Operations Manual

PRECISION C/N GENERATOR
UFX-BER

Telecom Analysis Systems, Inc.

Safety Summary

If the equipment is used in a manner not specified by the manufacturer the protection provided by the equipment may be impaired.

Safety Symbols

The following safety symbols are used throughout this manual and may be found on the instrument. Familiarize yourself with each symbol and its meaning before operating this instrument.

Instruction manual symbol. The product is marked with this symbol when it is necessary for the user to refer to the instruction manual to protect against damage to the instrument.

Frame terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Protective ground (earth) terminal. Used to identify any terminal which is intended for connection to an external protective conductor for protection against electrical shock in case of a fault, or to the terminal of a protective ground (earth) electrode.

Caution

The caution sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product or the user's data.

Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).

Alternating current (power line).

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Contents

The UFX-BER is designed for system and telecommunications engineers to conduct bit error rate (BER) testing of transmission systems, whether cellular, digital, or satellite. The UFX-BER combines a user-supplied carrier signal with internally generated AWGN to produce an output signal calibrated to a specific signal to noise ratio.

The UFX-BER also functions as an AWGN generator or RMS power meter.

This manual shows how to use the UFX-BER features and functions, and serves as a reference for standard operations.

The UFX-BER manual is divided into the following sections:

- **Section 1: Introduction** displays the UFX-BER and describes the unit's function and commands.
- **Section 2: Operation** describes UFX-BER operating procedures.
- **Appendix A: Installation and Troubleshooting** gives UFX-BER installation instructions, error messages, verification tests, and other troubleshooting information.
- **Appendix B: Description and Specifications** provides technical details regarding UFX-BER operation and lists available models and options.
- **Appendix C: Remote Operation** shows remote operation commands through the GPIB interface or optional RS-232 port.
- **Appendix D: Maintenance and Warranty** provides TAS warranty information, a recommended maintenance schedule, and procedures for returning the UFX-BER unit for maintenance or repair.

Conventions Used in this Manual

Text Conventions

This manual uses the following text conventions:

- *Italic text* Italic text indicates definitions or new terms.
- **Bold text** Indicates UFX-BER switches or keys, or messages from the UFX-BER screen.
- `Monospaced text` Indicates UFX-BER commands entered through remote mode.
- **`Bold monospaced text`** Indicates UFX-BER responses through remote mode.

Symbols

In addition to the safety summary and symbols described on the inside front cover of the manual, the following symbols also appear in the manual.

*This icon indicates a **tip**. This may be an optional procedure for accomplishing a task, or a time-saving procedure for advanced or familiar users.*

WARNING

This icon indicates a warning. Failure to follow the instructions shown here may result in personal injury or damage to the UFX-BER.

See also 

Text marked with this symbol indicates where to look for more information.

Contacting TAS

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Email -- Technical Support	*support@taskit.com*
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Section 1

Contents

1

Introduction

The UFX-BER series of instruments generate AWGN according to a user-specified carrier-to-noise ratio. Values can be set to four ratio types (carrier-to-noise, carrier-to-noise density, bit density-to-noise, and carrier-to-interferer). The UFX-BER includes built-in features such as a true RMS power meter, variable output power control, and signal path with linear phase and amplitude.

This section describes the UFX-BER unit. Topics include:

- Product description
- Front and rear views
- Controls and functions

Introduction

The UFX-BER series of precision C/N generators can provide a signal injected with internally generated additive white Gaussian noise, given the input signal and a signal-to-noise ratio. The instrument can calculate the amount of noise in terms of the bit energy-to-noise density (E_b/N_o), the carrier-to-noise (C/N), or carrier-to-noise density (C/N_o) ratio. The UFX-BER will also accept an interferer input and carrier-to-interferer (C/I) ratio for testing. The UFX-BER also serves as an AWGN noise generator and an RMS power meter accurate to ±0.5 dBm.

The tracking option (if installed) maintains a constant output carrier power given a varying input signal.

The UFX-BER series can be controlled through a 16-key keypad on the instrument, or remotely through an IEEE-488.2 interface or optional RS-232, RS-422, or RS-423 interface.

For installation instructions, see Installation on page 24.

If your UFX-BER included custom options or specifications, please read the data sheet included with the shipment.

UFX-BER Front and Rear Views

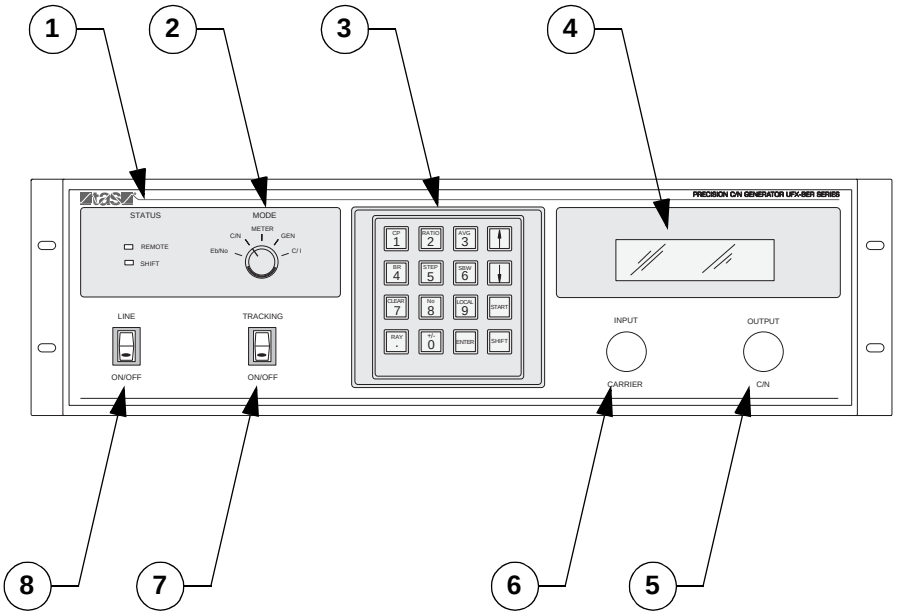


Figure 1-1. UFX-BER Front View

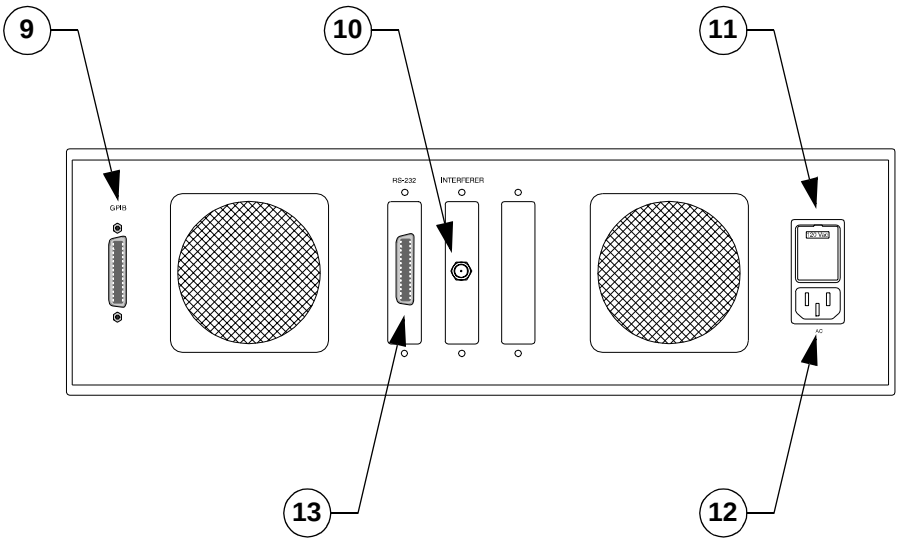


Figure 1-2. UFX-BER Rear View

UFX-BER Controls

Table 1-1. UFX-BER Controls

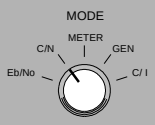
Callout	Control	Function
1	**Status Indicators**	Show remote and shift key status.
2	**Mode Dial** 	Selects a UFX-BER function. The **Eb/No**, **C/N**, and **C/I** selections have the UFX-BER output a signal calibrated to the corresponding ratio value; these are referred to as *ratio modes*. The **C/I** setting requires a carrier and interferer input. **METER** starts the RMS power meter. **GEN** starts the AWGN generator.
3	**Keypad**	Selects and modifies UFX-BER parameters. Press **SHIFT** before a numeric key to enable the function on top of the key. Unless specified, all references to functions in this manual require pressing **SHIFT** before the appropriate key.
	CP 1	Sets the output carrier power. Ranges from -55 dBm to +5 dBm or input carrier power, whichever is lower.
	RATIO 2	Sets the ratio value, in dB, for the appropriate mode (**Eb/No**, **C/N**, **C/I**, or **C/No**).
	AVG 3	Sets the number of samples for power averaging, from 10 to 65,535 samples (each 2.3 ms).
	BR 4	In any ratio mode, sets the bit rate of the input signal, in MBS. While in **METER** mode, prompts for a power meter offset value in dB.
	STEP 5	Changes the step value for the arrow keys, in multiples of the lowest step increment (see Options on page 39).

Table 1-1. UFX-BER Controls

Callout	Control	Function
	SBW 6	In ratio modes, sets the system bandwidth in MHz. In **METER** mode, reinitializes the UFX-BER.
	CLEAR 7	If pressed while entering a new parameter, erases the value entered. If pressed while the UFX-BER is in the **OPERATE** state, places the UFX-BER into the **READY** state.
	No 8	In ratio modes, toggles the noise signal. In **GEN** mode, sets the noise density
	LOCAL 9	If the **REMOTE** indicator is on, returns the UFX-BER to local operation. If the **REMOTE** indicator is off, sets the GPIB address and/or data rate (if a serial port is installed).
	RAY .	Toggles Rayleigh averaging on and off while in **METER** mode. Rayleigh averaging results in more accurate power measurements if the carrier signal has been affected by multipath fading. This function is only included if the Rayleigh option is installed on the UFX-BER.
	+/- 0	Inserts a minus sign when entering a new parameter (must be before any values).
	↑ and ↓	In the **OPERATE** state, the arrow keys step up or step down ratio values (in ratio modes) or the noise level (in **GEN** mode). Pressing **SHIFT** before the arrow keys step up or step down values by the user-entered step size. In **READY** state, the arrow keys toggle the **CF** and **Nbw** values, if the UFX-BER is capable of selecting from multiple bands.

Table 1-1. UFX-BER Controls

Callout	Control	Function
	START	Activates the secondary function on a UFX-BER key.
	ENTER	Saves parameter values and returns to the main screen.
	START	Starts UFX-BER operation.
4	**4x20 VFD Screen**	Displays the current settings and UFX-BER operation states: **CALIBRATE** The generator is performing self-calibration; occurs upon startup and prior to operation. **READY** The generator accepts parameter changes through the keyboard, but there is **no** signal output. **OPERATE** The signal output is active.
5	**Output Connector**	Output to next instrument in signal path.
6	**Input Connector**	Input from signal generator or previous instrument output.
7	**Tracking**	(*Optional)* If the tracking option is enabled, the UFX-BER screen displays **TRK ON** and the output power is held constant over variations from -4 to +4 dB (typical). If the input variation exceeds this range, the UFX-BER displays **TRK LOST**. If the tracking option is disabled, the UFX-BER displays **TRK OFF**. If the tracking option is not installed, the UFX-BER displays variations in the input signal since the last variation through the **ΔC** variable.
8	**Line On/Off**	Powers the UFX-BER on/off.
9	**GPIB Remote Port**	Remote operation input for IEEE-488.2 compatible cable. The default UFX-BER GPIB port is 5.

Table 1-1. UFX-BER Controls

Callout	Control	Function
10	**Interferer Input**	SMA connector for an interferer signal; used only when in C/I mode. Interferer power must be -4 ± 2 dBm and the frequency must not be outside UFX-BER ranges.
11	**Fuse/Voltage Selector Housing**	Holds the fuse and voltage selector wheel.
12	**AC Input**	AC input port. The input cable must be NEMA and “CE” marked.
13	**RS-232 Port**	Optional RS-232 port for remote operation at speeds up to 9600 baud.

Section 2

Contents

2

Operation

UFX-BER functions and settings are accessed quickly and easily through the included keypad; the LCD screen provides detailed settings and operating messages.

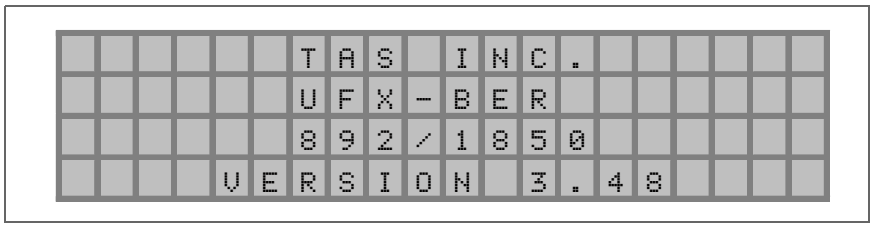
This section describes UFX-BER operating procedures. Topics include:

- Startup procedures
- The UFX-BER screen in different operating and ratio modes
- Operation mode parameter settings

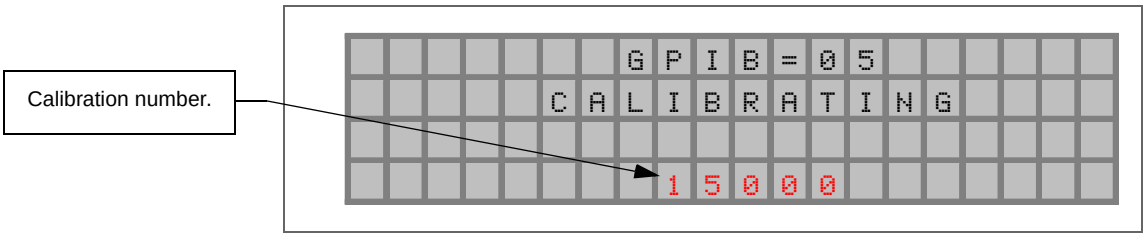
Starting the UFX-BER

1. Disconnect any inputs and terminate the output with the same load as indicated in the model (50 or 75 ohms).

2. Press the **ON/OFF** switch; the screen shows the model and firmware version.



3. After a few seconds, the UFX-BER begins internal calibration.



A *calibration number* appears in the last row of the screen. If it is between 8000 and 13000, skip to step 8.

4. After calibration, the screen displays the default parameters for the current **MODE** dial selection.

5. Switch the **MODE** dial to **METER**.

6. Leave the UFX-BER on for at least 30 minutes, then press **SHIFT** + **6** to reboot the unit. If the calibration number is between 8000 and 13000, skip to step 8.

7. If the calibration number is above 13000, leave the UFX-BER on for five minutes, then press **SHIFT** + **6** to reboot it. Repeat until the calibration number falls within the limits specified in step 6.

   If the calibration number is under 8000, turn the UFX-BER off and leave it off for five minutes. Turn it on and check the calibration number. Repeat until the calibration number falls within the limits specified in step 6.

8. Remove the output load and connect the signal input and output cables.

Operation

Your UFX-BER may have unique operating instructions in addition to those in this section. Any additional instructions are included in separate data sheets packaged with the UFX-BER shipment.

To use the UFX-BER:

1. Determine the placement of the UFX-BER in your test configuration and connect all necessary input, output, and/or interference cables.
2. Switch the **MODE** dial to the appropriate setting based on your test requirements.
3. Set the operating mode parameters with the keypad.
4. Press **START**. The UFX-BER self-calibrates again to check if input and output signal levels are within specified ranges. If so, the screen displays **OPERATE** and the output is:

   (*Ratio modes*) The carrier signal with the added noise.

   (**GEN** *mode*) An AWGN signal at the indicated noise density level.
5. During operation, the noise signal can be toggled on/off by pressing **No** (**SHIFT** + **8**).

Once the UFX-BER is in the **OPERATE** state, it continues until you:

- Change any parameter by pressing the appropriate key, *or*
- Press **CLEAR**, *or*
- Change the selection on the **MODE** dial.

If there is an operation error, the UFX-BER displays an error message, then switches to the **READY** state.

See also
Error Messages on page 25

UFX-BER Screens

Eb/No Mode

```
CF=897.   NbW=207.MHz
C=-35.9dBm  ΔC=+XX.X
EbNo=9.0      dB
BR=9.6  KBS       READY
```

You can modify the following parameters from this mode:

- **C** Output carrier power. To modify, press **CP** and enter the value through the keypad. Press **ENTER** to save the new value.

  For negative values, press **CP**, then **+/-**, then the value, followed by **ENTER**.
- **EbNo** Bit energy to noise density. To modify, press **RATIO** and enter the new value, followed by **ENTER**.
- **BR** Bit rate. To modify, press **BR** and enter the new value, followed by **ENTER**. Note that the default units are MBS; for the example above, you would enter **0.0096** for a 9.6 KBS rate.

While in **OPERATE** state, the E_b/N_o ratio can be adjusted in steps by pressing the arrow keys.

C/No Ratio Mode

To set the UFX-BER to carrier to noise density mode, press **BR** and enter **0** for the bit rate while in **Eb/No** mode.

The screen changes to reflect the new ratio value:

```
CF=897.   NbW=207.MHz
C=-35.9dBm  ΔC=+XX.X
C/No=9.0      dB
BR=1.0    BS      READY
```

You can modify the following parameters from this mode:

- **C** Output carrier power.

- **C/No** Carrier to noise density. To modify, press **RATIO** and enter the new value, followed by **ENTER**.

To return to **Eb/No** mode, press **BR** and enter a nonzero bit rate.

C/N Mode

```
CF=897.  Nbw=207.MHz
C=-35.9dBm  ΔC=+XX.X
C/N=  -1.0      dB
Sbw=1.2  MHz        READY
```

You can modify the following parameters from this mode:

- **C** Output carrier power.
- **C/N** Carrier to noise ratio. To modify, press **RATIO** and enter the new value, followed by **ENTER**.
- **Sbw** System bandwidth. To modify, press **SBW** and enter the new value, followed by **ENTER**.

While in this mode, note that the maximum noise power is:

$$5 - 10\log(SBW/\ NBW)\ \text{dBm} \qquad (Eq.\ 2\text{-}1)$$

While in the **OPERATE** state, the C/N ratio can be adjusted in steps by pressing the arrow keys.

C/I Mode

The carrier to interferer ratio requires an input through the **INTERFERER** port at the back of the UFX-BER. The interferer input must have a nominal input power of -4 dBm ± 2 dBm, and the frequency range must not exceed UFX-BER limits (varies depending on the model)

.

```
CF=897.  Nbw=207.MHz
C=-35.9dBm  ΔC=+XX.X
C/I=    0       dB
                    READY
```

You can modify the following parameters from this mode:

- **C** Output carrier power.
- **C/I** Carrier to interferer ratio. To modify, press **RATIO** and enter the new value, followed by **ENTER**.R

While in the **OPERATE** state, the C/I ratio can be adjusted in steps by pressing the arrow keys.

Meter Mode

The screen in **METER** mode is shown below:

```
CF=897.   Nbw=207.MHz
INPUT POWER=+XX.XdBm
    NORMAL METER
```

where **XX.X** is the power value. If the Rayleigh averaging option is not installed, the third line (**NORMAL METER**) is blank..

If the input signal is undergoing minor fluctuations, you may want to increase the number of samples for measurement. To do so, select **AVG** and enter the new value from 10 to 65,535. Note that the calibration time increases with the number of samples.

TAS recommends that the maximum AVG setting be in the low hundreds; improvements at higher settings are negligible and increase the calibration time.

To toggle Rayleigh averaging on and off, press **RAY**. When on, **RAYLEIGH AVERAGING** appears in the third line of the screen. When off, **NORMAL METER** appears.

See also Substitution Method on page 36

Rayleigh averaging also affects calculations in ratio modes, due to the substitution method.

TAS recommends that Rayleigh averaging be used only when the input signal is being affected by multipath fading.

The power meter displays either **UNDER** or **OVER** if the carrier signal power is out of range (< -55 dBm or > 5 dBm).

GEN Mode

The noise generator (**GEN**) setting provides an AWGN pattern at the given center frequency, noise bandwidth, and density.

```
CF=897.   Nbw=207.MHz
No=-78.2  dBm/Hz
                 READY
```

- **No** Output noise density. To modify, press **No** and enter the new value. The noise density is set automatically to the nearest step value (i.e. 0.1 or 0.25 dBm/Hz, or the value set by pressing **STEP**).

While in the **OPERATE** state, the output noise density can be adjusted in steps by pressing the arrow keys; the output noise density value is given only to a single decimal point.

If stepping the value up or down would bring the noise value past allowable limits, the message **AT LIMIT** appears and the value does not change.

Appendix A

Contents

A

Installation and Troubleshooting

UFX-BER error messages usually indicate a condition in the test setup which must be corrected before operation can proceed. Usually, such errors can be corrected by changing the test conditions. However, if error messages appear despite correct test conditions, or if the UFX-BER is not performing as intended, you may want to perform verification tests to confirm malfunctions.

This section will show how to troubleshoot UFX-BER errors and perform verification tests.

If the UFX-BER does not perform as described under the verification procedures, record the results on the provided test page and contact TAS.

Installation

Initial Inspection

Inspect the shipping container for damage. If the container is damaged, retain until the contents of the shipment have been checked against the packing list and the instrument has beeen checked for mechanical and electrical operation.

WARNING

If the UFX-BER appears to have been damaged during shipping, do not continue with installation. Notify TAS immediately.

Power Connections

Verify that the AC input is set to the desired voltage (120 or 220 VAC). Connect the power cord included with the UFX-BER to the AC input connection at the rear of the chassis and to a grounded power source of the proper voltage.

GPIB (IEEE 488 Bus) Interconnection

For GPIB remote operation, connect a standard GPIB 24-wire interface cable between the UFX-BER and the controller or PC. Note the following restrictions:

1. No more than 15 instruments may be installed on the bus.

2. The total cable length in meters may not exceed two times the number of bus instruments or 20 meters (whichever is less).

The UFX-BER is shipped with the GPIB address preset to 5.

Remote operation through the GPIB port requires a connection cable not included (see National Instruments' website at *http://www.natinst.com/gpib*).

RS-232, RS-422, and RS-423 Interconnections

The optional RS-232 connection uses a DB25S connector on the rear panel wired as DTE. Pin 3 is receive, pin 7 is ground, pins 4 and 5 (RTS-CSD) are jumper connected, as are pins 6, 8, and 20 (DSR, DCD, DTR).

RS-422 and RS-423 connections use pin 12 for positive data and pin 13 for negative data.

Caution

All signal and control cables should not exceed 3 meters (9 feet) in length.

Error Messages

TOO LITTLE CARRIER

See also
Equations on page 37

Indicates that the output signal is higher than the input signal (equation B-1). Press **CP** to modify the output signal.

CALCULATED SIG HIGH or CALCULATED SIG LOW

The output signal power is outside the range specified in equation B-2.

CALCULATED NOISE HI or CALCULATED NOISE LO

Indicates the output noise power is outside the ranges specified in equation B-3. To increase the noise power:

- **All ratio modes** Reduce the noise ratio (**RATIO**).
- **C/N only** Reduce the system bandwidth (**SBW**).
- **Eb/No only** Reduce the bit rate (**BR**).

To reduce the noise power:

- **All ratio modes** Increase the noise ratio (**RATIO**).
- **C/N only** Increase the system bandwidth (**SBW**).
- **Eb/No only** Increase the bit rate (**BR**).

MEASURED SIGNAL HIGH or MEASURED SIGNAL LO

These messages appear in ratio mode if the input signal power is too high or low for proper operation when **START** is pressed. Follow the same procedures as for the **CALCULATED NOISE** messages to adjust the noise power.

NOISE BW < SYSTEM BW

The noise bandwidth (internal noise source) cannot exceed the user-defined system bandwidth (equation B-4). Press **SBW** and enter a lower system bandwidth.

INPUT SIGNAL = UNDER or INPUT SIGNAL = OVER

In **METER** mode, indicates the input signal level or power offset is out of range (under -55 dBm or over 5 dBm). Press **BR** and enter a new power offset value.

ERROR

There is an unknown system error. Contact TAS for further information.

Verification Testing

WARNING

Under no circumstances should you attempt to repair the UFX-BER on your own. If the UFX-BER does not pass verification testing, turn off the unit, unplug it, and contact TAS. SeeMaintenance and Warranty on page 53 .

Requirements

You will need the following equipment for verification testing:

- Signal Generator
- RMS Power Meter (HP436A or equivalent)
- Spectrum Analyzer (HP8566 or equivalent)

Warmup

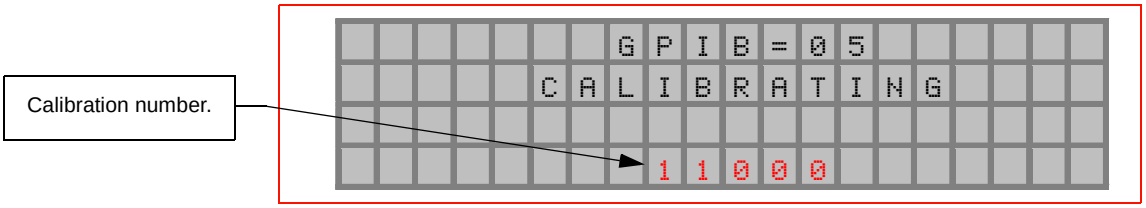
1. Turn on the UFX-BER and let it remain on for 30-45 minutes.

Warmup is necessary for accurate power measurements; the UFX-BER uses an automated substitution method to eliminate non-linearity from the power meter. This warmup time will only affect power meter measurements; ratio measurements do not require warmup for accuracy.

Initial Testing

1. Remove any signal input and terminate the output; this will ensure initial calibration is accurate.

2. Reboot the UFX-BER (**SHIFT** + **6** in **METER** mode, or turn off and on). During the opening sequence, note the *calibration number* in the last line of the screen:



NOTE RESULT The calibration number should be between 8000 and 13000.

3. Connect the signal generator and RMS power meter to the UFX-BER as shown in Figure A-1.

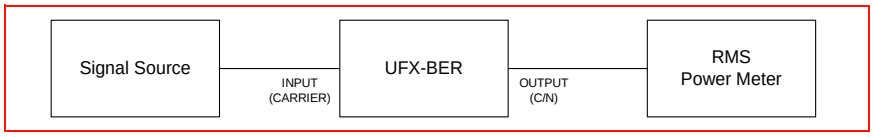


Figure A-1. Power Meter Measurement Setup

The signal source should be set to 0 dBm.

4. Note the RMS power meter reading.

NOTE RESULT The RMS power reading should be 0 ± 0.5 dBm.

Power Meter Testing

1. Switch the **MODE** dial to **METER**.

2. Vary the signal source to settings within the UFX-BER limits (+4 to -50 dBm). Mark each UFX-BER reading.

NOTE RESULT All power readings should *typically* be accurate within ± 0.3 dB, and the *maximum* error should be less than ± 0.6 dB.

Noise Ratio Accuracy Testing

1. Switch the **MODE** dial to **Eb/No**.

2. Set desired values for the center frequency (**C**), the signal to noise ratio (**EbNo**), and the bit rate (**BR**).

3. Based on the values you entered in step 2, calculate the output C/N target:

$$C/N\ \text{target} = \text{RATIO} + 10\log(BR/NBW) \qquad (Eq.\ A\text{-}1)$$

4. Press **START** to begin operation. The RMS power meter will display the carrier plus noise power (**C+N**); you do not need to note this reading.

5. Disconnect the input signal from the UFX-BER input and measure the output power with the RMS power meter.

NOTE RESULT This power reading is **N**.

6. Reconnect the input signal and press **No** to disable the noise input. Measure the output power.

   NOTE RESULT This power reading is **C**.

7. Subtract the noise power (step 5) from the carrier power (step 6) to determine the C/N ratio. For example, if C= -10 dBm and N = -7 dBm:

   C/N = C - N = (-10 dBm) - (-7 dBm) = -3dBm

8. Compare the measured result (step 7) with the target C/N calculated with equation A-1 (step 3).

   NOTE RESULT The measured and calculated C/N should *typically* be within ± 0.1 dB, with a *maximum error* of ± 0.3 dB.

9. If the measured and calculated C/N do not fall within the ranges noted in step 8, repeat steps 4-8 again, paying particular attention to the RMS power meter zeroing.

   NOTE RESULT Same as in step 8.

10. If step 9 does not produce a measured C/N within acceptable tolerances, then repeat steps 4-8 with the following values:

    Eb/No ratio to **0**.
    BR to the same value as **NBW**.

    This sets the target C/N to **0**.

    NOTE RESULT Same as in step 8.

See also
Equations on page 37

Noise Flatness and 3 dB BW Measurements

1. Disconnect the RMS power meter and connect the spectrum analyzer to the UFX-BER output, as in Figure A-2.

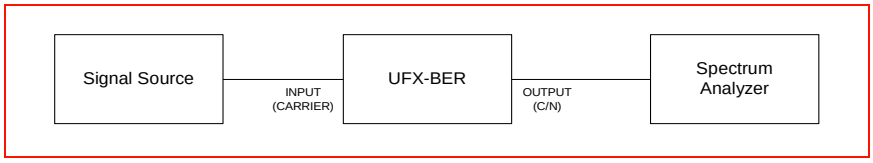


Figure A-2. Noise Flatness Measurement Setup

2. Set the **MODE** dial to **GEN** and press **START**.

3. Measure the noise flatness and 3 dB BW on the spectrum analyzer and record values.

Verification Test Results

Keep the results of the verification test on record; use a copy of the following page. If any portion of the test failed, make a note and contact TAS.

Results

Make copies of this page as needed to mark your results.

Warmup	❒	Warmup completed.
Initial Testing	_____ _____	Calibration Number RMS Power Meter
Power Meter Testing	_____ _____ _____ _____ _____	
Noise Ratio Accuracy Testing	_____ _____ _____	**N** **C** **C/N**

The noise flatness and 3dB BW setting information should be recorded on a separate sheet of paper.

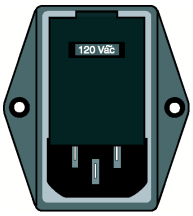
If verification testing fails, contact TAS with the results.

Troubleshooting

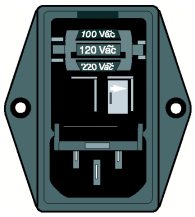
Replacing The Fuse

Caution

Make certain the UFX-BER is disconnected from external power and timing cables before servicing the unit.



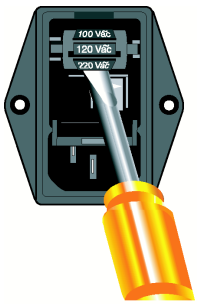
1. Turn off the UFX-BER and remove the plug from the AC connector
2. Open the fuse housing by inserting a small screwdriver at the tab shown.
3. Remove the fuse from the right hand slot and replace it, with the white arrow on the fuse facing the right.
4. Close the housing door and reconnect the AC power cord.



Changing Line Voltage

Caution

Changing the voltage selector when unnecessary can damage the UFX-BER.



1. Follow steps 1-2 from *Replacing The Fuse*.
2. Remove the voltage selection wheel, using a small screwdriver to gently pry the wheel from the latches.
3. Position the voltage selection wheel so that the desired voltage will appear when the housing is closed. Once the wheel has been aligned, push it into the holder until the ends snap into the latches.
4. Close the housing door and reconnect the AC power cord.

Appendix B

Contents

B

Description and Specifications

This section provides some technical details regarding the UFX-BER which may assist in understanding certain UFX-BER operations.

Topics include:

- Explanation of the substitution method.
- Example of UFX-BER testing.
- Equations describing the output and ratio types.
- UFX-BER models and options.
- UFX-BER general specifications

Functional Description

Substitution Method

The UFX-BER uses the *substitution method* to eliminate any non-linearity which may exist in measurement ranges. Upon starting the UFX-BER:

1. The UFX-BER measures the power of the input carrier signal.
2. The internal noise signal power is set to *match* the input carrier power; the initial signal-to-noise ratio is 0, regardless of the UFX-BER ratio mode.
3. Finally, the noise signal level is adjusted in order to match the given signal-to-noise ratio.

The UFX-BER displays **CALIBRATE** while these steps take place. Once it has finished and starts to output the carrier signal with noise, it displays **OPERATE**.

Because of the substitution method, UFX-BER ratio measurements are accurate to within the attenuator tolerance.

Typical Application

Figure B-1 shows a typical testing scenario. The UFX-BER is placed between the down-converter and the receiver. The UFX-BER adds noise to the carrier signal at the indicated ratio without disturbing the carrier phase characteristics. The interference input is optional and only used for C/I testing.

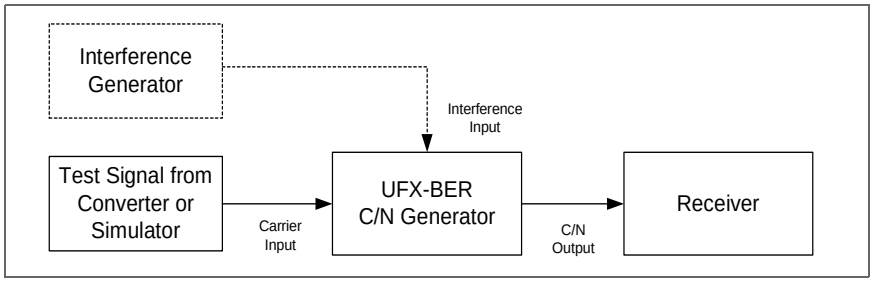


Figure B-1. Testing Scenario

Equations

Input/Output Limiting Equations

$$C_{in} \geq C \qquad (Eq.\ B\text{-}1)$$

where: C_{in} is the input carrier power.
C is the output carrier power (**C** on screen, **CP** on keyboard).
If $C_{in} < C$ the UFX-BER displays a **TOO LITTLE CARRIER** error.

$$5 \geq C_{in} \geq -55 \text{ dBm} \qquad (Eq.\ B\text{-}2)$$

If $C_{in} > 5 \text{ dBm}$, the UFX-BER displays a **CALCULATED SIG HIGH** error.

If $C_{in} < -55 \text{ dBm}$, the UFX-BER displays a **CALCULATED SIG LOW** error.

$$5 \geq \text{Noise Output Power} \geq -55 \text{ dBm} \qquad (Eq.\ B\text{-}3)$$

If the Noise Output Power > 5 dBm, the UFX-BER displays a **CALCULATED NOISE HI** error.

If the Noise Output Power < -55 dBm, the UFX-BER displays a **CALCULATED NOISE LO** error.

$$NBW > SBW \qquad (Eq.\ B\text{-}4)$$

where: NBW is the noise system bandwidth (**Nbw** on screen).
SBW is the system bandwidth in C/N mode (**Sbw** on screen).
If $NBW < SBW$, the UFX-BER displays a **NOISE BW < SYSTEM BW** error.

Noise Output Power Calculations

E_b/N_o Mode

$$\text{Noise Output Power (dBm)} = C - RATIO + 10\log(NBW/BR) \qquad (Eq.\ B\text{-}5a)$$

where: C is the output carrier power (**C** on screen, **CP** on keyboard).
$RATIO$ is the bit energy noise density (**Eb/No** on screen).
NBW is the noise bandwidth (**Nbw** on screen).
BR is the bit rate (**BR** on screen).

C/N Mode

$$\text{Noise Output Power (dBm)} = C - RATIO + 10\log(NBW / SBW) \quad (Eq.\ B\text{-}5b)$$

where: *C* is the output carrier power (**C** on screen, **CP** on keyboard).
RATIO is the carrier to noise ratio. (**C/N** on screen).
NBW is the noise bandwidth (**Nbw** on screen).
SBW is the system bandwidth (**Sbw** on screen).

C/No Mode

$$\text{Noise Output Power (dBm)} = C - RATIO + 10\log(NBW) \quad (Eq.\ B\text{-}5c)$$

where: *C* is the output carrier power (**C** on screen, **CP** on keyboard)
RATIO is the carrier to noise density ratio. (**C/No** on screen)
NBW is the noise bandwidth (**Nbw** on screen)

Options

Table B-1. UFX-BER Options

Option	Description
Option 1	Constant gain control for constant carrier power level
Option 3	50 ohm input and output impedance
Option 4	RS-232C, RS-422, or RS-423 interface
Option 5	230 VAC @ 50 Hz
Option 6	0.1 dB/step on output noise and C/N
Option 7	Switched filter bank for up to six customer-specified filters

Models

Table B-2. UFX-BER Models

Model Number	Frequency Range	Applications
UFX-BER-70	50-90 MHz	General purpose, SATCOM, VSAT
UFX-BER-140	100-180 MHz	General purpose
UFX-BER-1200	1000-1210 MHz 1190-1450 MHz 1430-1670 MHz	L-band Modems
UFX-BER 1500	1320-1680 MHz	L-band Modems, cellular
UFX-BER-CATV	50-860 MHz	Cable TV
UFX-BER-IBS/IDR	50-90 MHz 68-72 MHz 100-180 MHz	Intelsat, Sat Com

Specifications

Output Path

Table B-3. Output Path Specifications

Carrier Output Power Range	-55 dBm to carrier input level, or +5 dBm, whichever is lower
Noise Output Power Range	-55 to +5 dBm
Noise Flatness	±0.2 dB/40 MHz or less ±0.3 dB/80 MHz ±0.4 dB/200 MHz ±0.5 dB/300 MHz or greater
Noise Step Size	0.25 dB
Crest Factor	18 dB minimum
Accuracy of C/N	±0.30 dB WCU, ±0.21 dB RSS
Tracking Range (option 1)	±5 dB for below 200 MHz ±4 dB for above 200 MHz
Tracking Step Size	0.2 dB nominal
Tracking Update Range	25 ms
Interferer	-4 dBm back panel input

Carrier Path

Table B-4. Carrier Path Specifications

Attenuation	0 to 60 dB, automatically programmed in 0.1 dB steps
Carrier Input Power Range	-55 to +5 dBm
Absolute Max. Input Power	+21 dBm
Flatness	±0.20 dB for 70 MHz ± 20 MHz ±0.30 dB for 140 MHz ± 40 MHz ±0.40 dB for others
Group Delay	±0.20ns/40 MHz for frequencies above 20 MHz
Third-order Intercept Point	+29 dBm typical
Power Meter Accuracy	±0.5 dB
Power Meter Averaging	10 to 65,535 number of samples, 2.3 ms each
Impedance/Connector	75 ohms/N < 500 MHz 50 ohms/N > 500 MHz (options 2-3)

Appendix C

Contents

C

Remote Operation

You can control the UFX-BER through a remote PC using the GPIB or serial port on the back of the unit.

Topics include:

- Setting the GPIB bus address and/or serial data rate.
- Remote commands (read and write).

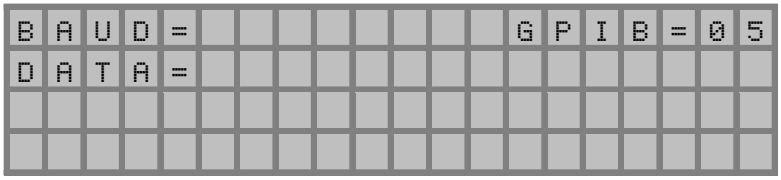
Configuring Remote Operation

Remote operation is possible by using the GPIB or optional serial interface at the rear of the UFX-BER, with the following restrictions:

- No more than 15 instruments can be installed on the bus.
- Total accumulative cable length may not exceed twice the number of bus instruments (in meters), or 20 meters, whichever is less. For example, if you have eight instruments on the bus, the maximum cable length is 16 meters.

To change the GPIB address or serial data rate:

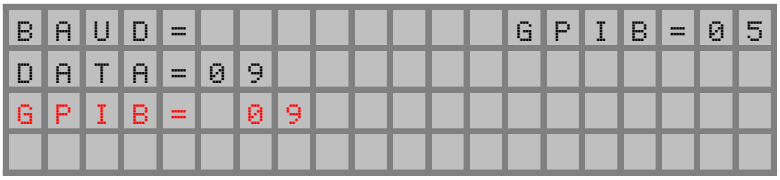
1. Press **LOCAL** while the UFX-BER is in the **READY** condition. The following screen appears:



2. Enter the new GPIB address from 01-31 through the keypad; the value appears in the **DATA** block.

   If you have option 4 installed (RS-232, RS-422 or RS-423 connector), enter the new baud rate; the value appears in the **DATA** block. Standard values include **0150**, **0300**, **0600**, **1200**, **2400**, **4800**, and **9600** (default setting). All serial communications are 8N1 (eight data bits, one stop bit, no parity).

3. Press **ENTER** to change the value; the new value appears:



   and you are returned to the normal UFX-BER screen.

You must reboot the UFX-BER (turn off and on or press **SBW** while in **METER** mode) in order for the new value to take effect.

To switch to remote mode, enter any command through the remote interface. The unit switches to remote mode and the **REMOTE** indicator lights.

To exit remote mode, press any key on the UFX-BER keypad.

Commands

`MODE=`*n* (**Mode Selection**)
Sets the operating mode to *n*, where *n* is:

1	**EB/NO**
2	**C/N**
3	**METER**
4	**GEN**
5	**C/I**

`N#=`*n* (**Center Frequency/Noise Bandwidth**)
Selects the *n*th noise band, where *n* is from 1 to the number of noise bands available. Entering 1 selects the noise band with the highest center frequency.

`CP=`*nnn* (**Carrier Power**)
Sets the output carrier power, where *nnn* is from -55 to 5 (in 0.1 dBm increments).

`SBW=`*nnnn* (**System Bandwidth**)
Sets the system bandwidth in MHz, where *nnnn* can range from .0001 to 9999. Valid only for **C/N** mode (`MODE=2`).

`BR=`*nnnn* (**Bit Rate**)
Sets the carrier modulation bit rate in Mb/s, where *nnnn* can range from .0001 to 9999. If in **EB/NO** mode (`MODE=1`) and *nnnn* is set to 0, the mode is set to **C/NO**.

`GE=-nnnn` (**Noise Density**)
Sets the noise density to -*nnnn* dBm/Hz, where *nnnn* is from 000.1 to 999.1. The minus sign is required. This command is valid for the noise generator mode (`MODE=4`), and the range may be constrained by hardware requirements.

`RATIO=`*nnn* (**Ratio**)
Sets the ratio value for the selected mode, where *nnn* is from -60 to 60 in 0.1 or 0.25 dB increments.

`TRKON` or `TRKOFF` (**Tracking**)
Enables/disables automatic gain control, if the tracking option has been installed. If on, the output carrier power is held constant for input signal variations from -5 to 10 dB.

`R+` or `R-` (**Rayleigh Filtering**)
Enables (`R+`) or disables (`R-`) Rayleigh averaging, if the option is installed. This option is only for **METER** mode. Note that once Rayleigh averaging has been enabled, calibration times take significantly longer.

`DF=`*nnnnn* (**Average (Digital Filtering)**)
Sets the average level from 10 to 65535 samples (default is 10). Note that calibration times increase proportionately to an increase in this setting.

`INC` (**Increment**)
In the **OPERATE** state, increases ratio by one step unit.
In the **READY** state, switches to the next noise band.
In **GEN** mode (`MODE=5`), increments noise by one step unit.

`DEC` (**Decrement**)
In the **OPERATE** state, decreases ratio by one step unit.
In the **READY** state, switches to the previous noise band.
In **GEN** mode (`MODE=5`), decrements noise by one step unit.

`S2=`*nn.n* (**Ratio Step Size**)
Sets the step size for the `I2` and `D2` commands to *nn.n* dB (where *nn.n* can range from the lowest step unit to 20.0, in multiples of the lowest step unit).

`I2` (**Ratio Step Up**)
Increases the ratio by the step size set with the `S2` command.

`D2` (**Ratio Step Down**)
Decreases the ratio by the step size set with the `S2` command.

`START` (**Start Calibration**)
Begins calibration and operation after startup parameters have been entered.

`CLEAR` (**Clear**)
If in the **OPERATE** state, switches to **READY** mode and output is disabled.
If in the **CALIBRATE** state, switches to **READY** after the calibration cycle.

`*R` or `QDE` (**System Reset**)
Reboots the UFX-BER.

Caution

After sending this command, you must wait at least ten seconds so the initial calibration cycle can be executed. Afterwards, reissue the GPIB BUS CLEAR command before continuing.

`N+` or `N-` (**Noise On/Off**)
In ratio modes, turns noise output on and off (while in the **OPERATE** state).

`C+` or `C-` (**Carrier On/Off**)
In ratio modes, turns carrier input on and off (while in the **OPERATE** state).

Read Status/Data Commands

The following commands return status information. The command format is `?`*XX* where *XX* is a command string. The UFX-BER returns **ERR** upon receiving an invalid command string, or **BUSY** if calibrating.

`?BR` returns the **bit rate**.

`?SBW` returns the **system bandwidth**.

`?CP` returns the **carrier power** if in a ratio mode, or the **input power** if in **METER** mode.

`?MO` returns the **mode** (1-5).

`?No` returns the **noise density** (ratio modes only).

`?N#` returns the **center frequency and noise bandwidth**.

`?RATIO` returns the **noise ratio** (ratio modes only).

`?TRACK` returns the **tracking** status (valid only if tracking option has been installed).

`?DF` returns the **average power sampling rate**.

`?GE` returns the **noise density** (**GEN** mode only).

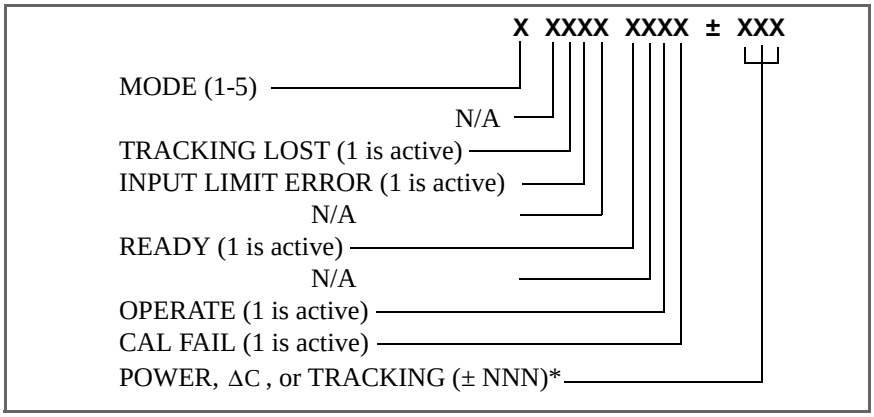
`?N+` returns the **noise source state** (on/off).

`?C+` returns the **carrier path state** (on/off).

`?*I` returns the **model number and firmware revision number**.

`?R+` returns the **Rayleigh filter state** (only if the option is installed).

`?STATUS` returns **status information** in the following format:



* This setting is POWER if in **METER** mode (`MODE=3`); C is the input carrier power in ratio modes. If tracking is enabled, the final portion reads **T*pp*** where *pp* is the carrier power value.

Appendix D

Contents

D

Maintenance and Warranty

This section outlines recommended maintenance procedures and warranty information for your UFX-BER Precision C/N Generator.

If you have any other questions regarding your UFX-BER unit, contact TAS.

Maintenance

Adjustments and Calibration

To maintain optimum performance, the UFX-BER should be calibrated after one year of service and every two years thereafter. TAS recommends that the unit be returned for calibration. For more information, contact our Customer Service Department at (732) 544-8700.

Troubleshooting and Repair

The UFX-BER should only be serviced by Telecom Analysis Systems, Inc. service personnel or trained customer service personnel using TAS Service Manuals.

For instruments requiring service, either in or out of warranty, contact the TAS Customer Service Department at (732) 544-8700 for pricing and instructions before returning your instrument. When you call, have the following information available:

- Model Number
- Serial Number
- Full description of problem or failure condition
- Name and phone number of the technical contact at your facility

Equipment Returns

All instruments returned to TAS for repair must be shipped prepaid. Instruments eligible for in-warranty repairs will be returned prepaid to the customer. For instruments that are out-of-warranty, or that have been mishandled, the customer will be responsible for return shipping charges. An evaluation fee will be charged for testing and processing units that are found to have no functional or performance defects.

For out-of-warranty instruments, TAS will provide an estimate for the cost of repair. Customer approval of the charges will be required before repairs can be made. For units deemed to be beyond repair, or in situations in which the customer declines to authorize repair charges, handling charges may be assessed for the evaluation by TAS.

Rights and Advises

TAS reserves the right to make changes without notice in UFX-BER hardware or software and hardware/software specifications. Customers are advised to obtain

the latest version of the UFX-BER specifications before placing an order to verify that the information is current.

Specifications contained in this publication supersede all data for the UFX-BER published by TAS, prior to March 1999.

Warranty and Assistance

All TAS products are warranted against defects in material and workmanship for a period of one year from the date of shipment. TAS will, at its option, repair or replace products that prove to be defective during the warranty period, provided they are returned to TAS, and provided the preventative maintenance procedures are followed. Repairs necessitated by misuse of the product are not covered by this warranty. No other warranties are expressed or implied, including but not limited to the implied warranties of merchantability and fitness for a particular purpose.

TAS is not liable for consequential damages.

averaging The number of samples the UFX-BER uses to calculate signal ratios and RMS power. Each signal sample is 2.2 ms long; the calibration time will increase with the number of samples.

AWGN (Additive White Gaussian Noise) Noise which has its power evenly distributed over all RF and microwave frequencies and has a Gaussian amplitude distribution.

bit rate The number of data bits transmitted per second.

C/I Carrier to interferer ratio; describes the relative power between an input RF signal and an interference signal.

C/N Carrier to noise ratio, in decibles. Indicates the relative strength between the input signal and the applied AWGN.

C/No Carrier to noise density ratio, in dBm. Indicates the relative strength between the input signal and the applied AWGN in a 1 Hz bandwidth.

center frequency The frequency at which the noise amplitude is highest, according to the Gaussian distribution.

Eb/No Energy per bit per noise spectral density ratio. Indicates the relative strength between the carrier power and noise power.

noise bandwidth The frequency range over which the UFX-BER applies additive white Gaussian noise. The *center frequency* marks the midpoint of the noise bandwidth.

noise density The noise level within a 1 Hz bandwidth; identified with the notation **No**.

ratio modes Any of the UFX-BER modes which require a signal-to-noise ratio value; includes **Eb/No** (and **C/No**), **C/N**, and **C/I**.

RMS Root-mean square; a term describing the method of finding the effective power given a sinusoidal input. The UFX-BER can find the RMS power P, where

$$P = \frac{V_{eff}^2}{R} \text{ and } V_{eff} = \sqrt{\frac{1}{T}\int_{t_o}^{t_o+T} v^2 dt}$$

system bandwidth The frequency range of the input carrier signal; used to calculate noise ratios. See Equations on page 37 for more information.

substitution method Describes the UFX-BER process when calculating noise outputs; the signal to noise ratio is initially set to zero before noise is added. This results in accurate signal and noise output.