22 dBm to -127 dBm

**Duplex:** +4 dBm to -127 dBm

**Residual Error Vector Magnitude:** <3.0%

**Residual Phase Error:** <3 degrees

**Residual Magnitude Error:** <3.0%

**IQ Origin Offset:** -30 dBc within  $\pm 15^\circ$  C of last calibration

**Frequency Error:**  $\pm 4$  Hz plus reference

---

## TDMA Analyzer Specifications

**Input Level Range:**

**RF In/Out:** 1 mW to 60 W (0 to +47.78 dBm)

**Antenna:** -36 dBm to +17 dBm

**Input Frequency Setting Error:** 1 kHz

**RXDSP Level Setting Range:** 0 dB to -23 dB full scale

**Residual Error Vector Magnitude:** <1.3%

**Error Vector Magnitude Measurement Accuracy:** 0.4% + 2% of reading

**Residual Phase Error:** <1.5 degrees

**Residual Magnitude Error:** <1.4%

**I/Q Origin Offset Accuracy:**  $\pm 0.5$  dB for values to -40 dBc

**Frequency Error Accuracy:**  $\pm 2$  Hz plus reference



---

## Installation

This chapter provides instructions for installing the Cellular Adapter onto the Test Set.

1. Check your Test Set's firmware revision number.

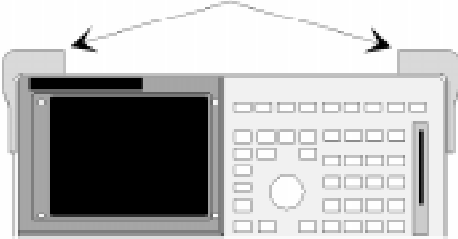
If your Test Set's firmware is not Revision A.16.00, you can not attach and use this Cellular Adapter.

2. Attach the Instrument.

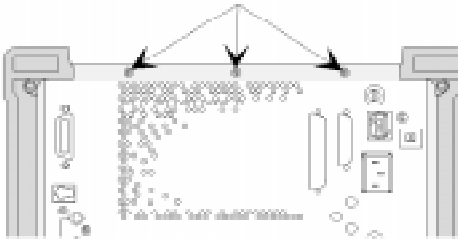


Inst011\_064

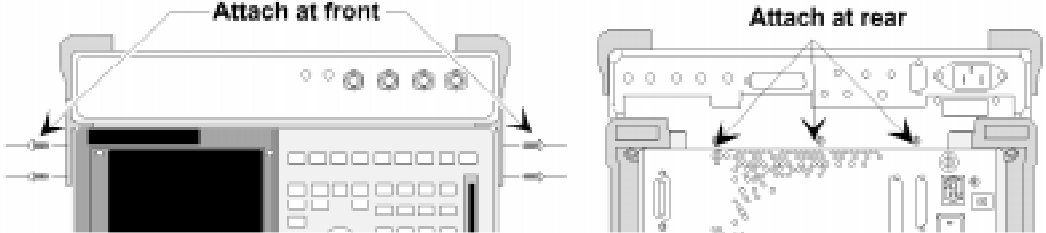
**a** Use a T-10 Torx Screwdriver to remove the top front bumpers from the Test Set. Keep the screws for attaching the top instrument.



**b** Use a T-10 Torx Screwdriver to remove the three screws along the top of the rear panel. Discard these screws; they are not long enough to reuse.

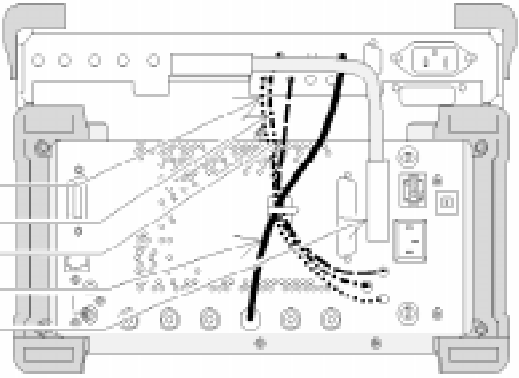


**c** Place the instrument on top of the the Test Set as shown below. Use the screws you removed in step 1 to attach the instruments together at the front. Use the the three new screws (T10, 15 cm) to attach the instruments at the rear.



**d** Peel and stick the cable tie, then connect the cables in the following order...

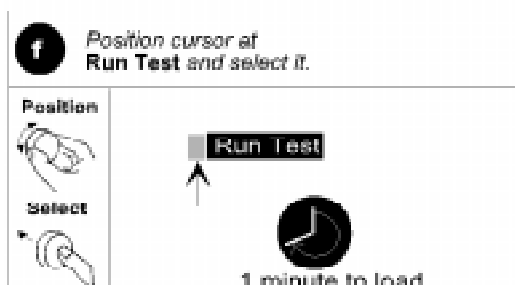
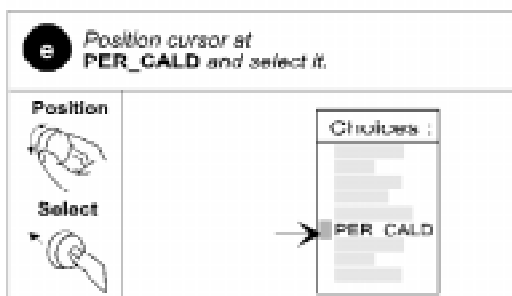
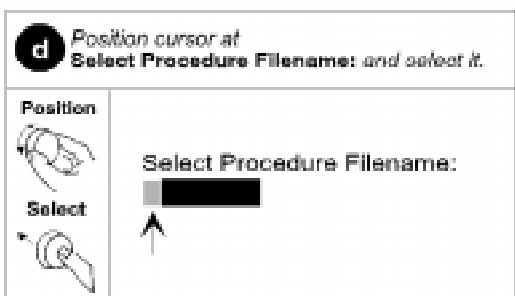
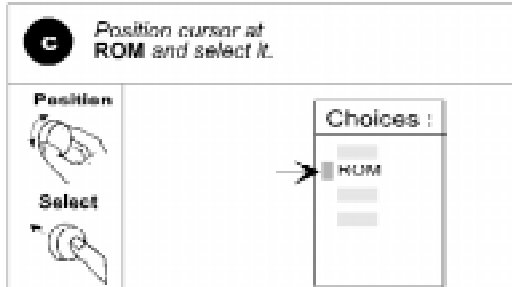
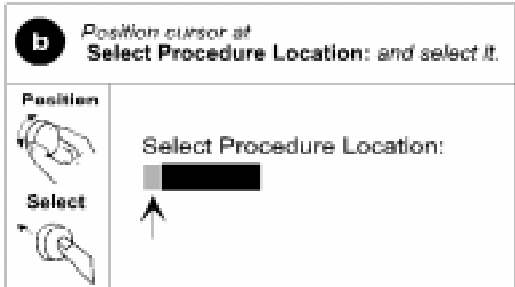
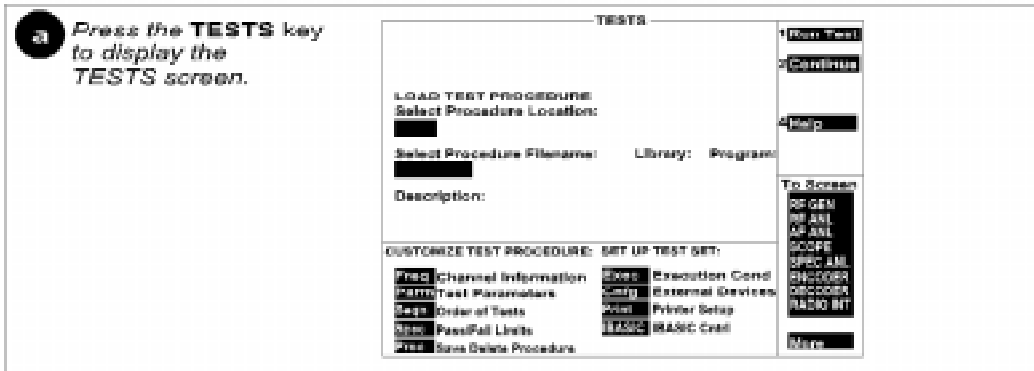
	Cellular Adapter	Cable	Test Set
1	CW RF IN	SMC to SMC	CW RF OUT
2	114.3 MHz IF IN	SMC to SMC	114.3 MHz IF OUT
3	IQ RF OUT	SMC to SMC	IQ RF IN
4	REF IN	SMC to BNC	10 MHz OUT
5	CONTROL I/O	46-pin bus	CONTROL I/O



### 3. Calibrate the Instruments.

Power-up the instruments and follow the instructions below.

install2.doc



**g**

Follow the on-screen instructions to complete & exit the calibration process.

---

**Numerics**

10 MHz REF OUT, 98

114.3 MHz IF IN, 99

**A**

ACP

measurement procedure, 57

System self-test, 61

ACP (Adjacent Channel Power), 35

AdcMaxAbs, 70

Add Errors, 71

Adj Hi, 71

Adj Lo, 71

adjacent channel power status codes, 92

Alt Hi, 71

Alt Lo, 71

Alt2 Hi, 71

Alt2 Lo, 71

AMPS, 18

analog modulation, 18

ANALYZER BASEBAND DATA IN,  
99

ANALYZER DATA CLOCK IN, 100

ANALYZER TRIGGER IN, 100

ANL TRIG OUT, 101

automated test, 66

**B**

BER

measurement procedure, 51

System self-test, 56

BER (Bit Error Rate), 34

BERT, 72

BERT status codes, 91

BIT CLK OUT, 101

block diagram, 38

**C**

CDVCC, 26  
channel assignments  
  analog systems, 23  
  digital systems, 24  
channel frequencies, 44  
channel spacing  
  analog systems, 23  
  digital systems, 24  
channel tuning, 44  
connector descriptions, 97  
Constellation diagram, 29  
CONTROL I/O, 102  
Correlate, 72  
CW RF IN, 102

**D**

DATA, 26  
Data Delay, 73  
Data Fields, 73  
Data Source, 74  
DIAG OUT, 103  
Digital Analyzer  
  status, 37  
Digital Anl, 74  
Digital Gen, 75  
Digital Generator  
  status, 37  
digital modulation, 21  
Digital Modulation Concepts, 17  
Droop, 75  
DVCC, 76

**E**

Err, 76  
Err Rate, 76  
Error Vector Magnitude, 35  
Error Vector Magnitude (EVM), 31  
EVM, 35, 76  
  measurement procedure, 46  
  System self-test, 50  
EVM Peak, 76  
EVM Program, 66  
EVM status codes, 89  
EXT IF IN, 103

---

**F**

FACCH, [26](#)  
frame  
  format, [25](#)  
FRAME CLK OUT, [104](#)  
frames, [24](#)  
Freq Err, [77](#)  
frequencies, channel, [44](#)  
FSK, [20](#)  
FUSE, [104](#)

**G**

Gain, [77](#)  
GEN BB DATA OUT, [105](#)  
GENERATOR BASEBAND DATA IN,  
  [106](#)  
GUARD, [26](#)

**I**

IBASIC Program, [66](#)  
Input, [78](#)  
IQ modulation, [27](#)  
IQ Origin, [29](#)  
IQ pattern, [30](#)  
IQ RF OUT, [107](#)  
IS-54, 55, 56, [32](#)

### M

Mag Err, [78](#)  
MAHO, [82](#)  
MAHO status codes, [92](#)  
MAINS (LINE) Power, [108](#)  
Max Abs, [79](#)  
Measurement, [81](#)  
measurements, [33](#)  
measurements, displaying, [37](#)  
modulation  
  IQ, [27](#)  
  Pi/4 DQPSK, [29](#)  
  QPSK, [28](#)  
Mssg Type, [83](#)

### N

NADC, [17](#)  
Num Slots, [84](#)

### O

Org Ofs, [84](#)

## P

Phase Error, [85](#)  
phase shifts, [27](#)  
Pi/4 DQPSK, [22](#)  
Pi/4 DQPSK modulation, [29](#)  
Power, [85](#)  
program example, [66](#)  
PWR Indicator, [108](#)

## Q

QPSK modulation, [28](#)

## R

RAMP, [26](#)  
REF IN,, [109](#)  
REF UNLOCK, [40](#)  
REF UNLOCK Indicator, [110](#)  
Reference, [86](#)  
reference connections, [40](#)  
RF Path, [86](#)  
RSVD, [26](#)

**S**

SACCH, 26  
Sample Clk, 87  
Sensitivity, 34  
Slot Type, 88  
Slots, 88  
Special, 88  
specifications  
    TDMA analyzer, 125  
    TDMA signal generator, 125  
standards  
    IS-54, 55, 56, 32  
Status, 89  
status codes  
    adjacent channel power, 92  
    BERT, 91  
    EVM, 89  
    MAHO, 92  
SYMBOL CLK OUT, 111  
symbols, 25  
    IQ pattern, 30  
Sync Err, 93  
Sync Word, 93  
SYNCH, 26  
SyncLoc, 93

**T**

TDMA, 17  
TDMA analyzer  
    specifications, 125  
TDMA DUAL MODE CELLULAR  
    TEST, 69  
    AdcMaxAbs, 70  
    Add Errors, 71  
    Adj Hi, 71  
    Adj Lo, 71  
    Alt Hi, 71  
    Alt Lo, 71  
    Alt2 Hi, 71  
    Alt2 Lo, 71  
    BERT, 72  
    Correlate, 72  
    Data Delay, 73  
    Data Fields, 73  
    Data Source, 74  
    Digital Anl, 74  
    Digital Gen, 75  
    Droop, 75  
    DVCC, 76  
    Err, 76  
    Err Rate, 76  
    EVM, 76  
    EVM Peak, 76  
    Freq Err, 77  
    Gain, 77  
    Input, 78  
    Mag Err, 78  
    MAHO, 82  
    Max Abs, 79  
    Measurement, 81  
    Mssg Type, 83  
    Num Slots, 84  
    Org Ofs, 84  
    Phase Error, 85  
    Power, 85  
    Reference, 86  
    RF Path, 86  
    Sample Clk, 87  
    Slot Type, 88  
    Slots, 88  
    Special, 88  
    Status, 89  
    Sync Err, 93  
    Sync Word, 93  
SyncLoc, 93  
Train Slots, 94  
Trig Delay, 94  
Trig Type, 95  
TDMA screen  
    accessing, 36  
    Digital Analyzer, 37  
    Digital Generator, 37  
TDMA signal generator  
    specifications, 125  
timebase connections, 40  
timeslots, 24  
    base and mobile, 25  
Train Slots, 94  
trajectories  
    IQ pattern, 30  
transmitter tests, 35  
Trig Delay, 94  
Trig Type, 95