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OPERATING MANUAL

gigaBERT-660 DRx
700 MHz BIT ERROR RATE RECEIVER

MICROWAVE LOGIC, INC.

Copyright 1990 by Microwave Logic, Inc.
20 Cummings Road
Tyngsboro, MA 01879

Rev 2.3 7/03/90

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NO OTHER WARRANTY, EXPRESSED OR IMPLIED, INCLUDING FITNESS FOR PURPOSE, MERCHANTABILITY OR OTHERWISE IS GIVEN.

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For repair information and service assistance please contact Microwave Logic Customer Service department at (508) 649-6099. The gigaBERT-660's high frequency design, and critically timed coaxial delay lines make field service difficult. The factory's experience and expertise will save valuable time in evaluating and correcting any unit malfunction.

REPAIR RETURNS

If the unit must be returned to the factory for repair please do the following:

1) Contact the factory for a Return Authorization Number (RAN), at (508) 649-6099. The use of a RAN will ensure prompt repair, and ease tracking of your unit.

2) Pack the unit in it's original packing materials or other suitable material, such as foam or bubble-wrap, to safely ship the unit. Pack unit in a double-walled carton, and seal the carton with suitable tape. Display the RAN number on the outside of the carton.

3) Ship unit to:

Microwave Logic, Inc.
20 Cummings Road
Tyngsboro MA 01879

Attn: Customer Service

Phone (508) 649-6099

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gigaBERT-660

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CAUTIONS AND WARNINGS

The following cautions and warnings should be read before operating the unit.

AC POWER SOURCE

The BERT-660 is grounded through the AC power cord. Attach only to a properly grounded outlet. Do not operate the unit without this ground, as all metal parts of the unit become a potential shock hazard.

STATIC SENSITIVE DEVICE NOTICE

The gigaBERT-660 Tx output amplifiers are of GaAs FET design, and are susceptible to damage from overdriven DC voltages, and from electrostatic damage. Never apply reverse voltage to the DATA or CLOCK outputs, or voltages outside the range specified in section 2 of this manual.

SMA CONNECTOR CARE

The SMA connectors used on the gigaBERT-660 units require care while attaching cables, to prevent damage to the connector or attaching cable. When attaching a cable turn the cable nut, not the cable. Tighten the nut to 10 lb-in maximum.

OUTPUT AMPLIFIER POWER CYCLE SEQUENCE

During unit power cycling the Tx output amplifiers may saturate to their specified positive or negative rail; (+2V, or -2V) for a minimum of 200 milli-seconds. If this condition is harmful to user circuitry the DATA and CLOCK signals should be disconnected from the circuitry before power cycling.

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QUICK START

HOW TO RUN THE gigaBERT-660 DRx (with a gigaBERT-660 Tx data source), WITHOUT READING THIS MANUAL

REQUIRED EQUIPMENT

1 - gigaBERT-660 Tx or other Data Pattern generating unit

2 - pairs of equal-length 50 ohm coax cables, preferably SMA, otherwise you'll need a lot of adapters.

BEGINNERS BERT

1) Connect two equal-length 50 ohm coaxial cables from the Tx CLOCK outputs to the DRx CLOCK inputs.

2) Connect two equal-length 50 ohm coaxial cables from the TX DATA outputs to the DRx DATA inputs.

3) Turn on Tx, DRx. Set Tx Output Amplitude to 2V, baseline Offset to -1V. See below for Tx control information.

4) Select 'AUTO-SEARCH' mode on the DRx (AUTO-SEARCH LED should be on). Auto-search will select code, input level, polarity, and phase delay.

5) Select 'PRBS' mode on Tx (PRBS LED should be on).

6) Push Display reset on DRx, and Error history reset keys on DRx.

7) You are now making BER, albeit on a piece on coax cable but BER just the same.

8) The unit's battery backed-up RAM will remember unit status, clock and WORD memory contents and where you left off when power failed.

9) Hook up a parallel printer to the printer port, GPIB port, or a serial printer to the serial port, push F4. An immediate unit status report will be printed for posterity, on one of these ports. To redefine which port prints see section 3 for PRINT PORT menu.

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ADVANCED TX TOPICS

1) To modify frequency of test;

Press 'FREQ' on Tx (FREQ LED should be on).

Change the frequency on Tx (use up/down CLOCK keys).

2) To modify data pattern of test;

Change the code on Tx (use up/down PATTERN keys).

3) To modify Tx Output Data levels;

Press 'DATA' on Tx (DATA LED should be on).

Change the AMPlitude (use up/down keys)

Change the OFFset (use up/down keys)

4) To modify Tx Output Clock levels;

Press 'CLOCK' on Tx (CLOCK LED should be on).

Change the AMPlitude (use up/down keys)

Change the OFFset (use up/down keys)

5) To inject errors into data stream;

Press Error Inj 'Rate' to inject an Error Rate, press again to change rate,

Push single to shut off error rate injection (if selected), or to inject a single error.

6) To change GPIB address;

Press GPIB key, change address with INPUT up/down keys.

7) To change CLOCK memory location;

Press INPUT RECALL key, change memory location with INPUT up/down keys.

8) To change WORD memory location;

Press WORD key, press PATTERN RECALL key, change memory location with PATTERN up/down keys.

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QUICK START (cont)

ADVANCED RX TOPICS

1) BER (Bit Error Rate) Display clear;

Press ERROR DETECT Clear key to clear BER display.

2) BER Display select;

Press ERROR DETECT DISPLAY key repetitively to select between Totalize, Window, and Test mode.

3) Input Phase delay adjust;

Press INPUT DELAY key, change delay with INPUT up/down keys.

4) Input Threshold adjust;

Press INPUT V-THRS key, change threshold with up/down keys.

5) To modify data pattern of test;

Press PRBS key, change pattern with PATTERN up/down keys.
NOTE: in 'AUTO SEARCH' mode the Rx will automatically select the correct code.

6) To change GPIB address;

Press GPIB key, change address with INPUT up/down keys.

7) To change AUTO SYNC mode;

Press AUTO SEARCH key, in AUTO mode (AUTO LED on) unit selects code, threshold, polarity, and delay, in MANUAL mode (LED off), user must select parameters. DISABLE key turns off synchronization circuitry.

8) To change WORD memory location;

Press WORD key, press PATTERN RECALL key, change memory location with PATTERN up/down keys.

9) To select Reference Data mode;

Press EXT REF DATA key, unit now compares data pattern at REF DATA input with pattern at DATA input, suitable for custom (non-standard) patterns.

10) To clear ERROR HISTORY LEDS;

Press ERROR HISTORY CLEAR key.

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SECTION 1

GENERAL DESCRIPTION

1.1 INTRODUCTION

This manual provides the user with the information required to set up and operate the Microwave Logic gigaBERT-660 DRx differential Bit-Error Rate Receiver.

When paired with the companion gigaBERT-660 Tx Transmitter, Bit Error Rate Tests (BERTs), can be performed.

1.2 GENERAL DESCRIPTION gigaBERT-660 RECEIVER (DRx)

The Microwave Logic gigaBERT-660 DRx is a Bit Error Rate Receiver and Detector, suitable for system and device evaluation in the frequency range of 1 MHz to 700 MHz. The 5 pseudo-random patterns and 16 bit (32K optional) programmable WORD, provide a variety of built-in data patterns for BER evaluation. The DRx Data and Clock Input structure provide a flexible interface for differential or single ended Clock and Data signals.

The gigaBERT-660 'AUTO SEARCH' feature allows effortless system setup and operation. Automatically setting the proper Input Data/Clock phase relationship, threshold level, data pattern and polarity, the 'auto-search' feature allows the user to immediately perform a wide range of tests on systems and components, eliminating the time and frustration associated with adjusting a multiple of input parameters.

A microprocessor is utilized to program WORD patterns, input level controls, and provide a user-friendly front panel and display. The gigaBERT-660 DRx supports both RS-232C and GPIB interfaces for remote control, allowing test repeatability and output of unit status and memory contents. The battery backed-up non-volatile RAM memory provides storage of 10 WORD patterns, error measurements and unit setup for future recall.

Front panel output monitors of Received Data and Clock provide convenient access to the received data signal. Pattern Sync provides a trigger for waveform analysis on an oscilloscope.

Rear panel output of RZ Errors, and Error Inhibit input allow custom BER, and support asynchronous Burst error measurements.

The gigaBERT-660 DRx is supplied in a 6x14x12 stand-alone cabinet, and is provided with an adjustable carrying handle for easy bench top angle adjustment. The supplied front panel cover protects the unit during transit.

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gigaBERT-660 DRx INPUT STRUCTURE

The DRx Clock and Data Input structure provides for both differential and single ended inputs.

SINGLE ENDED INPUT

To use single ended Clock and Data Inputs connect the system Data signal to the DRx's DATA input (true input), leaving DATA Invert input open. Connect system Clock signal to the DRx's CLOCK (true input), leaving CLOCK Invert input open.

Use V-TERM key to select between the three termination voltages, -2V, GND or AC (50 ohms AC coupled to GND).

DIFFERENTIAL INPUT

The DRx input provides a balanced termination for use with differential systems. Connect system Data to the DRx's DATA (true input), and system Data Invert to the DRx's DATA Invert input. Connect system Clock to the DRx's CLOCK (true input), and system Clock Invert to the DRx's CLOCK Invert input.

The DRx uses the DATA and CLOCk (true inputs) to receive the signals, and perform BER analysis upon it. The inverted DATA and CLOCK inputs are provided for balanced termination purposes only.

Use V-TERM key to select between the three termination voltages, -2V, GND or AC (50 ohms AC coupled to GND).

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SECTION 2

gigaBERT-660 DRx SPECIFICATIONS

EXTERNAL CLOCK INPUTS

Format:	Differential or Single ended
Frequency range:	1 MHz to 700 MHz
Input level:	500 mV to 1.5 Vp-p
Impedance:	50 ohms
Termination voltage:	Select; GND, -2 V, or AC.
Connectors:	SMA

DATA INPUTS

Format:	NRZ-L, true or inverted, differential of single ended
Input Threshold:	Variable; -1.5 V to +1.0 V (50 mV steps)
Input level:	500 mV to 1.5 Vp-p
Termination voltage:	Select; GND, -2 V, or AC.
Impedance:	50 ohms
Clock/data delay:	Variable; 0 to 4 nS (100, 200 pS steps)
Connectors:	SMA

DATA PATTERNS

Format:	NRZ-L, Normal or complement
PRBS pattern:	2^n-1 where n=7, 15, 17, 20, 23
WORD length:	16 bits (32K bits optional)
Pattern memory:	Ten 16 bit WORDs, (Ten 32K WORDs optional)
WORD Order:	Receive LSBit or MSBit First

REFERENCE DATA INPUT

Format:	NRZ-L, true
Data rate:	1 Mb/s to 700 Mb/s
Input Threshold:	Variable; -1.5 V to +1.0 V (50 mV steps)
Input level:	500 mV to 1.5 Vp-p
Termination voltage:	Select; GND, -2 V, or AC.
Impedance:	50 ohms
Clock/Ref delay:	Variable; 0 to 4 nS (100, 200 pS steps)
Connector:	SMA

AUXILIARY MONITOR OUTPUTS; Data, Clock, Pattern Sync

Level:	800 mV p-p, +/- 250 mV
Impedance:	AC coupled
Data monitor:	Latched Input Data
Clock monitor:	Buffered Input Clock
Pattern sync:	1 bit-wide pulse per frame
Connectors:	SMA

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SYNCHRONIZATION

Auto search: Unit automatically selects PRBS or WORD mode, Data polarity, Data threshold, and Clock/Data input timing phase delay. then synchronizes on the input data pattern.

Manual mode: User selects parameters, then unit attempts to synchronize on the input data pattern.

Disable mode: Sync circuitry disabled.

Sync thresholds: PRBS mode 25% (1024 errors/4096 bits)
WORD mode 3.1% (128 errors/4096 bits).

Optional 32K WORD thresholds, programmable

LEVEL	BER	RATIO(errors/bits)
1	3.1E-2	256/8192
2	7.8E-3	256/32768
3	1.9E-3	256/131072
4	9.7E-4	256/262144
5	4.8E-4	256/524288
6	2.4E-4	256/1048576
7	1.2E-4	256/2097152
8	6.1E-5	256/4194304
9	3.0E-5	256/8388608

MEASUREMENTS

BER MEASUREMENTS: 3 simultaneous BER measurements (Totalize, Window, and Test) displayed as;

BER: 9.9E-01 to <1.0E-16
TOTALIZE: 0 to 99999999, then 1.0E8 to 9.9E36

Totalize mode: BER since power on or reset.

Window mode: BER over sliding window, programmable in time (1 sec-24 hrs), or bits (1E8-1E16).

Test mode: BER over time of test, programmable in time (1 sec-24 hrs). Additional calculations include ES, EFS, TES, SES, DM, US, and LOS, see section 5.

Frequency: System Clock frequency, 10 KHz resolution

History indicators: Sync loss, Bit error, Phase error, Power

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RS-232C AND GPIB INTERFACES

Controlled functions:	Remote control of all front panel functions except POWER and PANEL LOCK.
Read back functions:	Read back of 10 data patterns stored in non-volatile memory, unit operating frequency, Bit error rate information, sync and history status, and pattern select.
GPIB EOS character:	LF (line feed) (0A hex)
GPIB Address:	Front panel select 0-30, or OFF-BUS.

PRINTER INTERFACE

Format:	Parallel Centronics type and re-directable to serial (RS-232C) or GPIB ports.
Hardcopy:	Front panel key, prints unit setup.
Print on event:	Print if BER threshold is exceeded; programmable rate (1E-02 to 1E-16).
Print on EOW:	Print on End of Window, programmable in time (1 sec-24 hrs), or bits (1E8-1E16).
Print on EOT:	Print on End of Test, programmable rate 1 sec to 24 hrs.

AC POWER REQUIREMENTS

Voltage range:	115 VAC, 230 VAC, (+/-10%) factory select
Frequency range:	47-63 Hz
Power:	100 VA max.
Fuse rating:	115 VAC; 2 Amp; 230 VAC 1 Amp.
Operating range:	0 to 50 degrees C

MECHANICAL

Weight:	10Kg (22 lbs)
Size:	152H x 366W x 340D mm (6" x 14.4" x 13.4")

OPTIONS

Op-MR1:	32K bit programmable WORD
Op-MR2:	32K bit programmable WORD, with 32K factory programmed ROM pattern
Op-RM1:	19" Rack Mount adapter

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SECTION 3

gigaBERT-660 RECEIVER OPERATING INSTRUCTIONS

3.1 AC POWER SET UP.

The AC power connector on the rear panel accepts nominal input voltage requirements for the original destination, (either 115 VAC, or 230 VAC, +/- 10%). This input voltage is set at the factory. Contact the factory for information on changing the operating voltage. To change the line fuse, slide the fuse cover upwards and remove the fuse. Install correct value fuse (2 AMP SLO-BLO for 115 VAC, 1 AMP SLO-BLO for 230 VAC operation) into holder. Close the fuse cover, plug in the line cord. The unit is now ready for power up.

3.2 UNIT MOUNTING

The gigaBERT-660 DRx is designed to be placed flat on a level surface, capable of supporting it's weight, or angled from the surface with the unit's feet or rotating carrying handle. To alter the handle's orientation, press both handle locking buttons, rotate the handle to the desired angle, release the buttons; the handle will click into a locked position. Assure the handle is locked before placing the unit on the work surface. A Rack Mount Option is available for installation of the unit into a 19" rack.

3.3 UNIT COOLING REQUIREMENTS

The rear panel fan openings and top mounted ventilation slots must be kept clear for proper cooling of the unit. Allow a minimum of 2 inches of rear panel clearance, and 1 inch of top clearance, while operating the unit.

3.4 FRONT PANEL

The gigaBERT-660 Receiver front panel is divided into eight functional control areas, refer to Figure 3.1, gigaBERT-660 DRx Front Panel. The following sections define all controls and indicators, and describes their operation. The front panel controls allow modification to the unit's operating status, and provides recall and storage access to the 10 programmable WORD memories.

The unit's operating status is shown on the 2 row by 24 column Liquid crystal display (LCD). Refer to Figure 3.2 for the LCD display fields associated with each function.

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3.4.1 POWER

This section controls unit power.

POWER — Unit power switch. This rocker switch turns on the unit.

3.4.2 OPERATING MODE

VIEW ANGLE — View control key. Pressing this key adjusts the LCD view angle, to provide adjustment in extreme lighting and viewing conditions.

PANEL LOCK — Panel Lock key. Pressing this key LOCKS the front panel, disabling all other keys. This prevents accidental change to the front panel operating status for long-term tests. To return the unit to normal operating status, press PANEL LOCK a second time.

An illuminated PANEL LOCK LED indicates the front panel is locked out from operation.

GPIB ADDR — GPIB Address select key. Pressing this key selects GPIB address mode, and displays the message 'GPIB xx' on the left bottom row of the LCD display. The GPIB address is programmable over the range 0 to 30 or OFF-BUS, with the INPUT up/down keys. When the desired GPIB address is selected press the key a second time.

An illuminated GPIB ADDR LED indicates the GPIB Address can be modified with the INPUT up/down keys.

LOCAL — Pressing this key will 'return to local' the control of the unit, when selected by the GPIB remote controller. Only the GPIB controller can select 'REMOTE' mode. NOTE if the GPIB bus command 'local lock out' has been sent by the controller, only the GPIB controller can unlock the front panel, or cycle unit power, which defaults to 'LOCAL' condition.

An illuminated REMOTE LED indicates the unit is in remote mode, and will not respond to front panel keys, until the LOCAL key has been pushed.

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3.4.3 INPUT

This section provides the signal inputs and control of parameters (Input Termination, Threshold, Logic Polarity and Data/Clock Phase Delay) for Data, Ref Data and Clock.

Selecting DELAY, V-TERM or V-THRS allows the INPUT up/down keys to modify the existing operating status, holding the up/down key repeats the function 5 times a second. Each key is described below.

Function key F3 (REF DATA) allows DELAY and V-THRS to vary the Ref Data phase delay and input threshold as described below.

DELAY

Pressing DELAY selects Data/Ref Data Delay adjust mode. The Input Data signal can be delayed over the range 0.0 nS to 3.9 nS in sub-nanosecond steps. The delay is modified with the INPUT up/down keys. The current Delay is displayed on the lower left side of the LCD.

An illuminated DELAY LED indicates that the unit's Delay can be modified by the up/down arrow keys.

V-TERM

Pressing V-TERM selects V-termination mode. The input termination voltage for Data, Ref Data, and Clock, is selectable between 0V, -2.0V, and AC. -2V mode provides active Termination for ECL and GaAs signals, AC mode allows RF termination.

An illuminated V-TERM LED indicates that the input termination can be modified by the up/down keys.

V-THRS

Pressing V-THRS selects V-Threshold mode. The Input Data/Ref Data (with F3 key) threshold is variable over the range of -1.5V to +1V in 50 mV steps. The currently selected threshold voltage is displayed in the lower right side of the LCD display.

An illuminated V-THRS LED indicates that the threshold voltage can be modified by the up/down arrow keys.

INV

Pressing INV toggles the input polarity.

An illuminated INV LED indicates the input Data has been inverted.

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EXT

Pressing this key selects REF DATA mode. In this mode the data pattern input at the REF DATA INPUT SMA connector is compared to the data pattern input at the DATA SMA connector. The DRx performs a bit-by-bit comparison, and measures the bit error rate between them.

An illuminated EXT LED indicates that REF data mode is selected.

DATA INPUTS

The DATA and $\overline{\text{DATA}}$ SMA connectors provide differential or single ended inputs for Data to the DRx for bit error analysis. Refer to Section 2, Specifications, for signal level. In AUTO THRESH mode when no input data signal is detected by the DRx, the message 'NO DATA' will be displayed on the LCD. The Data inputs provide a balanced differential input termination for the DUT output. When using the DRx in single-ended applications the true Data input MUST be used.

CLOCK INPUTS

The CLOCK and $\overline{\text{CLOCK}}$ SMA connectors provide differential of single ended inputs for system Clock. Refer to Section 2, Specifications, for signal level. The clock frequency is displayed on the upper left row of the LCD, when no input clock signal is detected by the DRx, the message 'NO CLK' will be displayed on the LCD. The Clock inputs provide a balanced differential input termination for the DUT output. When using the DRx in single-ended applications the true Clock input MUST be used.

REF DATA INPUT

The REF DATA SMA connector is the input for Reference Data to the DRx for bit error analysis. Refer to Section 2, Specifications, for signal level.

F3 (REFERENCE DATA MODE)

Pressing F3 places the unit into Reference data control mode. The Delay and V-THRS keys are redefined to allow control of the REF Data Delay, and Threshold. The status of each key LED and LCD displayed value now reflect the Reference Data Input signal.

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3.4.4 PATTERN

This section controls the internal pattern generator, selects between PRBS and programmable WORD pattern, programs pattern and word length, and accesses the WORD Memory.

Selecting PRN, WORD, RECALL, SAVE, or WORD LENGTH allows the INPUT up/down keys to modify the existing operating status, holding the up/down key repeats the function 5 times a second. Each key is described below.

The programmable WORD is modified from the front panel in 8 bit bytes. The 8 'BIT' keys allow direct modification to the selected byte. The CLEAR and SET keys allow all 8 bits of the selected byte to be set to a logic '0' or '1' respectively. The WORD LENGTH key allows selecting the programmable word to lengths of 8 or 16 bits, (optional 32K memory).

PRBS

Pressing PRBS selects Pseudo-Random Binary Sequence (PRBS) mode. 5 PRBS patterns (2^7-1, 2^15-1, 2^17-1, 2^20-1, and 2^23-1) can be selected with the PATTERN up/down keys. When selected the pattern is denoted on the LCD screen as PN[x] where x=7,15,17,20,or 23.

An illuminated PRN LED indicates that PRBS Pattern is currently selected, and the desired pattern can be selected with the PATTERN up/down keys.

WORD

Pressing WORD selects programmable WORD mode. The programmable WORD can be modified, recalled, or stored in memory. The programmable pattern's byte address can be selected with the PATTERN up/down keys. The byte to modify with the 'BIT' keys is denoted on the LCD screen by an arrow.

An illuminated WORD LED indicates the programmable WORD pattern is currently selected, and the byte to modify with the BIT keys can be selected with the PATTERN up/down keys.

The programmable WORD is modified through the front panel in 8 bit bytes. The number of available bytes is dependent on WORD length (16 bits standard, up to 32K bits optional). WORD length is selected with the WORD LENGTH key, and displayed on the LCD.

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Both 8 bit bytes of the 16 bit WORD are displayed in HEX in the LCD. The desired byte to modify (with the 'bit' keys) is selected with the PATTERN up/down keys, and marked by an arrow. The binary value of the byte is displayed on the row of 8 'BIT' keys. Each bit's value is displayed by the key's LED; an illuminated key signifies a '1', an unlit key a '0'. Pressing the 'BIT' key toggles it's logic value. For example to modify bit 13;

1) select WORD mode (press WORD key)
2) select byte to modify (pattern up/down keys)
3) toggle BIT 5 key (13th bit).

RECALL

Pressing RECALL selects WORD memory mode. 10 programmed WORDs can be stored and recalled. The selected WORD memory location is displayed on the lower left side of the LCD display as 'WORD m'. The memory location m (0 to 9) is selected with the PATTERN up/down keys. The data pattern stored in memory is programmed immediately upon selection.

An illuminated RECALL LED indicates the WORD memory location can be selected by the up/down keys.

SAVE

Pressing SAVE selects WORD save mode. The currently programmed data pattern memory location is displayed on the lower left side of the LCD as 'WORD m', which will blink in save mode. The data pattern can be stored in the current memory location, by pressing SAVE a second time. A different memory location can be first selected with the PATTERN up/down keys, followed by pressing SAVE a second time. The 'WORD m' will stop blinking when saved. Pressing any other key will escape from SAVE mode.

An illuminated SAVE LED indicates WORD SAVE mode is selected and the WORD memory location can be selected by the PATTERN up/down keys.

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3.4.4 PATTERN (cont)

SAVE (cont)

For example to modify the programmed data pattern stored in memory location 6;

1) select memory location 6 (RECALL, up/down keys),
2) modify WORD pattern (WORD, up/down keys, BIT keys),
3) press SAVE twice.

Alternatively:

1) modify the WORD pattern (WORD, up/down, BIT keys),
2) press SAVE,
3) select memory location 6 (up/down keys),
4) press SAVE a second time.

BITs 1-8 — Pressing a BIT key, toggles the logic value of the bit, of the selected 8 bit byte between a 0 and 1.

An illuminated LED indicates that the bit is a logic '1', unlit indicates a logic '0'.

CLEAR — Pressing CLEAR resets all 8 bits of the selected byte to a logic '0'.

SET — Pressing SET sets all 8 bits of the selected byte to a logic '1'.

WORD LENGTH — This key selects WORD length select mode. The programmable WORD length is variable between 8 or 16 bits, with the PATTERN up/down keys, and is displayed on the LCD to the right of the the WORD byte values. The new length data pattern will be output, starting with byte 0 through the respective highest byte (bytes 0 and 1 for 16 bit WORD, up to 32K bits optional), dependent on WORD length.

3.4.4.1 FUNCTION KEYS

F1 — User-menu access key, see section 3.5.

F2 — Undefined.

F3 — Reference Data key, see section 3.4.3.

F4 — Hardcopy key, see Section 5.

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3.4.5 ERROR HISTORY CONTROLS

This section contains the History LEDs that display prior LOSS of Sync, Bit error, Phase error, and power loss. These history LEDs remain on until cleared by the operator. Bit Error and Phase Error are cleared automatically in Auto Search mode by the unit, under certain conditions. See below.

CLEAR — Pressing this key will clear all four history LEDs.

SYNC LOSS — An illuminated SYNC LOSS LED indicates the input data error rate has exceeded the sync threshold. If the unit is NOT in 'DISABLE' mode, the receiver will attempt to resynchronize.

BIT — An illuminated BIT LED indicates that a bit error has occurred.

PHASE — An illuminated PHASE LED indicates that the Receivers guaranteed setup and hold time requirement has been violated, between either Clock and Data or Clock and Ref Data.

POWER — An illuminated POWER LED indicates that a power loss has occurred.

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3.4.6 ERROR DETECTION/DISPLAY CONTROL

This section contains the controls for the Synchronization circuitry, error measurement display, and audible BER 'BEEPER'.

3.4.6.1 SYNCHRONIZATION CIRCUITRY CONTROLS

The gigaBERT-660 has three modes of operation, select with the AUTO SEARCH and DISABLE keys.

AUTO-SEARCH -- Input parameters are selected by the DRx; clock/data phase delay, data input threshold, PRBS or WORD pattern, and data polarity.

MANUAL --- Input parameters are selected by the user, however the DRx synchronization circuitry continuously monitors input data for bit errors, and will attempt resynchronization on the SAME pattern if sync loss occurs.

DISABLE -- Sync circuitry is disabled, regardless of input data error rate no resynchronization attempt will be made.

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AUTO SEARCH

Pressing this key selects AUTO SEARCH mode; the gigaBERT-660 Receiver automatically sets input data parameters to gain synchronization and perform bit error rate analysis on it. Selecting Ref Data Mode will shut off Auto Search mode.

When AUTO SEARCH is not selected, the unit is in 'MANUAL' mode; all input parameters and pattern must be selected by the operator. When properly selected the unit will gain synchronization on the input data pattern and perform BER.

In AUTO SEARCH mode the unit automatically sets;

1) Input Data Threshold
2) Input Data/Clock Phase Delay
3) Input Data Pattern
4) Input Data Polarity

In AUTO SEARCH mode, when a NEW pattern has been found, the DRx clears 'Bit' and 'Phase' error history LEDs. 'Sync Loss' history remains lit.

An illuminated AUTO SEARCH LED indicates AUTO SEARCH mode is selected, unlit indicates MANUAL mode.

DISABLE

Pressing this key selects sync DISABLE mode. In this mode the unit's synchronization is disabled, and will not attempt to gain sync on the input data, regardless of error rate. This is useful on data streams with very high error rates (exceeding the Receivers sync threshold). Pressing DISABLE overrides the AUTO SEARCH key.

An illuminated DISABLE LED indicates the synchronization circuitry is disabled.

LOCK LED

An illuminated LOCK LED indicates the unit has synchronized on the incoming data pattern.

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3.4.6.2 ERROR RATE DISPLAY CONTROL

DISPLAY SELECT

This key toggles among the three display modes. As the display mode is changed, the BER analysis continues in the background for the other modes.

Totalize BER -- Errors are averaged over the time of test, starting at power up or when the 'CLEAR' button is pushed. Totalize BER results are preceded by an (infinity) symbol on the LCD.

Window BER --- Errors are calculated over a programmable sliding window, controlled by the WINDOW menu, section 3.5.5. Current WINDOW BER results are displayed on the LCD with no preceding symbol.

Test Mode --- Errors are calculated over a programmable length of time, controlled by the TEST menu, section 3.5.4 below.

Three TEST MODEs, (Timed, Untimed and Repeat) are selected through the TEST MODE menu, section 3.5.4 below. Test Mode results are displayed on the LCD preceded by the MODE's respective symbol (T, U, R). While a Test is in progress the T, U, or R symbol blinks.

CLEAR

This key clears the Exponential BER, and Totalized BER on the LCD display in Totalize and Window BER modes. In Test Mode this key STARTS/STOPS test time. While the Test is in progress and the display select mode is set to Test, the symbol (T, U, or R) will blink.

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3.4.6.3 AUDIBLE ERROR RATE CONTROL

This section controls the audible error rate detector, which allows 'eye-off' detection of error rate, over a programmable threshold, and audio volume.

VOL UP — Pressing this key increases the volume of the audible beeper, over a range of 4 steps.

An illuminated VOL UP LED indicates that the audible beeper is on, it can be disabled by pressing the VOL DOWN key until the lowest (off) volume is selected.

VOL DOWN — Pressing this key decreases the volume of the audible error rate beeper, over a range of 4 steps. The minimum volume is 'off', which shuts off the beeper and turns off the VOL LED.

RATE UP — Pressing RATE UP displays rate as '1E-xx' on the right lower side of the LCD for 7 seconds. Pressing this key again increases the beeper error rate threshold exponent by 1, over the range of 1E-2 to 1E-16.

RATE DOWN — Pressing RATE UP displays rate as '1E-xx' on the right lower side of the LCD for 7 seconds. Pressing this key again decreases the beeper error rate threshold exponent by 1, over the range of 1E-2 to 1E-16.

3.4.7 MONITOR SIGNAL OUTPUTS

These outputs provide Data and Clock monitor outputs, and a pattern sync for oscilloscope trigger.

DATA — Relatched input NRZ-L data is output from this SMA connector. This signal can be used as an indication of what the receiver is 'seeing' for an incoming data signal.

CLOCK — Buffered input Clock is output from this SMA connector.

PATTERN SYNC — This SMA connector outputs a signal suitable for oscilloscope trigger.

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3.5 USER-MENUS (FUNCTION KEYS F1-F4)

Function key F1 provides access to the USER-MENUS. The Function keys F1-F4 are re-assigned in user-menu mode to allow convenient front-panel programming of a variety of features, and to provide control for unit options. Refer to Section 2 for a description of available options. Function keys F2-F4 are defined during user-menu mode as tabulated below. The menus are structured as follows;

3.5.1 USER-MENU STRUCTURE

ESCAPE KEY (F1)

Menu key F1 is the MENU ESCape key, functions as follows (sub-menu dependent);

1) Enter USER-MENU mode,
2) Provide MORE selections,
3) ESCAPE from an editing level, or
4) EXIT from menu mode.

F1 will either escape or access more menus, pushing repetitively will eventually EXIT menu mode, without changing previously set conditions.

EDITING KEYS (F2, F3, F4)

Menu keys F2, F3, and F4 are editing keys. Their functions are re-assigned for each sub-menu, as tabulated throughout this section.

3.5.2 USER-MENU SELECTION

The USER-MENU structure consists of three top-level menus entitled;

'MAIN', 'MORE' and 'MORE'.

The function key access sequence to each sub-menu, follows the Menu title in brackets []. Each top level menu is structured into 4 sub-menus.

Following the sub-menu names below are the sections in this manual where the detailed descriptions can be found.

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3.5.3 USER-MENU REFERENCE TABLE

MAIN user-menu

Pressing F1 from normal operating mode, places the unit into 'USER-MENU mode'. Normal unit operation continues while in user-menu mode, and is displayed as;

```
F1      F2      F3      F4
MORE    TEST    WINDOW  WORD
```

F1 -- selects MORE user-menu, see below

F2 -- selects TEST user-menu, section 3.5.4

F3 -- selects WINDOW user-menu, section 3.5.5

F4 -- selects WORD user-menu, section 3.5.6,
NOTE: see OPTION section if WORD option installed.

Pressing 'F1' from the MAIN MENU selects the menu;

```
F1      F2      F3      F4
MORE    RS232   GPIB    PRINT
```

F1 -- selects MORE user-menu, see below,

F2 -- selects RS232 user-menu, section 3.5.7

F3 -- selects GPIB user-menu, section 3.5.8

F4 -- selects PRINT user-menu, section 3.5.9

Pressing 'F1' from the above menu selects the menu;

```
F1      F2      F3      F4
EXIT    DATE    TIME    UTIL
```

F1 -- EXITs from user-menu mode,

F2 -- selects DATE user-menu, section 3.5.10

F3 -- selects TIME user-menu, section 3.5.11

F4 -- selects UTIL user-menu, section 3.5.12

A selected sub-menu will appear as follows;

```
F1:ESC          F4:SET
VALUE: PPPPP
```

F1 Escapes from the sub-menu without change.
F4 Sets the selected VALUE as noted 'PPPPP'

The Value is selected with the PATTERN up/down keys.

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3.5.4 TEST user-menu

The TEST menus provide user control of the following Bit Error Rate TEST (BERT) parameters, which control the BER display during TEST mode;

LENGTH -- Length of TEST (time)

MODE -- Timed, Untimed or Repeat

REPORT -- Print On Error, End of Test, or both

THRES -- Threshold Errored Seconds (TES) control

SQUEL -- Print On Error Squelch (TES)

PRINT -- Immediate hardcopy of test results

VIEW-CUR -- View current Test results

VIEW-PRE -- View previous Test results

Pressing 'F2' from MAIN menu, selects the menu as;

F1	F2	F3	F4
MORE	LENGTH	MODE	REPORT

Pressing 'F1' from the above menu, selects the menu as;

F1	F2	F3	F4
MORE	THRES	SQUEL	PRINT

Pressing F1 from the above menu, selects the menu;

F1	F2	F4
ESC	VIEW-CUR	VIEW-PRE

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LENGTH allows programming of the TEST length over the range of (1 sec to 23:59:59), in HH:MM:SS format. The LENGTH is set by selecting the character to edit with the F2 (left) and F3 (right) keys, the selected character will blink. Edit value with the pattern up/down keys.

MODE allows selection of the Test MODE among the values of (TIMED, UNTIMED, REPEAT). This provides the ability to start/stop current Bit Error measurements by front panel, remote, and software control. TEST is selected by the front panel DISPLAY SELECT key. The type of TEST is selected by the TEST MODE menu. See section 3.4.6.2 for DISPLAY SELECT information.

TIMED 'T' Test will continue until stopped by TEST LENGTH time-out, front panel 'DISPLAY CLEAR' (START/STOP) key, remote STOP command, or power loss.

UNTIMED 'U' Test will continue until stopped by front panel 'DISPLAY CLEAR' (START/STOP) key, remote STOP command, or power loss.

REPEAT 'R' Test will continue until stopped by TEST LENGTH time-out, front panel 'DISPLAY CLEAR' (START/STOP) key, remote STOP command, or power loss. If TEST LENGTH time-out occurs, the test will repeat continuously.

REPORT allows selection of the Test MODE among the values of;

NONE -- No Output

END OF TEST -- Output at End Of Test (EOT)

ON ERROR -- Output On Error (TES)

EOT/ERROR -- Output on End Of Test or On Error

THRES allows programming of the TEST THREShold over the range of (1E-02 TO 1E-16). This provides control of the Threshold Errored Seconds (TES) calculations. The TES threshold generates the 'ON ERROR' condition, and will generate a REPORT if enabled by the TEST REPORT menu. The PRINT ON/OFF must be enabled for the TEST REPORT to print, see PRINT menu 3.5.9 below.

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SQUEL allows activation (ON) or deactivation (OFF) of Test Report SQUELch, providing control of the 'ON ERROR' condition REPORT output. The output (to printer, or controller) is SQUELCHed if the TEST THRESHOLD has been exceeded for 10 consecutive seconds. Once SQUELCHED the reports will resume after 5 consecutive seconds of below the threshold.

PRINT provides IMMEDIATE hardcopy printout of current TEST results.

VIEW-CUR provides access to the CURRENT TEST measurement results. 16 lines of TEST DATA are available for display with the PATTERN up/down keys.

VIEW-PRE provides access to the PREVIOUS TEST measurement results. 16 lines of TEST DATA are available for display with the PATTERN up/down keys.

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3.5.5 WINDOW menu

The WINDOW menus provide the user control of the following Bit Error Rate measurement WINDOW parameters, which control the BER sliding Window display;

MODE	--	measurement WINDOW in BITS or SECONDS
BITS	--	sets WINDOW size in bits (1E8 TO 1E16)
SECOND	--	sets WINDOW size in time (1sec to 24hrs)
REPORT	--	End Of WINDOW REPORT output control

Pressing F3 from MAIN menu, selects the menu;

F1	F2	F3	F4
MORE	MODE	BITS	SECOND

Pressing F1 from the above menu, selects the menu;

F1	F2
MORE	REPORT

MODE allows selection of WINDOW MODE among the two modes (BITS, or SECONDs).

BITS allows programming of BIT Window length over the range (1En, where n=8 to 16)

SECOND allows programming of SECONDs Window length over the range (1 second to 23:59:59 hours) in HH:MM:SS format. The TIME is set by selecting the character to edit with the F2 (left) and F3 (right) keys, the selected character will blink. Edit value with the pattern up/down keys.

REPORT allows activation (ON) or deactivation (OFF) of Output report (to printer or controller) for END OF WINDOW tests. The PRINT ON/OFF must be enabled for the WINDOW REPORT to print, see PRINT menu 3.5.9 below.

NOTE: The bit error rates of the sliding window are calculated and displayed on the LCD at every sliding step (1/100 of the window length), but the printed reports are generated at the fixed interval of the window length.

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3.5.6 WORD user-menu

The WORD menu provides control of the 16-bit WORD order;

ORDER -- Receive LSB or MSB of each byte first

Pressing F4 from the MAIN menu selects the menu;

F1	F2
ESC	ORDER

ORDER allows selection between receiving the 16-bit WORD starting with the MSB of the first byte or the LSB of the first byte (MSB/LSB). After the MSB (or LSB), the bits would be received continuing with the bits of the first byte until the LSB (or MSB) is reached, then proceeding with the next byte in the same order.

NOTE: The selected ORDER is effective only on the pattern bytes edited after the setting of the ORDER. If the ORDER is changed in the middle of programming pattern bytes, the bytes programmed before the ORDER change will be reversed.

For example, if the word ORDER is previous LSB at word location 6 and the data pattern is programmed as follows:

```
edit_begin  6
byte_length 4,0
byte_block  0,16,#HAA,#HAA
word_order  MSB
byte_block  2,16,#HAA,#HAA
edit_end    6
```

The pattern at location 6 would be:

```
byte_block  0,32,#H55,#H55,#HAA,HAA
```


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3.5.7 RS232 user-menu

The RS232 menus provide user control of the following RS-232C Remote Interface parameters;

BAUD	--	Serial BAUD rate (300 to 9600)
PARITY	--	Serial byte PARITY (NONE, ODD, EVEN)
SIZE	--	Serial byte SIZE (7 or 8 bits)
EOL	--	End Of Line character (CR, LF, CR/LF, LF/CR)
XON/XOFF	--	XON/XOFF protocol (ON or OFF)
ECHO	--	ECHO of command to terminal (ON or OFF)

Pressing F2 from the MAIN menu, selects the menu;

F1	F2	F3	F4
MORE	BAUD	PARITY	SIZE

Pressing F1 from the above menu selects the menu;

F1	F2	F3	F4
ESC	EOL	XON/XOFF	ECHO

BAUD allows selection of BAUD Rate among the values of (300, 600, 1200, 2400, 4800, 9600).

PARITY allows selection of PARITY (NONE, EVEN, ODD).

SIZE allows selection of RS-232 word SIZE among the values of (7, 8).

EOL allows selection of EOL character among the values of (LF, CR, CR/LF, LF/CR).

XON/XOFF allows activation (ON) or deactivation (OFF) of XON/XOFF protocol.

ECHO allows activation (ON) or deactivate (OFF) RS-232 Echo feature, which echoes back to the terminal all characters entered.

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3.5.8 GPIB user-menu

The GPIB menu provide user control of the following GPIB (IEEE-488.2) Remote Interface parameters;

EOI -- Response Message Terminator sent by the gigaBERT-660 in TALK mode.

Pressing F3 from the MAIN menu:

EOI allows selection of the EOI Terminator among the values (EOI, EOI/LF). The EOI character is selected with the PATTERN up/down keys. F4 sets the value, F1 escapes without change.

3.5.9 PRINT user-menu

The PRINT menu provides user control of the following PRINTER port parameters;

PORT -- Redirects printer Output to Serial, Parallel, or GPIB port.

ON/OFF -- Master Printer control, must be enabled for any report outputs (TEST, WINDOW, HARDCOPY) to occur.

Pressing F4 from the MAIN menu selects the menu;

F1	F2	F3
ESC	PORT	ON/OFF

PORT allows selection of printer PORT among the values (PARALLEL, GPIB, SERIAL)

ON/OFF allows activation (ON) or deactivation (OFF) of PRINTOUT ENABLE.

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3.5.10 DATE user-menu

Pressing F2 from the MAIN menu selects the menu;

```
      F1:ESC F2<- ->F3 F4:SET
      DATE =  MMM DD YY
```

F1 -- ESCapes from DATE menu, and returns to main menu,
F2 -- moves the cursor to the left,
F3 -- moves the cursor to the right,
F4 -- SETs the current programmed DATE.

'MMM DD YY' is the DATE in 'Month Day Year' format.

The DATE is set by selecting the character to edit with the F2 and F3 keys (the selected character will blink), and then editing the value with the pattern up/down keys. The SET key 'F4' must be pushed to save the DATE, press 'F1' to escape without change.

3.5.11 TIME user-menu

Pressing F3 from the MAIN menu selects the menu;

```
      F1:ESC F2<- ->F3 F4:SET
      TIME =  HH:MM:SS
```

F1 -- ESCapes from TIME menu, and returns to main menu,
F2 -- moves the cursor to the left,
F3 -- moves the cursor to the right,
F4 -- SETs the current programmed TIME.

'HH:MM:SS' is the TIME in 'Hours:Minutes:Seconds' (24 hour) format.

The TIME is set by selecting the character to edit with the F2 and F3 keys (the selected character will blink), and then editing the value with the pattern up/down keys. The SET key 'F4' must be pushed to save the TIME, press 'F1' to escape without change.

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3.5.12 UTILITY user-menu

The UTILITY menu provides convenient access to the following system information;

OPTION -- Installed unit OPTIONS

VERsion -- System software VERSION revision

Pressing F2 from the MAIN menu selects the menu;

F1	F2	F3
ESC	OPTION	VER

OPTION displays installed gigaBERT-660 options, refer to Section 2, for available options.

VER displays software version.

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3.6 REAR PANEL AUXILIARY OUTPUTS

Three rear panel mounted BNC connectors provide signals for Error Output from the receiver's error detection circuitry, and an asynchronous Error Inhibit input. An auxiliary BNC connector provides user-specified custom factory installed options, consult factory for details. Refer to Section 2, Specifications for signal levels.

3.7 REMOTE INTERFACE CAPABILITIES

The gigaBERT-660 DRx supports remote control through the RS-232C and IEEE-488 GPIB remote interface bus connectors on the rear panel. The unit can be operated from the front panel and over the remote interface simultaneously, any unit status changes made remotely will be displayed on the front panel. All front panel functions except Power and PANEL LOCK can be controlled remotely.

The remote commands sent to the gigaBERT-660 DRx differ from front panel control. The current operating mode is entered directly rather than through sub-menus. Data patterns, and memory contents are programmable directly over the interface.

Refer to Appendix A. for a complete description and programming guide to the RS-232C interface.

Refer to Appendix B. for a complete description and programming guide to the GPIB interface.

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SECTION 4

gigaBERT-660 RECEIVER

PRINCIPLES OF OPERATION

4.1 DESIGN OVERVIEW

The gigaBERT-660 DRx is designed to receive a differential or single ended programmable WORD of 16 bits, and 5 Pseudo-random binary sequences (PRBS) of 2^n-1 (n= 7, 15, 17, 20, 23), at serial data rates of 1 to 700 MBit/s, compare it to a locally generated identical data stream and perform Bit-Error-Rate (BER) analysis upon it.

Very high frequency GaAs, ECL and discrete circuitry is incorporated on multilayer controlled impedance printed circuit boards. RF shielding and critically timed coaxial cables provide wideband operation with sub-nanosecond timing. An embedded CPU controls the high speed data generator hardware, programmable WORD loading, error counter calculations, AUTO-SEARCH parameters, remote RS-232C and GPIB interfaces, and soft front panel control.

The gigaBERT-660 DRx consists of five functional block sub-assemblies, as shown in Figure 6.1 gigaBERT-660 DRx Block diagram.

4.2 INPUT AMPLIFIER PCB

The Input Amp PCB contains the circuitry required to receive differential/single ended Data and Clock, and single ended Reference Data signals. The signals are provided with selectable termination voltages, variable threshold level and phase delay between clock and data to accommodate DUT skew. Delay, and Input Threshold are controlled by the CPU either automatically in 'auto-search' mode, or manually through front panel control.

4.3 DATA GENERATOR PCB

The Data Generator PCB contains the circuitry required to generate the local PRBS pattern, programmable WORD, for comparison with the received pattern. The locally generated pattern is compared bit-by-bit at full rate. The differences are 'Bit-Errors' and are counted by the Error Counter PCB.

When the Bit-Error Rate (BER) exceeds the 'Sync' threshold (25% in PRBS, 3.1% in WORD mode, variable with 32K WORD option), the Data Gen PCB initiates the synchronization process, by feed-forward technique on incoming PRBS data, or clock-slip technique on programmable WORD data. Once synchronization is established BER measurements begin.

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4.3 DATA GENERATOR PCB (cont)

The PRBS data generator utilizes a pattern dependent, n-length shift register (where n is 2^n-1) with modulo-2 feedback, to generate the desired PRBS (pseudo random binary sequence) pattern.

The programmable WORD is level shifted from TTL to ECL and loaded into ECL registers, then multiplexed and clocked out in a serial stream at full-rate. The 16 bits are loaded at full rate, allowing immediate change to the data pattern.

In PRBS mode, the Pattern sync circuit detects the start (n-1 zeros) of the pseudorandom pattern. This produces a single bit width pulse once per pattern frame. In WORD mode the shift register detects the programmable WORD load pulse, which occurs once every 16 bit frame.

4.4 ERROR COUNTER PCB

The Error Counter PCB contains the circuitry to count the Bit errors detected by the Data Gen PCB, and also measures the system clock frequency. A Bit-Error-Rate (BER) is defined as a ratio of errors/bits, the CPU divides the total errors by the total bits, and displays the quotient on the front panel LCD as BER. Total bit errors are also displayed, along with frequency. All counting is done at full rate, latched and calculated by the CPU.

4.5 CPU PCB

The CPU PCB contains the CPU, RAM, and software PROMs. The 80188 microprocessor handles all inter-board communication, storage and loading of the programmable 16 bit WORD, Error counting and frequency calculations, front panel interface and remote communication over the RS-232C and GPIB interfaces. Battery backup RAM provides storage of the 10 programmed data patterns, error status, and unit operating status after power loss.

4.6 FRONT PANEL PCB

The front panel PCB provides user control of the unit, and contains the key decoders, LED drivers and 2 X 24 Liquid crystal display. The soft key front panel design and large display allows future enhancements to functionality, and additional custom factory installed options.

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SECTION 5

BIT ERROR RATE TESTS (BERT) APPLICATION INFORMATION

5.1 BERT-660 WINDOW MEASUREMENTS

BIT ERROR RATES (BER)

Bit Error Rates (BER) are defined by the following ratio;

BER = TE / TB

where TE = Total Errors,
TB = Total Bits.

Total Bits (TB) can be defined in Bits or Time. Control of this in the gigaBERT-660 Receiver is accessed in the WINDOW user-menu, section 3.5.5.

5.2 BERT-660 TEST MEASUREMENTS

TIMED MEASUREMENTS

The gigaBERT-660 Receiver can record Error Rate data over three Timed measurement modes, Timed, Untimed, and Repeat. Control of this in the gigaBERT-660 Receiver is accessed in the TEST user-menu section 3.5.4.

TIMED

Test will continue until stopped by TEST LENGTH time-out, front panel 'DISPLAY CLEAR' (start/stop) key, remote stop command, or power loss. The Error Rate displayed on the LCD is preceded by a 'T' to denote Timed.

UNTIMED

Test will continue until stopped by front panel 'DISPLAY CLEAR' (start/stop) key, remote stop command, or power loss. The Error Rate displayed on the LCD is preceded by a 'U' to denote Untimed.

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REPEAT

Test will continue until stopped by TEST LENGTH time-out, front panel 'DISPLAY CLEAR' (start/stop) key, remote stop command, or power loss. If TEST LENGTH time-out occurs, the test will repeat continuously. The Error Rate displayed on the LCD is preceded by a 'R' to denote Repeat.

ERROR SECOND (ES)

A one second period during which there is one or more errors. The Error Second is Synchronous, i.e., the one second interval starts with an error. Measured over the Time of test. ES is displayed as # OF ES and as a percentage Test time.

%ES = (ES / TT) * 100%

where ES = Errored Seconds,
TT = Test Time.

ERROR FREE SECONDS (EFS)

For Untimed, Timed or Repeat measurements. Measured over the Time of test. Presented as EFS and %EFS.

%EFS = ((TT - ES - US) / TT) * 100%

where ES = Errored Seconds,
TT = Test Time,
US = Unavailable Seconds.

THRESHOLD ERROR SECONDS (TES)

The user sets an Error Rate Threshold (ERT) of 1E-02 to 1E-16. Each Errored Second (ES) is evaluated for exceeding the Error Rate Threshold (ERT), which is a Threshold Errored Second (TES).

%TES = (TES / TT) * 100%

where TES = Threshold Errored Seconds,
TT = Test Time.

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DEGRADED MINUTES (DM)

A Degraded Minute is any continuous block of 60 seconds where the Bit Error Rate (BER) is greater than the Error Rate Threshold (ERT). Presented as DM and %DM.

%DM = ((DM * 60) / TT) * 100%

where DM = Degraded Minute,
TT = Test Time.

UNAVAILABLE SECONDS (US)

Unavailable Seconds count begins when 10 continuous seconds of;

(BER) > (ERT) Error Rate Threshold, or
LOS (Loss of Signal)

Unavailable Seconds (US) continue until 10 continuous seconds of;

Bit Error Rate (BER) < (ERT) Error Rate Threshold, and NO LOS (Loss of Signal)

During US = true, all other measurements are stopped and last value held until counting begins again when US = false. Presented as US and %US.

%US = (US / TT) * 100%

where TT = Test Time,
US = Unavailable Seconds.

LOSS OF SIGNAL (LOS)

Loss of Signal (LOS) is declared when the input Activity detector sees no activity for 20 msec. During Loss of Signal (LOS) condition, Unavailable Seconds (US) only are counted. All other measurements are stopped at last value.

SEVERELY ERRORED SECONDS (SES)

Threshold Errored Second where threshold is 1E-03.

%SES = (SES / TT) * 100%

where SES = Severely Errored Seconds,
TT = Test Time.

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5.3 BERT-660 HARDCOPY PRINTOUTS

The gigaBERT-660 supports four printer reports; (EOT, On Error, EOW, and Hardcopy). The REPORT can be directed to either of the three remote interfaces (Serial, Parallel or GPIB) through the PRINT PORT menu, and the PRINT ON/OFF mode must be 'ON' for print-out, section 3.5.9.

END OF TEST PRINT-OUT (TEST MENU)

Parameters set in the TEST menu provide for automatic print-outs at the END OF TEST, (by STOP, power loss, or remote control). Timed, Untimed and Repeat TESTS are supported. TEST LENGTH is programmable, TEST REPORT must be enabled for Output, see section 3.5.4. Additionally the TEST PRINT menu provides immediate print-out of test results, without stopping on-going tests. END OF TEST print-outs are separated by dashed lines to indicate start/stop of test. The print-out appears as follows;

```
-------------------------------------------------------------------

gigaBERT-660                  TEST SUMMARY        Mar 01,90 02:43:48

TEST MODE:  TIMED             FREQ: 100.0 MHz     PATTERN:  PRBS 20

          DATE     TIME              ALARMS            PERFORMANCE
START: Mar 01,90 02:43:26    SIG LOSS:     0S    US:       0   0.0%
STOP:  Mar 01,90 02:43:31    SYNC LOSS:    0S    SES:      0   0.0%
ELAPSED:     000-00:00:05    PHASE ERR:    0S    TES:      5 100.0%
                                                 ES:       5 100.0%
                     ERRORS/BITS                 EFS:      0   0.0%
TOTAL ERRS:          000050000  AVG RATE:1.0E-04 DM:       0   0.0%
TOTAL BITS:          500002816  CUR RATE:1.0E-04 ERROR THRES: E-05

-------------------------------------------------------------------
```


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ON ERROR PRINT-OUT (TEST MENU)

Parameters set in the TEST menu provide for automatic print-outs at 'ON ERROR' condition. 'ON ERROR' THRESHOLD is programmable, and TEST REPORT must be enabled, section 3.5.4. Every second that the error threshold exceeds the programmed THRESHOLD, an ON ERROR REPORT will occur, unless SQUELCHED. PRINT ON/OFF mode must be 'ON' for print-out, section 3.5.9. ON ERROR print-outs are separated by dashed lines to indicate start/stop of test. The print-out appears as follows;

```
-------------------------------------------------------------------
gigaBERT-660                TEST RESULTS            Mar 01,90 02:42:48

TIME: 02:42:48     ERRORS:     10000      RATE:  1.00E-004
TIME: 02:42:49     ERRORS:     10000      RATE:  1.00E-004    SynLos
TIME: 02:42:50     ERRORS:     10000      RATE:  1.00E-004
-------------------------------------------------------------------
```

END OF WINDOW PRINT-OUT (WINDOW MENU)

Parameters set in the WINDOW menu provide for automatic print-outs at the 'End of Window', WINDOW LENGTH is programmable over BITS or SECONDS, section 3.5.5. Note: Data Los, Sync Los, and Phase Err measurements are defined as the number of 20 mSec intervals that had that condition. PRINT ON/OFF mode must be 'ON' for print-out, section 3.5.9. At 'End of Window' the following print-out occurs;

```
WINDOW MODE: SEC  LENGTH: 00:00:05 DATE:  MAR 01,90  TIME:02:42:34.46
   BITS= 5.00e+08 ERRS=      50000 ERR RATE= 1.0e-04 FREQ= 100.00 MHz
   PATT= AA55 MSB DATA LOS=      0 SYNC LOS=      0  PHASE ERR=     0
```


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HARDCOPY (F4-NORMAL OPERATION)

Pressing F4 from Normal operating mode produces a Hardcopy of Receiver status. An example follows;

```
**** MICROWAVE LOGIC BERT-660 RX V2.30  06/90
AUDIO_RATE 3
AUDIO_VOL 0
AUTO_SEARCH OFF
DATA_DELAY 1.800E-9
DATA_INVERT ON
DATA_PATTERN PRBS
DATA_THRES 0.00
DIFF_TERM GND
DISP_SELECT TOTAL
PRBS_LENGTH 23
PRINT_ENABLE ON
PRINT_PORT PARALLEL
RDATA_DELAY 0.000E-9
RDATA_THRES -1.50
TEST_LENGTH "00:00:30"
TEST_MODE TIMED
TEST_PREV PREVIOUS
TEST_REPORT ON_ERROR
TEST_SQUELCH OFF
TEST_STATE STOP
TEST_THRES 5
VIEW_ANGLE 0
WIN_BIT_LEN 09
WIN_MODE SEC
WIN_PREV CURRENT
WIN_REPORT OFF
WIN_SEC_LEN "00:00:01"
WORD_BITS 16,#HAA,#H55
WORD_ORDER LSB
```


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APPENDIX A

RS-232C INTERFACE APPLICATION INFORMATION

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A.1 RS-232C REMOTE INTERFACE CAPABILITIES

The BERT-660 supports remote control through the RS-232C interface bus connector on the rear panel. The unit can be operated from the front panel and over the remote interface simultaneously, any unit status changes made remotely will be displayed on the front panel. All of the front panel functions can be controlled over the RS-232C interface, except 'POWER'.

The remote commands sent to the BERT-660 differ from front panel control; the current operating mode is entered directly rather than through sub-menus.

Commands are provided to read back stored Data Memory contents. Memory contents can be read back and printed out for hardcopy archiving. A list of remote commands is given in Appendix C.

A.2 RS-232C INTERFACE DEVICE SETTINGS

The RS-232C interface device settings are programmable through the front panel MENU function (F1 key). The following RS-232C parameters are programmable, along with the possible selections and the default setting in parentheses:

	PARAMETER	(DEFAULT)	VALUES
o	BAUD RATE	(9600)	4800, 2400, 1200, 600, 300
o	PARITY	(EVEN)	NONE, ODD
o	DATA SIZE	(8)	7
o	EOL	(CR/LF)	LF/CR, CR, LF
o	XON/XOFF	(ON)	OFF
o	ECHO	(ON)	OFF

To change an RS-232C setting through the front panel,

Step 1: Press F1 to select MENU mode,
Step 2: Select the RS-232C menu choice,
Step 3: Select the desired setting type,
Step 4: Select the desired setting,
Step 5: Press F4 to SET the selection,
Step 6: Press F1 to Exit.

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A.3 RS-232C INTERFACE HARDWARE/HANDSHAKING CONSIDERATIONS

The remote interface consists of a 25 pin female D-type connector located on the rear panel. When using the RS-232C remote interface, connect the controller to the BERT-660 rear-panel connector with an appropriate 25 pin cable.

The BERT-660 is configured as an RS-232C Data Circuit terminating Equipment (DCE). For a local (direct) connection to a DTE device (most RS-232C controllers), connect the controller to the BERT-660 with a straight (non-null modem) cable.

To interface to another DCE device, a null modem is required to cross-connect signal pairs (2 & 3, 4 & 5, and 6 & 20). Refer to Table A.1 for RS-232C signal names, pinouts, and functional descriptions.

Table A.1 RS-232C Interface Connector Pin-out

PIN	NAME	FUNCTION
1	GND	Protective Ground.
2	RxD	Received Data Input. Data sent to the BERT-660 is received on this input.
3	TxD	Transmitted Data Output. Data sent from the BERT-660 to the terminal is transmitted on this pin.
4	CTS	Clear to Send. Sent to the BERT-660, a hi-level indicates that external device is ready to accept data from the unit. This pin must be high or open for the BERT to transmit Data. This pin is pulled high internally by 27K ohm to +12V.
5	RTS	Request to Send. Always High.
6	DTR	Data terminal Ready. A high indicates that the unit is ready to transmit data.
7	GND	Signal Ground.
20	DSR	Data Set Ready. Ignored
ALL OTHER PINS		Not used.

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A.4 RS-232C INTERFACE TESTING

To test that the RS-232C interface is properly connected, attach a standard 25 pin D-type connector cable between the BERT-660 RS-232C rear panel connector and the controller, with the BERT-660 off. Turn on the BERT-660, the following message should appear on the RS-232C controller's screen, followed by the prompt "BERT660> ":

```
***** MICROWAVE LOGIC BERT-660 RX V2.30 6/90 *****
BERT660>
```

If the message does not appear, check the following;

1) The cable may be defective,
2) The controller may be configured as DCE equipment; a null modem may be required,
3) The controller signal format, or Baud rate may not match the BERT-660's settings; refer to section A.2 for interface setting information.

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A.6 RS-232C ERROR MESSAGES

All RS-232C remote commands received by the BERT-660 are checked for command validity, and appropriate parameters (parameters listed with commands within brackets []). All valid command strings are executed, incorrect command strings are responded to with error messages.

ERROR MESSAGE	ERROR
"Input Lost"	Input data lost over interface.
"Input Buffer Overflow"	Input buffer overflow, command line too long without terminator.
"Command Mnemonic Not Found"	Command not found.
"Invalid Command For Interface"	Command found, but not valid for this interface.
"Invalid Command Type"	Command mnemonic found, but command issued incorrectly: missing, or added, '?' on end of command.
"Too Few Parameters"	Missing parameter.
"Too Many Parameters"	Too many parameters or trailing garbage at end of command.
"Invalid Parameter"	Parameter invalid.
"Parameter Out of Range"	Parameter out of range.
"Parameter Not in Set"	Parameter not one of the values specified for the command.
"Invalid String Length"	Parameter string too long.
"Parameter Separator"	Parameter separator, ';', is missing or command line is terminated following separator.
"Invalid Hexadecimal Parameter"	Parameter not in hexadecimal format, or more than two hexadecimal characters.
"Command Execution Error"	Command not executed properly.

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A.5 PROGRAMMING RS-232C REMOTE COMMANDS

There are two types of remote commands for the BERT-660;
1) set commands (or commands) and,
2) queries commands (or queries).

The set commands force the BERT-660 to take a specific action. The query commands direct the BERT-660 to return status information.

Commands are entered one line at a time. Errors may be corrected while entering a line, with the backspace key. A command string is terminated by a carriage return, which transmits the string to the BERT-660 and executes the command string. All valid commands are executed, incorrect or unsupported commands are responded to by an error message. Refer to section A.6 for RS-232C error messages.

Command lines may contain a single command or multiple commands. The command line may contain both queries and commands. Individual commands within the command line must be separated by semi-colons (;), parameters must be separated by commas (,). Non-decimal numeric parameters, Hexadecimal, Octal, and Binary, must be preceded by a '#H', '#Q', or '#B', respectively. Refer to section A.7 for command line examples.

The entire command name does not have to be entered for the command to be recognized as valid. There is a minimum valid length associated with each command, which is the length that makes it unique from all other commands listed below.

Refer to Appendix C for BERT-660 commands.

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A.7 RS-232C COMMAND EXAMPLES

COMMAND	RESPONSE
clock_freq?	Returns the current operating frequency.
word_memory?	Returns all 10 data patterns stored in memory.
word_memory? 7	Returns the data pattern stored in WORD memory 7.
word_memory 9 , 16 , #Haa , #H23	Programs the '16' bits of the data pattern stored in WORD memory '9' to the HEX data pattern 'AA23'
word_bits 8 , #Q307	Sets the first '8' bits of the currently generated data to the octal data pattern '307', leaving upper bytes as they were.
recall_word 7	Sets the currently generated data pattern to that stored in WORD Memory 7.
word_mem_len 6 , 16	Sets the length of data pattern stored in WORD memory 6 to 16 bits.
view_angle?	Returns the current Front Panel view angle.
view_angle 3	Sets the front panel LCD view angle to angle '3'.
rs_prompt '660'	Sets the prompt to '660 '.
all_mem?	Returns all 10 WORD Memory contents.

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B.1 GPIB REMOTE INTERFACE CAPABILITIES

The BERT-660 supports remote control through the GPIB interface bus connector on the rear panel. The unit can be operated from the front panel and over the remote interface simultaneously, any unit status changes made remotely will be displayed on the front panel. All of the front panel functions can be controlled over the GPIB interface bus, except 'POWER'.

The remote commands sent to the BERT-660 differ from front panel control; the current operating mode is entered directly rather than through sub-menus.

Commands are provided to read back stored Data Memory contents. The memory contents can be read back and printed out for hardcopy archiving. A list of remote commands is given in Appendix C.

B.2 GPIB INTERFACE DEVICE SETTINGS

For proper GPIB Interface communication and handshaking, the GPIB controller (Computer or other controller), and the Device (BERT-660 DRx), must have their addresses and terminating characters set up prior to use. These 2 requirements are met as noted below.

B.2.1 GPIB INSTRUMENT ADDRESS

Each instrument on the GPIB interface bus must have a unique INSTRUMENT address. The INSTRUMENT address range for the BERT-660 (0 TO 30 decimal) is programmed on the front panel by the 'GPIB ADDR' key. The address cannot be set outside of the range 0 to 30 decimal, except to place the unit OFF-BUS. To select the BERT-660'S GPIB address:

Step 1: Press GPIB ADDR, 'GPIB xx' is displayed on the LCD,
Step 2: Press the left-most up/down keys (INPUT) to select the desired GPIB address 'xx',
Step 3: Press GPIB ADDR a second time.

The BERT-660 will then respond to commands sent to that INSTRUMENT address. This will be done without affecting the remote command processing.

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APPENDIX B

GPIB INTERFACE APPLICATION INFORMATION

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B.3 BERT-660 GPIB INTERFACE FUNCTIONS

The BERT-660 is configured as a talker/listener. No controller functions are implemented. As described in the IEEE-488 GPIB standards the BERT-660 supports the following implementation:

SH1	Complete source handshake.
AH1	Complete acceptor handshake.
T6	Basic talker, serial poll, no talk only, unaddressed if addressed to listen, no extended talker.
L4	Basic listener, no listen only, unaddressed if addressed to talk, no extended listener.
SR1	Complete service request.
RL1	Complete remote/local capability including local lockout.
PP0	No parallel poll capability.
DC1	Complete device clear capability.
DT0	No device trigger capability.
C0	No controller capability.
E2	Tri-state drivers used on DI0 lines for maximum data transfer rate.

B.4 GPIB CONNECTOR PIN-OUTS

The BERT-660 DRx uses the standard D-type 24 pin GPIB connector located on the rear panel. All signals and pins conform to standard GPIB pin out protocol.

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B.2.2 GPIB MESSAGE TERMINATOR (EOI or EOI/LF)

The GPIB Message Terminator is set to either EOI or EOI/LF, using the Utility Menu (F1) key.

For EOI -- The EOI line will be asserted when the last byte of a message is transmitted.

For EOI/LF -- The last byte of the message will be the line feed character, and the EOI line will be asserted with it's transmission.

To select the GPIB Message Terminator:

Step 1: Press F1 (the MENU key),
Step 2: Select the GPIB menu choice,
Step 3: Select the TERMinator choice,
Step 4: Select between EOI and EOI/LF,
Step 5: Press F4 (the SET key), to enter the selection.

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B.6 GPIB STATUS REPORTING

There is status reporting functionality provided for the GPIB interface, which is based on the service request (SRQ) and is fully defined in the ANSI/IEEE standard 488.2-1987. The implementation used by the BERT-660 for status reporting includes one additional register from what is specified within the IEEE 488.2 standard.

STATUS BYTE

There is a status byte which is used to determine the SRQ status. The individual bits within the status byte represent the different conditions which might cause the request for service, defined as follows:

```
Bits 1 to 3 : Unused
Bit 4       : (TSB)  Test Event Status Bit
Bit 5       : (MAV)  Message Available Bit
Bit 6       : (ESB)  Standard Event Status Bit
Bit 7       : (MSS)  Master Summary Status Bit
Bit 8       : Unused
```

Test Status Event Bit - This is the summary of the Test Status Event Status Byte. It will be set whenever an enabled Test event condition occurs.

Message Available Bit - Set whenever there is output available for the controller.

Standard Event Status Bit - This is the summary of the Standard Event Status Byte. It will be set whenever an enabled standard event condition occurs.

Master Summary Status Bit - This is the Master Summary Status. It is a summary of the status byte, so that whenever one of the bits (TSB, MAV or ESB) is set and it is also enabled (by the Service Request Enable byte), the MSS bit will be set.

SERVICE REQUEST ENABLE

The different conditions for a service request can be individually enabled. The Service Request Enable byte contains the enabling bits for the status byte. For a service request to occur, either the TSB, MAV or ESB bit must be enabled. Each time the BERT-660 is powered on, this byte is reset so that no bits are enabled. The bit definition is the same as the status byte, except bit 7 is undefined.

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B.5 PROGRAMMING GPIB REMOTE COMMANDS

There are two types of remote commands for the BERT-660;
1) set commands (or commands) and,
2) queries commands (or queries).

The set commands force the BERT-660 to take a specific action. The query commands direct the BERT-660 to return status information.

The controller sends commands to the BERT-660 as strings terminated by EOI or EOI/LF character. These command lines can contain a single command or multiple commands. The command line may contain both queries and commands. Each individual command within the command line must be separated by semi-colons (;), parameters must be separated by commas (,). HEXadecimal parameters must be proceeded by a '#H'. Refer to section B.7 for command line examples.

Each query command sent to the BERT-660 will return one response. The response may contain multiple response units (separated by semi-colons), however only one EOI or EOI/LF character is sent by the BERT-660 to the controller for each query command.

The responses for the BERT-660 commands will be either character mnemonics (Example; INT or EXT) or numerics (Example; 700.0). Appendix C lists all queries and specifies the query response format the command will return. If the query returns a mnemonic, the valid mnemonics will be listed.

B.5.1 GPIB NUMERIC RESPONSES

If the query responds with a numeric, it will be specified as one of the following types:

1) <NR1 Numeric> - decimal integer
2) <NR2 Numeric> - decimal real number without exponent
3) <NR3 Numeric> - decimal real number with exponent
4) <Non-decimal Numeric> - non-decimal number with leading '#H' (Hex), '#Q' (Octal), or '#B' (Binary) and always in the range 0 to 255 decimal.

Appendix C defines all of the GPIB commands, along with a brief description of each command, the valid parameters, and the basic response format. The parameters shown within brackets '[]' following the command name are required.

Refer to section B.7 for examples of using the GPIB commands with HP BASIC. These command examples shown are in Basic, other controller languages will differ. Refer to the GPIB controller manual for specifics on its implementation.

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Execution Error - Set under the following conditions:
- o when a command parameter is out of range,
- o when the command has too many or too few parameters,
- o when the command cannot be properly executed due to a device condition.

Command Error - Set whenever the BERT-660 receives an unrecognized command, or invalid GPIB command.

User Request - Not Used.

Power On - Set whenever the BERT-660 is powered on.

STANDARD EVENT STATUS ENABLE REGISTER

The different conditions within the Standard Event Status Register can be individually enabled and disabled. The Standard Event Status Enable Register contains enabling bits. Each time one of the event conditions or one of the enabling bits change, the status of the ESB bit is re-evaluated; If any status bit is set and its corresponding enable bit is set, the ESB bit will be set.

Each time the BERT-660 is powered on, this byte is reset so that no bits are enabled. The bit definition for the Standard Event Status Enable Register is the same as for the Standard Event Status Register.

TEST STATUS EVENT REGISTER

The TSB bit is the summary of the Test Status Event Register. This byte has an enabling byte which works in a similar manner to the above Status Byte. The individual bits within the Test Status Event Register represent the different conditions which might cause a Test Event. The bit definitions for the Test Status Event Register are as follows:

Bit 1	: End-Of-Window Condition
Bit 2	: End-Of-Test Condition
Bit 3	: Threshold Error Condition
Bit 4	: Synchronization Loss Condition
Bit 5	: Phase Error Condition
Bits 6 to 8	: Unused

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SRQ

The status byte is used to create a service request. Whenever a condition occurs in the BERT-660 which requires service from the controller, the SRQ (Service Request) line will be set. The SRQ will be reset after the controller finishes a serial poll of the BERT-660 or when all of the service request conditions have stopped.

STANDARD EVENT STATUS REGISTER

The ESB bit is the summary of the Standard Event Status Register. This byte has an enabling byte which works in a similar manner to the above Status Byte. The individual bits within the Standard Event Status Register represent the different conditions which might cause a Standard Event. The bit definitions for the Standard Event Status Register are as follows:

Bit 1 : Operation Complete
Bit 2 : Request Control
Bit 3 : Query Error
Bit 4 : Device Dependent Error
Bit 5 : Execution Error
Bit 6 : Command Error
Bit 7 : User Request
Bit 8 : Power On

Operation Complete - Only set following an *OPC command.

Request Control - Not used.

Query Error - Set under the following conditions:

- o when output has been requested from the BERT 660 and none is available,
- o when a command is sent to the BERT-660 and the BERT-660 still has a message available,
- o when output has been requested from the BERT 660 and an unterminated command has been sent to the BERT-660.

Device Dependent Error - Not used.

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B.7 GPIB COMMAND EXAMPLES

The following command examples use HP BASIC, consult your controller/language manuals for it's specific command syntax. The program lines below are command specific lines extracted from a complete program, line numbers have been omitted for clarity.

A GPIB command consists of three parts, a Basic command ('OUTPUT'), followed by a space, then the address ('723'), another space, and finally the BERT-660 specific command ('clock_freq?'). As shown by the following example:

1) a command to the BERT-660 is entered, in a BASIC program as;

```
OUTPUT 723 clock_freq?
```

2) a command to the BERT-660 to retrieve the response from the BERT-660 is entered, in a BASIC program as;

```
ENTER 723; a$
```

which places the response string into variable a$.

COMMAND LINE(S)	RESPONSE
OUTPUT 723 clock_freq? ENTER 723; B$	Returns to the controller the current operating frequency and places the value in variable b$.
DIM I$[200] OUTPUT 723 word_memory? ENTER 723; I$ PRINT I$	Returns to controller all 10 data patterns stored in memory and outputs them to a printer.
DIM J$[80] OUTPUT 723 word_memory? 7 ENTER 723; J$	Returns to controller data pattern stored in memory 7 and places it in variable J$.
OUTPUT 723 word_memory 9 , 16 , #Haa , #H23	Programs the '16' bits of the data pattern stored in memory location '9' to to the hex data pattern 'AA23'. Note that all hex values have leading '#H', octal '#Q', and binary '#B'.
OUTPUT 723 word_bits 8 , #Hba	Sets the first '8' bits of the currently generated data to pattern to 'ba', leaving upper bytes as they were.

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End-Of-Window - Set at the end of each window period.

End-Of-Test - Set at the end of each Test.

Threshold Error - Set whenever Test is running and Errored Second occurs, where error rate is above Test Error Rate Threshold.

Synchronization Loss - Set whenever SYNC LOSS occurs.

Phase Error - Set whenever a Phase Error occurs.

TEST STATUS EVENT ENABLE REGISTER

The different conditions within the Test Status Event Register can be individually enabled and disabled. The Test Status Event Enable Register contains enabling bits. Each time one of the event conditions or one of the enabling bits change, the status of the TSB bit is re-evaluated; If any status bit is set and its corresponding enable bit is set, the TSB bit will be set.

Each time the BERT-660 is powered on, this byte is reset so that no bits are enabled. The bit definition for the Test Status Event Enable Register is the same as for the Test Status Event Register.

GPIB COMMON COMMANDS

The following commands are provided to use with the GPIB status reporting, as defined by IEEE 488.2 for service request:

*STB?, *SRE, *SRE?, *ESR?, *ESE, *ESE?, *CLS

ADDITIONAL SRQ GPIB COMMANDS

The following commands are provided to use with the Test Status SRQ feature, as explained above:

TSE, TSE?, TSR?

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B.8 IEEE-488.2 PROGRAMMING MANUAL REQUIREMENTS

Certain programming requirements are specified for GPIB interfaces by the American National Standard Institute (ANSI) document, ANSI/IEEE Std 488.2-1987, which are detailed in this section.

B.8.1 POWER ON SETTINGS

The BERT-660 will restore the device settings to their values from when it was last powered off. There are no remote commands which will affect this. The only exception to this is when the non-volatile RAM becomes corrupted, (which should never happen during normal unit operation). RAM Corruption, if it occurs will be displayed on the units LCD display. When this happens, the BERT-660 will have the settings specified in Appendix C.

B.8.2 MESSAGE EXCHANGE

The following message exchange options are as follows:

- The input buffer is command line oriented. There will be a new input buffer for each command line, or program message. The input buffer has a maximum length of 80 characters.

- The only remote commands which will return more than one response message unit (responses separated by semi-colons) are the following:

  sta? , rdm? , rfm? , all? , *lrn?

- All queries (commands) generate their response messages immediately when they are parsed. No queries are held until the responses are read for them to be generated.

- No commands are coupled.

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COMMAND LINE(S)	RESPONSE
OUTPUT 723 recall_word 7	Sets the currently generated data pattern to that stored in WORD Memory 7.
OUTPUT 723 word_mem_len 6 , 16	Sets the length of data pattern stored in WORD Memory 6 to 16 bits.
OUTPUT 723 view_angle? ENTER 723; M$	Returns to the controller the currently set view angle, and places it in variable M$.
OUTPUT 723 view_angle 3	Sets the front panel LCD view angle to angle '3'.
DIM P$[255] OUTPUT 723 all_mem? ENTER 723;P$ PRINT P$	Returns to the controller the 10 WORD mode, Memory contents, and outputs them to a printer, and stores them in an array P$.
DIM P$[80] OUTPUT 723 clock_term? ; data_term? ; clock_freq ENTER 723;P$ PRINT P$	Returns the corresponding data associated with the command queries.
OUTPUT 723 recall_word 7 ; word_mem_len 6 , 16	Sets the currently generated data pattern to that stored in WORD Memory 7 and sets the length of data pattern stored in data memory 6 to 16 bits.

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B.8.4 SPECIFIC COMMAND IMPLEMENTATIONS

Reset Command

The reset command, "*rst", performs a device reset. As defined in the IEEE 488.2 standard it will:

- Resets the device settings to default settings, with the exception of stored memory locations and any remote interface settings (see Appendix D).
- Macros are not implemented in the BERT-660, macros are ignored.
- Forces the BERT-660 into Operation Complete Command Idle State (OCIS) and Operation Complete Query Idle State (OQIS).

Self Test Query

The scope of the self test function is limited; it tests the basic BERT-660 functionality.

Overlapped vs Sequential Commands

All commands are sequential commands.

Operation Complete Message

All commands actions are immediate (no overlapped commands), such that operation complete is immediate.

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B.8.3 FUNCTIONAL ELEMENTS

A list of the functional elements which are used by the BERT 660 is required by the IEEE 488.2 standard. These are the functional elements used in constructing the remote commands that control the BERT-660. For further details about this, see the IEEE 488.2 standard, sections 4.3, 7.1.1, and 7.3.3.

From Tables 4.2 and 4.3 of the IEEE 488.2 standard, the BERT-660 performs the following:

<PROGRAM MESSAGE>
<PROGRAM MESSAGE TERMINATOR>
<PROGRAM MESSAGE UNIT>
<PROGRAM MESSAGE UNIT SEPARATOR>
<COMMAND MESSAGE UNIT>
<QUERY MESSAGE UNIT>
<COMMAND PROGRAM HEADER> *
<QUERY PROGRAM HEADER> *
<PROGRAM HEADER SEPARATOR>
<PROGRAM DATA SEPARATOR>
<PROGRAM DATA>
<DECIMAL NUMERIC PROGRAM DATA>
<CHARACTER PROGRAM DATA>
<NON-DECIMAL NUMERIC PROGRAM DATA>

* <compound command program header> and <compound query program header> are not handled.

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C.1.1 BERT-660 DRx DATA AND REFERENCE DATA COMMANDS

COMMAND	ACTION
data_delay [v]	Sets the Input Data Delay to the specified delay 'v', in seconds: 0.0 to 3.9 nS in 0.1 or 0.2 nS steps Example: To program a delay of 2.4ns: "data_delay 2.4E-9"
data_delay?	Returns the Input Data Delay. Response: <NR3 Numeric>
data_del_up [v]	Data Delay Up, increments Data Delay by 'v', in seconds: 0.1 to 3.9 in 0.1 nSec steps
data_del_up	Increment Data Delay by 0.1 nSec.
data_del_dn [v]	Data Delay Down, decrements Data Delay by 'v', in seconds: 0.1 to 3.9 in 0.1 nSec steps
data_del_dn	Decrement Data Delay by 0.1 nSec.
data_thres [v]	Sets the Input Data Threshold to the specified voltage 'v': -1.50 to 1.00 in 0.05 V steps
data_thres?	Returns the Input Data Threshold. Response: <NR2 Numeric>
data_thr_up [v]	Data Threshold Up, increments the Input Data Threshold by value 'v': 0.05 to 2.50 in 0.05 V steps
data_thr_up	Increment Data Threshold by 0.05 V.
data_thr_dn [v]	Data Threshold Down, decrements the Input Data Threshold by value 'v': 0.05 to 2.50 in 0.05 V steps.
data_thr_dn	Decrement Data Threshold by 0.05 V.
rdata_delay [v]	Sets the Reference Data Delay to the specified delay 'v', in seconds: 0.0 to 3.9 nS in 0.1 or 0.2 nS steps
rdata_delay?	Returns the Reference Data Delay. Response: <NR3 Numeric>
rdata_del_up [v]	Ref Data Delay Up, increments Ref Data Delay by 'v', in seconds: 0.1 to 3.9 in 0.1 nSec steps

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APPENDIX C

gigaBERT-660 REMOTE COMMANDS

C.1 gigaBERT-660 DRx REMOTE COMMANDS

This is the command set for the BERT-660 DRx (Receiver). All remote commands are listed here. A brief description of each command, valid parameters, and response format are included. The parameters shown within brackets '[]' following the command name are required. The commands are separated into eight functional groups, listed in the following order.

	GROUP	FUNCTION
1	Data and Ref Data	Delay, Threshold, and Termination Voltage adjustments for Data, Reference Data, and Clock
2	Data Pattern	Data Pattern Programming
3	Auto/Status	Auto Search / Synchronization Mode and Status Display
4	Test Mode/Status	Test Mode Settings and Test Results
5	Window Mode/Status	Window Mode Settings and Results
6	Error Beeper	Error Beeper Volume and Threshold
7	Miscellaneous	Miscellaneous commands
8	Common Commands	IEEE-488 defined Common Commands

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C.1.2 BERT-660 DRx DATA PATTERN PROGRAMMING COMMANDS

COMMAND	ACTION
prbs_length [v]	Sets the current data pattern to PRBS pattern PN[v], where 'v'; 7,15,17,20,23
prbs_length?	Returns the current PRBS pattern. Response: <NR1 Numeric>
word_bits [l],[b1,b2]	Sets the current data pattern to the 16 bit programmable Data pattern with the data being specified as the data length 'l' and the data as the bytes 'b1' and 'b2', with the following: 'l' : 8 or 16 'b1','b2': #H00 to #HFF, (Hex) or #Q000 to #Q377, (Octal) or #B0 to #B11111111 (Binary) NOTE: 'b2' allowed only with l = 16 Example: To program an 8 bit word of E4H: "word_bits 8 , #HE4"
word_bits?	Returns the programmable WORD pattern. The response will contain the pattern length, and data bytes. Response: <NR1 Numeric> , <Non-decimal Numeric(s)>
word_length [l]	Sets the current pattern to the programmable WORD pattern with a length of 'l': 8 or 16
word_memory [m],[l],[b1,b2]	Sets the programmable WORD Memory at memory location 'm', with WORD length 'l' and data bytes 'b1' and 'b2', with the following: 'm' : 0 to 9 'l' : 8 or 16 'b1','b2': #H00 to #HFF, (Hex) or #Q000 to #Q377, (Octal) or #B0 to #B11111111 (Binary) NOTE: 'b2' allowed only with l = 16 Example: To program memory location 3 with a 16 bit word of C4F0H: "word_memory 3,16,#HC4,#HF0"

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COMMAND	ACTION
rdata_del_up	Increment Ref Data Delay by 0.1 nSec.
rdata_del_dn [v]	Ref Data Delay Down, decrements Ref Data Delay by 'v', in seconds: 0.1 to 3.9 in 0.1 nSec steps
rdata_del_dn	Decrement Ref Data Delay by 0.1 nSec.
rdata_thres [v]	Sets the Reference Data Threshold to the specified voltage 'v': -1.50 to 1.00 in 0.05 V steps
rdata_thres?	Returns the Ref Data Threshold. Response: <NR2 Numeric>
rdata_thr_up [v]	Ref Data Thresh Up, increments Ref Data Threshold by value 'v': 0.05 to 2.50 in 0.05 V steps
rdata_thr_up	Increment Ref Data Thresh by 0.05 V.
rdata_thr_dn [v]	Ref Data Thresh Down, decrements Ref Data Threshold by value 'v': 0.05 to 2.50 in 0.05 V steps
rdata_thr_dn	Decrement Ref Data Thresh by 0.05 V.
diff_term [neg_2v,gnd,ac]	Sets the Input Termination Voltage to 'v': neg_2v - terminates at -2 Volts gnd - terminates at ground ac - terminates at AC
diff_term?	Returns the Input Term Voltage. Response: NEG_2V, GND, or AC

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C.1.2 BERT-660 DRx DATA PATTERN PROGRAMMING COMMANDS (cont)

COMMAND	ACTION
data_invert [on,off]	Sets the Output Data polarity: on - Outputs Inverted Data, off - Outputs True Data.
data_invert?	Returns current status of Output Data Polarity. Response: ON or OFF
word_order [msb,lsb]	Sets the WORD Receive Order to MSB or LSB. The unit will start the receiving with the MSB of the first byte or the LSB of the first byte (MSB/LSB). After the MSB (or LSB), the bits would be continued with the bits of the first byte until the LSB (or MSB) is reached, then proceeding with the next byte in the same order. msb - Receive MSBit first. lsb - Receive LSBit first.
word_order?	Returns WORD Receive Order; Response: MSB or LSB

NOTE: The selected ORDER is effective only on the pattern bytes edited after the setting of the ORDER. If the ORDER is changed in the middle of programming pattern bytes, the bytes programmed before the ORDER change will be reversed.

For example, if the word ORDER is previous LSB at word location 6 and the data pattern is programmed as follows:

```
edit_begin  6
byte_length 4,0
byte_block  0,16,#HAA,#HAA
word_order  MSB
byte_block  2,16,#HAA,#HAA
edit_end    6
```

The pattern at location 6 would be:

```
byte_block  0,32,#H55,#H55,#HAA,HAA
```


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C.1.2 BERT-660 DRx DATA PATTERN PROGRAMMING COMMANDS (cont)

COMMAND	ACTION
word_memory? [m]	Returns the contents of the 16 bit programmable WORD Memory at memory location 'm': 0 to 9 The response will contain the memory location, length, and data bytes. Response: <NR1 Numeric> , <NR1 Numeric> , <Non-decimal Numeric(s)>
word_memory?	Returns the contents of all 10 programmable WORD Memories. The response will be 10 message units separated by semi-colons ';', and will contain the memory location, length, and data bytes of each memory. Response: <NR1 Numeric> , <NR1 Numeric> , <Non-decimal Numeric(s)>
word_mem_len [m],[l]	Sets the pattern length of the programmable WORD Memory at memory location 'm' to length 'l', with the following: 'm' : 0 to 9 'l' : 8 or 16
recall_word [m]	Sets the current data pattern to the pattern stored in the WORD Memory location 'm': 0 to 9
save_word [m]	Stores the current programmable WORD pattern into WORD Memory location 'm': 0 to 9
data_pattern [prbs,word,rdata]	Sets the current pattern, prbs - switches to PRBS mode, word - switches to WORD mode. rdata - switches to REF Data mode.
data_pattern?	Returns the current operating pattern mode; Response: PRBS or WORD

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C.1.3 BERT-660 DRx AUTO MODE / STATUS COMMANDS (cont)

COMMAND	ACTION
histry_stat?	Returns the BERT-660 Receiver Front Panel status, including: - Totalized error rate - Window error rate - Totalized error count - Received clock frequency - Sync Lock status - History status LEDs

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C.1.3 BERT-660 DRx AUTO MODE / STATUS COMMANDS

COMMAND	ACTION
auto_search [off,auto,disab]	Sets the Auto Search/Disable Mode: off - sets auto search/disable off auto - sets auto search on disab - sets synchronization disable
auto_search?	Returns the Auto Search Mode. Response: OFF, AUTO, or DISAB
disp_select [total,window,test]	Sets the Front Panel Error Display Select mode: total - Totalize error rate/total to appear on FP display. window - Window error rate/total to appear on FP display. test - Test error rate/total to appear on FP display.
disp_select?	Returns the FP Error Display Select. Response: TOTAL, WINDOW, or TEST
error_reset	Error reset, resets the Totalize and Window measurements.
clock_freq?	Returns the Received Clock Frequency. Response: <NR3 Numeric>
sync?	Returns the Sync Lock LED status. Response: ON or OFF
histry_sync?	Returns the Sync Loss history LED status. Response: ON or OFF
histry_bits?	Returns the Bit Error history LED. status. Response: ON or OFF
histry_phase?	Returns the Phase Error history LED status. Response: ON or OFF
histry_power?	Returns the Power Loss history LED status. Response: ON or OFF
histry_clear	History LED Clear, resets all the History LEDs; Sync loss, Bit Error, Phase Error, and Power loss.

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C.1.4 BERT-660 DRx TEST MODE / STATUS COMMANDS (cont)

COMMAND	ACTION
test_discard	Discards the Test results of the previously completed Test, making the results unavailable.
test_report [eot,on_error,both,none]	Sets the Test Report Enable Mode: eot - End-Of-Test Report Enabled on_error - On Error Report enabled both - Both, End-Of-Test and On Error Reports enabled none - Neither report enabled
test_report?	Returns the Test Report Mode. Response: EOT, ON_ERROR, BOTH or NONE
test_print	Test summary report will be printed. If a Test is in progress, the report is a summary of the current test. If no Test is in process, the report is an END-of-TEST summary of the previous Test.
test_thres [v]	Sets the Test Error Rate Threshold for 'On Error' reports and Threshold Error Second calculations. The threshold is 1E-'v', where 'v' is: 2 to 16
test_thres?	Returns the Test Error Rate Threshold. Response: <NR1 Numeric>
test_squelch [on,off]	Sets the Test On Error Squelch Enable: on - On Error Reports will be squelched after 10 consecutive seconds of On Error condition, and unsquelched after 5 consecutive seconds below the Test Error Rate Threshold. off - Disables On Error squelching
test_squelch?	Returns the Test On Error Squelch Enable. Response: ON or OFF

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C.1.4 BERT-660 DRx TEST MODE / STATUS COMMANDS

COMMAND	ACTION
test_mode [untimed,timed,repeat]	Sets the Test Mode. The test once started, will stop and start according to the Mode: timed - Test will continue until stopped by TEST LENGTH time-out, front panel key, remote command, or power loss. untimed - Test will continue until stopped by front panel key, remote command, or power loss. repeat - Test will continue until stopped by TEST LENGTH time-out, front panel key, remote command, or power loss. If TEST LENGTH time-out occurs, the test will REPEAT again, continuously.
test_mode?	Returns the Test Mode; Response: UNTIMED, TIMED or REPEAT.
test_length [s]	Sets the Test Length to the time specified in the string 's'. The string will be in 24 Hour format 'HH:MM:SS', enclosed in single or double quotes, and will have a maximum length of '23:59:59', and a minimum length of '00:00:01'.
test_length?	Returns the Test Length; Response: <String Response> in format 'HH:MM:SS'
test_prev [current,previous]	Sets the Test Previous Remote Status to return either status results from the current Test or from the previously completed Test. current - Test status commands will return the results from the current test. previous - Test status commands will return the results from the previous test.
test_prev?	Returns the Test Previous Remote Status. Response: CURRENT or PREVIOUS.

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res_elapsed?

C.1.4 BERT-660 DRx TEST MODE / STATUS COMMANDS (cont)

COMMAND	ACTION
res_cur_rate?	Returns the Current/Previous Current Error Rate for the last second of the Test period. Response: <NR3 Numeric>
res_es?	Returns the Current/Previous Total number of Errored Seconds for the Test period. Response: <NR1 Numeric>
res_es_per?	Returns the Current/Previous Percent of the number of Errored Seconds over the Test period. Response: <NR2 Numeric>
res_efs?	Returns the Current/Previous Total number of Error Free Seconds for the Test period. Response: <NR1 Numeric>
res_efs_per?	Returns the Current/Previous Percent of the number of Error Free Seconds over the Test period. Response: <NR2 Numeric>
res_tes?	Returns the Current/Previous Total number of Threshold Errored Seconds for the Test period. Response: <NR1 Numeric>
res_tes_per?	Returns the Current/Previous Percent of the number of Threshold Errored Seconds over the Test period. Response: <NR2 Numeric>
res_ses?	Returns the Current/Previous Total number of Severely Errored Seconds for the Test period. Response: <NR1 Numeric>
res_ses_per?	Returns the Current/Previous Percent of the number of Severely Errored Seconds over the Test period. Response: <NR2 Numeric>
res_dm?	Returns the Current/Previous Total number of Degraded Minutes for the Test period. Response: <NR1 Numeric>

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COMMAND	ACTION
res_dm_per?	Returns the Current/Previous Percent of the number of Degraded Minutes over the Test period. Response: <NR2 Numeric>
res_us?	Returns the Current/Previous Total number of Unavailable Seconds for the Test period. Response: <NR1 Numeric>
res_us_per?	Returns the Current/Previous Percent of the number of Unavailable Seconds over the Test period. Response: <NR2 Numeric>
res_sync?	Returns the Current/Previous Total number of Synchronization Loss Seconds for the Test period. Response: <NR1 Numeric>
res_los?	Returns the Current/Previous Total number of Signal Loss Seconds for the Test period. Response: <NR1 Numeric>
res_pha_es?	Returns the Current/Previous Total number of Phase Errored Seconds for the Test period. Response: <NR1 Numeric>

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C.1.5 BERT-660 DRx WINDOW MODE / STATUS COMMANDS

COMMAND	ACTION
win_mode [bits,sec]	Sets the BER Window Length Mode. The length of the window will be adjustable in terms of seconds (time length) or bits (pattern length): bits - length in terms of bits sec - length in terms of time
win_mode?	Returns the BER Window Length Mode. Response: BITS or SEC.
win_bit_len [v]	Sets the bit length of the BER Window to a value 1E+'v', where 'v' is: 8 to 16
win_bit_len?	Returns BER Window bit length. Response: <NR1 Numeric>
win_sec_len [s]	Sets the second length of the BER Window to the time specified in the string 's'. The string will be in 24 Hour format 'HH:MM:SS', enclosed in single or double quotes, and will have a maximum length of '23:59:59'.
win_sec_len?	Returns BER Window second length. Response: <String Response> in format 'HH:MM:SS'
win_prev [current,previous]	Sets the Window Previous Remote Status to return either status results from the current BER Window or from the previously completed BER Window. current - window status commands will return the results from the current window. previous - window status commands will return the results from the previous window.
win_prev?	Returns the Window Previous Remote Status. Response: CURRENT or PREVIOUS.
win_report [on,off]	Sets the End of BER Window Report Enable Mode: on - End-Of-Window Report Enabled off - End-Of-Window Report Disabled

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C.1.5 BERT-660 DRx WINDOW MODE / STATUS COMMANDS (cont)

COMMAND	ACTION
win_report?	Returns the End of BER Window Report Mode. Response: ON or OFF
win_bits?	Returns the Current/Previous total number of bits evaluated in the BER Window. Response: <NR1 Numeric>
win_error?	Returns the Current/Previous total number of errors detected in the BER Window. Response: <NR1 Numeric>
win_time?	Returns the Current/Previous total length of time in the BER Window. Response: <String Response> in format 'DDD-HH:MM:SS'
win_rate?	Returns the Current/Previous Error Rate of the BER Window. Response: <NR3 Numeric>
total_bits?	Returns the Total number of bits evaluated for the Totalize BER. The number will reset at power-up and on Error Reset. Response: <NR1 Numeric>
total_error?	Returns the Total number of errors detected for the Totalize BER. The number will reset at power-up and on Error Reset. Response: <NR1 Numeric>
total_time?	Returns the Total length of time for the Totalize BER/Total. The number will reset at power-up and on Error Reset. Response: <String Response> in format 'DDD-HH:MM:SS'
total_rate?	Returns the Totalize Error Rate. The number will reset at power-up and on Error Reset. Response: <NR3 Numeric>

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C.1.6 BERT-660 DRx ERROR BEEPER COMMANDS

COMMAND	ACTION
audio_vol [v]	Sets the Audio Volume of the Audible Error Indicator to value 'v': 0 to 4 , where 0 turns it off
audio_vol?	Returns the current Audio Volume. Response: <NR1 Numeric>
audio_vol_up [v]	Audio Volume Up, increments Audio Volume by 'v': 1 to 4
audio_vol_up	Increment audio volume value by 1.
audio_vol_dn [v]	Audio Volume Down, decrements Audio Volume by 'v': 1 to 4
audio_vol_dn	Decrement audio volume value by 1.
audio_rate [v]	Sets the Audio Error Rate Threshold of the Audible Error Indicator to a value of 1E-'v', where 'v' is: 2 to 16
audio_rate?	Returns the Audio Error Rate Threshold. Response: <NR1 Numeric>
audio_rat_up [v]	Audio Error Rate Threshold Up, increments threshold exponent by 'v': 1 to 14
audio_rat_up	Increments rate threshold by 1.
audio_rat_dn [v]	Audio Error Rate Threshold Down, decrements threshold exponent by 'v': 1 to 14
audio_rat_dn	Decrements rate threshold by 1.

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C.1.7 BERT-660 DRx MISCELLANEOUS COMMANDS

COMMAND	ACTION
date [s]	Sets the Internal Time of Day Clock to the date specified in the string [s], where the date is of the format 'YY[YY]/MM/DD': YY[YY] - year, Ex. 90 or 1990 MM - month, 1 to 12 DD - day, 1 to 31
date?	Returns the Date from the Internal Time of Day Clock. Response: <String response> in format 'YY-MM-DD'
time [s]	Sets the Internal Time of Day Clock to the time specified in the string [s], where the time is of the format 'HH:MM:SS': HH - hours, 0 to 23 MM - minutes, 0 to 59 SS - seconds, 0 to 59
time?	Returns the Time from the Internal Time of Day Clock. Response: <String response> in format 'HH:MM:SS'
gpib_address [v]	Sets the GPIB Address to 'v': 0 to 30 (allowed by RS-232 only)
gpib_address?	Returns the current GPIB Address. (allowed by RS-232 only) Response: <NR1 Numeric>
gpib_bus [talk_listen,off_bus]	Sets the BERT-660 GPIB Bus control. When set OFF-BUS, it will not communicate over the GPIB bus. talk_listen - Communicates over BUS off_bus - No GPIB Communication (allowed by RS-232 only)
gpib_bus?	Returns the GPIB Bus status. (allowed by RS-232 only) Response: TALK_LISTEN or OFF_BUS
rs_prompt [s]	Sets the RS-232 prompt to the string 's'. Maximum length is 8 characters.

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C.1.7 BERT-660 DRx MISCELLANEOUS COMMANDS (cont)

COMMAND	ACTION
rs_xon_xoff [on,off]	Sets the RS-232 XON/XOFF protocol status. on - Enables XON/XOFF protocol. off - Disables XON/XOFF protocol.
rs_xon_xoff?	Returns the RS-232 XON/XOFF protocol status. Response: ON or OFF
rs_echo [on,off]	Sets the RS-232 ECHO mode status. on - Enables ECHO mode. off - Disables ECHO mode.
rs_echo?	Returns the RS-232 ECHO mode. Response: ON or OFF
rs_pmt_lf [on,off]	Sets the RS-232 Prompt Line-Feed (0AH) Control status. on - Line-Feed (0AH) sent after RS-232 prompt. off - Line-Feed (0AH) not sent after RS-232 prompt.
rs_pmt_lf?	Returns the RS-232 Prompt Line-Feed (0AH) Control Status. Response: ON or OFF
print_enable [on,off]	Sets the Master Print Enable. on - Enables any printouts. off - Disables all printouts.
print_enable?	Returns the Master Print Enable status. Response: ON or OFF
print_port [parallel,gpib,serial]	Redirects the Printer port. All printouts will be redirected to this port. parallel - parallel printer port gpib - GPIB (IEEE-488) port serial - Serial (RS-232C) port
print_port?	Returns the Printer port. Response: PARALLEL, GPIB, or SERIAL
print_string [s]	Prints the string [s] out to the redirected print port.

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C.1.7 BERT-660 DRx MISCELLANEOUS COMMANDS (cont)

COMMAND	ACTION
header [on,off]	Sets the remote command response header status. on - Responses include command header (command name). off - Disables header in response.
header?	Returns the remote command response header status. Response: ON or OFF
view_angle [v]	Sets the front panel LCD View Angle to 'v': 0, 1, 2, or 3.
view_angle?	Returns the current LCD view angle. Response: <NR1 Numeric>
all_mem?	Returns all 10 WORD Memory location contents. The response is 10 message units, and are separated by ';'. The responses are specified under the command 'data_memory?'.
options?	Returns the options included with BERT-660: Response: 32K, PROM and/or DIFF, or NONE.
logo?	Returns the BERT-660 Logo. (allowed by RS-232 only)

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C.1.8 BERT-660 DRx IEEE-488 COMMON COMMANDS

COMMAND	ACTION
*cls	Clear Status, clears the Standard Event Status Register.
*ese [v]	Sets the Standard Event Status Enable Register to 'v': 0 to 255
*ese?	Returns the current contents of the Standard Event Status Enable Register. Response: <NR1 Numeric>
*esr?	Returns the current contents of the Standard Event Status Register. Response: <NR1 Numeric>
*idn?	Returns the BERT-660 identification as follows: Response: Manufacturer,Model, 0,Firmware Level
*lrn?	Returns the current device setup, as a series of message units that can be later sent back to the BERT660 to restore the unit to the same setup. Response: sequence of response messages
*opc	Operation Complete Command, sets the operation complete message in the Standard Event Status Register immediately, because all device operations are completed immediately.
*opc?	Returns the value '1' immediately. Response: <NR1 Numeric>
*rst	Performs a device reset, resetting the BERT-660 to the factory supplied setup, see Appendix D.
*sre [v]	Sets the Service Request Enable Register to 'v': 0 to 255
*sre?	Returns the current contents of the Service Request Enable Register, where bit 6 is ignored. Response: <NR1 Numeric>

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C.1.8 BERT-660 DRx IEEE-488 COMMON COMMANDS (cont)

COMMAND	ACTION
*stb?	Returns the current contents of the Status Byte, where bit 6 is the Master Summary Status bit. Response: <NR1 Numeric>
*tst?	Returns the result of the self-test. Successful completion of the test will return a value of '0'. The scope of the test is limited. Response: <NR1 Numeric>
*wai	Wait To Continue, forces the BERT-660 to stop processing remote commands, until all operations are completed, which is immediately.

NOTE: See section B.8, "GPIB Status Reporting", for information concerning the usage of the Standard Event Status Enable Register, the Standard Event Status Register, the Service Request Enable Register, and the Status Byte.

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APPENDIX D

gigaBERT-660 DRx FACTORY DEFAULT SETTINGS

Clock, Data and Ref Data Inputs

Input Data Delay	-	0 pS
Input Data Threshold	-	0.00 V
Reference Data Delay	-	0 pS
Reference Data Threshold	-	-1.50 V
Data Termination	-	GND

Data Pattern

PRBS Pattern	-	PN7
WORD Memory (All 10)	-	AA 55
Programmable Data Pattern	-	AA 55
Current Pattern Setting	-	PRBS
Data Invert	-	OFF
Reference Data Mode	-	OFF
WORD Order	-	LSB

Auto / Status

Auto Search Mode	-	ON
Synchronization Disable	-	OFF
Error Display Select Mode	-	TOT

Error Beeper

Audio Volume	-	0 (OFF)
Audio Error Rate Threshold	-	1E-3

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gigaBERT-660 DRx FACTORY DEFAULT SETTINGS (cont)

Miscellaneous

View Angle	-	0
Panel Lock	-	OFF
Response Header	-	ON

Remote Interfaces

Remote Mode	-	LOCAL
GPIB Address	-	14
GPIB Off Bus Capability	-	OFF
GPIB Terminator	-	EOI/LF
RS-232 Prompt	-	BERT660>
RS-232C Baud Rate	-	9600
RS-232C Parity	-	EVEN
RS-232C Data Size	-	8 bits
RS-232C EOL	-	CR/LF
RS-232C Echo	-	ON
RS-232C Prompt Line-Feed	-	OFF

Time Keeping

Date	-	1-1-1990
Time	-	00:00:00.0

Printer

Port	-	Parallel
Output Enable	-	ON

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gigaBERT-660 DRx FACTORY DEFAULT SETTINGS (cont)

Current BER

Mode	-	SECONDS
BITS	-	1.0E09
SECONDS	-	00:00:01
Previous Remote Status	-	CURRENT
Report Enable	-	OFF

Test Parameters

Test Mode	-	TIMED
Test Length	-	00:00:30
Test Report Enable	-	ON ERROR
Test Error Rate Threshold	-	1.0E-05
Test Squelch	-	OFF
Previous Remote Status	-	PREVIOUS
Test Status Event Enable	-	0

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APPENDIX E

gigaBERT-660 FIGURES

E.1 STATEMENT OF CONFIDENTIALITY

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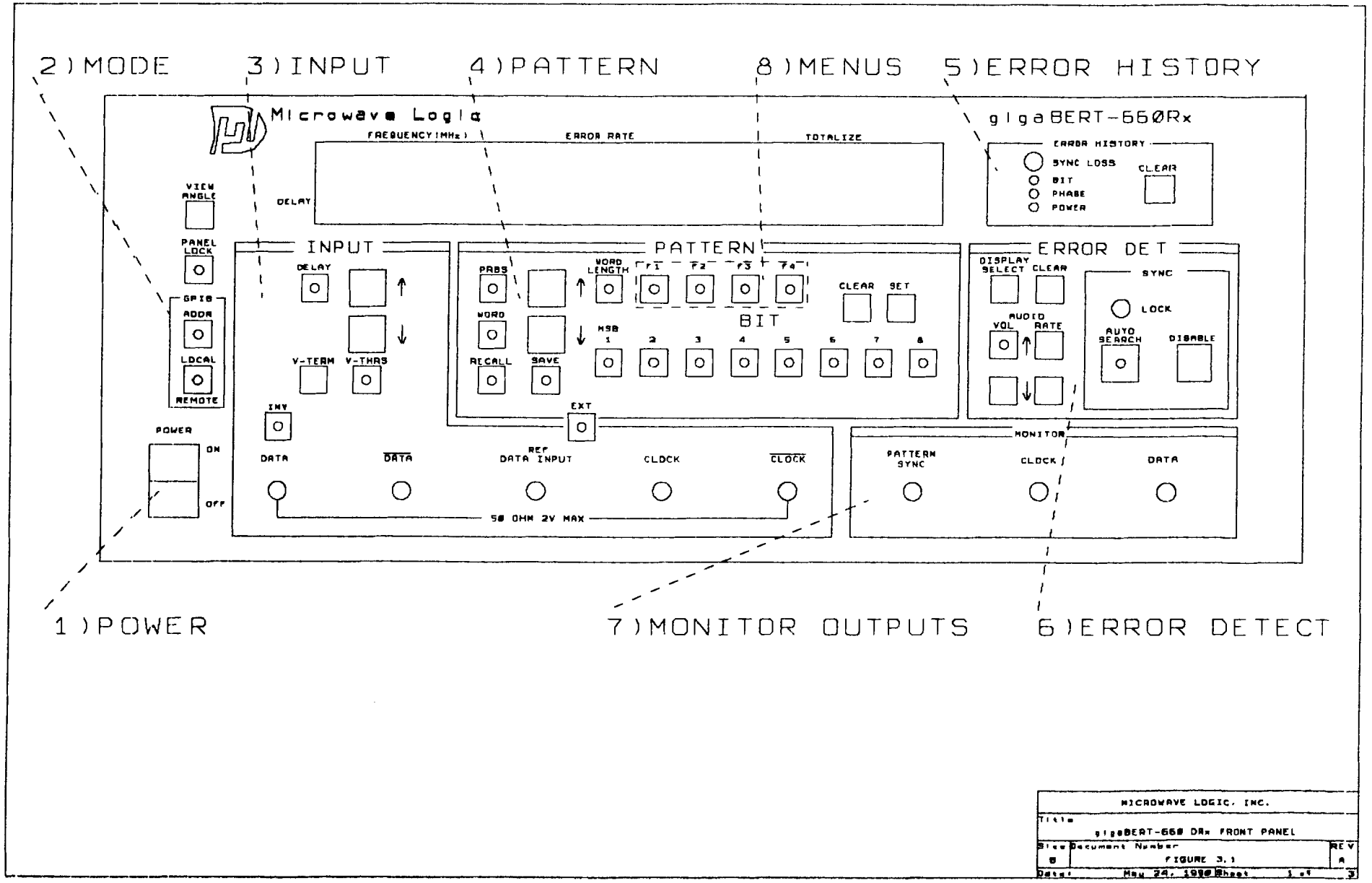
E.2 LIST OF FIGURES

Figure 3.1 gigaBERT-660 DRx Front Panel

Figure 3.2 gigaBERT-660 DRx LCD Display

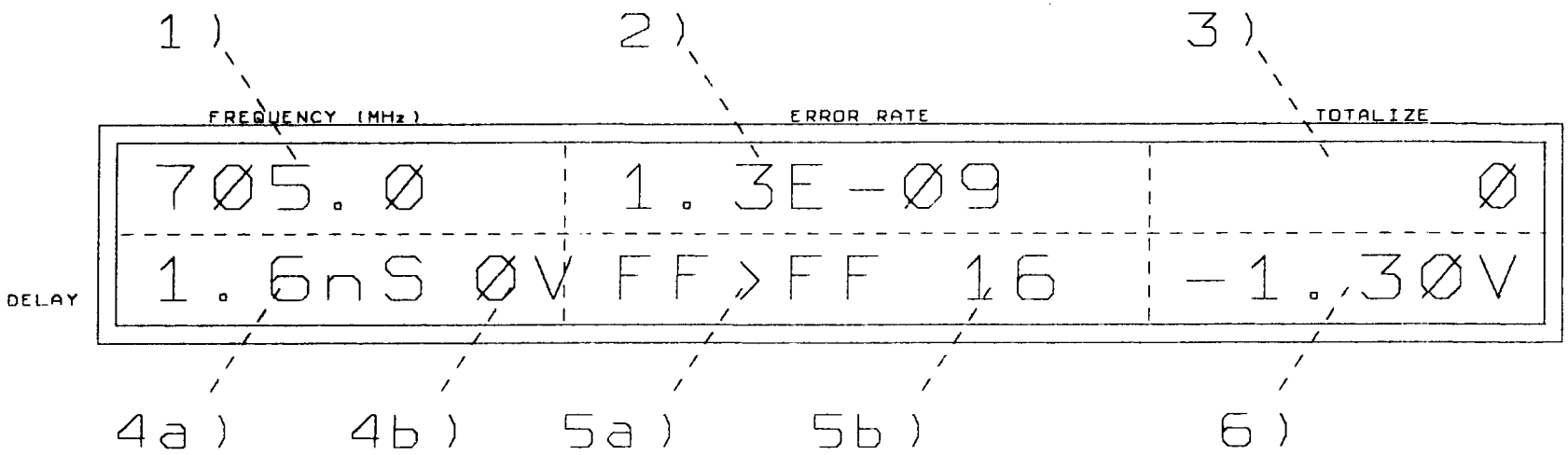
Figure 4.1 gigaBERT-660 DRx Block Diagram

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MICROWAVE LOGIC, INC.		
Title: gigaBERT-660 DRx FRONT PANEL		
Size: B	Document Number: FIGURE 3.1	REV: A
Date: May 29, 1998	Sheet 1 of 1	

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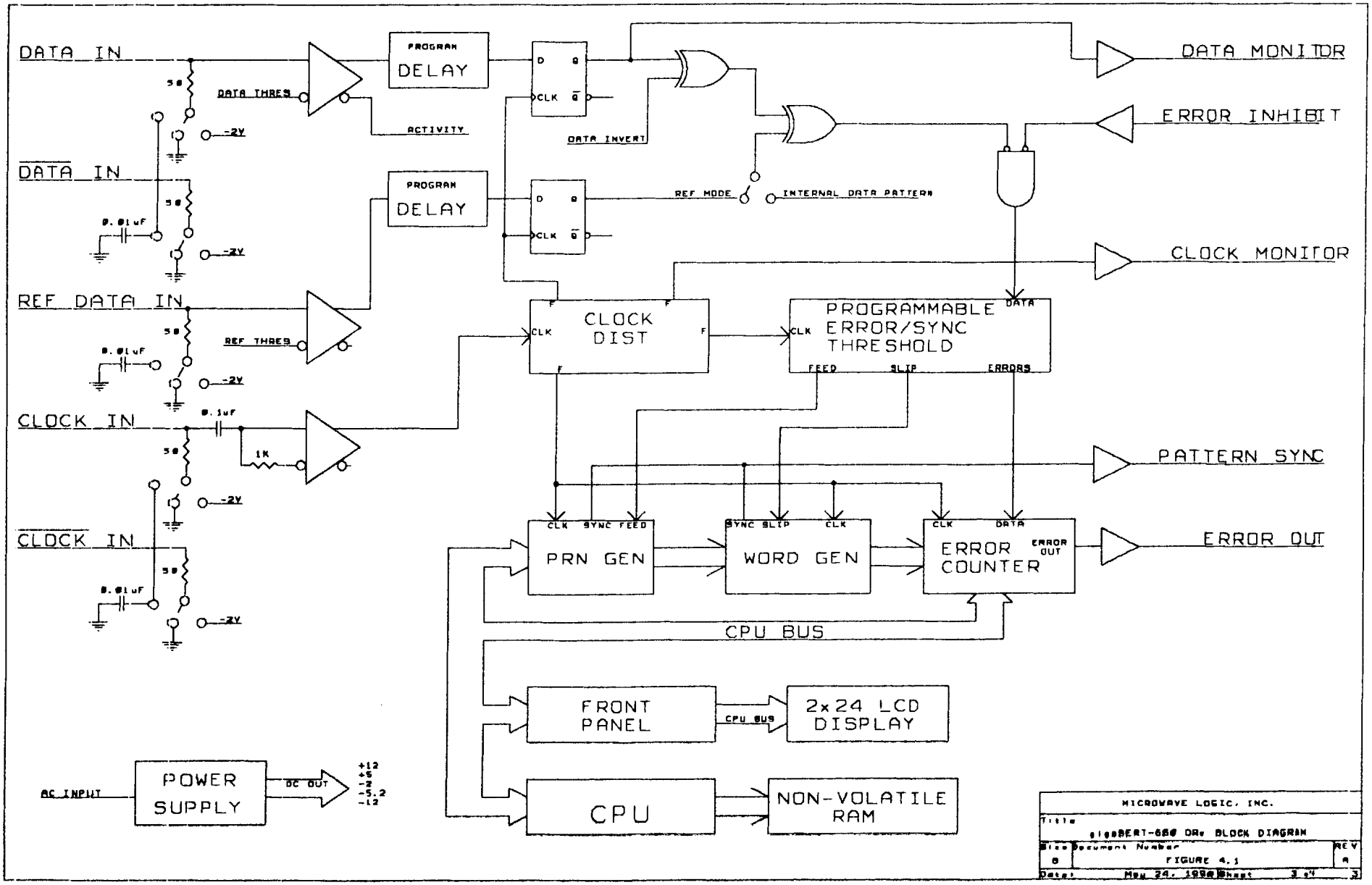


LCD FIELD DISCRIPTION

1) RECEIVED CLOCK FREQUENCY
2) BIT ERROR RATE
3) TOTAL ERRORS
4a) CLOCK-DATA PHASE/GPIB ADDR
4b) INPUT TERMINATION VOLTAGE
5a) WORD BYTE(S)/PRBS PATTERN
5b) WORD LENGTH/INVERT
6) DATA THRESHOLD/BEEPER

MICROWAVE LOGIC, INC.		
Title: gigaBERT-660 DRx LCD DISPLAY FIELDS		
Size: A	Document Number: FIGURE 3.2	REV: F
Date: May 24, 1990	Sheet 2 of 3	

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OPTION OP-MR1

32K PROGRAMMABLE WORD OPTION

OP-MR1.1 INTRODUCTION

This section describes the 32K WORD option, and provides operating information for programming the WORD, both front panel control and RS-232C/GPIB remote control.

The following section replaces the WORD, and WORD LENGTH control information in section 3.4.4 Rx Pattern of this manual, all other Pattern controls function as described in section 3.4.4 remain unchanged.

OP-MR1.2 WORD CONTROL

WORD

Pressing WORD selects programmable WORD mode. The programmable WORD can be modified, recalled, or stored in memory. The programmable pattern's byte address can be selected with the PATTERN up/down keys, and is displayed on the upper row of the LCD;

'AAAA HH'

1) AAAA is the byte address (0 to 4095),
2) HH is the byte HEX value.

An illuminated WORD LED indicates programmable WORD pattern is currently selected.

The programmable WORD is modified through the front panel in 8 bit bytes. The number of available bytes is dependent on WORD length. WORD length is selected with the WORD LENGTH key, and displayed on the LCD.

The desired byte to modify (with the 'bit' keys) is selected with the PATTERN up/down keys, and displayed on the LCD in HEX, while the binary value of the byte is displayed by the row of 8 'BIT' keys. Each bit's value is displayed by the key's LED; an illuminated key signifies a '1', an unlit key a '0'. Pressing the 'BIT' key toggles it's logic value.

For example to modify bit 13;

1) select WORD mode (press WORD key)
2) select WORD address 1 (pattern up/down keys)
3) toggle BIT 5 key (13th bit).

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OP-MR1.3 WORD LENGTH CONTROL

WORD LENGTH This key selects WORD length select mode, and displays the length on the upper row of the LCD. The WORD length increment size varies as;

WORD LENGTH	INCREMENT
1-256 bytes	1 bit
256-4096 bytes	1 byte

The WORD length is changed with the PATTERN up/down keys. The new length WORD pattern is immediately output, starting with byte 0 through the respective highest byte, dependent on WORD length. The original pattern is maintained in RAM, and is recalled (until power down) if the original length is returned.

OP-MR1.4 WORD UTILITY MENU

The WORD utility menu allows programming of WORD length, EDITing of WORD contents, FILLing of WORD contents over a specified range, and programming of WORD sync threshold in the Rx. See section 3.5 for utility menu details.

Function key F4 from the main menu accesses the WORD Utility menu. The WORD sub-menus are structured as follows for the Rx;

F1	F2	F3	F4
MORE	EDIT	LENGTH	FILL

F1	F2	F3
ESC	SYNC	ORDER

The WORD menu provides control of the 32K WORD as follows:

EDIT -- Change the pattern at an address.

LENGTH -- Change the WORD Pattern Length.

FILL -- Fill the WORD with an 8 bit pattern.

SYNC -- Programmable WORD Sync Threshold

ORDER -- Receive LSB/MSB of each byte first

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EDIT allows the editing of the WORD at the address specified using the BIT/CLEAR/SET keys.

LENGTH allows the change of the WORD LENGTH in terms of Bytes and Bits. The WORD length can be set as follows:

```
    0 BYTES + 1 BITS
  512 BYTES + 0 BITS in 1 bit increments

  512 BYTES + 0 BITS
 4096 BYTES + 0 BITS in 1 byte increments
```

FILL allows the entire WORD Pattern to be filled with the specified 8-bit pattern.

SYNC allows control of the WORD Synchronization Threshold Level. The WORD Sync Threshold is a user adjustable threshold used to determine Sync Lock. At a level of 1, the Sync Lock will easier to attain, and harder to lose. At a level of 9, Sync Lock will harder to attain, and easier to lose.

ORDER allows selection between receiving the WORD PATTERN starting with the MSB of the first byte or the LSB of the first byte (MSB/LSB). After the MSB (or LSB), the bits would be received continuing with the bits of the first byte until the LSB (or MSB) is reached, then proceeding with the next byte in the same order.

NOTE: The selected ORDER is effective only on the pattern bytes edited after the setting of the ORDER. If the ORDER is changed in the middle of programming pattern bytes, the bytes programmed before the ORDER change will be reversed.

For example, if the word ORDER is previous LSB at word location 6 and the data pattern is programmed as follows:

```
edit_begin  6
byte_length 4,0
byte_block  0,16,#HAA,#HAA
word_order  MSB
byte_block  2,16,#HAA,#HAA
edit_end    6
```

The pattern at location 6 would be:

```
byte_block  0,32,#H55,#H55,#HAA,HAA
```


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OP-MR1.5 BERT-660 32K PROGRAMMABLE WORD REMOTE COMMANDS

These are the additions to the command set of the BERT-660 for the 32K Programmable Word option. All of the remote commands used in controlling the BERT-660 Rx are listed here.

The following commands replace the standard BERT-660 remote commands found in APPENDIX C of this manual. The commands which are replaced or modified are:

MODIFIED:

all_mem? - will not return Data Memories

REPLACED:

word_bits [l],[b1,b2]
word_bits?
word_memory [m],[l],[b1,b2]
word_memory?
word_length [l]
word_mem_len [m],[l]

COMMAND	ACTION
edit_begin [n]	Starts the remote edit process of the 32K Programmable Word. The 32K word pattern to edit/download/upload is copied to a scratch pad location. The pattern location is specified by 'n'. 'n' : -1 to 9 (-1, current pattern) (0 to 9, memory locations) NOTE: This command MUST be done prior to changing any 32K pattern data.
edit_end [n]	Ends the remote edit process of the 32K Programmable Word. The 32K word pattern which has been edited/downloaded can be copied to memory or to the current pattern, or can be discarded. The pattern is specified by 'n', as follows: 'n' : -2 to 9 (-2, discards pattern) (-1, copies to current pattern) (0 to 9, copies to memory 'n') NOTE: This command MUST be done after edit session completed.

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COMMAND	ACTION
edit_cntrl?	Returns which interface is currently editing any 32K word pattern, if any. If the front panel Menu is in a 32K edit screen, it will return LOCAL. If a remote interface is in the process of editing a 32K word pattern, it will return REMOTE. Otherwise, it will return NONE. Response: LOCAL, REMOTE, or NONE
byte_length [by],[bi]	Sets the current 32K Programmable Word to the length 'by' bytes plus 'bi' bits, with the following: 'by' : 0 to 4096 'bi' : 0 to 7 NOTE: If 'by' is greater than 255, 'bi' must be set to 0. Example: To set the 32K length to 19 bytes + 6 bits (158 bits): "byte_length 19 , 6 "
byte_length?	Returns the current 32K Programmable Word length. The response will contain the number of bytes and the number of bits, as follows: Response: <NR1 Numeric> , <NR1 Numeric>
byte_fill [l],[b1,...,bn]	Fills the entire 32K Programmable Word buffer with the pattern 'b1',...'bn', which is of length 'l' bits, as follows: 'l' : 8 to 80, in 8 bit increments 'b1'...'bn': #H00 to #HFF, (Hex) or #Q000 to #Q377, (Octal) or #B0 to #B11111111 (Binary) NOTE: 'bn' only with l > 8 * (n-1) Example: To fill the 32K Word with a repeating 'A4C2F0' pattern: "byte_fill 24, #HA4,#HC2,#HF0"

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COMMAND	ACTION
byte_block [a],[l],[b1,b2,...,bn]	In terms of blocks, edits the up to 10 bytes of the 32K Programmable Word at the address 'a', for a length 'l', replacing what is currently there with the pattern 'b1','b2',..., as follows: 'a' : 0 to 4095 'l' : 1 to 80 (10 bytes Maximum) 'b1'...'bn': #H00 to #HFF, (Hex) or #Q000 to #Q377, (Octal) or #B0 to #B11111111 (Binary) NOTE: 'bn' only with l > 8 * (n-1) Example: To edit addresses 340, 341 and 342 of the 32K Word and replace with the pattern 'C4FD56': "byte_block 340 , 24 ,#HC4,#HFD,#H56"
byte_block? [a]	Returns the contents of 32K Word for a length of 10 bytes starting at addr 'a': 'a' : 0 to 4095 The response will contain the address, the length, and the 10 byte pattern, as follows: Response: <NR1 Numeric> , <NR1 Numeric> , <Non-decimal Numeric(s)> NOTE: If 'a' is within 10 bytes of the end of the pattern, the number of bytes will be less than 10. Also, if the last byte of the pattern is included and it is not 8 bits in length, the unused bits will be '0'.
byte_edit [a],[b1]	Edits the 32K Programmable Word at the address 'a', replacing what is currently there with the pattern 'b1', as follows: 'a' : 0 to 4095 'b1' : #H00 to #HFF, (Hex) or #Q000 to #Q377, (Octal) or #B0 to #B11111111 (Binary) Example: To edit addresses 340 of the 32K Word and replace with 'C4': "byte_edit 340 , #HC4"

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COMMAND	ACTION
byte_edit? [a]	Returns the contents of 32K Word at addr 'a': 'a' : 0 to 4095 The response will contain the address and the byte, as follows: Response: <NR1 Numeric> , <Hexadecimal Numeric(s)> NOTE: If the returned byte is the last byte of the pattern and it is not 8 bits in length, the unused bits will be '0'.
byte_insert [a],[l],[b1,b2,...]	Inserts into the 32K Programmable Word at the address 'a', for a length 'l', with the pattern 'b1','b2',..., where the address must be less than the word length, as follows: 'a' : 0 to 4095 'l' : 8 to 80, in 8 bit increments 'b1'...'bn': #H00 to #HFF, (Hex) or #Q000 to #Q377, (Octal) or #B0 to #B11111111 (Binary) NOTE: 'bn' only with l > 8 * (n-1) Example: To insert the pattern 'B44B' into the 32K Word at address 400: "byte_insert 400 , 16 ,#HB4,#H4B"
byte_delete [a],[l]	Deletes 'l' bits from the 32K Programmable Word starting at the address 'a', where the address must be less than the word length, as follows: 'a' : 0 to 4095 'l' : 8 to 80, in 8 bit increments Example: To delete 24 bits from the 32K Word starting at address 400: "byte_delete 400 , 24 "
byte_sync [t]	Sets the current 32K Programmable Word Synchronization threshold level, as follows: 't' : 1 to 9
byte_sync?	Returns the current 32K Programmable Word Synchronization threshold level. Response: <NR1 Numeric>

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COMMAND	ACTION
word_order [msb,lsb]	Sets the WORD Receive Order to MSB or LSB. The unit will start looking for the MSB of the first byte or the LSB of the first byte (MSB/LSB). After the MSB (or LSB), the bits will be examined continuing with the bits of the first byte until the LSB (or MSB) is reached, then proceeding with the next byte in the same order. msb - Receive MSBit first. lsb - Receive LSBit first.
word_order?	Returns WORD Receive order; Response: MSB or LSB

NOTE: The selected ORDER is effective only on the pattern bytes edited after the setting of the ORDER. If the ORDER is changed in the middle of programming pattern bytes, the bytes programmed before the ORDER change will be reversed.

For example, if the word ORDER is previous LSB at word location 6 and the data pattern is programmed as follows:

```
edit_begin  6
byte_length 4,0
byte_block  0,16,#HAA,#HAA
word_order  MSB
byte_block  2,16,#HAA,#HAA
edit_end    6
```

The pattern at location 6 would be:

```
byte_block  0,32,#H55,#H55,#HAA,HAA
```


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Example #1: To download a 4096 byte pattern to memory location 6 without affecting the current 32K pattern.

```
edit_begin    6
word_order    msb
byte_length   4096,0
byte_block    0,80,#H00,#H01,#H02,#H03,#H04,#H05,#H06,
                                              #H07,#H08,#H09
byte_block   10,80,#H00,#H01,#H02,#H03,#H04,#H05,#H06,
                                              #H07,#H08,#H09
  .
  .
  .
byte_block 4080,80,#H00,#H01,#H02,#H03,#H04,#H05,#H06,
                                              #H07,#H08,#H09
byte_block 4090,48,#H00,#H01,#H02,#H03,#H04,#H05
edit_end      6
```

Example #2: To edit memory location 6 and save into memory location 8 without affecting the current 32K pattern.

```
edit_begin    6
word_order    msb
byte_block    12,16,#H24,#H23
edit_end      8
```

NOTE: If the data pattern being programmed is not of the same WORD ORDER as the WORD ORDER associated with the pattern location, the word order must be specified prior to editing (downloading) any data.

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OPTION OP-MR2

32K WORD PROM OPTION

OP-MR2.1 INTRODUCTION

This section describes the 32K WORD PROM option, and provides operating information for controlling the 32K PROM, with both front panel control and remote control.

The following section replaces the PATTERN RECALL control information in sections 3.4.4 DRx Pattern of this manual, all other Pattern controls function as described in section 3.4.4 remain unchanged.

OP-MR2.2 PATTERN RECALL CONTROL

RECALL — Pressing RECALL selects WORD memory mode. 10 programmed WORDs can be stored and recalled. There are also 10 programmed WORDs permanently stored on PROM. The selected WORD memory location is displayed on the lower left side of the LCD display. The memory location (0 to 9, or PROM WORDs P0 to P9) is selected with the PATTERN up/down keys. The data pattern stored in memory is output immediately upon selection.

An illuminated RECALL LED indicates the WORD memory location can be selected by the PATTERN up/down keys.

OP-MR2.3 BERT-660 32K WORD PROM REMOTE COMMANDS

These is one addition to the command set of the BERT-660 for the 32K WORD PROM option. There are no modifications. The addition is to allow the Recall of the PROM WORD pattern.

COMMAND	ACTION
recall_prom [m]	Sets the current data pattern to the pattern stored in the 32K WORD PROM Memory location 'm': 0 to 9

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OPTION OP-DRx1

TRUE DIFFERENTIAL WITHOUT THRESHOLD

OP-DRx1.1 INTRODUCTION

This section describes the TRUE DIFFERENTIAL option, and provides operating information for both front panel control and remote control.

OP-DRx1.2 GENERAL DESCRITPTION -- gigaBERT-660 DRx INPUT STRUCTURE

The following section replaces the gigaBERT-660 DRx INPUT STRUCTURE section in section 1.2 of this manual, the remainder of the description is as described in section 1.2.

DIFFERENTIAL INPUT

Connect system Data to the DRx's DATA and system DATA INVERT to the DRx's DATA Invert input. Connect system CLOCK to the DRx's CLOCK and system CLOCK INVERT to the DRx's CLOCK Invert input.

The DRx uses the DATA/DATA Invert and CLOCK/CLOCK Invert with a differential amplifier to receive the signals, and perform BER analysis upon it.

Use V-TERM key to select between the three termination voltages, -2V, GND, AC (50 ohms AC coupled to GND).

SINGLE ENDED INPUT

To use in a single ended mode, the user must provide an external slicing threshold into the invert input (DATA Invert, CLOCK Invert).

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OP-DRx1.3 FRONT PANEL -- INPUT CONTROL

The following section replaces the gigaBERT-660 DRx Front Panel INPUT Control V-THRESHOLD, DATA INPUTS, and CLOCK INPUTS sections in section 3.4.3 of this manual, the remainder of the description is as described in section 3.4.3.

V-THRS

Pressing V-THRS selects V-Threshold mode. The Ref Data (with F3 Key) threshold is variable over the range of -1.5V to +1V in 50mV steps. The currently selected threshold voltage is displayed in the lower right side of the LCD display. When Data Input is being controlled and V-THRS is pressed, a message will be displayed in place of the Data Threshold ("TDIFF") to notify the user that the Data Threshold is not adjustable.

DATA INPUTS

The DATA and $\overline{\text{DATA}}$ SMA connectors provide differential or single ended inputs for Data to the DRx for bit error analysis. Refer to section 2, Specifications, for signal level. In AUTO SEARCH mode when no input data signal is detected by the DRx, the message 'NO DATA' will be displayed on the LCD.

CLOCK INPUTS

The CLOCK and $\overline{\text{CLOCK}}$ SMA connectors provide differential or single ended inputs for system CLOCK. Refer to section 2, Specifications, for signal level. The clock frequency is displayed on the upper left row of the LCD, when no input clock signal is detected by the DRx, the message 'NO CLK' will be displayed on the LCD.

OP-DRx1.4 BERT-660 REMOTE COMMAND CHANGES

These are three changes to the command set of the BERT-660 for the TRUE DIFFERENTIAL option. The three remote commands, which controlled the Data Threshold, no longer have any function and will generate a Command Error when executed.

DATA_THRES
DATA_THR_DN
DATA_THR_UP

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MANUAL ADDENDUM

gigaBERT-660 Receiver

Op-RB1 - Burst Mode

1.0 ABSTRACT

This addendum note defines the gigaBERT-660 option Op-RB1, "Burst Mode" operation and its applications related to Bit Error Rate Test Sets. It also defines the differences in operation from the standard gigaBERT-660 Bit Error Rate Test set.

2.0 INTRODUCTION

2.1 Bit Error Rate Test set definition

A Bit Error Rate Test Set is commonly used to determine the ability of a transmission system to carry information accurately from one place to another. The transmitter portion of the test set provides both a clock signal source and a data signal source (FIG. 1). These clock and data signals then become the input to the system under test.

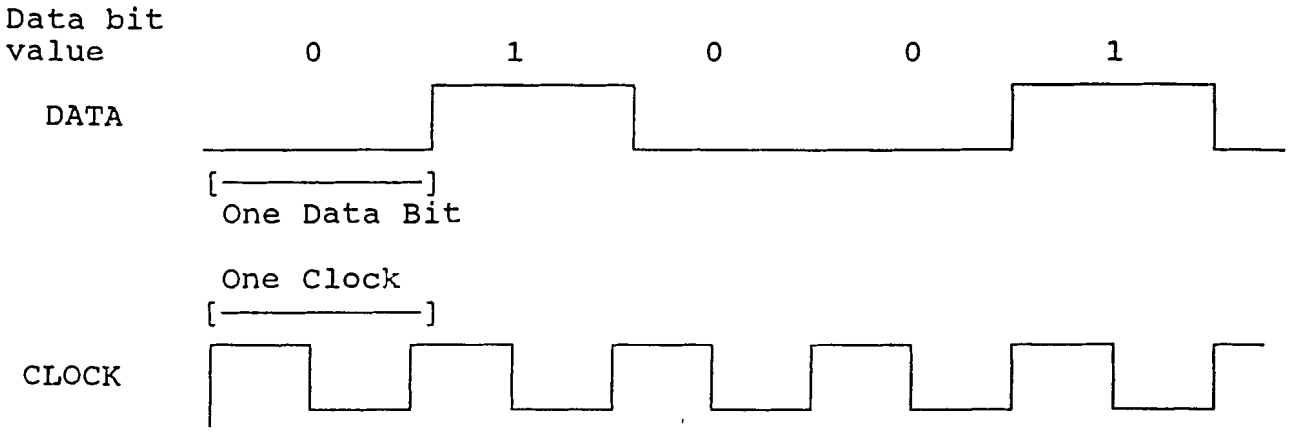


FIG. 1

The receiver portion of the test set is connected to the clock and data outputs of the system under test. The clock signal is used to indicate to the receiver exactly when there is valid data available at the receiver data input (FIG. 2).

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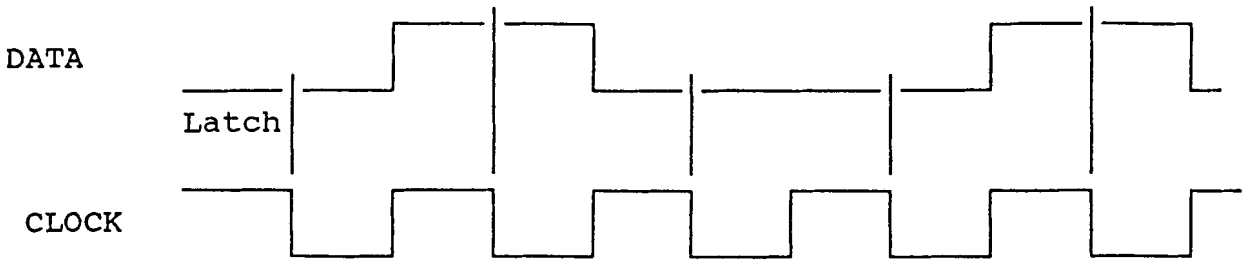


FIG. 2

2.2 Standard gigaBERT-660 operation

The standard gigaBERT-660 operates over a clock frequency range of 1Mb/s to 700Mb/s.

The gigaBERT-660 Transmitter has an internal clock source that has a range of 1Mhz to 700 Mhz. It also has provision for using an external clock source of the same frequency range. When using the external clock source, it must be applied continuously without interruption. Should it become interrupted, the pattern generated at the time of interruption may not be contiguous with the pattern being generated upon reapplication of the clock.

The gigaBERT-660 receiver also requires that at all times during the test a clock signal within the 1 to 700Mb/s frequency range be continuously applied. If the clock signal should be removed, or go below 1 Mhz for any reason during a test, the receiver will probably become out of sync as soon as the clock signal is reapplied. This will initiate a resynchronization of the receiver and restart any tests.

3.0 gigaBERT-660 RECEIVER MODIFICATIONS

The receiver has been modified to work normally or in Burst Mode from 150 Khz to the normal 700Mhz upper limit. Here the clock input internal capacitive coupling has been removed. The clock input must be configured as true differential, used with a true differential input or single ended and provided with an externally supplied threshold voltage for the clock bar input. The three standard clock input termination selections of GND, AC, and -2V are still present.

These and other changes will now allow the receiver to maintain synchronization whenever clock and data are removed and reapplied providing there has not been a bit slip between the clock and data.

Like the transmitter, there can be any length of time that both clock and data can be missing and the minimum clock/data step can be as low as a single cycle, providing the same restrictions are observed for minimum and maximum clock cycle period.

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Similar transmitter changes allow transmitter data and clock outputs to follow, cycle by cycle, the input from the External Clock Input. This means that the transmitter can be used in a start-stop, or "Burst Mode". For every clock cycle in to the External Clock Input there will be the same number of clock cycles and data bits output through the clock and data outputs (FIG. 3). The time between clock cycle inputs is unrestricted and can be any length of time. The number of clock cycles can be any number from continuous to a single cycle. During the time there is no clock input to the External Clock Input, the internal code generator is idle (not running). Each clock cycle steps the code generator by one bit. Clock cycle period must not be more than 6.67 microseconds (150KHz) nor less than 1.428 nanoseconds (700MHz).

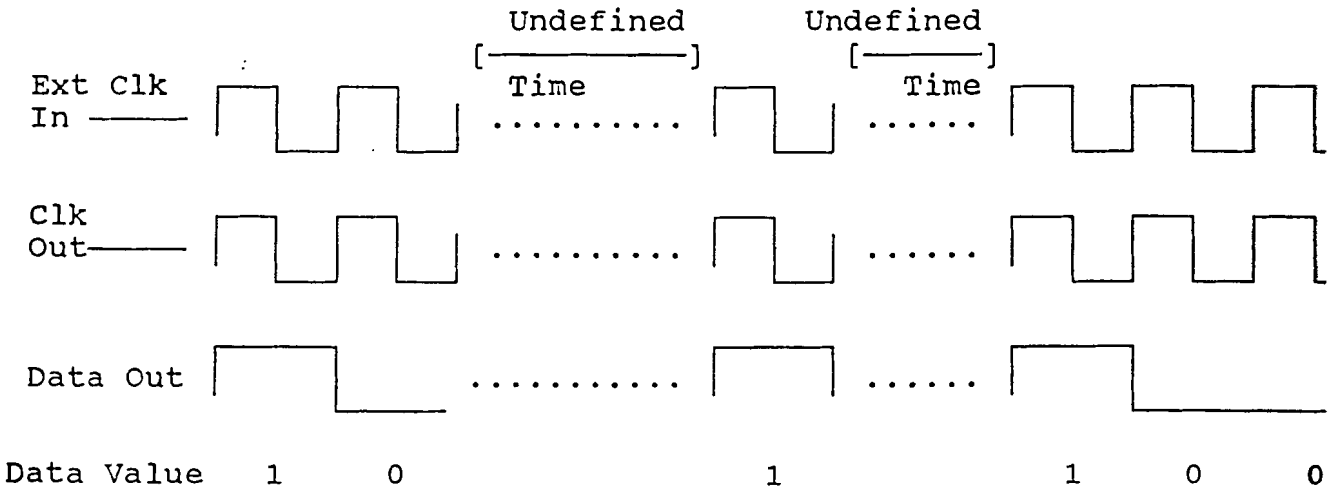


FIG.3

5.0 Auto Search

The Auto Search function of the receiver will work normally at clock frequencies of 500KHz or greater. Below 500Khz the user must manually turn off the Auto Search feature. This is required because Auto Search would take much too long to do its code searching and is not reliable due to internal timing constraints. Below 500Khz Auto Search may be activated for a short time to allow automatic threshold and delay setting. After threshold and delay are determined, the Auto Search should be turned off and the code and polarity set manually. Above 500Khz but below 1Mhz Auto Search functions normally but may be slow in performing its tasks.

4.0 Burst Mode Usage

The Burst Mode option of the gigaBERT-660 will find usage in applications where traditional BERTS cannot operate. As indicated earlier, traditional BERTS require a continuous clock and data signal with no interruption (FIG. 4A). Should interruptions occur, the receiver will resynchronize or indicate errors that actually did not occur (FIG. 4B).

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There are communications and telemetry systems that do not necessarily send data continuously. These systems send data in "bursts" with variable times of inactivity between bursts. Traditional BERTS cannot accurately check these systems, especially if the bursts are of short duration. This is because a traditional BERTS may require more bits than are available in the burst to (re)synchronize. Even if the bursts were large, many bits in the burst would not be checked during the (re)synchronization procedure.

In Burst Mode, the receiver will follow the input clock and data without regard for inactive time between bursts (FIG. 4C). The only requirement is that there be no bit slips between the clock and data and that there be a clock cycle for every data bit received.

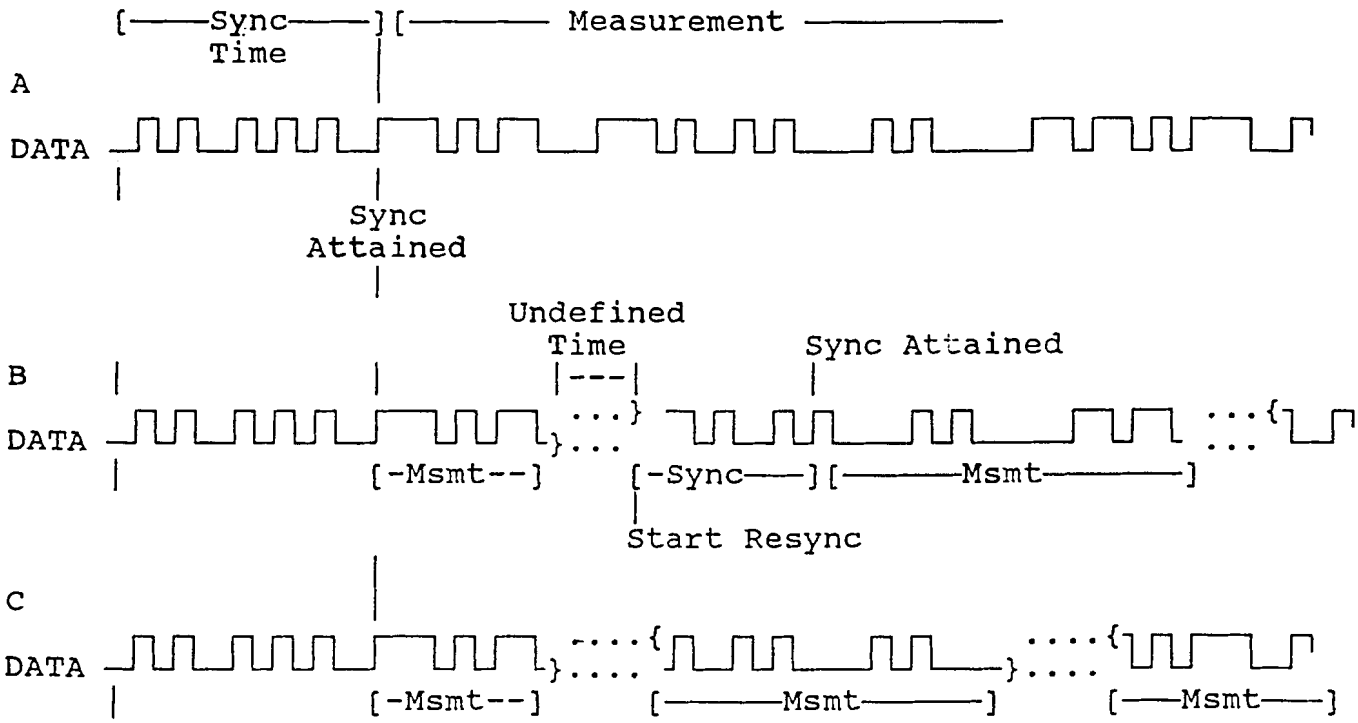


FIG. 4

5.0 SPECIFICATIONS

a) Maximum time between Bursts - no restriction.
b) Minimum time between Bursts - one clock pulse.
c) External Receiver Clock -
   Input Option - Must be True Differential, both Clocks are required
   Level - ECL
   Termination - 50 ohms to -2V
   Minimum rate during Burst - 150kb/s
   Maximum rate during Burst - 700Mb/s

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d) Receiver AutoSearch restriction - Below 500kb/s the AutoSearch can take a very long time due to code word search. Finding both Threshold and Delay is rapid but Data Pattern search is lengthy. As a result, the user will want to use Manual Search Mode to keep Synchronization time as low as possible.
e) Restriction on other options - none.

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