Agilent Technologies 8960 Series 10 E5515B Wireless Communications Test Set
Agilent Technologies E1960A GSM Mobile Test Application

Programming Guide

Test Application Revision A.06

Agilent Part Number: E1960-90014

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All Editions and Updates of this manual and their creation dates are listed below.

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March 2000 - Test Application Revision A.04

June 2000 - Test Application RevisionA.05

January 2001 - Test Application Revision A.06

Safety Summary

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies Inc. assumes no liability for the customer's failure to comply with these requirements.

GENERAL

This product is a Safety Class 1 instrument (provided with a protective earth terminal). The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

All Light Emitting Diodes (LEDs) used in this product are Class 1 LEDs as per IEC 60825-1.

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.

ENVIRONMENTAL CONDITIONS

This instrument is intended for indoor use in an installation category II, pollution degree 2 environment. It is designed to operate at a maximum relative humidity of 95% and at altitudes of up to 2000 meters. Refer to the specifications tables for the ac mains voltage requirements and ambient operating temperature 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.

BEFORE APPLYING POWER

Verify that the product is set to match the available line voltage, the correct fuse is installed, and all safety precautions are taken. Note the instrument's external markings described under Safety Symbols.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cover must be connected to an electrical protective earth ground. The instrument must be connected to the ac power mains through a grounded power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

FUSES

Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short-circuited fuse holders. To do so could cause a shock or fire hazard.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes.

DO NOT REMOVE THE INSTRUMENT COVER

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made only by qualified service personnel.

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

WARNING **The WARNING sign 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 The CAUTION sign denotes a hazard. It calls attention to an operating procedure, 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 a CAUTION sign until the indicated conditions are fully understood and met.

Safety Symbols

Caution, refer to accompanying documents

Warning, risk of electric shock

Earth (ground) terminal

Alternating current

Frame or chassis terminal

Standby (supply). Units with this symbol are not completely disconnected from ac mains when this switch is off.

To completely disconnect the unit from ac mains, either disconnect the power cord, or have a qualified electrician install an external switch.

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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.

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Agilent Technologies certifies that this product met its published specifications at the time of shipment from the factory. Agilent Technologies 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

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Agilent Technologies 8960 Series 10 E5515B Wireless Communications Test Set, E1960A GSM Mobile Test Application

Duration of Warranty: 1 year

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DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and CEN/CENELEC EN45014

Manufacturer's Name:	**Agilent Technologies UK Ltd.**	**Agilent Technologies, Inc.**
Manufacturer's Address:	**Electronic Products & Solutions Group - Queensferry South Queensferry West Lothian, EH30 9TG Scotland, United Kingdom**	**24001 E. Mission Avenue Liberty Lake Washington 99019-9599 USA**

Declares that the product

Product Name: 8960 Series 10 Wireless Communications Test Set

Model Number: E5515B

Product Options: This declaration covers all options of the above product.

EMC:

Conforms with the following product specifications:

Standard:	**Limit:**
CISPR11:1990 / EN55011:1991	Group 1 Class A
IEC 801-2:1991 / EN 50082-1:1992	4kV CD, 8kV AD
IEC 801-3:1984 / EN 50082-1:1992	3V/m, 27-500 MHz
IEC 801-4:1988 / EN 50082-1:1992	0.5kV signal lines, 1kV power lines

Safety:

The product conforms to the following safety standards:

IEC 61010-1(1990) +A1(1992) +A2(1995) / EN 61010-1:1993
Canada / CSA-C22.2 No. 1010.1-93

The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC, and the EMC Directive 89/336/EEC, and carries the CE mark accordingly.

South Queensferry, Scotland. ***04 May 2000***

R.M. Evans / Quality Manager

Spokane, Washington, USA. ***04 May 2000***

W.V.Roland / Reliability & Regulatory Engineering Manager

For further information, please contact your local Agilent Technologies sales office, agent, or distributor.

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

Contents

Programming the Agilent Technologies 8960 Series 10 for GSM Mobile Testing in Active Cell Operating Mode

Introduction

Conventions used in this Programming Guide

Throughout this Programming Guide the term "test set" refers to an Agilent Technologies 8960 Series 10 wireless communications test set with the E1960A GSM mobile test application installed.

Purpose of this Programming Guide

The test set represents state-of-the-art technology in one-box-testers and contains many powerful test capabilities which are accessible through easy-to-use GPIB programming commands. The purpose of this Programming Guide is to teach you how to write a basic control program, using the test set's GPIB command set. This program will perform fundamental manufacturing tests on a mobile station with the test set operating in active cell mode.

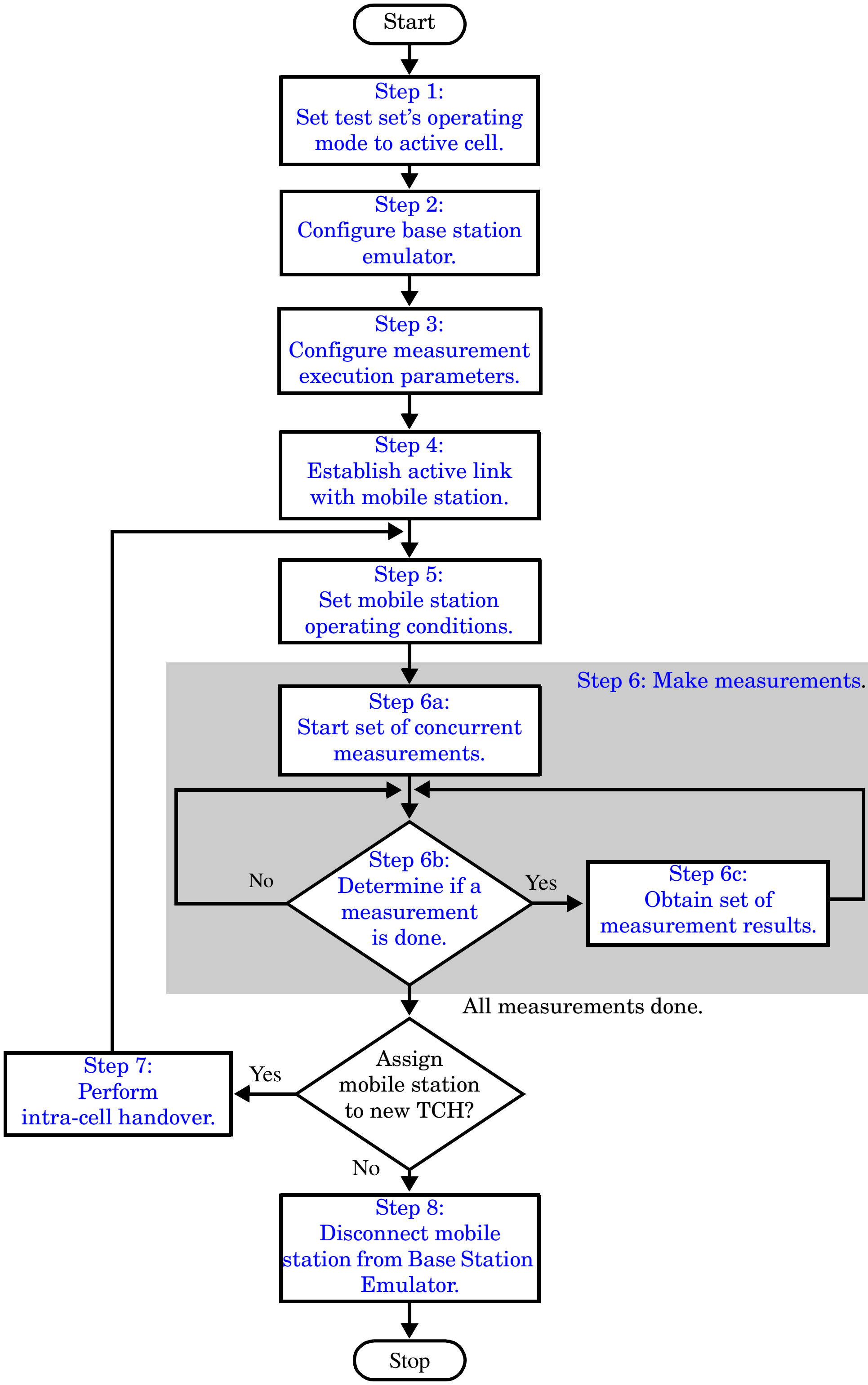
How this Programming Guide is Organized

The Programming Guide is organized around a typical set of tasks a control program would normally perform when testing a mobile station in a manufacturing environment. The set of tasks is shown in "Figure 1. Typical Flow of Tasks Performed by a Control Program" on page 15.

Typically in a manufacturing environment:

- steps 1, 2, and 3 are done once each time a production run is started,
- steps 4 and 8 are done once for each mobile station tested during the production run,
- steps 5, 6, and 7 are done iteratively for each mobile station tested during the production run. The number of iterations for these steps is dependent upon how many mobile station operating conditions are being tested (that is, number of channels, number of power levels, and so fourth).

Figure 1. Typical Flow of Tasks Performed by a Control Program



How to use this Programming Guide

This Programming Guide is divided into 9 sections. Sections 1 through 8 (Step 1 through Step 8) should be read in sequence. Each section, in order, describes one of the tasks to be performed by the control program and shows how to accomplish that task using the test set's GPIB command set. As you progress through each section your understanding of how the test set's GPIB interface operates will increase as you see the control program evolve.

The last section of the Programming Guide presents a "Comprehensive Program Example" on page 61 which uses all of the topics discussed in sections 1 through 8 together in one program to give you a sense of how to tie everything together.

About the Programming Examples Presented in This Programming Guide

Programming Language:

The programming examples presented in this guide are written in the HP BASIC programming language, also known as Rocky Mountain BASIC or RMB.

Syntax Used in Programming Examples:

- The programming examples use the shortened form of the command syntax to reduce test time by minimizing GPIB bus transactions. The shortened form of a command is defined by use of capital letters in the command syntax. For example, for the command syntax:

  ```
  SETup:TXPower:CONTinuous <ON|1|OFF|2>
  ```

  the shortened form would be:

  ```
  SET:TXP:CONT <ON|1|OFF|2>
  ```

- The programming examples do not include optional nodes. Optional nodes in the command syntax are defined by enclosing the node inside the [ ] brackets. For example, the command syntax:

  ```
  CALL[:CELL[1]]:POWer[:SAMPlitude] <numeric value>[<suffix>]
  ```

  appears in the programming examples as:

  ```
  CALL:POW <numeric value>
  ```

The programming examples make extensive use of compound commands using the ; and the ;: separators. Refer to the test set's reference documentation for details on the definition and use of these command separators.

Step 1: Set the Test Set's Operating Mode to Active Cell

Background

The test set contains a GSM base station emulator. The base station emulator's primary purpose is to provide the GSM call processing necessary for parametric measurements on the RF and audio signals of a GSM mobile station.

An important characteristic of the test set's base station emulator is its operating mode. The operating mode sets the way in which the base station emulator interacts with the mobile station. The base station emulator has two operating modes; active cell mode and test mode.

Active cell mode is used when emulating a normal GSM cell. Test mode is used when it is not possible, or not desired, to communicate with the mobile station via over-the-air signaling, but downlink stimulus and uplink measurements are still needed.

This Programming Guide focuses on programming the test set's base station emulator in active cell operating mode.

Overview of Active Cell Operating Mode

Active cell is the default operating mode of the test set's base station emulator and is used when emulating a normal GSM cell (that is, active signaling between the mobile station and the base station emulator).

Active Cell Features

The basic features provided by the base station emulator when the operating mode is set to active cell are:

- Generation of a BCH (broadcast channel) without TCH (traffic channel).
- Support for location updating.
- Call setup, both mobile station and base station emulator originated.
- Changing TCH parameters during a call using over-the-air signaling.
- Base station emulator initiated and mobile station initiated call disconnection.
- All measurements supported in the test application are available.
- The base station emulator automatically controls the test set's demodulation receiver.

Setting the Test Set's Operating Mode to Active Cell

The test set's operating mode is set using the CALL:OPERating:MODE command.

Example 1. Command Syntax:

```
CALL:OPERating:MODE <CELL|TEST>
```

Programming Example:

```
!*********************************************************************
! Step 1: Set Test Set Operating Mode To Active Cell
!*********************************************************************
!
OUTPUT Test_set;"CALL:OPER:MODE CELL"
```

Step 2: Configure the Base Station Emulator

Background

In active cell operating mode the base station emulator, using the test set's GMSK modulated source, generates a downlink (base station to mobile station direction) broadcast channel (BCH) which represents a cell. The mobile station can camp to this signal, just as it would camp to a cell on a real network. The base station emulator can then page the mobile station on the BCH and listen to the response of the mobile station on the uplink (mobile station to base station direction), using the test set's demodulating receiver. Calls can then be set up with the establishment of a traffic channel (TCH) in both the downlink and uplink directions. Measurements can be made, using the base station emulator's measuring receiver, under essentially identical conditions to that which the mobile station would experience on a real network.

The base station emulator can emulate a cell in any one of the following GSM frequency bands:

- PGSM - Primary (band) GSM, also known as GSM900
- EGSM - Extension (band) GSM (includes PGSM)
- DCS - Also known as DCS1800
- PCS - Also known as PCS1900, DCS1900

NOTE The term GSM is used to refer to any combination of, or all of, the supported bands. It is not used as a shortened term for PGSM.

To configure the base station emulator you must configure the BCH and the TCH as described in the following sections. There are numerous parameters that can be configured for both the BCH and the TCH. It may not be necessary to configure all the parameters all the time. The test set's default settings will allow a properly functioning mobile station to successfully camp on the cell under most circumstances.

In a manufacturing environment it may be desirable to explicitly configure the BCH and TCH parameters to ensure that the settings have not been changed by someone setting a parameter's value through the test set's front panel.

Configuring the Broadcast Channel Parameters

The BCH parameters are configured using the CALL processing subsystem commands shown in the following table.

Table 1. Broadcast Channel Settable Parameters

<table>
<tr><th>Parameter</th><th>Command Syntax</th><th>Footnote</th></tr>
<tr><td>Cell Band</td><td>CALL[:CELL[1]]:BAND <PGSM|EGSM|DCS|PCS></td><td>1</td></tr>
<tr><td>Cell Power</td><td>CALL[:CELL[1]]:POWer:AMPlitude <numeric value>[<suffix>]</td><td></td></tr>
<tr><td>Cell Power State</td><td>CALL[:CELL[1]]:POWer:STATe <ON|1|OFF|0></td><td></td></tr>
<tr><td>Cell Power and State</td><td>CALL[:CELL[1]]:POWer[:SAMPlitude]<numeric value>[<suffix>]</td><td>2</td></tr>
<tr><td>Broadcast Channel (ARFCN)</td><td>CALL[:CELL[1]]:BCHannel[:ARFCn][:SELected]<numeric value>
OR
CALL[:CELL[1]]:BCHannel[:ARFCn]:<PGSM|EGSM|DCS|PCS> <numeric value></td><td>3</td></tr>
<tr><td>Mobile Country Code</td><td>CALL[:CELL[1]]:MCCode <numeric value></td><td>4</td></tr>
<tr><td>PCS Mobile Country Code</td><td>CALL[:CELL[1]]:PMNCode:VALue <numeric value></td><td>4</td></tr>
<tr><td>PCS Mobile Country Code State</td><td>CALL[:CELL[1]]:PMNCode:STATe <ON|1|OFF|0></td><td>4</td></tr>
<tr><td>PCS Mobile Country Code and State</td><td>CALL[:CELL[1]]:PMNCode[:SVALue] <numeric value></td><td>4,5</td></tr>
<tr><td>Mobile Network Code</td><td>CALL[:CELL[1]]:MNCode <numeric value></td><td>4</td></tr>
<tr><td>Location Area Code</td><td>CALL[:CELL[1]]:LACode <numeric value></td><td>4</td></tr>
<tr><td>Network Color Code</td><td>CALL[:CELL[1]]:NCCode <numeric value></td><td>4</td></tr>
<tr><td>Base Station Color Code</td><td>CALL[:CELL[1]]:BCCode <numeric value></td><td>4</td></tr>
<tr><td>Paging IMSI</td><td>CALL:PAGing:IMSI <string></td><td></td></tr>
<tr><td>Repeat Paging</td><td>CALL:PAGing:REPeat[:STATe] <ON|1|OFF|0></td><td></td></tr>
<tr><td>Paging Mode</td><td>CALL:PAGing:MODE <NORMal | REORg></td><td>7</td></tr>
<tr><td>Paging Multiframes</td><td>CALL:PAGing:MFRames <numeric value></td><td></td></tr>
<tr><td>Auto IMEI Request</td><td>CALL:IMEI:AUTO <ON|1|OFF|0></td><td></td></tr>
<tr><td>BA Table</td><td>CALL[:CELL[1]]:BA:TABle[:SELected][<numeric value>{,<numeric value>}]
OR
CALL[:CELL[1]]:BA:TABle:<PGSM|EGSM|DCS|PCS> [<numeric value>{,<numeric value>}]</td><td>6</td></tr>
</table>

Table Footnotes

1. The broadcast band setting becomes the selected (:SELected) band (see note 3).
2. Sets amplitude to <numeric value> and state to ON in one command.
3. Sets the BCH channel for the broadcast band selected with the broadcast band command (see note 1).
4. Can only be set when Cell Activated State = OFF. See "Things That Can Go Wrong" on page 24.
5. Sets PCS mobile country code to <numeric value> and state to ON in one command.
6. Sets the BA table entries for the broadcast band selected with the broadcast band command (see note 1).
7. Setting Paging Mode to Normal causes the mobile station to use discontinuous reception (that is, DRX = ON).

Programming Example: The following program example illustrates the use of the base station emulator BCH configuration commands. Note the use of the cell activated state command to set the network configuration parameters.

```
OUTPUT Test_set;"CALL:CELL:BAND PGSM"
OUTPUT Test_set;"CALL:PAG:MODE REOR" ! Sets discontinuous reception to OFF
OUTPUT Test_set;"CALL:ACT OFF"
OUTPUT Test_set;"CALL:CELL:MCC 1;LAC 1;MNC 1;NCC 1;BCC 5"
OUTPUT Test_set;"CALL:ACT ON"
OUTPUT Test_set;"CALL:BCH 20"
OUTPUT Test_set;"CALL:POW:SAMP -85"
```

Configuring the Traffic Channel Parameters

The TCH parameters are configured using the CALL processing subsystem commands shown in the following table.

Table 2. Traffic Channel Settable Parameters

<table>
<tr><th>Parameter</th><th>Command Syntax</th><th>Footnotes</th></tr>
<tr><td>TCH Band</td><td>CALL:TCHannel:BAND <PGSM|EGSM|DCS|PCS></td><td>1</td></tr>
<tr><td>Channel Number</td><td>CALL:TCHannel[:ARFCn][:SELected] <numeric value>
OR
CALL:TCHannel[:ARFCn]:<PGSM|EGSM|DCS|PCS> <numeric value></td><td>2</td></tr>
<tr><td>Loopback Mode</td><td>CALL:TCHannel:LOOPback <OFF|A|B|C></td><td></td></tr>
<tr><td>Timeslot</td><td>CALL:TCHannel:TSLot <numeric value></td><td></td></tr>
<tr><td>Downlink Speech Source</td><td>CALL:TCHannel:DOWNlink:SPEech
<NONE|ECHO|PRBS15|SIN300|SIN1000|SIN3000></td><td></td></tr>
<tr><td>Channel Mode</td><td>CALL:TCHannel:CMODe <FRSP|EFRS></td><td></td></tr>
</table>

Table Footnotes

1. The TCH band setting becomes the selected band (see Note 2).
2. Sets the TCH channel for the TCH band selected with the TCH Band command (see Note 1).

Programming Example: The following program example illustrates the use of the base station emulator TCH configuration commands.

```
OUTPUT Test_set;”CALL:TCH 45”
OUTPUT Test_set;”CALL:TCH:TSL 4”
```

Things That Can Go Wrong

Trying to Set the MCC, MNC, LAC, NCC, or BCC While the Cell Activated State = ON

Trying to set any of the network configuration parameters while the cell is in the active state will generate the following error:

```
GSM operation rejected; Attempting to set <MCC|MNC|LAC|NCC|BCC> while generating a BCH
```

Background The network configuration parameters are encoded into the messaging broadcast on the BCH. Changing the network parameter values while the BCH is active would require the BCH to be stopped, and have the new values encoded, and then the BCH would have to be re-started. This would cause calls to be dropped or disrupt a mobile station camped to the cell. Consequently the network configuration parameters cannot be changed while the cell is active.

Control of the Cell Activated State The active/inactive state of the cell is controlled using the cell activated state command. This command is only used when the operating mode is set to active cell mode.

Example 1. Command Syntax:

```
CALL[:CELL[1]]:ACTivated[:STATe]<ON|1|OFF|0>
```

Programming Example:

```
OUTPUT Test_set;"CALL:ACT ON"
```

Effects of Activating and Deactivating the Cell

Effects of Deactivating the Cell Among others (refer to the test set's reference information for a complete listing of actions), setting the cell activated state to OFF causes the following actions to take place:

- The control program is no longer prevented from setting the following parameters: MCC, MNC, PCS MNC, Use PCS MNC, BCC, NCC and LAC.
- All signaling operations, uplink demodulation and downlink (BCH & TCH) generation are stopped.
- Any measurements that rely on uplink demodulation are aborted. No special error messages are generated.

Effects of Activating the Cell Among others (refer to the test set's reference information for a complete listing of actions), setting the cell activated state to ON causes the following actions to take place:

- The control program is prevented from setting the following parameters: MCC, MNC, PCS MNC, Use PCS MNC, BCC, NCC and LAC.
- If the cell activated state was previously OFF, the TDMA frame number of the BS emulator starts from zero, and a BCH is generated.
- If a TCH was present prior to setting cell activated state to OFF, the TCH is not reinstated.

Step 3: Configure the Measurement Execution Parameters

Measurement Execution Parameters

Measurement execution parameters allow you to control the conditions under which a measurement operates. Not all measurements use all the execution parameters shown below. Additionally, some measurements have parameters that are specific to the measurement such as offset frequency lists or filter settings. Each measurement has its own set of parameters which are unique to it and have no affect on the execution of other measurements. Refer to the GPIB syntax listing in the reference documentation for a detailed list of execution parameters for individual measurements. The general set of measurement execution parameters and their generic categories are:

- Measurement Averaging (used by most measurements)

  Multi-Measurement Count
  Multi-Measurement Count State

- Measurement Triggering (used by most measurements)

  Trigger Arm
  Trigger Source
  Trigger Delay
  Trigger Qualifier

- Measurement Synchronization (used by some measurements)

  Burst Synchronization

- Measurement Timeouts (used by all measurements)

  Measurement Timeout
  Measurement Timeout State

- Measurement Specific (execution parameters specific to an individual measurement)

Overview of the SETup subsystem

The SETup subsystem allows you to configure the measurement parameters. Each individual measurement parameter can be set and queried using the associated SETup subsystem command. The general hierarchy of the SETup subsystem command structure is as follows:

```
SETup:<measurement mnemonic>:<measurement parameter> <parameter setting/value>
```

For example, the SETup subsystem is used below to set a timeout value for the transmit power measurement:

```
SET:TXP:TIM 5
```

The following table shows the measurements available in the test application and their associated <measurement mnemonic> used in the SETup command syntax.

Table 1. Measurement Mnemonics Used In The SETup Subsystem

Measurement	<meas-mnemonic>
Transmit Power	TXPower
Power vs Time	PVTime
Phase & Frequency Error	PFERror
Output RF Spectrum	ORFSpectrum
Bit Error	BERRor
Fast Bit Error	FBERror
Decoded Audio	DAUDio
Analog Audio	AAUDio
I/Q Tuning	IQTuning
Dynamic Power	DPOWer
Decoded Audio	DAUDio

Configuring Measurement Averaging Parameters

Table 1. Measurement Averaging Parameters

Parameter	Command Syntax
Measurement Count Number and State	`SETup:<measurement mnemonic>:COUNt[:SNUMber] <numeric value>`
Measurement Count State	`SETup:<measurement mnemonic>:COUNt:STATe <ON|1|OFF|0>`
Measurement Count Number	`SETup:<measurement mnemonic>:COUNt:NUMBer <numeric value>`

Configuring Multi-Measurement Count State and Count Number Simultaneously

The multi-measurement count state can be set to ON and the multi-measurement count number can be set to some value using a single command. For example:

```
OUTPUT Test_set;"SET:TXP:COUN 10"
```

would set the multi-measurement count state to ON and set the number of averages to 10 for the transmit power measurement.

Multi-Measurement Count State Parameter

The Multi-Measurement Count State parameter is used to turn measurement averaging on and off.

Multi-Measurement Count Number Parameter

The Multi-Measurement Count Number parameter sets the number of measurement samples taken during each measurement cycle when the COUNt:STATe parameter is set to ON.

Configuring Measurement Triggering Parameters

Table 2. Measurement Triggering Parameters

<table>
<tr><th>Parameter</th><th>Command Syntax</th></tr>
<tr><td>Trigger Arm</td><td>SETup:<measurement mnemonic>:CONTinuous <ON|1|OFF|0></td></tr>
<tr><td>Trigger Source</td><td>SETup:<measurement mnemonic>:TRIGger:SOURce
<AUTO|IMMediate|PROTocol|RISE></td></tr>
<tr><td>Trigger Delay</td><td>SETup:<measurement mnemonic>:TRIGger:DELay <numeric value>[<suffix>]</td></tr>
<tr><td>Trigger Qualifier</td><td>SETup:<measurement mnemonic>:TRIGger:QUALifier <ON|1|OFF|0></td></tr>
</table>

Trigger Arm Parameter

The Trigger Arm parameter allows you to set whether a measurement either:

- make one measurement then stop (single), or
- automatically re-arm upon completion of one measurement and repeat the process (continuous).

For example,

```
OUTPUT Test_set;"SET:TXP:CONT OFF"
```

would set the trigger arming to single for the transmit power measurement.

NOTE If you are using the test set remotely, set the trigger arm to single (CONTinuous OFF) for each measurement or, a single command (SET:CONT:OFF) or the *RST command can be used to set the trigger arm to single for all measurements.

Trigger Source Parameter

The Trigger Source parameter selects the source of the measurement trigger signal.

```
OUTPUT Test_set;"SET:TXP:TRIG:SOUR AUTO"
```

would set the trigger source to AUTO for the transmit power measurement.

Trigger Delay Parameter

The Trigger Delay parameter controls the delay between the trigger event (the point in time at which the trigger signal is received) and the start of sampling. Negative values indicate that the sampling occurs prior to the trigger event.

```
OUTPUT Test_set;"SET:TXP:TRIG:DEL 10 US"
```

would set the trigger delay to 10 µs for the transmit power measurement.

Trigger Qualifier Parameter

The Trigger Qualifier parameter allows you to enable or disable automatic trigger re-arming following a trigger event which occurred when no valid signal (burst) was present.

```
OUTPUT Test_set;"SET:TXP:TRIG:QUAL ON"
```

would turn the trigger qualifier on for the transmit power measurement.

Configuring the Burst Synchronization Parameter

Burst Synchronization Parameter

The burst synchronization parameter allows you to specify where in the sampled data stream the test set starts analyzing the captured data. Burst synchronization occurs after the measurement data is captured. The burst synchronization parameter's setting determines how the measurement's time reference is developed from the sampled data.

Not all measurements have synchronization choices and not all synchronization choices are available in measurements that use synchronization. Measurement synchronization and measurement triggering are independent from each other and may be used in any combination.

The command syntax for setting the burst synchronization parameter is:

```
SETup:<measurement mnemonic>:BSYNc <MIDamble|AMPLitude|NONE>
```

The burst synchronization is set to midamble for the power versus time measurement in the following example:

```
OUTPUT Test_set;"SET:PVT:BSYN MID"
```

Configuring Measurement Timeout Parameters

Table 3. Measurement Timeout Parameters

Parameters	Command Syntax
Measurement Timeout Time and State	`SETup:<meas-mnemonic>:TIMeout[:STIMe] <numeric value>[<suffix>]`
Measurement Timeout State	`SETup:<meas-mnemonic>:TIMeout:STATe <ON|1|OFF|0>`
Measurement Timeout Time	`SETup:<meas-mnemonic>:TIMeout:TIME <numeric value>[<suffix>]`

Configuring Measurement Timeout State and Timeout Time Simultaneously

The measurement timeout state can be set to ON and the measurement timeout time can be set to some value using a single complex command.

```
OUTPUT Test_set;"SET:TXP:TIM:STIM 10"
```

would set the measurement timeout state to ON and set the measurement timeout time to 10 seconds for the transmit power measurement. Note that in this example the optional command mnemonic :STIMe has been included for purposes of clarity.

Measurement Timeout State Parameter

The Measurement Timeout State parameter allows you to enable or disable measurement timeouts.

```
OUTPUT Test_set;"SET:PVT:TIM:STAT ON"
```

would enable measurement timeouts for the power versus time measurement.

Measurement Timeout Time Parameter

The Measurement Timeout Time parameter allows you to set the maximum time that a measurement executes before failing with a timeout error (when the TIMEout:STATe parameter is set to ON).

```
OUTPUT Test_set;"SET:TXP:TIM:TIME 10 S"
```

would set the measurement timeout time to 10 seconds for the transmit power measurement.

Configuring Measurement Specific Parameters

Some measurements have parameters that are specific to the measurement. Refer to the GPIB syntax listings for a detailed list of execution parameters for individual measurements. Some of the possible programming techniques that you can use to configure measurement specific execution parameters are described below.

Sending Comma-Separated Parameter Configuration Lists to the Test Set

Numerous parameters may be necessary to configure a measurement. For example, the output RF spectrum measurement can require up to 22 frequency offsets for the modulation part of the measurement and up to 8 frequency offsets for the switching part of the measurement. You send these offsets as comma separated lists. There are a variety of techniques that you can use to send these lists. Some of these techniques are shown below.

1. Include each individual parameter in the command itself. For example:

   ```
   OUTPUT Test_set;"SET:ORFS:SWIT:FREQ .4MHZ,.6MHZ,-.4MHZ,-.6MHZ"
   ```

2. Store the parameter values in a data structure and send the command with the data structure appended to it. For example:

   - Using a string variable:

     ```
     DIM Swit_offs$[255]
     Swit_offs$=”.4MHZ,.6MHZ,-.4MHZ,-.6MHZ,1.2MHZ,-1.2MHZ”
     OUTPUT Test_set;”SET:ORFS:SWIT:FREQ “&Swit_offs$
     ```

   - Using numeric arrays:

     ```
     OPTION BASE 1
     REAL Swit_offs(8),Mod_offs(22)
     !
     DATA 400,-400,600,-600,1200,-1200,1800,-1800
     DATA .1,-.1,.2,-.2,.25,-.25,.4,-.4,.6,-.6,.8,-.8
     DATA 1,-1,1.2,-1.2,1.4,-1.4,1.6,-1.6,1.8,-1.8
     !
     READ Swit_offs(*)
     READ Mod_offs(*)
     !
     Swit_img:IMAGE K,7(K,”KHZ,”),K,”KHZ”
     Mod_img:IMAGE K,21(K,”MHZ,”),K,”MHZ”
     OUTPUT Test_set USING Swit_img;”SET:ORFS:SWIT:FREQ”,Swit_offs(*)
     OUTPUT Test_set USING Mod_img;”SET:ORFS:MOD:FREQ”,Mod_offs(*)
     ```

Programming Example:

The following example illustrates configuring the measurement execution parameters for the output RF spectrum, transmit power, and phase and frequency error measurements.

```
! Configure ORFS Measurement:
!
OUTPUT Test_set;"SET:ORFS:SWIT:COUN 5"     ! Examples of using complex
OUTPUT Test_set;"SET:ORFS:MOD:COUN 10"     ! commands to set multi-meas
                                           ! state and count at same time.
OUTPUT Test_set;"SET:ORFS:TRIG:SOUR AUTO"  ! Set trig source to AUTO.
OUTPUT Test_set;"SET:ORFS:CONT OFF"        ! Set trig mode to single.
OUTPUT Test_set;"SET:ORFS:TIM 60"          ! Set timeout time to 60 sec.
! Put switching and modulation offsets to be tested into string variables.
Swit_offs$="400KHZ,-400KHZ,600KHZ,-600KHZ,1200KHZ,-1200KHZ,1800KHZ,-1800KHZ"
Mod_offs$=".2MHZ,-.2MHZ,.4MHZ,-.4MHZ,.6MHZ,-.6MHZ,.8MHZ,-.8MHZ,1MHZ,-1MHZ"
OUTPUT Test_set;"SET:ORFS:SWIT:FREQ "&Swit_offs$
OUTPUT Test_set;"SET:ORFS:MOD:FREQ "&Mod_offs$
!
! Configure TX Power Measurement:
!
OUTPUT Test_set;"SET:TXP:COUN 3;CONT OFF;TIM 20"
OUTPUT Test_set;"SET:TXP:TRIG:SOUR RISE;QUAL ON"
!
! Configure Phase & Frequency Error Measurement:
!
OUTPUT Test_set;"SET:PFER:COUN 8;CONT OFF;TIM 30;BSYN MID"
OUTPUT Test_set;"SET:PFER:TRIG:SOUR PROT;QUAL ON"
```

Step 4: Establish an Active Link with Mobile Station

Call Connect Synchronization

Why is Call Connect Synchronization Important?

When the control program requires that an active link be established between the mobile station and the test set, it must also be able to obtain knowledge abou the status of the link. The control program issues the commands necessary to initiate the call connect/disconnect process, either to the test set (for a base station emulator originated call) or to the mobile station (for a mobile station originated call). The control program must then be able to determine when the call has been successfully connected so that the control program can proceed. It must also be able to determine if the call has not been successfully connected so appropriate action can be taken.

Call States

At any instant in time a call can be in one of the following states:

- Idle
- Setup Request
- Proceeding
- Alerting
- Disconnecting
- Connected

Setup Request, Proceeding, Alerting and Disconnecting are referred to as transitory states because the amount of time which the call can spend in any of these states is limited by GSM protocol (that is, the call transitions through these states, it is not allowed to stay in a transitory state forever).

NOTE If repeat paging is on it is possible for the call process to stay in one of the transitory states beyond the time specified by the GSM protocol timers.

The control program can directly query the state of a call with the CALL:STATus:STATe? query command, which immediately returns the current call state (that is, Idle, Setup Request, Proceeding, Alerting, Disconnecting, or Connected)

Determining if a Call Connect/Disconnect Process is Completed

The most common technique used by control programs to determine if a call connect/disconnect process has completed (either successfully or unsuccessfully), is to repeatedly query the call state using the CALL:STATus:STATe? query command inside a program loop. The return value from each query is checked to determine if the connect/disconnect process is proceeding or has reached the desired state.

There are, however, some inherent problems associated with this technique:

- The rapid polling of the instrument increases bus traffic and places increased demand on the instrument's processors to respond to the constant stream of queries.
- The control program must handle failure conditions. For example: if a call origination process is started but the call never leaves the Idle state, the control program must incorporate some technique to prevent the program from staying in the loop forever waiting for a transition out of the Idle state.

The test set implements a set of commands designed specifically for call connect/disconnect synchronization. (see "Step 8: Disconnect the Mobile Station from the Base Station Emulator" on page 55 for call disconnect synchronization). These commands directly address many of the inherent problems discussed above. When properly used these commands eliminate the need for rapid polling of the instrument, and relieve the programmer of many of the tasks associated with error handling.

Call Connect/Disconnect Synchronization Commands

Call Connected State Query Command The call-connected-state query command is used to query the connected state of a call. This command allows the control program to determine if a call is connected (that is, in the Connected state) or disconnected (that is, in the Idle state), with a built-in provision to automatically wait if the call is in one of the transitory states.

The basic operation of this query is:

- If the call is in the Connected state when the query is received by the test set, the query immediately returns a 1.
- If the call is in the Idle state (that is, disconnected) when the query is received by the test set, the query immediately returns a 0.
- If the call is in one of the transitory states (that is, Setup Request, Proceeding, Alerting, or Disconnecting) when the query is received by the test set, the query hangs (that is, does not return an answer) until the call state changes to either Idle or Connected and then behaves as above.

The call-connected-state query command can be used at any time to determine the connected state of a call. The built-in provision to automatically wait if the call is in one of the transitory states eliminates the need for rapid polling when the call-connected-state query command is used to synchronize to a call connect/disconnect process.

NOTE If repeat paging is on, a call origination process can stay in one of the transitory states until the mobile either answers the page or until the user stops the paging process. This means that if a call-connected-state query command is sent to the test set with repeat paging set to on, the query could hang "forever".

Example 1. Command Syntax:

```
CALL:CONNected[:STATe]?
```

Using the Call Connected State Query for Call Connect Synchronization The call-connected-state query only hangs if the call is in a transitory state, otherwise it immediately returns a 1 (Connected state) or a 0 (Idle state). At the start of a call connect process the call state is Idle. Sending call-connected-state query at the start of a call connect process could immediately return a zero if the query is satisfied before the connection process has started (that is, moved from the Idle state into one of the transitory states). For correct call connect synchronization it is necessary that the query be temporarily held off until after the call connect process has started. A call-state-change-detector is provided which can be used to temporarily hold off the query from returning an answer until the appropriate state change has occurred.

Call Connected Arm Command The call-connected-arm command is used to 'arm' the call-state-change-detector.

Example 2. Command Syntax:

```
CALL:CONNected:ARM[:IMMediate]
```

If the call-state-change-detector is armed when a call-connected-state query is received, the reply is held off until the call-state-change-detector is disarmed. The call-state-change-detector is disarmed upon a state change from any of the transitory states to the Idle or Connected state.

The call-state-change-detector is not disarmed by a state change from Idle to any of the transitory states, from Connected to any of the transitory states, nor is it disarmed by any transitions from Idle to Idle, or Connected to Connected. These restrictions ensure that when the call-connected-state query returns an answer:

- the connect process has started since the call state must have moved from Idle to one of the transitory states

  AND

- the connect process has finished since the call state has moved from a transitory state to either the Idle or Connected state.

The arm state of the change detector can be queried with the call-connected-arm-state query command. This query never hangs and immediately returns a 1 if the change detector is armed and a 0 if it is not armed. The command is:

Example 3. Command Syntax:

```
CALL:CONNected:ARM:STATe?
```

Using the Call Connected Arm Command for Call Connect Synchronization The call-state-change-detector arm command is used by the control program to tell the test set that it is expecting a change to the state of a call prior to initiating the state change. By first arming the call-state-change-detector, then querying the call connected state, and then attempting a BS or MS originated call, the call-connected-state query will hang until the connection operation begins and then reaches a final (Idle or Connected) state.

However, if the change detector is armed and a call connection is attempted but the call state never progresses from the Idle state, the call-connected-state query would hang forever. This could easily happen if the mobile is badly broken, the mobile is not connected to the test set, no one pushes the “send” button on the mobile, etc.

A call-state-change-detector time-out timer is provided which is used to prevent the call-connected-state query from hanging forever.

Call Connected Time-out Command The call-connected-time-out command is used to set the time-out value for the call-state-change-detector time-out timer.

Example 4. Command Syntax:

```
CALL:CONNected:TIMeout <numeric value>[<suffix>]
```

Using the Call State Change Detector Time-out for Call Connect Synchronization The call-state-change-detector time-out mechanism allows the test set to disarm the call-state-change-detector which releases the call connected state query if it is currently hanging.

The time-out timer is started whenever the call-state-change-detector is armed or gets rearmed when already armed. The duration of the time-out is set using the call-connected-time-out command and should be set to the maximum amount of time the control program should wait between arming and the connect process to begin. Once the process starts and the call state has moved into one of the transitory states the GSM defined protocol timers take over and prevent the call state from staying in a transitory state forever.

If the timer expires while the call is in the Idle or Connected state, the call-state-change-detector is disarmed, which releases the call connected state query if it is currently hanging.

If the timer expires while the call is in one of the transitory states it is ignored as, once in any transitory state, the GSM-defined protocol timers limit the amount of time that can be spent in any transitory state.

Call-state-change-detector Auto Arming As a programming convenience the test set automatically arms the call-state-change-detector, using a fixed time-out value of 60 seconds, whenever a BS originate or BS disconnect is requested.

Because of this, there is never a need for the control program to explicitly arm the call-state-change-detector or set a call-state-change-detector time-out value before BS initiated events. If for sake of coding efficiency, the programmer wishes to use the same code segment for both BS and MS call processing events, the commands to arm the call-state-change-detector and to set the call-state-change-detector time-out time will be accepted but ignored should the control program actually send the commands to the test set for BS call processing events.

Overview

You can establish an active link with the mobile station when the test set is in active cell operating mode in two ways:

- Base station originated call
- Mobile station originated call

Process for Making a Base Station Originated Call

The process for making a base station originated call is shown in "Figure 1. Process for Making a Base Station Originated Call" on page 38.

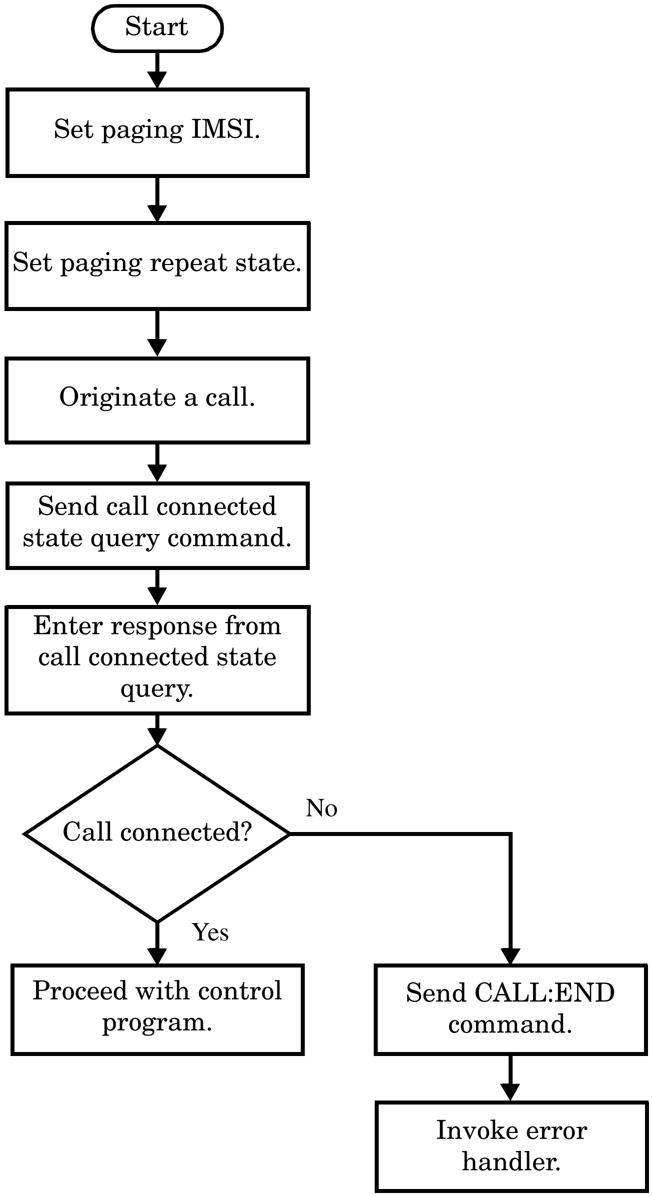
You will use the CALL:ORIGinate command to initiate a base station originated call.

If the call origination process fails it is necessary for you to send the CALL:END command to the test set to force immediate termination of all processes associated with the current call origination. This ensures that if another CALL:ORIGinate command is sent to the test set before all processes associated with the failed call origination have been terminated, it will not be ignored. Note that if the test set is currently executing a call origination and it receives another call origination command it will be ignored (that is, you are telling the test set to do something it is already doing and hence it will accept the command but it will be ignored).

Table 1. Call Origination Process Commands

Process Step	Command Syntax
Paging the Mobile Station	CALL:ORIGinate
Setting the Paging IMSI	CALL:PAGing:IMSI <string>
Setting the Paging Repeat Sate	CALL:PAGing:REPeat[:STATe] <ON|1|OFF|0>

Figure 1. Process for Making a Base Station Originated Call



Programming Example:

```
OUTPUT Test_set;"CALL:PAG:IMSI '001012345678901'" ! Set paging IMSI
OUTPUT Test_set;"CALL:PAG:REP OFF"  ! Set paging repeat state to off
OUTPUT Test_set;"CALL:ORIG" ! Start a base station originated call
OUTPUT Test_set;"CALL:CONN:STAT?" ! Hanging HP-IB query
ENTER Test_set;Call_connected     ! Program will hang here until
                                  ! origination passes or fails
IF NOT Call_connected THEN        ! Check if connection successful
  OUTPUT Test_set;"CALL:END"
! <put error handler here>
END IF
! Call is connected so proceed with control program
```

Process for Making a Mobile Station Originated Call

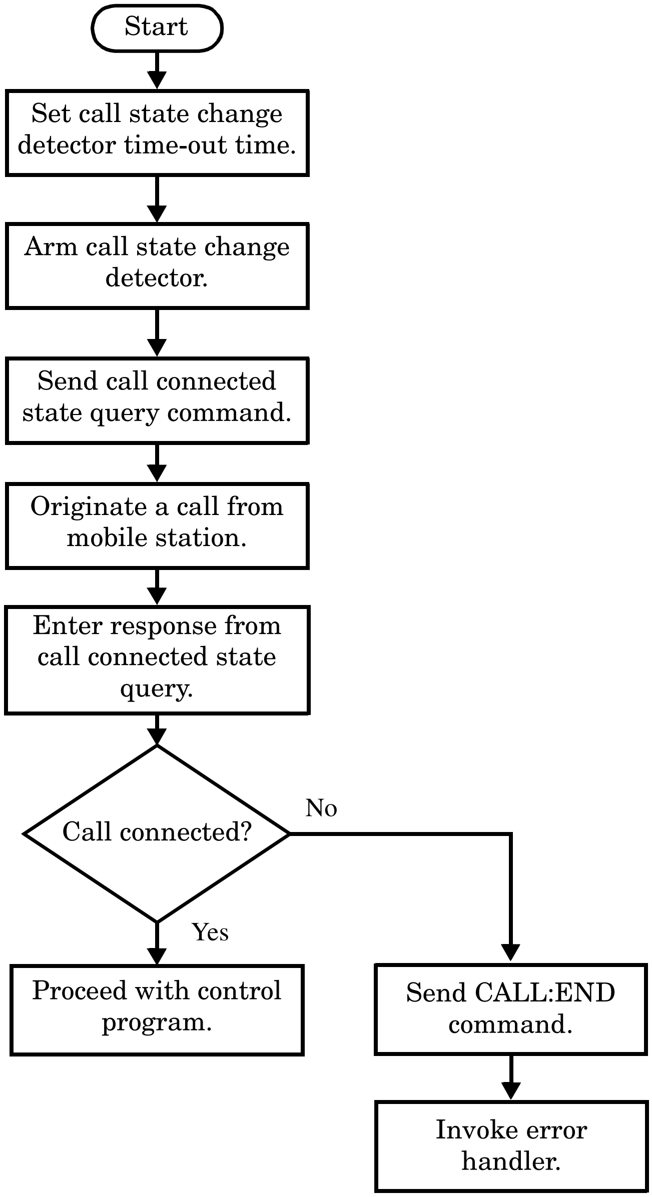
The process for making a mobile station originated call is shown in "Figure 2. Process For Making A Mobile Station Originated Call" on page 40.

There is no facility in the test set to initiate a call connect from the mobile station. This must be accomplished manually or through a test bus built into the mobile station.

If the call origination process fails it is necessary to send the CALL:END command to the test set to force immediate termination of all processes associated with the current call origination. This ensures that if the mobile station attempts another originate before all processes associated with the failed call origination have been terminated, it will not be ignored. Note that if the test set is currently executing a call origination and it receives another call origination command it will be ignored (that is, you are telling the test set to do something it is already doing and hence it will accept the command but it will be ignored).

For mobile station originated calls where the call is originated by physically dialing a number (as opposed to using a test bus) ensure that the call-state-change-detector time-out time is long enough to allow a human to dial the number.

Figure 2. Process For Making A Mobile Station Originated Call



Programming Example:

```
OUTPUT Test_set;"CALL:CONN:TIM 5"    ! Set timeout time to 5 seconds
OUTPUT Test_set;"CALL:CONN:ARM"      ! Arm the change detector
OUTPUT Test_set;"CALL:CONN:STAT?"    ! Initiate call connect state query
DISP "Originate call from mobile station."
ENTER Test_set;Call_connected        ! Program will hang here until
                                     ! origination passes or fails
IF NOT Call_connected THEN           ! Check if connection successful
  OUTPUT Test_set;"CALL:END"
! <put error handler here>
END IF
! Call is connected so proceed with control program
```

Step 5: Set the Mobile Station’s Operating Conditions

Mobile Station Transmit Power Level

The mobile station’s transmit power level is specified by the test set in a command sent to the mobile station. In this way, the test set emulates the actions of the base station, which sends transmit level change commands to a mobile station. The test set also uses the MS TX Level parameter to determine the power it should expect from the mobile station when making measurements on the mobile station’s transmitter.

Overview

The mobile station’s operating conditions are set using the CALL processing subsystem commands shown in the following table.

Table 1. Settable Mobile Station Operating Conditions

Parameter	Command Syntax	Footnotes
Timing Advance	CALL:MS:TADVance <numeric value>	
MS TX Level	CALL:MS:TXLevel[:SELected] <numeric value> OR CALL:MS:TXLevel:<PGSM|EGSM|DCS|PCS> <numeric value>	1
Discontinuous Transmission	CALL:MS:DTX[:STATe] <ON|1|OFF|0>	

Table Footnotes

1. The TCH band setting becomes the selected band.

Programming Example: The following example illustrates how to set the mobile station’s operating conditions.

```
OUTPUT Test_set;"CALL:MS:DTX OFF"
OUTPUT Test_set;"CALL:MS:TXL 14
```

The first line sets mobile station discontinuous transmission off. Then, the mobile’s transmit level is set to 14.

Step 6: Make Measurements

- "Measurement Concurrency"
- "Programming Example:"
- "Things That Can Go Wrong"

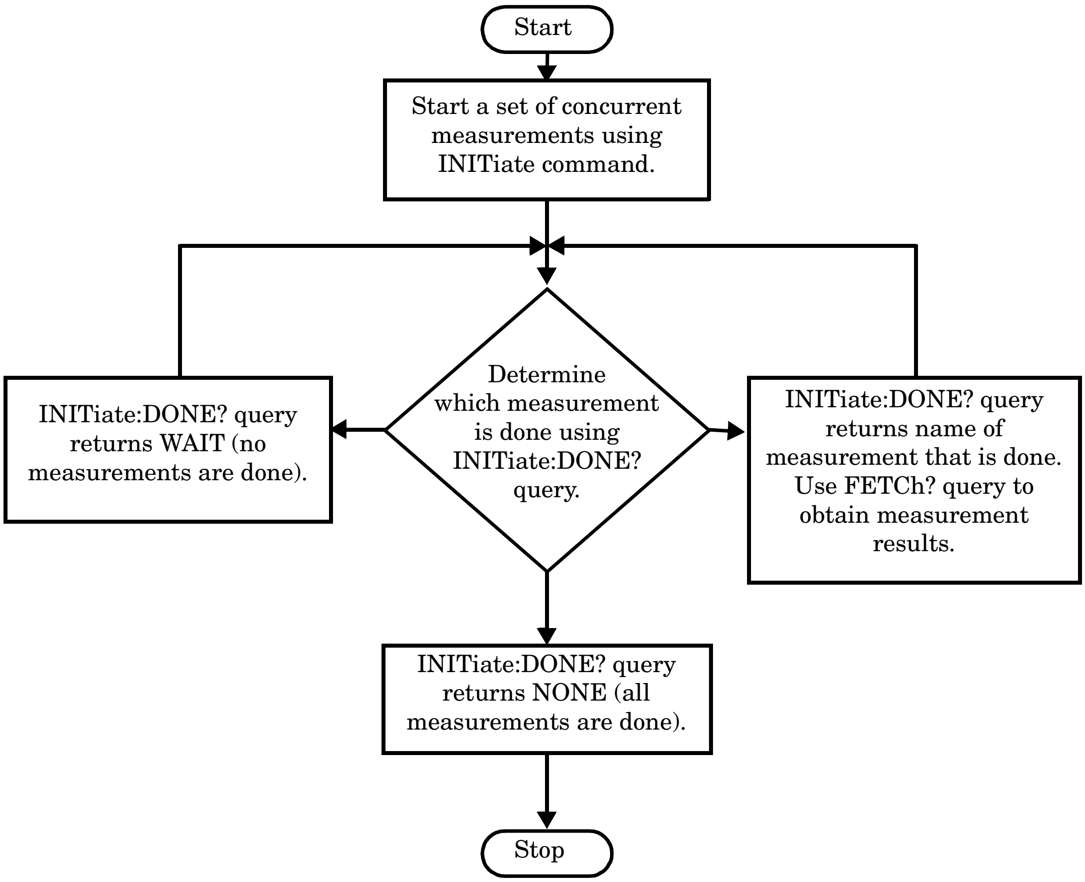
Measurement Concurrency

The multiple signal path, DSP based, multiple processor architecture of the test set allows the test set to make concurrent measurements. This means that:

- multiple measurements can execute and finish at the same time.
- individual measurement completion is not influenced by other measurement processes.
- availability of measurement results is not dependent upon the sequence that the measurements were requested in.
- results from measurements that take few processor cycles are available without having to wait for measurements that take many processor cycles.

"Figure 1. Process for Making Measurements" on page 44 shows the recommended process for making concurrent measurements using the test set's command set.

Figure 1. Process for Making Measurements



Programming Example:

The following programming example shows you how to make a transmit power measurement and a phase and frequency error measurement concurrently using the process shown in "Figure 1. Process for Making Measurements" on page 44.

```
! Step 6a: Start Set of Concurrent Measurements:
!
OUTPUT Test_set;"INIT:TXP;PFER"
!
! Step 6b: Determine If A Measurement Is Done:
!
LOOP
  OUTPUT Test_set;"INIT:DONE?"
  ENTER Test_set;Meas_done$
!
! Step 6c: Obtain Measurement Results
!
  SELECT Meas_done$
    CASE "TXP"
      OUTPUT Test_set;"FETC:TXP:POW?"
      ENTER Test_set;Avg_tx_power
    CASE "PFER"
      OUTPUT Test_set;"FETC:PFER:RMS?"
      ENTER Test_set;Max_rms_phas_er
  END SELECT
EXIT IF Meas_done$="NONE"
END LOOP
```

Things That Can Go Wrong

Measurement Integrity Always Returns a Value of 6

A measurement integrity value of 6 indicates that some characteristic of the input signal is under range. Typically this is the amplitude (power) of the signal. This low amplitude causes the level of the DSP sampler to be below a threshold required by the test set to produce results with the accuracy specified for the test set.

Possible Cause One of the most likely causes of a measurement underrange condition is signal loss caused by either the test fixture or cabling.

Suggested Workaround You can compensate for fixture or cable loss by using the RF IN/OUT port's amplitude offset parameters. Twenty different offsets can be set up for twenty different frequencies. To set the frequencies use the command:

```
SYSTem:CORRection:SFRequency (comma separated numeric values)<suffix>
```

Similiarly, to then set the offsets for these frequencies, use the following command syntax:

```
SYSTem:CORRection:SGAin (comma separated numeric values)<suffix>
```

Refer to the reference documentation for details about how to use these commands properly.

Step 6a: Start Set Of Concurrent Measurements

Starting Measurements

The INITiate command is used to start measurements. Each individual measurement can be started using the INITiate command. For starting measurements, the syntax of the INITiate command is as follows:

```
INITiate:<measurement mnemonic>[:ON]
```

The following table shows the measurements available in the test application and their associated <measurement mnemonic> used in the INITiate command syntax.

Table 1. Measurement Mnemonics Used In The INITiate Subsystem

Measurement	<meas-mnemonic>
Transmit Power	TXPower
Power vs Time	PVTime
Phase & Frequency Error	PFERror
Output RF Spectrum	ORFSpectrum
Bit Error	BERRor
Fast Bit Error	FBERror
Decoded Audio	DAUDio
Analog Audio	AAUDio
I/Q Tuning	IQTuning
Dynamic Power	DPOWer
Decoded Audio	DAUDio

Programming Example:

The following command starts the transmitter power measurement.

```
OUTPUT Test_set;"INIT:TXP"
```

Using Compound Commands to Start Multiple Measurements

More than one measurement can be started using a single INITiate command. For example:

```
OUTPUT Test_set;"INIT:TXP;PFER"
```

starts the transmit power measurement and the phase and frequency error measurement. These measurements then run concurrently.

Step 6b: Determine if a Measurement Is Done

Background

After a set of concurrent measurements have been started, you can set up your control program to determine when individual measurement results are available. This enables you to request results for a completed measurement while other measurements are still running.

Overview

Use the INITiate:DONE? query command to determine which measurement has completed.

This command is a query only and returns only one response per query. The responses returned and their meaning are shown in the following table.

Once a measurement is reported as being complete via the INITiate:DONE? query it is removed from the done list (it is not reported again). To use the INITiate:DONE? query properly, your control program should immediately fetch a measurement's results once it is reported as being complete.

Table 1. Responses Returned from INITiate:DONE? Query

Response	Meaning
TXP	The transmit power measurement is done.
PVT	The power versus time measurement is done.
PFER	The phase and frequency error measurement is done.
ORFS	The output RF spectrum measurement is done.
AAUD	The analog audio measurement is done.
DAUD	The decoded audio measurement is done.
BERR	The bit error measurement is done.
FBER	The fast bit error measurement is done.
DPOW	The dynamic power measurement is done.
IQT	The I/Q Tuning measurement is done.
DAUD	The decoded audio measurement is done.
WAIT	There are one or more measurements that are in progress, but none of those measurements are done yet.
NONE	No measurements are in progress.

For an example of how the INIT:DONE? query is used, see "Programming Example:" on page 45.

Step 6c: Obtain a Set of Measurement Results

Background

In order to minimize bus traffic and reduce test time, the test set's measurements are designed to return multiple measured values in response to a single measurement request.

For example, if a transmit power measurement with averaging is initiated there are five measurement results available. These are:

1. Measurement integrity value
2. Average value
3. Minimum value
4. Maximum value
5. Standard deviation value

The test set can return the measurement results in a variety of formats to suit your needs. For example, the transmitter power measurement results can be returned as:

- Measurement integrity and average value, or

  or

- Average value and minimum value and maximum value and standard deviation value

  or

- Average value only

  or

- Minimum value only

  or

- Maximum value only

  or

- Standard deviation value only

  or

- Measurement integrity value only

The formats available for individual measurements are specifically defined in the reference documentation and can be found in the FETCh? subsystem's GPIB command syntax.

Overview

After a measurement is initiated, the measurement results can be queried using the FETCh? subsystem. The general structure of the FETCh? command is as follows:

```
FETCh:<measurement mnemonic>:<result format>?
```

The following table shows the measurements available in the test application and their associated <measurement mnemonic> used in the FETCh? command syntax.

The command syntax used to obtain the various measurement result formats (<result format>) for each measurement can be found in the test set's FETCh? subsystem's GPIB command syntax reference information.

Table 1. Measurement Mnemonics Used In The FETCh Subsystem

Measurement	<meas-mnemonic>
Transmit Power	TXPower
Power vs Time	PVTime
Phase & Frequency Error	PFERror
Output RF Spectrum	ORFSpectrum
Bit Error	BERRor
Fast Bit Error	FBERror
Decoded Audio	DAUDio
Analog Audio	AAUDio
I/Q Tuning	IQTuning
Dynamic Power	DPOWer
Decoded Audio	DAUDio

Programming Example:

The following command returns the minimum value from the set of samples taken during the transmit power measurement (when averaging is turned on and number of samples taken >1).

```
OUTPUT Test_set;"FETCh:TXP:POW:MIN?"
```

Step 7: Perform an Intra-Cell Handover

Background

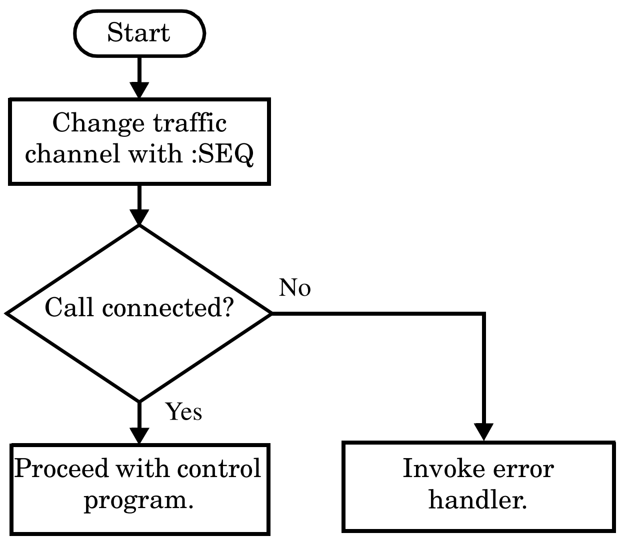
A handover is defined as assigning the mobile station to a new traffic channel. The test set is capable of performing two types of handovers:

- Intra-cell handover: assigning the mobile station to a new traffic channel within the currently active broadcast band.
- Dual-band handover: assigning the mobile station to a traffic channel in a traffic band which is different from the currently active traffic band.

Performing an Intra-Cell Handover

An intra-cell handover is accomplished using the CALL:TCHannel command in conjunction with the :SEQ synchronization command. The recommended process for performing an intra-cell handover is shown in the following figure.

Step 7: Figure 1. Process for Performing an Intra-Cell Handover



Example 1. Command Syntax:

```
CALL:TCHannel[:ARFCn][:SELected]:SEQ <numeric value>
```

OR

```
CALL:TCHannel[:ARFCn]:<PGSM|EGSM|DCS|PCS>:SEQ <numeric value>
```

Programming Example:

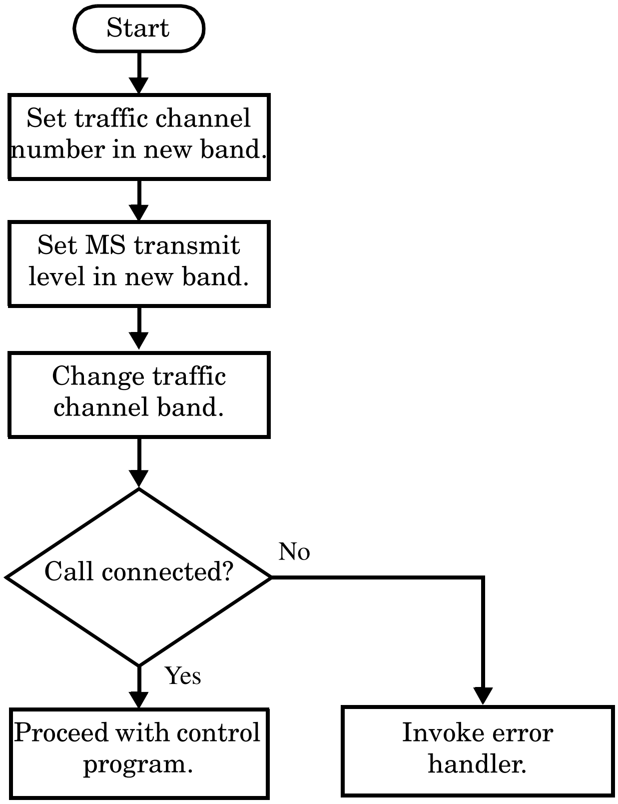
The following example illustrates how to use these commands to perform an intra-cell handover.

```
! existing conditions: a mobile station is connected to the test
! set, operating mode is set to active cell and a call is in the
! connected state.
! Step 1: Change the traffic channel number
OUTPUT Test_set;"CALL:TCH:SEQ 65"!Starts process of handing over MS
                                 !to new traffic channel 65.
                                 !No other commands will be processed
                                 !until this operation completes
                                 !because the :SEQ has been attached.
! Step #2: Check that the call is still in the connected state. It
          ! is possible that the MS did not successfully connect on the
          ! new channel.
OUTPUT Test_set;"CALL:STAT:STAT?"
ENTER Test_set;Call_status$
IF Call_status$ <> "CONN" THEN
! <put error handler here>
END IF
! Call is connected so proceed with control program
```

Performing a Dual-Band Handover

A dual-band handover is accomplished using the CALL:TCHannel:BAND command. The recommended process for performing a dual band handover is shown in the following figure.

Step 7: Figure 2. Process for Performing a Dual-Band Handover



Programming Example:

The following example illustrates how to use the CALL:TCHannel:BAND command to perform a dual-band handover.

```
! existing conditions: a mobile station is connected to the test
! set, MS TX Level = 11, Timeslot = 4, Timing Advance = 0,
! operating mode is set to active cell, a call is in the
! connected state, and active broadcast band is EGSM
! Step #1: Configure the traffic channel in the new broadcast band
OUTPUT Test_set;"CALL:TCH:DCS 556"
OUTPUT Test_set;"CALL:MS:TXL:DCS 4"
! Step #2: Change the traffic channel band
OUTPUT Test_set;"CALL:TCH:BAND DCS" !This is a sequential command so no
                               !other commands will be executed until
                               !the handover is complete (the
                               !MS has communicated to the BSE that it
                               !has successfully transitioned to the
                               !new channel OR a protocol timer has
                               !timed out).
! Step #3: Check that the call is still in the connected state. It
          ! is possible that the MS did not successfully connect on the
          ! new channel.
OUTPUT Test_set;"CALL:STAT:STAT?"
ENTER Test_set;Call_state$
IF Call_state$ <> "CONN" THEN
! <put error handler here>
END IF
! Call is connected so proceed with control program
```

Step 8: Disconnect the Mobile Station from the Base Station Emulator

Call Disconnect Synchronization

Using the Call Connected State Query for Call Disconnect Synchronization

The call-connected-state query only hangs if the call is in a transitory state, otherwise it immediately returns a 1 (Connected state) or a 0 (Idle state). At the start of a call disconnect process the call state is Connected. Sending a call-connected-state query at the start of a call disconnect process could immediately return a one if the query is satisfied before the disconnection process has started (that is, moved from the Connected state into one of the transitory states). For correct call disconnect synchronization it is necessary that the query be temporarily held off until after the call disconnect process has started. The call-state-change-detector is provided which can be used to temporarily hold off the query from returning an answer until the appropriate state change has occurred.

Using the Call Connected Arm Command for Call Disconnect Synchronization

The call-state-change-detector arm command is used by the control program to tell the test set that it is expecting a change to the state of a call prior to initiating the state change. By first arming the call-state-change-detector, then querying the call connected state, and then attempting a base station or mobile station call termination, the call-connected-state query will hang until the disconnection operation begins and then reaches a final (Idle or Connected) state.

However, if the change detector is armed and a call disconnection is attempted but the call state never progresses from the Connected state, the call-connected-state query would hang forever. This could easily happen if the mobile is badly broken, no one pushes the "end" button on the mobile, etc.

The call-state-change-detector time-out timer is provided which is used to prevent the call-connected-state query from hanging forever.

Using the Call State Change Detector Time-out for Call Disconnect Synchronization

The call-state-change-detector time-out mechanism allows the test set to disarm the call-state-change-detector which releases the call connected state query if it is currently hanging.

The time-out timer is started whenever the call-state-change-detector is armed or gets rearmed when already armed. The duration of the time-out is set using the call-connected-time-out command and should be set to the maximum amount of time the control program should wait between arming and the disconnect process to begin. Once the process starts and the call state has moved into one of the transitory states the GSM defined protocol timers take over and prevent the call state from staying in a transitory state forever.

If the timer expires while the call is in the Idle or Connected state, the call-state-change-detector is disarmed, which releases the call connected state query if it is currently hanging.

If the timer expires while the call is in one of the transitory states it is ignored as, once in any transitory state, the GSM-defined protocol timers limit the amount of time that can be spent in any transitory state.

Disconnecting an Active Call

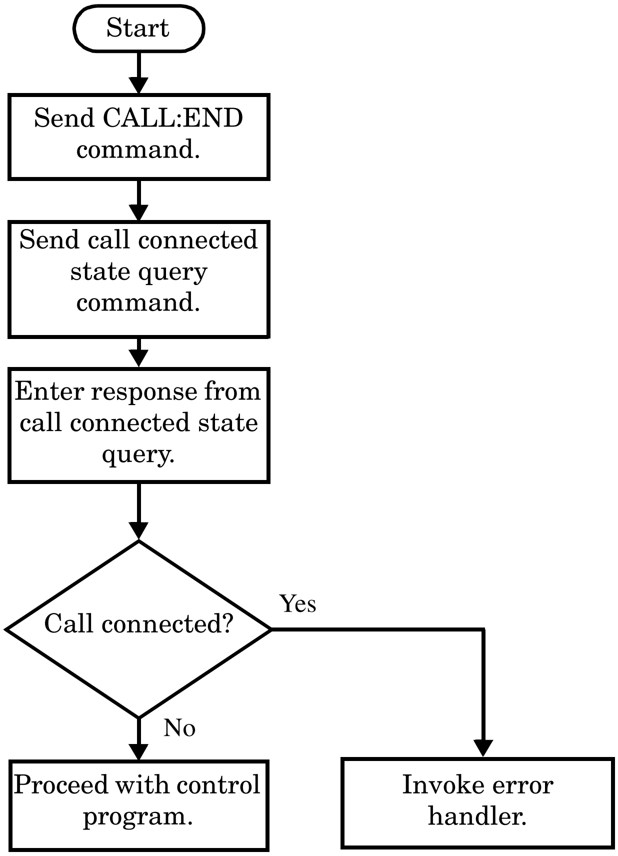
You can disconnect an active call with the mobile station when the test set is in active cell operating mode in one of two ways:

- Disconnect the active call from the base station emulator.
- Disconnect the active call from the mobile station.

Disconnecting an Active Call from the Base Station Emulator

The process for disconnecting an active call from the base station emulator is shown in the following figure. You will use the CALL:END command to initiate a base station disconnect. It is unnessecary for you to arm the change detector or set a change detector timeout when using the base station emulator to terminate a call. The test set automatically arms the change detector and uses a default timeout in this situation.

Step 8: Figure 1. Process for Terminating an Active Call from the Base Station Emulator



Programming Example:

The programming example below illustrates initiating a call disconnect from the base station emulator and how the call disconnect synchronization commands are used.

```
OUTPUT Test_set;"CALL:END"        ! Initiate a base station disconnect.
OUTPUT Test_set;"CALL:CONN:STAT?" ! Initiate call connect state query.
ENTER Test_set;Call_connected     ! Program will hang here until state
                                  ! change or timer expires.
IF Call_connected THEN            ! Check if disconnect successful
! <put error handler here>
END IF
! Call is disconnected so proceed with control program
```

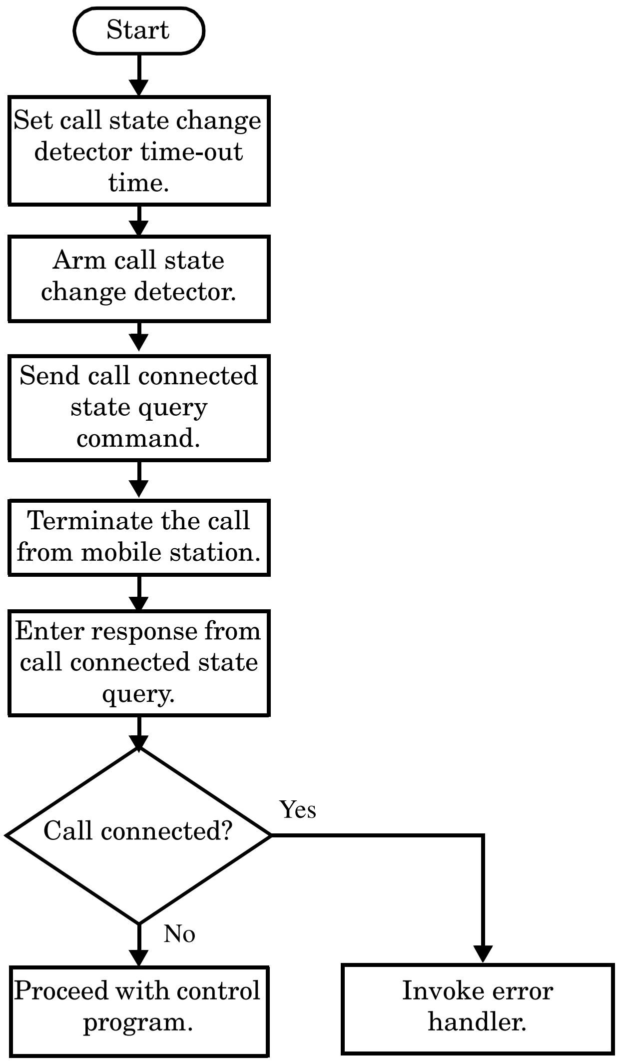
Disconnecting an Active Call from the Mobile Station

The process for disconnecting an active call from the mobile station is shown in the following figure.

There is no facility in the test set to initiate a call disconnect from the mobile station. This must be accomplished manually or through a test bus built into the mobile station.

For mobile station disconnected calls where the call is terminated by physically pushing a button on the phone (as opposed to using a test bus) ensure that the call-state-change-detector time-out time is long enough to allow a human to push the button.

Step 8: Figure 2. Process for Terminating an Active Call from the Mobile Station



Programming Example:

```
OUTPUT Test_set;"CALL:CONN:TIM 5" !Set timeout time to 5 seconds.
OUTPUT Test_set;"CALL:CONN:ARM"   !Arm the change detector.
OUTPUT Test_set;"CALL:CONN:STAT?" !Initiate call connect state query.
DISP "Terminate the call from the mobile station."
ENTER Test_set;Call_connected     !Program will hang here until state
                                  !change or timer expires.
IF Call_connected THEN            !Check if disconnect successful.
! <put error handler here>
END IF
! Call is disconnected so proceed with control program
```

Comprehensive Program Example

This section contains two example programs for making measurements using the test set. The first program follows the task flow shown in "Figure 1. Typical Flow of Tasks Performed by a Control Program" on page 15. The second program, "Example Program Without Comments" on page 68, is basically the same as the first but comments have been removed and the coding reflects the use of compound commands and complex commands to achieve coding efficiency.

Example Program With Comments

```
10    ! Prog Name: com_man_ex.txt     Rev: A.0.3      Date Code: 27 Nov 2000
20    !
30    ! Configure the BASIC environment, dimension and initialize variables.
40    ! These actions are unrelated to programming the 8960.
50    !
60    OPTION BASE 1
70    COM /Address/ Test_set
80    ! Allocate arrays to hold ORFS switching & modulation frequency offsets.
90    DIM Swit_offs$[255],Mod_offs$[255]
100   ! Allocate arrays to hold measurement results.
110   REAL Txpower(4)
120   Test_set=714  ! Test set’s GPIB address.
130   PRINTER IS CRT
140   CLEAR SCREEN
150   !
160   ! Reset test set to start from a known state. Not always necessary to do full
170   ! preset in a manufacturing environment but desireable in programming example.
180   !
190   OUTPUT Test_set;”*RST”
200   !
210   ! Turn on the GPIB debugger.  This is optional but very helpful for debugging
220   ! GPIB commands when developing new code.
230   !
240   OUTPUT Test_set;”SYST:COMM:GPIB:DEB:STAT ON”
250   !
260   ! Check error message queue and STOP if any errors present. This ensures that
270   ! the example program starts with no error conditions present in the test set.
280   !
290   CALL Chk_err_msg_que
300   !
310   !***************************************************************************
320   ! Step 1: Set Test Set’s Operating Mode to Active Cell
330   !***************************************************************************
340   !
350   OUTPUT Test_set;”CALL:OPER:MODE CELL”
360   !
370   !***************************************************************************
380   ! Step 2: Configure the Base Station Emulator
390   !***************************************************************************
400   !
410   ! Set RF IN/OUT port’s amplitude offset to compensate for fixture loss of MS.
420   ! After setting offset, cell power settings reflect RF power at the MS antenna
430   ! input.
440   !
450   OUTPUT Test_set;”SYST:CORR -5.98,-6,-5.98,-6”    ! Set amplitude offsets in dB
455   OUTPUT TEST_SET;”SYST:CORR:FREQ 914 MHZ,914.8 MHZ,959 MHZ,959.8 MHZ”
460   !
470   OUTPUT Test_set;”CALL:CELL:BAND PGSM” ! Set active broadcast band to PGSM.
480   OUTPUT Test_set;”CALL:ACT OFF”        ! Deactivate cell to set network parms.
490   OUTPUT Test_set;”CALL:CELL:MCC 1;LAC 1;MNC 1;NCC 1;BCC 5” ! Set network parms.
500   OUTPUT Test_set;”CALL:ACT ON”         ! Reactivate the cell.
```

```
510   OUTPUT Test_set;”CALL:BCH 20”         ! Set broadcast channel to 20.
520   OUTPUT Test_set;”CALL:POW -85”   ! Set cell power to -85 dBm and cell
530                                         ! power state to ON with complex command.
540   OUTPUT Test_set;”CALL:TCH 45”         ! Set traffic channel to 45.
550   OUTPUT Test_set;”CALL:TCH:TSL 4”      ! Set timeslot to 4.
560   !
570   !*************************************************************************
580   ! Step 3: Configure the Measurement Execution Parameters
590   !*************************************************************************
600   !
610   ! Configure ORFS Measurement:
620   !
630   OUTPUT Test_set;”SET:ORFS:SWIT:COUN 5” ! Examples of using complex commands to
640   OUTPUT Test_set;”SET:ORFS:MOD:COUN 10” ! set multi-meas state and count at
650                                          ! same time.
660   OUTPUT Test_set;”SET:ORFS:TRIG:SOUR AUTO”  ! Set trig source to AUTO.
670   OUTPUT Test_set;”SET:ORFS:CONT OFF”        ! Set trig mode to single.
680   OUTPUT Test_set;”SET:ORFS:TIM 60”          ! Set timeout time to 60 seconds.
690   ! Put switching and modulation offsets to be tested into string variables.
700   Swit_offs$=”400KHZ,-400KHZ,600KHZ,-600KHZ,1200KHZ,-1200KHZ,1800KHZ,-1800KHZ”
710   Mod_offs$=”.2MHZ,-.2MHZ,.4MHZ,-.4MHZ,.6MHZ,-.6MHZ,.8MHZ,-.8MHZ,1MHZ,-1MHZ”
720   OUTPUT Test_set;”SET:ORFS:SWIT:FREQ “&Swit_offs$
730   OUTPUT Test_set;”SET:ORFS:MOD:FREQ “&Mod_offs$
740   !
750   ! Configure TX Power Measurement:
760   !
770   OUTPUT Test_set;”SET:TXP:COUN 3”
780   OUTPUT Test_set;”SET:TXP:TRIG:SOUR RISE;QUAL ON”
790   OUTPUT Test_set;”SET:TXP:CONT OFF”
800   OUTPUT Test_set;”SET:TXP:TIM 20”
810   !
820   ! Configure Phase & Frequency Error Measurement:
830   !
840   OUTPUT Test_set;”SET:PFER:COUN 8”
850   OUTPUT Test_set;”SET:PFER:TRIG:SOUR PROT;QUAL ON”
860   OUTPUT Test_set;”SET:PFER:CONT OFF”
870   OUTPUT Test_set;”SET:PFER:TIM 30”
880   OUTPUT Test_set;”SET:PFER:BSYN MID”
890   !
900   !*************************************************************************
910   ! Step 4: Establish an Active Link with the Mobile Station
920   !*************************************************************************
930   !
940   OUTPUT Test_set;”CALL:PAG:IMSI ‘001012345678901’”  ! Set paging IMSI.
950   OUTPUT Test_set;”CALL:PAG:REP OFF”  ! Set paging repeat state to off.
960   !
970   ! This example uses a BSE originated call. The MS must be camped to the BSE
980   ! in order for the BSE to originate a call. The following code will try to
990   ! originate a call 50 times and then STOP the program. This should give
1000  ! adequate time for the MS to camp to the BSE.
1010  !
1020  ! NOTE: This technique will cause the following error to be displayed on the
1030  !       test set’s display and be put in the error message queue each time
```

```
1040  !       that the call fails to connect.  This is normal for this technique.
1050  ! ‘GSM call disconnected; No response to page (Timer T3113 expiry)’
1060  !
1070  Tries=1
1080  LOOP
1090    OUTPUT Test_set;”CALL:ORIG”        ! Originate a call.
1100    OUTPUT Test_set;”CALL:CONN:STAT?”  ! CALL:CONNected hanging HP-IB query.
1110    ENTER Test_set;Call_connected  ! Program will hang here until origination
1120                                   ! process completes.  If successful and
1130                                   ! the call is connected the query will
1140                                   ! return a 1.  If unsuccessful and the call
1150                                   ! is not connected the query returns 0.
1160  EXIT IF Call_connected
1170    OUTPUT Test_set;”CALL:END”
1180    IF Tries=50 THEN
1190      BEEP
1200      DISP “”
1210      PRINT “Call did not connect after”;Tries;”. Program terminated.”
1220      STOP
1230    END IF
1240    DISP “Call has not connected after”;Tries;”attempts. Trying again.”
1250    Tries=Tries+1
1260  END LOOP
1270  DISP “”
1280   !
1290  !***************************************************************************
1300  ! Step 5: Set the Mobile Station’s Operating Conditions
1310  !***************************************************************************
1320  !
1330  OUTPUT Test_set;”CALL:MS:DTX OFF”             ! Turn DTX off for all MS tests.
1340  !
1350  FOR Traf_chan=120 TO 124 STEP 2               ! Test channels 120, 122 & 124.
1360    OUTPUT Test_set;”CALL:TCH:SEQ “;Traf_chan   ! Use :SEQ to force sequential
1370                                                ! execution of the TCH command.
1380    OUTPUT Test_set;”CALL:STAT:STAT?”     ! Verify that the call is still in
1390    ENTER Test_set;Call_status$           ! the connected state after handover.
1400    IF Call_status$<>”CONN” THEN
1410      PRINT “Call handover failed. New channel assignment =”;Traf_chan
1420      PRINT “Program terminated.”
1430      STOP
1440    END IF
1450    FOR Ms_pwr_lvl=5 TO 15 STEP 5               ! Test power levels 5, 10 & 15.
1460      OUTPUT Test_set;”CALL:MS:TXL:SEQ “;Ms_pwr_lvl ! Use :SEQ to force
1470                                                    ! sequential execution of
1480                                                    ! the TXLevel command.
1490  !
1500  !***************************************************************************
1510  ! Step 6: Make Measurements
1520  !***************************************************************************
1530  !
1540  ! Step 6a: Start a set of concurrent measurements:
1550  !
1560      OUTPUT Test_set;”INIT:TXP;PFER;ORFS”
```

```
1570  !
1580  ! Step 6b: Determine if a measurement is done:
1590  !
1600      LOOP
1610        OUTPUT Test_set;”INIT:DONE?”
1620        ENTER Test_set;Meas_done$
1630  !
1640  ! Step 6c: Obtain measurement results: Each measurement illustrates a
1650  !          different way of reading in results. There is no one right way. The
1660  !          method used is application dependent. Note that the examples do not
1670  !          show all possible ways.
1680  !
1690        SELECT Meas_done$
1700  !
1710        CASE “TXP”  ! TX Power measurement done.
1720          OUTPUT Test_set;”FETC:TXP:INT?;POW:ALL?”
1730          ENTER Test_set;Integrity,Txpower(*)
1740          IF (Integrity=0) THEN  ! Always check integrity value.
1750            PRINT “TX Power results: TCH =”;Traf_chan;”and TXL =”;Ms_pwr_lvl
1760            PRINT USING “5X,””Minimum:””,M2D.2D,”” dBm”””;Txpower(1)
1770            PRINT USING “5X,””Maximum:””,M2D.2D,”” dBm”””;Txpower(2)
1780            PRINT USING “5X,””Average:””,M2D.2D,”” dBm”””;Txpower(3)
1790            PRINT USING “5X,””Std Dev:””,M2D.2D,”” dB”””;Txpower(4)
1800          ELSE
1810            GOSUB Bad_measurement
1820          END IF
1830  !
1840        CASE “PFER”  ! Phase & Frequency Error measurement done.
1850          OUTPUT Test_set;”FETC:PFER:ALL?”
1860          ENTER Test_set;Integrity,Rms_phas_err,Peak_phas_err,Worst_freq_err
1870          IF (Integrity=0) THEN
1880            PRINT “PFERror results: TCH =”;Traf_chan;”and TXL =”;Ms_pwr_lvl
1890            PRINT USING “5X,””RMS Phase Error:””,M2D.2D,”” deg”””;Rms_phas_err
1900            PRINT USING “5X,””Peak Phase Error:””,M2D.2D,”” deg”””;Peak_phas_err
1910            PRINT USING “5X,””Worst Freq Error:””,M3D.2D,”” Hz”””;Worst_freq_err
1920          ELSE
1930            GOSUB Bad_measurement
1940          END IF
1950  !
1960        CASE “ORFS”  ! ORFS measurement done.
1970        !
1980        ! This code illustrates a more ‘generic’ approach to reading measurement
1990        ! results. By using the capabilities designed into high-level
2000        ! measurements, routines that access measurement results do not have to
2010        ! explicitly know what the measurement execution conditions were.  That
2020        ! information can be determined at the time the measurement results are
2030        ! queried.
2040        !
2050          OUTPUT Test_set;”FETC:ORFS:INT?”        ! Check measurement integrity.
2060          ENTER Test_set;Integrity
2070          IF (Integrity=0) THEN
2080            OUTPUT Test_set;”SET:ORFS:SWIT:FREQ:POIN?” ! Get number of offsets
2090                                                       ! tested.
```

```
2100            ENTER Test_set;Points
2110            IF Points THEN  ! Only query if one or more offsets tested.
2120              ALLOCATE Orfs_swit_res(Points),Orfs_swit_offs(Points)
2130              OUTPUT Test_set;”SET:ORFS:SWIT:FREQ?”  ! Get measurement offsets.
2140              ENTER Test_set;Orfs_swit_offs(*)
2150              OUTPUT Test_set;”FETC:ORFS:POW?;:FETC:ORFS:SWIT?” ! Get results.
2160              ENTER Test_set;Tx_power,Orfs_swit_res(*)
2170              PRINT “ORFS Swit Results: TCH =”;Traf_chan;”and TXL =”;Ms_pwr_lvl
2180              PRINT USING “19X,””TX Power =””,M2D.2D,”” dBm”””;Tx_power
2190              PRINT “     Offset(kHz)          Level(dBm)”
2200              PRINT “     -----------          ----------”
2210 Orfs_image:  IMAGE 6X,M4D.2D,12X,M4D.2D
2220              FOR J=1 TO Points
2230                PRINT USING Orfs_image;(Orfs_swit_offs(J)/1.E+3),Orfs_swit_res(J)
2240              NEXT J
2250              DEALLOCATE Orfs_swit_res(*),Orfs_swit_offs(*)
2260            END IF
2270            OUTPUT Test_set;”SET:ORFS:MOD:FREQ:POIN?” ! Get number of offsets
2280                                                      ! tested.
2290            ENTER Test_set;Points
2300            IF Points THEN ! Only query if one or more offsets tested.
2310              ALLOCATE Orfs_mod_res(Points),Orfs_mod_offs(Points)
2320              OUTPUT Test_set;”SET:ORFS:MOD:FREQ?” ! Get measurement offsets.
2330              ENTER Test_set;Orfs_mod_offs(*)
2340              OUTPUT Test_set;”FETC:ORFS:POW?;:FETC:ORFS:MOD?” ! Get results.
2350              ENTER Test_set;Tx_power,Pwr_30khz,Orfs_mod_res(*)
2360              PRINT “ORFS Mod Results: TCH =”;Traf_chan;”and TXL =”;Ms_pwr_lvl
2370              PRINT USING “18X,””30 KHz BW Power =””,M2D.2D,”” dBm”””;Pwr_30khz
2380              PRINT “     Offset(kHz)          Level(dB)”
2390              PRINT “     -----------          ---------”
2400              FOR J=1 TO Points
2410                PRINT USING Orfs_image;(Orfs_mod_offs(J)/1.E+3),Orfs_mod_res(J)
2420              NEXT J
2430              DEALLOCATE Orfs_mod_res(*),Orfs_mod_offs(*)
2440            END IF
2450          ELSE
2460            GOSUB Bad_measurement
2470          END IF
2480        END SELECT
2490      EXIT IF Meas_done$=”NONE”
2500      END LOOP  ! If ‘WAIT’ is returned from ‘INIT:DONE?’ query, it just falls
2510                ! through the loop.
2520    NEXT Ms_pwr_lvl
2530   !
2540  !************************************************************************
2550  ! Step 7: Perform an Intra-cell Handover
2560  !************************************************************************
2570  !
2580  NEXT Traf_chan  ! The handover is performed at the top of the FOR loop at line
2590                  ! 1300
2600  !
2610  !************************************************************************
2620  ! Step 8: Disconnect the Mobile Station From the Base Station Emulator
```

```
2630  !*****************************************************************************
2640  !
2650  OUTPUT Test_set;”CALL:END”
2660  OUTPUT Test_set;”CALL:CONN:STAT?”
2670  ENTER Test_set;Call_connected
2680  IF Call_connected THEN
2690    BEEP
2700    PRINT “Unable to complete BS termination. Program terminated.”
2710    STOP
2720  END IF
2730  PRINT “Program completed.”
2740  STOP
2750  !
2760 Bad_measurement: !
2770  PRINT “Measurement error: “&Meas_done$
2780  PRINT “Measurement Integrity value =”;Integrity
2790  RETURN
2800  !
2810  END  ! End of program
2820  !
2830  SUB Chk_err_msg_que
2840    COM /Address/ Test_set
2850    DIM Error_message$[255]
2860    Error_flag=0
2870    LOOP
2880      OUTPUT Test_set;”SYST:ERR?”
2890      ENTER Test_set;Error_number,Error_message$
2900    EXIT IF Error_number=0
2910      IF Error_number=-350 THEN
2920        Error_flag=1
2930        PRINT “Error Message Queue overflow. Error messages have been lost.”
2940      ELSE
2950        Error_flag=1
2960        PRINT Error_number,Error_message$
2970      END IF
2980    END LOOP
2990    IF NOT Error_flag THEN
3000      PRINT “No errors in Error Message Queue.”
3010      SUBEXIT
3020    END IF
3030    STOP
3040  SUBEND
```

Example Program Without Comments

The following program is basically the same as the example program presented in "Example Program With Comments" on page 62 but comments have been removed and the coding reflects the use of compound commands and complex commands to achieve coding efficiency.

```
10    ! Prog Name: sim_man_ex.txt     Rev: A.0.3      Date Code: 27 Nov 2000
20    OPTION BASE 1
30    COM /Address/ Test_set
40    DIM Swit_offs$[255],Mod_offs$[255]
50    REAL Txpower(4)
60    Test_set=714
70    PRINTER IS CRT
80    CLEAR SCREEN
90    OUTPUT Test_set;”*RST;SYST:COMM:GPIB:DEB:STAT ON”
100   CALL Chk_err_msg_que
110   OUTPUT Test_set;”CALL:OPER:MODE CELL”
111   OUTPUT Test_set;”SYST:CORR -5.98,-6,-5.98,-6”    ! Set amplitude offsets in dB
112   OUTPUT TEST_SET;”SYST:CORR:FREQ 914 MHZ,914.8 MHZ,959 MHZ,959.8 MHZ”
120   OUTPUT Test_set;”CALL:CELL:BAND PGSM;BCH 20;POW:SAMP -85;:CALL:TCH:ARFC 45;TSL 4”
130   OUTPUT Test_set;”CALL:CELL:ACT OFF;MCC 1;LAC 1;MNC 1;NCC 1;BCC 5;ACT ON”
140   OUTPUT Test_set;”SET:ORFS:SWIT:COUN 5;:SET:ORFS:MOD:COUN 10”
150   OUTPUT Test_set;”SET:ORFS:CONT OFF;TIM 60;TRIG:SOUR AUTO”
160   Swit_offs$=”400KHZ,-400KHZ,600KHZ,-600KHZ,1200KHZ,-1200KHZ,1800KHZ,-1800KHZ”
170   Mod_offs$=”.2MHZ,-.2MHZ,.4MHZ,-.4MHZ,.6MHZ,-.6MHZ,.8MHZ,-.8MHZ,1MHZ,-1MHZ”
180   OUTPUT Test_set;”SET:ORFS:SWIT:FREQ “&Swit_offs$&”;:SET:ORFS:MOD:FREQ “&Mod_offs$
190   OUTPUT Test_set;”SET:TXP:COUN 3;CONT OFF;TIM 20;TRIG:SOUR RISE;QUAL ON”
200   OUTPUT Test_set;”SET:PFER:COUN 8;CONT OFF;TIM 30;BSYN MID;TRIG:SOUR PROT;QUAL ON”
210   OUTPUT Test_set;”CALL:PAG:REP OFF;IMSI ‘001012345678901’”
220   Tries=1
230   LOOP
240     OUTPUT Test_set;”CALL:ORIG;CONN:STAT?”
250     ENTER Test_set;Call_connected
260   EXIT IF Call_connected
270     OUTPUT Test_set;”CALL:END”
280     IF Tries=50 THEN
290       BEEP
300       DISP “”
310       PRINT “Call did not connect after”;Tries;”. Program terminated.”
320       STOP
330     END IF
340     DISP “Call has not connected after”;Tries;”attempts. Trying again.”
350     Tries=Tries+1
360   END LOOP
370   DISP “”
380   OUTPUT Test_set;”CALL:MS:DTX OFF”
390   FOR Traf_chan=120 TO 124 STEP 2
400     OUTPUT Test_set;”CALL:TCH:SEQ “;Traf_chan;”;:CALL:STAT:STAT?”
410     ENTER Test_set;Call_status$
420     IF Call_status$<>”CONN” THEN
430       PRINT “Call handover failed. New channel assignment =”;Traf_chan
440       PRINT “Program terminated.”
450       STOP
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460     END IF
470     FOR Ms_pwr_lvl=5 TO 15 STEP 5
480       OUTPUT Test_set;”CALL:MS:TXL:SEQ “;Ms_pwr_lvl;”;:INIT:TXP;PFER;ORFS”
490       LOOP
500         OUTPUT Test_set;”INIT:DONE?”
510         ENTER Test_set;Meas_done$
520         SELECT Meas_done$
530         CASE “TXP”
540           OUTPUT Test_set;”FETC:TXP:INT?;POW:ALL?”
550           ENTER Test_set;Integrity,Txpower(*)
560           IF (Integrity=0) THEN
570             PRINT “TX Power results: TCH =”;Traf_chan;”and TXL =”;Ms_pwr_lvl
580             PRINT USING “5X,””Minimum:””,M2D.2D,”” dBm”””;Txpower(1)
590             PRINT USING “5X,””Maximum:””,M2D.2D,”” dBm”””;Txpower(2)
600             PRINT USING “5X,””Average:””,M2D.2D,”” dBm”””;Txpower(3)
610             PRINT USING “5X,””Std Dev:””,M2D.2D,”” dB”””;Txpower(4)
620           ELSE
630             GOSUB Bad_measurement
640           END IF
650         CASE “PFER”
660           OUTPUT Test_set;”FETC:PFER:ALL?”
670           ENTER Test_set;Integrity,Rms_phas_err,Peak_phas_err,Worst_freq_err
680           IF (Integrity=0) THEN
690             PRINT “PFERror results: TCH =”;Traf_chan;”and TXL =”;Ms_pwr_lvl
700             PRINT USING “5X,””RMS Phase Error:””,M2D.2D,”” deg”””;Rms_phas_err
710             PRINT USING “5X,””Peak Phase Error:””,M2D.2D,”” deg”””;Peak_phas_err
720             PRINT USING “5X,””Worst Freq Error:””,M3D.2D,”” Hz”””;Worst_freq_err
730           ELSE
740             GOSUB Bad_measurement
750           END IF
760         CASE “ORFS”
770           OUTPUT Test_set;”FETC:ORFS:INT?”
780           ENTER Test_set;Integrity
790           IF (Integrity=0) THEN
800             OUTPUT Test_set;”SET:ORFS:SWIT:FREQ:POIN?”
810             ENTER Test_set;Points
820             IF Points THEN
830               ALLOCATE Orfs_swit_res(Points),Orfs_swit_offs(Points)
840               OUTPUT Test_set;”SET:ORFS:SWIT:FREQ?;:FETC:ORFS:POW?;:FETC:ORFS:SWIT?”
850               ENTER Test_set;Orfs_swit_offs(*),Tx_power,Orfs_swit_res(*)
860               PRINT “ORFS Swit Results: TCH =”;Traf_chan;”and TXL =”;Ms_pwr_lvl
870               PRINT USING “19X,””TX Power =””,M2D.2D,”” dBm”””;Tx_power
880               PRINT “     Offset(kHz)          Level(dBm)”
890               PRINT “     -----------          ----------”
900 Orfs_image:   IMAGE 6X,M4D.2D,12X,M4D.2D
910               FOR J=1 TO Points
920                 PRINT USING Orfs_image;(Orfs_swit_offs(J)/1.E+3),Orfs_swit_res(J)
930               NEXT J
940               DEALLOCATE Orfs_swit_res(*),Orfs_swit_offs(*)
950             END IF
960             OUTPUT Test_set;”SET:ORFS:MOD:FREQ:POIN?”
970             ENTER Test_set;Points
980             IF Points THEN
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990              ALLOCATE Orfs_mod_res(Points),Orfs_mod_offs(Points)
1000             OUTPUT Test_set;”SET:ORFS:MOD:FREQ?;:FETC:ORFS:POW?;:FETC:ORFS:MOD?”
1010             ENTER Test_set;Orfs_mod_offs(*),Tx_power,Pwr_30khz,Orfs_mod_res(*)
1020             PRINT “ORFS Mod Results: TCH =”;Traf_chan;”and TXL =”;Ms_pwr_lvl
1030             PRINT USING “18X,””30 KHz BW Power =””,M2D.2D,”” dBm”””;Pwr_30khz
1040             PRINT “     Offset(kHz)          Level(dB)”
1050             PRINT “     -----------          ---------”
1060             FOR J=1 TO Points
1070               PRINT USING Orfs_image;(Orfs_mod_offs(J)/1.E+3),Orfs_mod_res(J)
1080             NEXT J
1090             DEALLOCATE Orfs_mod_res(*),Orfs_mod_offs(*)
1100           END IF
1110         ELSE
1120           GOSUB Bad_measurement
1130         END IF
1140       END SELECT
1150     EXIT IF Meas_done$=”NONE”
1160     END LOOP
1170   NEXT Ms_pwr_lvl
1180 NEXT Traf_chan
1190 OUTPUT Test_set;”CALL:END;CONN:STAT?”
1200 ENTER Test_set;Call_connected
1210 IF Call_connected THEN
1220   BEEP
1230   PRINT “Unable to complete BS termination. Program terminated.”
1240   STOP
1250 END IF
1260 PRINT “Program completed.”
1270 STOP
1280 !
1290 Bad_measurement: !
1300 PRINT “Measurement error: “&Meas_done$
1310 PRINT “Measurement Integrity value =”;Integrity
1320 RETURN
1330 !
1340 END
1350 !
1360 SUB Chk_err_msg_que
1370   COM /Address/ Test_set
1380   DIM Error_message$[255]
1390   Error_flag=0
1400   LOOP
1410     OUTPUT Test_set;”SYST:ERR?”
1420     ENTER Test_set;Error_number,Error_message$
1430   EXIT IF Error_number=0
1440     IF Error_number=-350 THEN
1450       Error_flag=1
1460       PRINT “Error Message Queue overflow. Error messages have been lost.”
1470     ELSE
1480       Error_flag=1
1490       PRINT Error_number,Error_message$
1500     END IF
1510   END LOOP
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1520    IF NOT Error_flag THEN
1530      PRINT "No errors in Error Message Queue."
1540      SUBEXIT
1550    END IF
1560    STOP
1570  SUBEND
```