5.13 Operational Description

Refer to Appendix 10.

GENEX Telecom Co., LTD

2.4GHz DSSS Digital Cordless Telephone Unit

(FOR FCC APPROVAL)

General Description

40 CHANNEL POSSIBLE IN THE 2402~2475 MHz BAND WIDTH.

2.4GHz DIGITAL CORDLESS TELEPHONE UNIT

MODEL : GCT-430 USA VERSION

Basic Feature List

ò BETTER VOICE QUALITY

ò 40 CHANNEL OPERATION

ò 1-WAY PAGE (base to hand)

ò 2^24 SECURITY CODES AUTO-SECURITY CODE COMBINATION

ò HIGH PERFORMANCE MERLIN CHIPSET

(Hand Unit)

INNER ANTENNA

AUTO ANSWER (When pick up the handy during incoming ring)

AUTO STAND-BY

2 USER SELECTABLE VOLUME

AUDIBLE AND LED INDICATOR OUT OF RANGE WARNING

LOW BATTERY INDICATOR

ANYKEY ANSWER

POWER S/W

TALK ON/OFF

12 DIAL KEY

(Base Unit)

INNER Antenna.

In use/CHG indicator.

Page button.

- Used to page the handset party and to stop paging.
- charging contacts.

T/P USER SELECTABLE switch

Specification

2.4GHz DIGITAL CORDLESS TELEPHONE UNIT

MODEL : GCT-430 USA VERSION

1. REFERENCE SPECIFITION

Designed to conform to RF regulations

Designed to conform to SAFETY regulations

POWER : 9V DC 300mA CLASS 2 TRANSFORMER WALL ADAPTOR PROVIDED

INTERCONNECTION : RJ-11 JACK 2 CORD PROVIDED

FCC PART 68 HEARING AID COMPLIANCE (12 dB spread)

HAND SET VOLUME CONTROL RANGE: 13dB

2. GENERAL SPECIFICATION

FREQUNCY BANDWIDTH : 2402 ~2475MHz BAND WIDTH

NUMBER OF CHANNEL : 40 CHANNELS

CHANNEL SPACE : 1.8MHzKHz

SPEECH CODER : 32Kbps ADPCM with parity

TYPE OF MODULATION : DBPSK SS MODULATION / DEMODULATION

PROCESSING GAIN : 11dB

DATA RATE : 80Kbps Time Division Duplex

FRAME TIME : 1ms Transmit / 1ms Receive

SAMPLE RATE : 1.92M SAMPLES/S (2 SAMPLES / CHIP)

TX POWER LEVELS : base 13dBm, 3dBm, -7dBm, hand 2dBm

RECEIVER SENSITIVITY: -104dBm, -84dBm

ADDTIONAL SECURITY : 2^24 SECURITY CODES

STANBY TIME : 5 .5 days

TALK TIME : 2 hours

BATTERY CAPACITY : 3.6 V DC 230mAh

3. TELEPHONE SPECIFICATION

OFF - HOOK RESISTANCE : Max 300ohm (ON 20mA LOOP Condition)

ON - HOOK IMPEDANCE : Min 15Kohm (FREQ. 16Hz ~ 68Hz)

RETURN LOSS : Min 7 dB

DTMF LEVEL : High -5.5 2dB
: Low -7.5 2dB

TRANSMISSION : TX - 40 dB £ TOLR £-53 dB
RX 41 dB £ ROLR £51 dB
ST 3dB £ SOLR

BREAK RADIO : 2 : 3

PULSE SPEED : 10pps

4. RF SPECIFICATION

- *POWER LINE CONDUCTED EMISSIONS : SECTION 15.207 PASSED*
  (CLASS B REQUIREMENT)
- *BANDWIDTH : SECTION 15.247(a) PASSED*
  (700KHz > 500KHz)
- *POWER OUTPUT : SECTION 15.247(b) PASSED*
  (MAX 13dBm < 30dBm)
- *SPURIOUS EMISSIONS(CONDUCTED) : SECTION 15.247(c) PASSED*
  AT BAND EDGES : 25.3dBc < 20dBc
- *SPURIOUS EMISSIONS(RADIATED) : SECTION 15.247(c) PASSED*
  PER SEC 15.209(30 - 960MHz) UP TO 10^{th} HARMONICS
- *POWER SPECTRAL DENSITY : SECTION 15.247(d) PASSED*
  (5.47dBm < 8dBm)
- *PROCESSING GAIN SECTION 15.247(e) PASSED*
  (11.2dB > 10dB)

Processing Gain Measurement

Processing Gain Measurements for GCT-D430

1. Scope

This document details the results of measurement of the processing gain of a DCT CT-D201 phone with reference to the Code of Federal Regulations, Title 47, Chapter 1, Part 15 Radio Frequency Devices (FCC).

FCC	Federal Communications Commission
SNR	Signal to Noise Ratio
JSR	Jammer to Signal Ratio
CW	Continuous wave (jammer)
HS	Handset
BS	Base station
DBPSK	Differential Binary Phase Shift Keying

Table 1. Abbreviations

2. An Overview of the Processing Gain

Processing Gain Calculation

Theoretical processing gain limit for the 12bit Spreading BPSK system is 10.8dB.

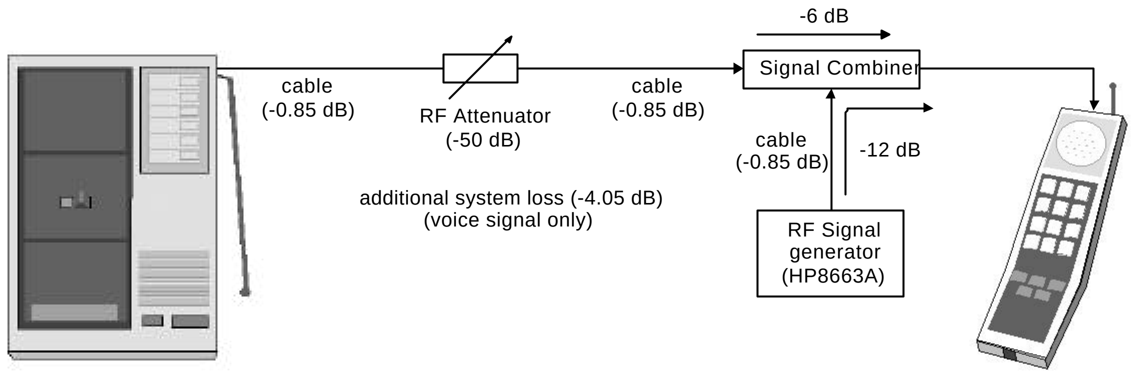
Processing Gain Measurement Method

Following method is specified by the FCC to measure processing gain. The detailed are in FCC documents 15.247 (e)(1). This involves transmitting a CW jammer in the RF passband of the system and measuring the jammer to signal ratio (JSR) required to achieve a certain bit error rate. The choice of the actual value of the bit error rate is left up to the tester. The jammer is stepped in 50 kHz increments across the entire passband and in each case the JSR to achieve the desired bit error rate is measured. The JSR is measured at the RF input to the system under test. The lowest 20% of the JSR data (in dB) are discarded. The processing gain can then be calculated as follows: -

$$G_p = \left(\frac{S}{N}\right)_{theory} + \left(\frac{J}{S}\right)_{measured} + L_{system}$$

where G_p is the processing gain, the SNR is that theoretically predicted for the system under the test to achieve the desired bit error rate, the JSR is the lowest value (in dB) in the remaining data set and L_{sys} adjusts for non-ideal system losses. L_{sys} can not be greater than 2 dB.

3. Processing Gain Measurement Test Setup



The following parameters were used in the test setup.

HS Tx power (dBm)	*-1.9*	
BS LNA gain (dB)	*0*	
Channel attenuation (dB)	*-50*	
Test system losses (signal) (dB)	*-11.75*	*-4.05 dB (system), -6 dB (signal combiner), -1.7 dB (2 cables)*
Test system losses (jammer) (dB)	*-12.85*	*-12 dB (signal combiner), -0.85 dB (cable)*

Table 2. Test Setup Parameters

4. Results & Calculation

The following measurement results were taken at the base station. The desired bit error rate was set at 10^{-3}.

Jammer Frequency (MHz)	BER (BS)	Received jammer power (dBm)	Received signal power (dBm)	Jammer/Signal ratio (dB)
2404.8	9.4×10^{-4}	-59.55	-63.65	4.1
2406.6	9.6×10^{-4}	-57.95	-63.65	5.7
2408.4	9.6×10^{-4}	-60.15	-63.65	3.5
2410.2	9.6×10^{-4}	-64.25	-63.65	-0.6
2412.0	1.1×10^{-3}	-61.55	-63.65	2.1
2413.8	9.8×10^{-4}	-61.55	-63.65	2.1
2415.6	1.1×10^{-3}	-61.95	-63.65	1.7
2417.4	9.2×10^{-4}	-62.85	-63.65	0.8
2419.2	1.0×10^{-3}	-59.85	-63.65	3.8
2421.0	1.0×10^{-3}	-61.15	-63.65	2.5
2422.8	1.1×10^{-3}	-62.05	-63.65	1.6
2424.6	1.0×10^{-3}	-57.65	-63.65	6.0
2426.4	1.1×10^{-3}	-55.65	-63.65	8.0
2428.2	1.0×10^{-3}	-49.35	-63.65	14.3
2430.0	1.1×10^{-3}	-59.25	-63.65	4.4
2431.8	1.0×10^{-3}	-62.35	-63.65	1.3
2433.6	9.7×10^{-4}	-59.05	-63.65	4.6
2435.4	1.0×10^{-3}	-61.05	-63.65	2.6
2437.2	1.1×10^{-3}	-62.55	-63.65	1.1
2439.0	9.0×10^{-4}	-61.95	-63.65	1.7

Table 3-1. Test Results (1Ch~20Ch)

Jammer Frequency (MHz)	BER (BS)	Received jammer power (dBm)	Received signal power (dBm)	Jammer/Signal ratio (dB)
2440.8	1.0×10^{-3}	-61.05	-63.65	2.6
2442.6	9.9×10^{-4}	-62.35	-63.65	1.3
2444.4	1.1×10^{-3}	-64.05	-63.65	-0.4
2446.2	9.2×10^{-4}	-56.25	-63.65	7.4
2448.0	1.0×10^{-3}	-59.85	-63.65	3.8
2449.8	1.1×10^{-3}	-57.25	-63.65	6.4
2451.6	9.9×10^{-4}	-58.15	-63.65	5.5
2453.4	9.6×10^{-4}	-57.95	-63.65	5.7
2455.2	9.6×10^{-4}	-64.25	-63.65	-0.6
2457.0	1.1×10^{-3}	-61.55	-63.65	2.1
2458.8	9.2×10^{-4}	-62.85	-63.65	0.8
2460.6	1.0×10^{-3}	-61.15	-63.65	2.5
2462.4	1.0×10^{-3}	-57.65	-63.65	6.0
2464.2	1.0×10^{-3}	-49.35	-63.65	14.3
2466.0	1.0×10^{-3}	-62.35	-63.65	1.3
2467.8	1.0×10^{-3}	-61.05	-63.65	2.6
2469.6	9.0×10^{-4}	-61.95	-63.65	1.7
2471.4	1.0×10^{-3}	-61.05	-63.65	2.6
2473.2	1.1×10^{-3}	-64.05	-63.65	-0.4
2475.0	1.0×10^{-3}	-59.85	-63.65	3.8

Table 3-2. Test Results (21Ch~40Ch)

For DBPSK at 10^{-3} bit error rate the required SNR is 8.0 dB. Using the results above and the data in *the table below the processing gain is calculated to be 11.3 dB.*

required SNR (dB)	*8.0*
system losses (dB)	*2.0*
J/S ratio at 80% point (dB)	*1.30*
FCC Processing gain (dB)	***11.3***

Table 4. Processing Gain Calculation data

Conclusions

The result measured for processing gain of 11.3 dB is close to the actual processing gain due to a 12 chip spreading code of $10 \times \log_{10}(12) = 10.8$ *dB*

FCC Test Support Program
Application Note

Equipment Required:

A PC with two COMM ports

FCC Test Support Program

2 RS232 Adapter Boards

Unit-Under-Test (UUT) - Handset or Base station or both

Installing the FCC Test Support Program onto the PC

Create a subdirectory and copy the self-extracting zip files, ***FCC3_3d1.exe*** *and* ***FCC3_3d2.exe****, into a subdirectory on the PC. Execute these two* ***.exe*** *files to unzip the FCC Test Support Program files.*
Run setup.exe to install all the necessary files into the PC to run the visual basic program. This will create an executable file, ***FCCv3_3.exe.***

RS232 Adapter Boards:

Two Adapter boards will be needed to provide an interface between the PC and the UUTs. The adapter provides the proper TTL/RS-232 voltage level translation between the ASIC and the PC. The adapter consists of an RS232 DB-9 connector (part number 613R08-004), an RS232 DRVR/RCVR IC (part number MAX242CWN) and a 4-pin JST shrouded connector (part number EHR-4 with 4 SEH-001T-P0.6). Figure 1 shows the schematic for the RS-232 adapter board.

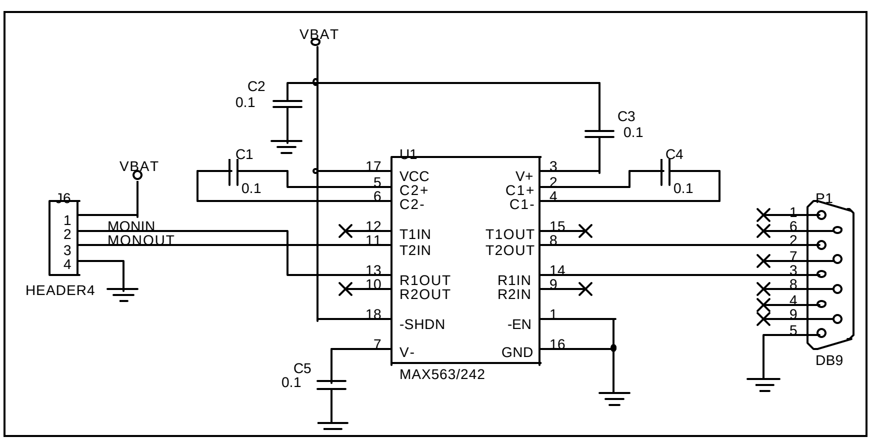


Figure 1. RS-232 Adaptor Board Schematic232

Test Setup *:*

Figure 1 shows the block diagram of the test setup. The RS-232 adapter can be connected to the Base station and handset through the test connector(4pin connector) and to the PC throught the DB9 connector.

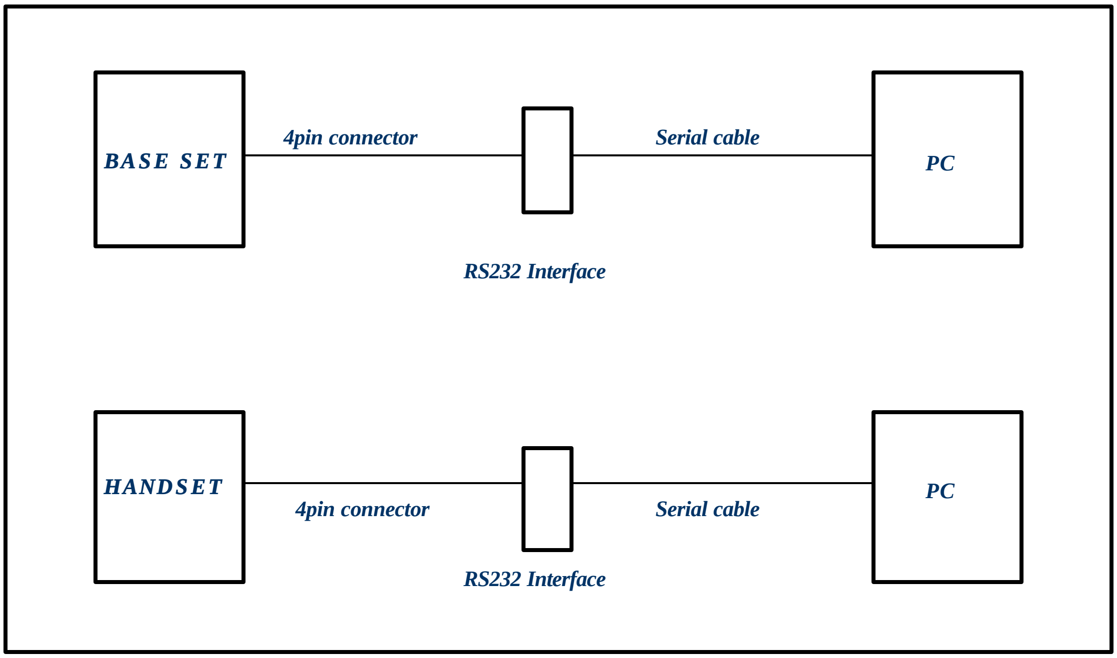


Figure 1. Test Setup Block Diagram

Handset Parking Switch

In order to access the serial test port from the handset, the UUT has to be in a parked condition. To set the handset into a "parked" condition, without physically placing it onto the base station cradle, a switch can be used as shown in Figure 2. The PARK signal on the handset is active high. By switching the PARK signal to VBAT, the handset will be in a parked mode.

NOTE: After the handset is parked, if the handset does not receive some commands through the serial interface in 50 seconds, the serial port will go into sleep mode.

The serial port on the base station can be accessed without parking the base station unit.

How to use the FCC Test Support Program:

After the FCC Test Support program is installed, run the ***FCCv3_2.exe*** *file. Two options will be given, one is "Transmit Only test" and the other is "BER test"). The "Transmit only test" is used to run most of the FCC required tests on a DSS cordless phone (FCC part 15.247a to d) that require measurements of the conducted RF output. The "BER test" is used to run the processing gain test (FCC part 15.247e).*

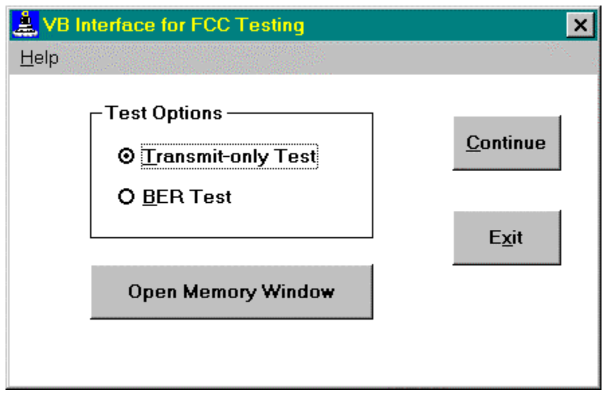


Figure 3. FCC Support Test Window

Window Buttons:

- *Transmit-only Test: selects the continuous transmit mode.*
- *BER Test: selects the BER test mode.*
- *Open Memory Window: opens the memory utility window shown in Figure 4.*
- *Continue: brings up the test window for the selected test.*
- *Exit: quits the FCC test program.*

The Hummingbird Test Manual, order no. W152-3, describes the ASIC built-in test modes. The "transmit-only test" uses the Continuous Transmit (TxCont) built-in test mode of the ASIC. The option buttons on the "transmit-

*only test" are used to select the transmission parameters such as power level, and channel number as shown in Figure 5. Transmission starts when the **START** button is clicked. The transmission parameters may be changed, but the test must first be stopped by clicking on the **STOP** button. Once the new parameters have been selected, the test can be restarted by clicking the **START** button again.*

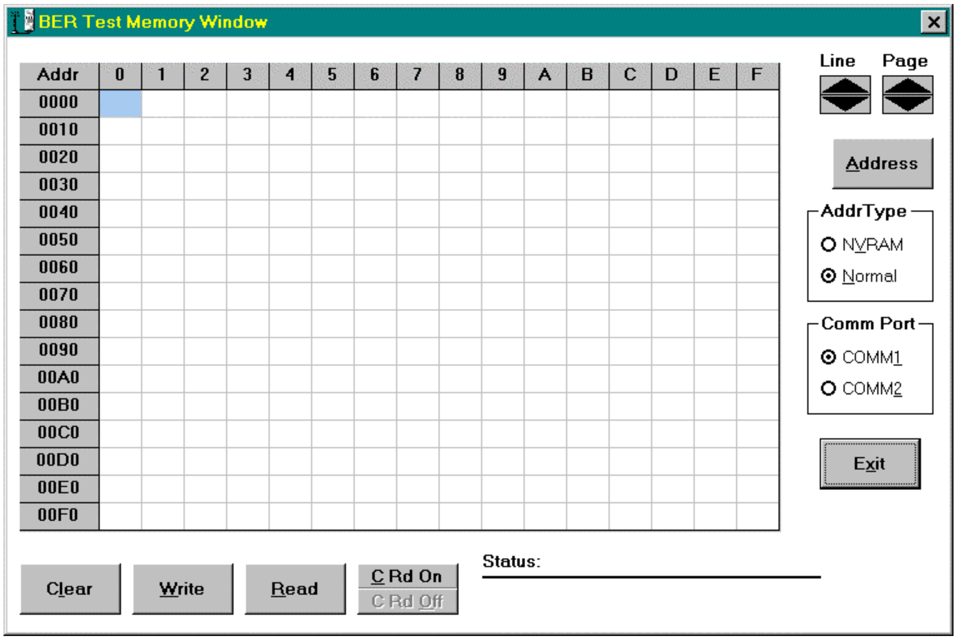


Figure 4. Memory Utility Window

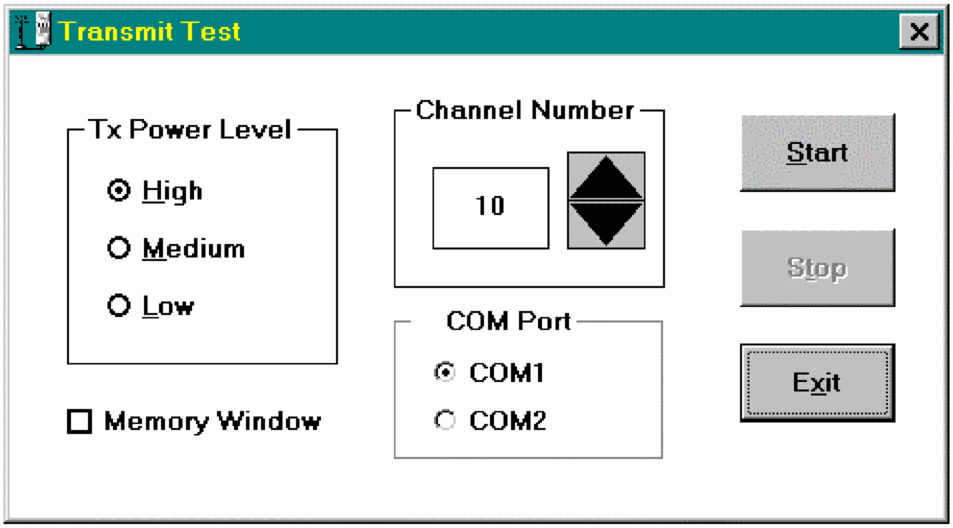


Figure 5. Continuous Transmit Test Window

Window Buttons:

- *Tx Power Level: selects high, medium or low transmit output power. This can only be changed when the test is stopped.*
- *Channel Number: selects the link channel number (1-20). Clicking on the up arrow increases the channel number. Clicking on the down arrow decreases the channel number. This can only be changed when the test is stopped.*
- *COM Port: selects PC communication port.*
- *Start: initiates the continuous transmit test.*
- *Stop: stops the continuous transmit test.*
- *Memory Window: when this box is checked, the Memory Utility window is opened.*
- *Exit: quits the continuous transmit test and goes back to the main menu window.*

The "BER test" uses the TxMaster/RxSlave or the Simple Access Protocol built-in test modes of the ASIC. In these modes, a TDD link is established with a fixed data pattern to measure the BER of the system. The option buttons are used to select power level and channel number as shown in Figure 6. In addition, the master and slave relation between HS and BS can be selected. Once the START button is clicked, the status of the HS and BS will be reported in the test status window. When both "HS link established" and "BS link established" appear in the status window, the BER will be reported at an interval selected by the BER sample rate button.

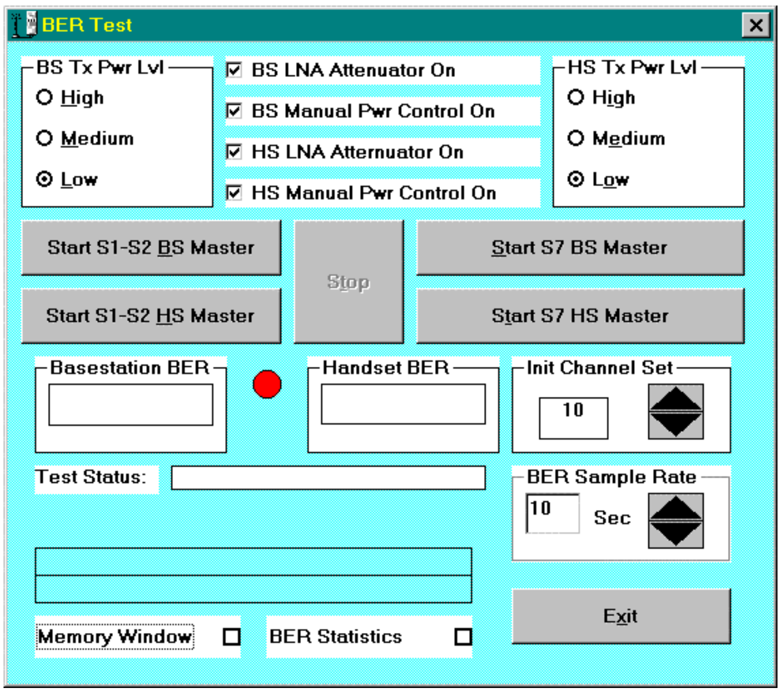


Figure 6. BER Test Window

Window Buttons:

- *HS Manual Pwr Control On: when this box is checked, the handset output power can be manually set using the HS Tx Pwr Lvl selection. When this box is not checked, the handset automatic power control is enabled*
- *BS Manual Pwr Control On: when this box is checked, the base station output power can be manually set using the BS Tx Pwr Lvl selection. When this box is not checked, the system automatic power control is enabled.*
- *HS Tx Pwr Lvl: selects high, medium or low transmit output power for the handset when the HS Manual Pwr Control On box is checked. This can only be changed when the test is stopped.*
- *BS Tx Pwr Lvl: selects high, medium or low transmit output power for the base station when the BS Manual Pwr Control On box is checked. This can only be changed when the test is stopped.*
- *Channel Number: selects the link channel number (1-20). Clicking on the up arrow increases the channel number. Clicking on the down arrow decreases the channel number. This can only be changed when the test is stopped.*
- *BER Sample Rate: selects the sampling and update rate for measuring the BER (1-10 seconds). Clicking on the down arrow decreases the channel number. This can only be changed when the test is stopped.*
- *Start S1-S2 BS Master: initiates the BER test with the base station configured in the TxMaster (S1) mode and the handset configured in the RxSlave (S2) mode. In this mode, both the base station and handset must use manual power level control.*
- *Start S1-S2 HS Master: initiates the BER test with the handset configured in the TxMaster (S1) mode and the base station configured in the RxSlave (S2) mode. In this mode, both the base station and handset must use manual power level control.*
- *Start S7 BS Master: initiates the BER test with the base station and handset configured in the Simple Protocol Access (S7) mode with the base station as the master.*
- *Start S7 HS Master: initiates the BER test with the base station and handset configured in the Simple Protocol Access (S7) mode with the handset as the master.*
- *Stop: stops the BER test.*
- *Basetstation BER: this box will display the bit error rate measured at the base station.*
- *Handset BER: this box will display the bit error rate measured at the handset.*
- *Memory Window: when this box is checked, the Memory Utility window is opened.*
- *BER Statistics: when this box is checked, the BER statistics window is opened.*
- *Test Status: this box will display the status of the BER tests as well as any error messages.*
- *Exit: quits the BER test and goes back to the main menu window.*

Test setup for Transmit Only test:

The "transmit only test" needs COMM1 only. No calibration is needed for this test.

1) Power the UUT (either the handset or the base station).

2) Connect the UUT to COMM1 via the RS232 adapter board.

3) If the handset is being tested, close the PARK park switch to park the UUT.

4) Execute the FCC test support program to select desired parameters.

5) Perform measurements for the desired FCC tests.

Test setup for BER test:

The "BER test" needs both COMM1 and COMM2. The HS and BS need to be calibrated for this test.

1) Power both the handset and base station.

2) Physically park the HS to the BS to calibrate the system to insure that the system ID is transferred from the basesation to the handset.

3) Remove the HS from the BS.

4) Connect BS to COMM1 via the RS232 adapter board.

5) Connect HS to COMM2 via the second RS232 adapter board.

6) Close the PARK switch to set the handset in a "parked" condition. (Don't wait too long to do the next step)

8) Execute the FCC test support program to monitor the BER and configure the system for the appropriate settings using the window buttons.

Using the FCC Test Support program on Development Systems

The FCC test support program can also be used on the development systems. The Development System has an RS232 connector (J3), so the two RS232 Adapter boards are not needed. For the handset, SW7 on S1 (the eight switch DIP switch on the main board) should be in the ***UP*** *or* ***ON*** *position to park the handset and allow PC communication to the ASIC serial port.*

The 3-pin jumper E3 (see DCT System Development Platform User's manual or its schematics for l ocation) needs to have a switch on it to select source for the ASIC. Place a shunt across E3 pins 1 and 2, the RS232 port will be connected to the ASIC. Use the FCC test support program the same way as on the FFF phone. Note that after the SW7 is up for 50 sec, the handset serial port will go to sleep if no data are sent.

Frequency Table

Channel Number and Frequency for 1.8MHz Channel Spacing

Channel Number	Channel Center Frequency (MHz)	Channel Number	Channel Center Frequency (MHz)

1	2404.8	21	2440.8
2	2406.6	22	2442.6
3	2408.4	23	2444.4
4	2410.2	24	2446.2
5	2412.0	25	2448.0
6	2413.8	26	2449.8
7	2415.6	27	2451.6
8	2417.4	28	2453.4
9	2419.2	29	2455.2
10	2421.0	30	2457.0
11	2422.8	31	2458.8
12	2424.6	32	2460.6
13	2426.4	33	2462.4
14	2428.2	34	2464.2
15	2430.0	35	2466.0
16	2431.8	36	2467.8
17	2433.6	37	2469.6
18	2435.4	38	2471.4
19	2437.2	39	2473.2
20	2439.0	40	2475.0

Circuit Explanation

Base Circuit Description

The signal which inputted in TEL-LINE is DC coupled at T1, this signal is and transformed Analog into Digital at U1.
Data which is transformed into Digital signal is mixed with PN code at U1 (by spread spectrum) and transmitted to RF part.
Spreading signal which inputted to RF part is mixed with Carrier supplied to VCO (U903) and create TX frequency of using channel and then is transmitted to ANTENNA through U801 by TX control of U802.

The signal received to antenna is transmitted to U901 by RX/TX control time.
The signal inputted at U901 is mixed Carrier of VCO(U903) and got to direct conversion and create Base band signal. And then, create I and Q signal by demodulation (QPSK : Quadrature Phase Shift Keying method is phase-shifted by 90°).
I and Q signal (Two signal phase is 90°) is transmitted to U1 and remixed with PN code and enerated Digital signal.
Digital signal is transformed into Analog at U1.
This audio signal is passed through U1 and transmitted to TEL-LINE.

When the ring is incoming in to the TEL-LINE, the signal passes through D13,D14,C89,R11,U8 and then detected at U1. The ring data is transformed into analog to digital at U1 and transmitted to Handset.

X1 is X-tal generating RF - reference signal and should be adjusted by TC1 accurately.

Q3,Q2 is charge circuitry. (Charger detector Q2).

Hand Circuit Description

The signal which is inputted to MIC is transformed Analog into Digital at U701.
DATA which is transformed into Digital signal is mixed with PN code at U701 (by spread spectrum) and transmitted to RF part.
Spreading signal which inputted to RF part is mixed with Carrier supplied to VCO(U903)and create TX frequency of using channel and then is transmitted to ANTENNA through Q901, Q900 by TX control of Q903, Q902.

The signal received to antenna is transmitted to U901 through the filter FL801.
The signal inputted at U901 is mixed Carrier of VCO(U903) and got to direct conversion and create base band

signal.
And then, create I and Q signal by demodulation (QPSK : Quadrature Phase Shift Keying method is phase- shifted by 90°)
I and Q signal (Two signal phase is 90°) is transmitted to U701 and remixed with PN code and generated Digital signal.
Digital signal is transformed into Analog at U701.
This audio signal is passed through receiver and transmitted.

When the handset is low voltage
R729,R730,C737 make pin 77 of U701 change HIGH to LOW and indicate low voltage.

X701 is X-tal generating RF - reference signal s and should be adjusted by CV701 accurately.

RF Circuit Description

LO Generation : *The LO signal is generated by a programmable PLL frequency synthesizer in the U901(RF109) and the an external 2.4GHz VCO(U903). The RF109 synthesizer requires differential input signals from the external VCO to generate the LO Frequency.*
Therefore a BALUN(U905) transformer is used to generate differential signals from single-ended VCO output.

Receive Path : *The signal is received at the antenna and pass the T/R switch(U802) and an RF bandpass filter.*
The output of the bandpass filter is ac-coupled to the Low Noise Amplifier (LNA) of the U901.
The U901 downconverts the RF signal into In-phase(I) and Quadrature signal(Q) baseband signals.
The differential I and Q baseband signals are dc-coupled to the ASIC(U1 or U701) RXIP, RXIN, RXQP and RXQN

inputs.

Transmit Path : *The baseband digital data input signal is shaped by external filter (R919,C925, L901, C924, R918) and inputted to the TXD1 Port of the U901 (RF109).*
The inputted baseband digital data is mixed with Carrier supplied to VCO (U903) and transmitted to the U801 (RF110) with a phase difference of 180 degreed between the two branch.
The inputted a differential signals to the U801 (RF110) are amplified by the U801 (RF110) And the differential output signals of the U801 (RF110) output port are converted to a single- Ended signal at the RF matching network.