

Cell Master MT8212A T1 Measurements

CELL MASTER™

Introduction

Cellular wireless telephony has expanded dramatically over the past ten years. Both the size and the number of service providers have increased. Technology has advanced with the expansion. The consumer sees his link to the network as his handset to the Base Transceiver Station. Service provider differentiation may have consisted mainly in user features and the ubiquity of service access – many BTS's. As service becomes more competitive, service quality and efficiency are becoming more important.



Service providers have become experts in wireless technologies, transceivers, antennas and coverage maps. What may not always be acknowledged is the ever-expanding wired network supporting the wireless service. Most commonly the “backhaul” links connecting the BTS's to their Mobile Switching Centers (MSC) are based on wired DS1 (or T1) circuits. The quality of the service provided over those T1 lines has a direct effect on the quality of service experienced by the wireless service provider's customers. Call setup failures, dropped calls, data errors and noise can often be attributed to the T1 backhaul facilities.

Because these circuits are usually leased from the local exchange carrier (LEC), there has been an inclination to depend on that carrier for service assurance and maintenance. That may not be the optimum strategy if rapid fault isolation and service quality restoration are critical to superior customer service. Indeed, after deferring to the LEC for fault analysis, the LEC may report “no trouble found,” pointing the finger back at possibly faulty wireless provider's equipment.

Fundamentals and Practical Tips on Measuring T1 Circuits Feeding Base Transceiver Stations

T1 Theory

You may be somewhat confused by the use of the terms T1 and DS1. Technically, a T1 line is a digital transmission facility consisting of wire pairs and regenerators or optical media carrying a DS1 signal. DS1 refers to the digital signal itself carrying the information at a rate of 1.544 Mb/s. The DS1 signal may be formatted using various framing patterns, most commonly (but not always) divided into 24 channels each carrying encoded voice or data. If this is confusing, don't worry. The terms are commonly used interchangeably so that for all practical purposes they mean the same thing.

Voice signals are sampled and digitized at a rate of 8000 samples per second. This results in a frequency response to approximately 3.4 kHz. The low frequency response is limited to about 300 Hz. The digitized samples are encoded into 8 bits using a non-linear coding scheme called u-law. The entire process is called pulse code modulation, or PCM.

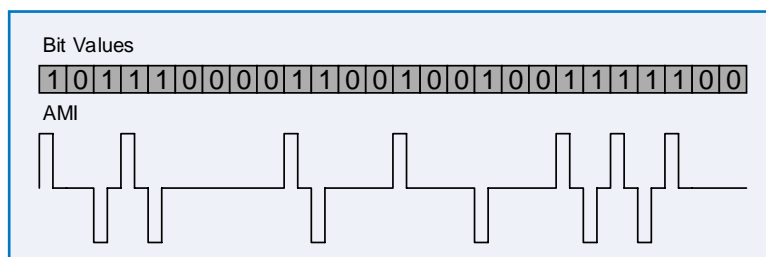
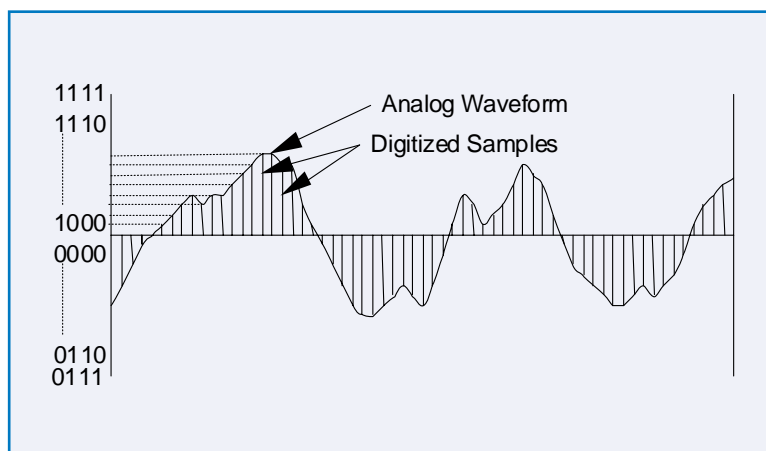
The DS1 signal is sent in a serial bit stream of one's and zeros. In order to extend communication beyond 6000 feet over wire pairs, it is necessary to insert one or more amplifying repeaters in the line to periodically regenerate the pulses. Regenerators and receivers detect the incoming signal by deriving their sampling clock from the signal itself.

In order to avoid a varying DC bias from being present on the line (and for other reasons) the pulses undergo what is called line coding. The coding used is called Alternate Mark Inversion (AMI). Ones are sent at nominal amplitude of three volts, zeros as zero volts. The ones pulses are bipolar, that is, each successive occurrence of a one has the opposite polarity as the previous one.

Occurrences of two simultaneous pulses of the same polarity is called a bipolar violation (BPV) and is an indication that the data has been corrupted by noise detected incorrectly as data. This can be caused by faults or degradations in the line quality. For example electrical noise may be coupled into the line if it is poorly balanced as a result of leakage to ground.

Because the sampling clock in receivers and repeaters is actually derived from the signal itself, it is important that a minimum density of ones be present to ensure synchronization of the detection process. Standards require that for AMI line coding a minimum of 12.5% of bits must be ones, and no more than 15 consecutive zeros may be transmitted. This requirement is usually not a problem for encoded voice transmissions.

Transmission of digital data over the T1 circuits required an enhancement to the basic AMI requirements. It is common in data transmission to have a succession of zeros, which would violate the minimum ones density requirement or the maximum successive zeros requirement. In order to deal with this a technique called Bipolar with 8 Zero Substitution (B8ZS) was devised. Using B8ZS, pulse transmitters modify the basic AMI coding to insert a specific pulse pattern of two BPVs whenever a string of eight consecutive zeros occurs in the data. Receivers then look for the BPV pattern in received data and restore the original sequence of eight zeros. It is important that the transmission equipment at both ends of a circuit be correctly optioned for B8ZS. A receiver, for example a CSU or Channel Bank, incorrectly set to AMI only will indicate errors when the B8ZS pattern is detected.



Each digitized voice or data channel is allotted an 8 kHz sampling frequency. Each sample is itself allotted 8 bits. T1 communication accommodates 24 channels per carrier circuit. Each set of samples requires 8 bits x 24 channels = 192 bits, sometimes referred to as the payload. An additional bit, called the framing bit, is added at the beginning of each set of samples. The resulting 193 bits is called a frame. The frame rate of 8 kHz results in an overall data rate for the T1 Carrier of 193 bits/frame x 8000 frames/second 1.544 Mbps.

The purpose of the framing bit is to allow receivers to synchronize on the frames, that is to find the beginning of each frame. The framing bits are sent in a specific sequence or pattern. Receivers synchronize by identifying the unique repeating pattern of the framing bits.

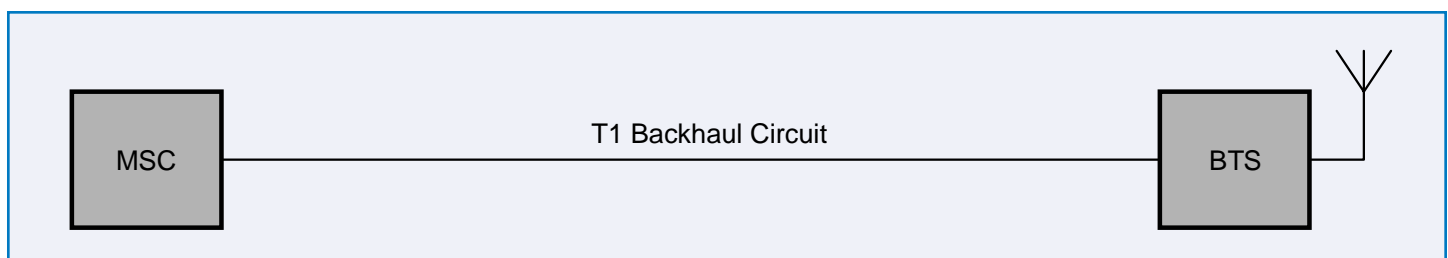
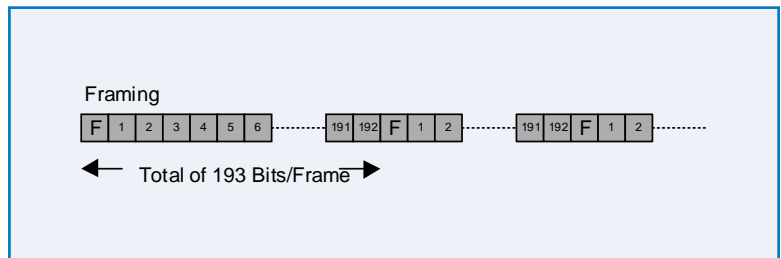
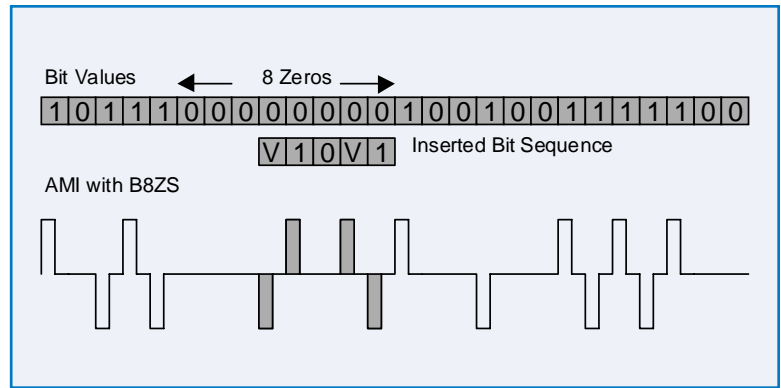
There are two commonly used framing formats, D4 or Superframe format, and Extended

Superframe (ESF) format. The F (frame) bits in the D4 format are used only for synchronization purposes. The F bits in the ESF frame format take on additional utility. Of the 8 kbps available via the framing bits, ESF uses only 2 kbps as a fixed pattern used for frame detection. Of the remaining 6 kbps, two are allocated to a Cyclic Redundancy Check (CRC) for error rate estimation and 4 kbps are allocated to a Facility Data Link (FDL) used for various maintenance communication functions, for example performance monitoring data.

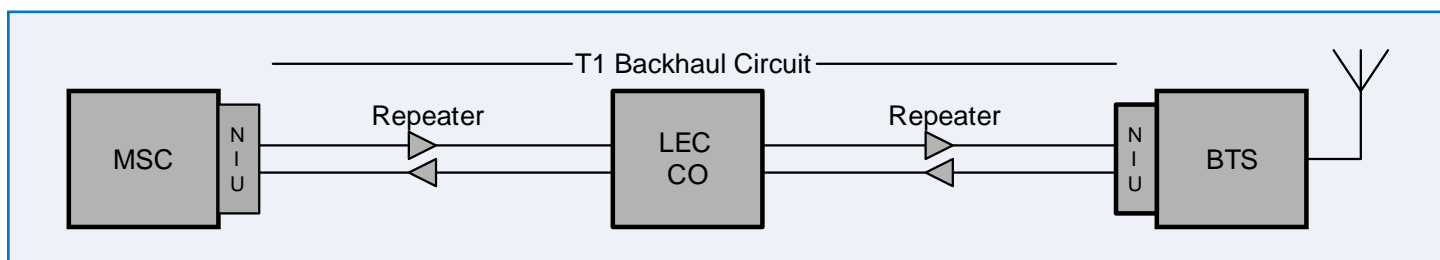
Network Topologies and Equipment

Some understanding of the network itself is useful because it is faulty operation of the network equipment that often causes the degraded link performance. The local service provider often owns much of the equipment. Some may be located at the BTS and MSC, but more likely it is at the LSP Central Office or part of the outside plant cable or equipment.

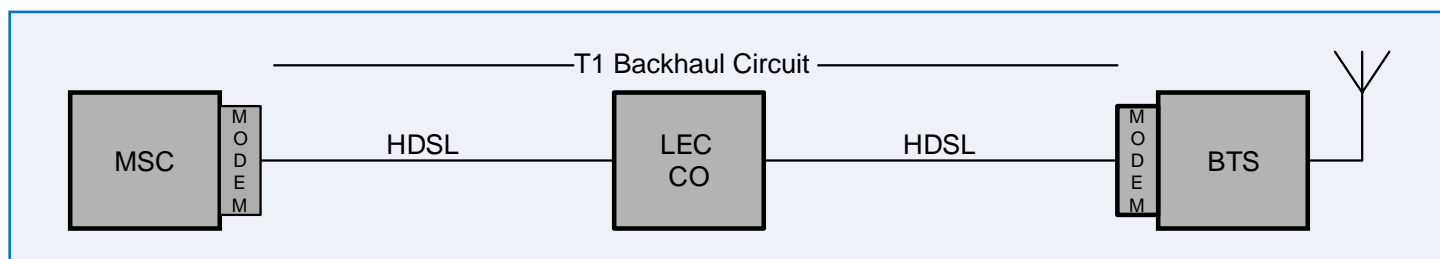
The figure below depicts a very simplified picture of the T1 backhaul circuit. Although useful for building a general understanding of the wireless network, especially the parts directly controlled by the wireless provider, it is too simplified to be useful when troubleshooting problems on the T1 backhaul links themselves.



The figure below gives a better depiction of one possible circuit topology. Note that the circuit between the MSC and BTS passes through the LEC central office. In fact the circuit may pass through multiple central offices. Within each office it will in turn pass through multiple pieces of transmission equipment. Note too the Network Interface Unit (NIU) shown at the MSC and BTS. The NIU, if provided, is owned by the LEC and serves as the point of interface at the site. The NIU may be a very simple device having only a remote loopback capability, or it may provide very sophisticated performance monitoring capabilities. Its capabilities may or may not be accessible to the wireless service provider technician. Note too the existence of repeaters in the outside plant. They are necessary when the circuit must travel more than 6000 feet. The repeaters are full duplex devices that regenerate or restore the pulse shape and amplitude.



The figure below shows a variation of the previous circuit. It makes use of an outside plant technology for T1 called High Speed Digital Subscriber Line (HDSL). Most new installations of T1 circuits now utilize HDSL. HDSL enables full duplex T1 service over a single pair of wires and without the installation of repeaters. Although the modem itself is more costly than the NIU provided for standard T1, the savings in installation costs and outside plant wires and repeaters more than justifies it. In most cases the wireless provider technician need not be concerned with the outside plant technology, but there are situations unique to the two topologies. For example, the HDSL circuit obviously is not subject to problems due to faulty repeaters. It is, however, more sensitive to the existence of some problems with the outside plant wire pairs, for example bridge taps.



Testing T1 Circuits

Testing may be divided into two classes: out of service testing and in-service monitoring. Out of service testing is reserved for the time of initial installation and before final acceptance from the LEC. At that time the circuit should be subjected to critical testing to guarantee that the level of contracted service is being met. Out of service testing may also be performed when the circuit performance is so poor that it is better to remove it from service.

Most troubleshooting and routine maintenance should be performed using in-service monitoring. This can be done without removing the circuit from service or affecting its performance in any way.

Out of Service Testing

There are two general ways to perform out of service testing: point to point testing and testing from a single point on the circuit by applying loopbacks at various other points. Point to point testing is usually preferred, but the requirement to have a trained service technician at each end is often impractical. In either case, the testing usually consists of transmitting various patterns and checking that the circuit faithfully transfers the patterns without errors.

In Service Monitoring

In service monitoring involves observing existing signals on the circuit. The level of testing possible is dependent especially on whether the circuit is framed as an SF or an ESF circuit. ESF circuits yield much more performance data. The CRC-6 bits may be monitored to estimate the overall bit error rate on the circuit. In addition ESF circuits may also provide access to the performance monitoring features of some network equipment. SF framed circuits may be monitored for framing bit errors and bipolar violations only.

T1 Tests

Frame Errors

This measurement identifies the number of errors in a framing bit position. It can give a general indication of the overall bit error performance of a circuit, especially if the signal is observed for an extended period. It is useful because it may be performed as an in service monitor test. Note that some network equipment, especially digital cross-connect systems, may correct frame errors, making this measurement less useful for end-to-end testing.

CRC Errors

This measurement is available only on ESF circuits. The test device calculates the CRC of a block of data and compares that result with the CRC word sent from the far end. This measurement may also be performed while in service. It gives a highly accurate estimate of error performance. Note again that network equipment may re-calculate the CRC, making an end-to-end measurement less useful.

Bipolar Violations

This measurement indicates the number of times that successive pulses of the same polarity are received, that is, violations of the AMI convention. It is especially useful when assessing the quality of copper transmission circuits and repeaters. Note that the BPVs sent in B8ZS coding are ignored. This measurement is useful for performing in-service tests. As with the prior measurements, BPVs are removed by network equipment, so the measurement is not useful for end-to-end testing.

Bit Error Rate (BER)

This measurement is performed by counting the number of times a received bit pattern does not conform to the transmitted pattern. It is ordinarily necessary to remove a circuit from service in order to perform this measurement. BER tests are always performed when initially placing a circuit in service so as to verify performance to a guaranteed standard. They may also be performed when returning a circuit to service after repair. In ordinary troubleshooting, it is generally avoided because of the need to remove the circuit from service. But in cases where service is unacceptable, it is the most effective troubleshooting tool. Unlike the in-service tests above, it may be used to verify end-to-end circuit performance.

Errored Seconds

An errored second is defined as a one-second period during which any of the above listed errors occurred. It is usually the metric used as the measure of circuit performance for tariffed lines. The service provider will guarantee a limit of errored seconds within a given period of time.

Stress Patterns for BER Testing

The table below summarizes the patterns available from the Cell Master. The ones shown in bold face are the primary patterns specified for T1 testing by the Network Operations Forum (NOF). Although not officially endorsed by the NOF, the DALY pattern is also commonly used. The others are less commonly used for DS1 circuit testing.

Pattern	Description	Application
QRSS	1,048,575 bit pattern	Simulates live traffic including both high and low-density sequences
1 IN 8	Eight bit pattern of a 1 and 7 zeros	Checks clock recovery on circuits optioned for B8ZS
2 IN 8	Eight bit pattern of two ones and 6 zeros	Used to determine correct optioning of AMI or B8ZS line coding
3 IN 24	24 bit pattern with 3 ones and 15 consecutive zeros. 12.5% ones density	Stresses AMI optioned circuits for minimum ones density and maximum consecutive zeros performance. Forces zero substitutions in B8ZS optioned circuits
ALL ONES	All ones sent as payload in a framed sequence	Stresses ability of circuit to operate under maximum power conditions
ALL ZEROS	All zeros sent as payload in a framed sequence	Checks for B8ZS optioning. Circuit will drop if optioned for AMI
T1-DALY	Framed 55 octet sequence which changes rapidly from high to low density	Stresses timing recovery and ability of automatic line build out and equalizer circuits to respond quickly to changing ones density
PRBS-9 (511)	511 bit pseudo-random pattern	Test sub-rate DDS circuits operating below 56 kbps
PRBS-11 (2047)	2047 bit pseudo-random pattern	Test 56 kbps DDS circuits
PRBS-15	32,767 bit pseudo-random pattern. Generates up to 14 consecutive zeros and 15 consecutive ones	Tests to CCITT Recommendations O.151 and G.703. Provides maximum number of zeros for testing non-B8ZS circuits
PRBS-20	1,048,575 bit pseudo-random pattern. Generates up to 19 consecutive zeros and 20 consecutive ones	Used to test synchronous T1 circuits only
PRBS-20 (O.153)	1,048,575 bit pseudo-random pattern	Tests to CCITT Recommendation O.153
PRBS-23	8,388,607 bit pseudo-random pattern. Generates up to 22 consecutive zeros and 23 consecutive ones	Used to test synchronous T1 and T3 circuits

Using Cell Master to Test T1 Circuits

Test Setup – Setting the Circuit Parameters

Before performing a T1 test on any circuit it is necessary to do some preliminary setup to configure the Cell Master to be compatible with the circuit conditions. Note that the sequence below covers all parameters, but it is usually not necessary to select and change every one. Steps may be skipped depending on the current test to be performed and the current setup conditions displayed at the bottom of the screen. See the Histogram display at the end of this section. Setup conditions may also be saved and recalled using the **Save** and **Recall** buttons.

Step 1. Press **MODE** once and using the up/down arrow keys select T1 Tester. Press **ENTER**.

Step 2. Press the **BERT** soft key.

Step 3. Press the Setup **BERT** soft key. The soft key labels now show the setup parameters, which must be configured. At the bottom of the screen, the current Setup parameter selections are displayed.

Step 4. Press the **Framing Mode** soft key. If you know the framing mode of the circuit, press either **D4 SF** or **ESF**. Notice that the “Framing =” indication at the bottom of the screen changes to conform to the selection. If you are not sure, then press the **Auto** soft key. If Auto is selected, the Cell Master will examine the framing pattern of the incoming signal and match it.

Step 5. Press the **Back** soft key.

It is important to note that problems with errors are often caused by improperly optioned equipment, so it is better to know what the expected framing pattern should be. It is important to check the optioning of the local equipment to determine if the framing selection and the expected framing matches that found on the circuit.

Step 6. Press **Receive Input** soft key. If you are about to perform a monitor test using the monitor jack at a DSX, then press the **Monitor +20 dB** soft key. This selection properly terminates the signal coming from the DSX monitor jack and compensates for the 20 dB loss found there. If a BERT test is to be done, then usually this is done by splitting the circuit. When connecting patch cords from the IN and OUT jacks of the DSX that are associated with the outgoing circuit, contacts on the jacks “split” the circuit, disconnecting the local transmission equipment. In that case press the **Terminate** soft key. The **Bridged** soft key selection is only used if you are tapping into a circuit to monitor a signal at some point other than at the jacks of a DSX or provided on the equipment itself.

Step 7. Press the **Back** soft key.

Step 8. Press the **Pattern** soft key. Using the arrow keys, position the cursor on the desired test pattern, or the pattern being sent from the far end. Then press **ENTER**. If the pattern expected from the far end is not known, then select **Auto Detect**. The most common selection for a BERT test is **QRSS**.

Step 9. Press the **Line Coding** soft key. Press either the **B8ZS** or **AMI** soft key.

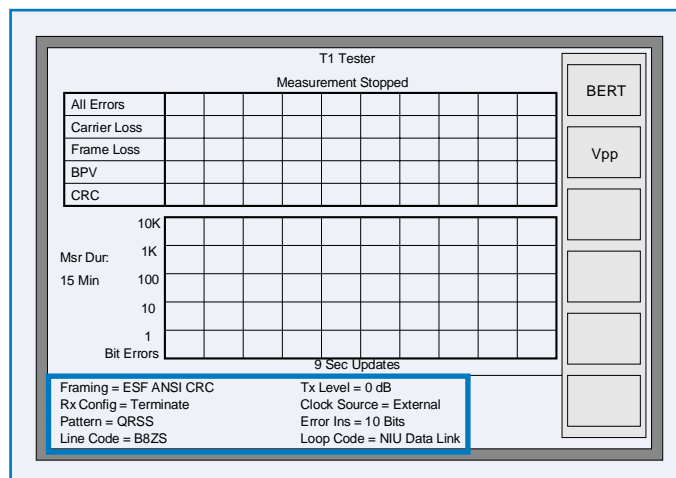
Step 10. Press the **Back** soft key.

Note again the potential for incorrectly optioned equipment to cause errors. Line Coding must be correctly optioned at all equipment in the circuit.

Step 11. Press the **Transmit Level** soft key. Press the soft key corresponding to the desired transmit level. When performing a test toward the far end of a circuit at a DSX, this will usually be **0 dB**. The other values might be used to test toward the local equipment for proper operation at its specified lower receive levels. The incoming signal going to the equipment could be 22 dB down from its original value at the source.

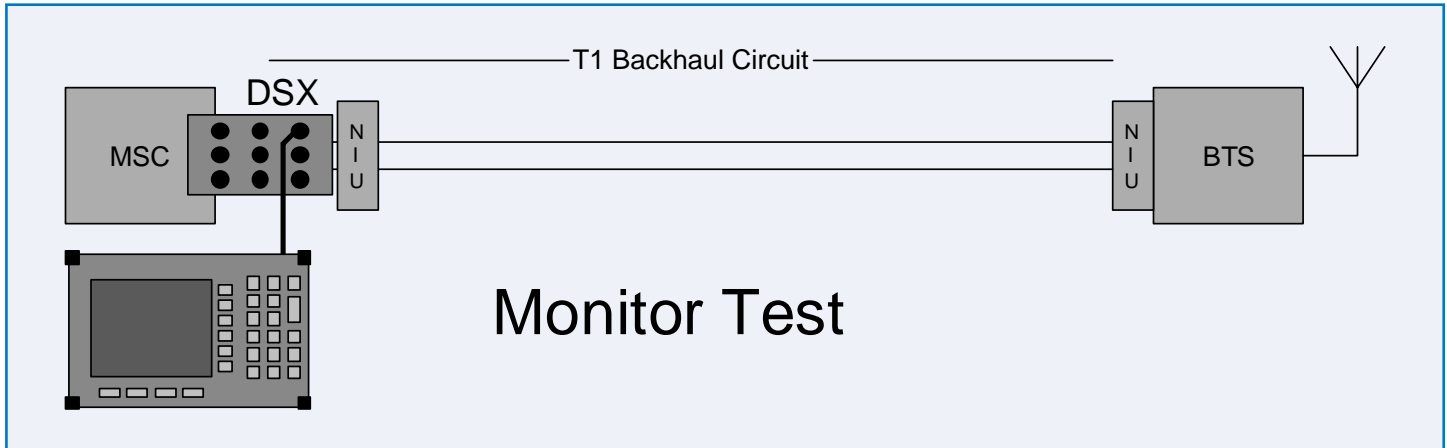
- Step 12. Press the **Back** soft key.
- Step 13. Press the **More** soft key. Press the **Clock Source** soft key. If a test is to be made from a cell site to a far end of a circuit which passes through a LEC central office, then that office will ordinarily establish the timing on the circuits. For that situation the circuit is loop timed at the cell site. Press **External** for that situation. If testing toward the equipment at the local site, then ordinarily the press the **Internal** soft key.
- Step 14. Press the **Back** soft key.
- Step 15. Press the **Setup Error Insert** soft key. Select the type of errors desired for the test. Another screen then appears allowing you to select the number of errors to be sent. Enter the desired number using numeric keys, then press **ENTER**.
- Step 16. Press the **Back** soft key.
- Note that errors are sent when performing a point to point test to confirm with the tester at the far end that each has correctly set up his test equipment and that it identifies the errors. That also confirms that you are both connected to the same circuit. Another reason for sending errors is to check how the equipment in the circuit responds to various kinds of errors. For example, central office equipment will ordinarily remove bipolar violations before retransmitting. The NIU or CSU at the far end may identify and log errors for later retrieval of circuit performance data.*
- Step 17. Press the **Loop Code** soft key. Press the soft key corresponding to the device **CSU** or **NIU** you intend to cause to loop. Note that two keys are available for user defined patterns. When you press either of these, an additional screen appears allowing direct entry of the code to be stored. When finished press **ENTER**.
- Step 18. Press **In Band/Data Link** to toggle the selection of whether the code is to be sent in-band or in the data link. This selection depends on the circuit and the type of device at the far end.
- Step 19. Press the **Back** soft key.
- Step 20. If desired press the **ANSI CRC/Japan CRC** soft key. Then press either the **ANSI CRC** for normal US operation or **Japanese CRC** soft key to select the CRC specification for the country in which you are operating.
- Step 21. When finished with SETUP, press the **MEAS/DISP** key to exit the SETUP mode and return to the top-level menu.
- Step 22. Press the **BERT** soft key followed by the **Measure BERT** soft key.
- Step 23. Press the **Display Raw Data/Histogram** soft key.

The screen should appear as shown (Note that the Histogram display is shown. The display could also be showing Raw Data.). The setup parameters you have just selected should be displayed at the bottom of the screen. The current state of the parameters may always be referenced at the bottom of the screen.



Monitor Test Procedure (At DSX or CSU Monitor Jacks)

When testing a line that is in service it is always best to first perform a monitor test. This avoids disrupting service needlessly. Even in cases where you know that service is down the monitor test helps you verify that you have correctly identified the faulty circuit.



Step 1. Connect a jumper cord from the monitor jack of a DSX panel or CSU to the Rx jack on the **Cell Master**

Step 2. Press **MODE** once and using up/down arrow keys select T1 Tester. Press **ENTER**.

At this point you should examine the setup parameters at the bottom of the screen and determine if they match the conditions of the circuit to be tested. Note that for a Monitor test, Loop Code, Tx Level, and Error Ins are ignored. If Framing type is unknown, then it may be automatically detected.

Step 3. Press the **BERT** soft key.

Step 4. Press the Setup **BERT** soft key.

Step 5. Press the **Framing Mode** soft key.

Step 6. Press **D4 SF** or **ESF** if the framing type is known. Otherwise, press **Auto** to have the Cell Master automatically determine the framing it sees on the circuit.

Step 7. Press the **Back** soft key.

Step 8. Press the **Receive Input** soft key.

Step 9. Press the **Monitor** soft key.

Step 10. Press the **Back** soft key twice.

Steps 11 through 13 need be performed only if a specific test duration is needed. If the monitor test is being done as a quick verification only, then proceed to step 14.

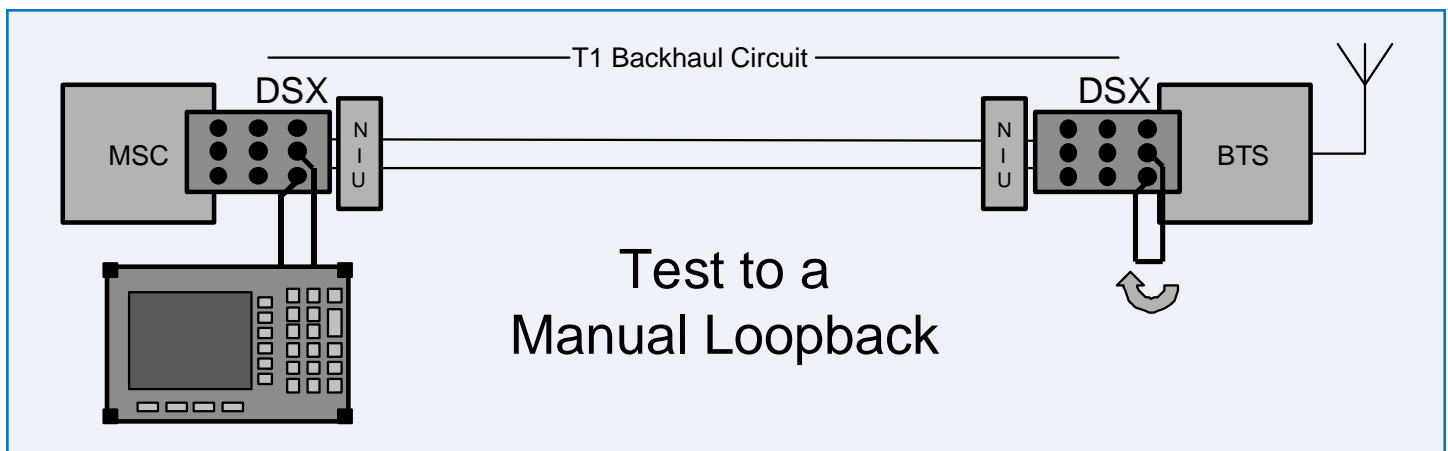
Step 11. Press the **Measure Duration** soft key. The Measurement Duration screen should appear showing the currently selected duration value.

Step 12. Using the Up/Down arrow keys, select the desired measurement duration. Selecting **MANUAL** will allow a test to run up to two days until manually terminated. Press **ENTER** to accept the value.

- Step 13. If the histogram measurement screen is not displayed, press the **Display Raw Data/Histogram** soft key to select the histogram screen.
- Step 14. Press **Time Scale**. The Histogram Resolution screen will appear. Use the Up/Down arrow keys to select a horizontal scale resolution for the histogram display. Selection of AUTO will usually result in the optimum scaling for the selected time duration of the test. Press **ENTER** to accept the value.
- Step 15. Press the Measure **BERT** soft key.
- Step 16. Press the **Start/Stop Measure** soft key.
- The display now shows the results of the measurement. Observe the results for several minutes to check for error performance. If the far end is sending a pattern for a BERT test, then check that the Cell Master detects that pattern in order to verify that the measurement is being performed on the correct circuit.
- Step 17. If desired, press the **Display Raw Data/Histogram** soft key to toggle between the raw data tabular and the histogram display presentations. For a quick, short term test, the raw data display is usually preferable. The histogram display may be preferred for longer term measurements.
- Step 18. Press the **Start/Stop Measure** soft key to terminate the measurement. Note that the results remain accessible until the next measurement is started.

Testing To A Manual Loopback

*If the service person at the far end is not equipped with a test device, that person may still be called upon to patch in a loop back at the local DSX. This is done by connecting a patch cord from the **IN** to the **OUT** jack at the DSX. Care must be taken to correctly identify the circuit jacks serving the outgoing direction of the circuit.*

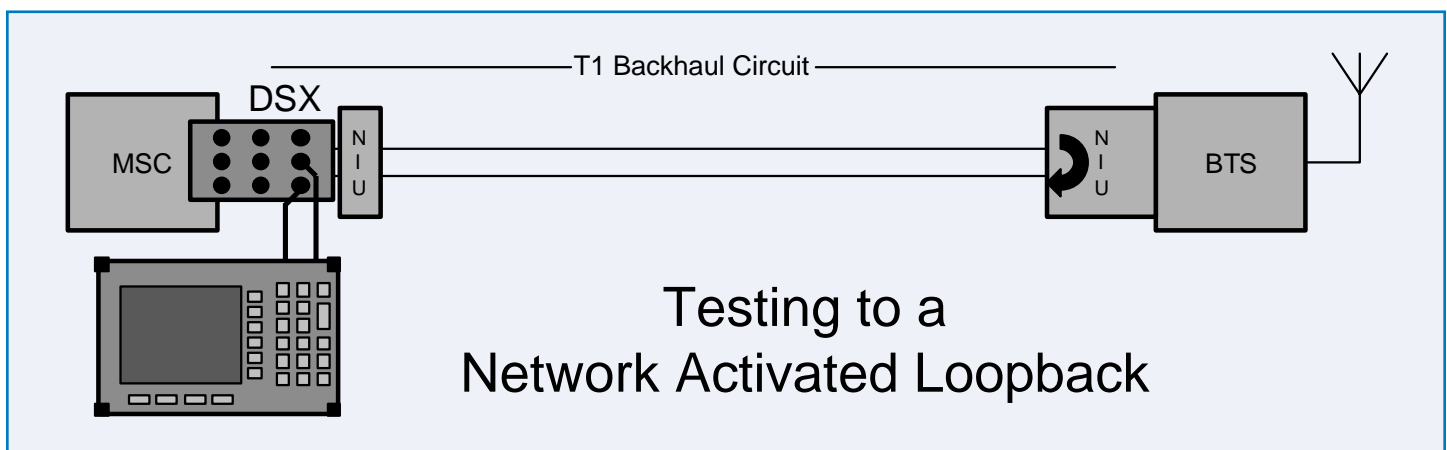


- Step 1. Connect patch cables from the Rx and Tx jacks of the Cell Master to the Out and In jacks respectively of the local DSX or other point of circuit access. At the DSX be sure to select the jacks which access in the direction of the outgoing circuit, not those accessing toward the local equipment.
- Step 2. Ask the technician at the far end to provide a manual loopback at his local DSX.
- Step 3. Press the **BERT** soft key.
- Step 4. Press the **Setup BERT** soft key and perform the steps beginning on page 8. These must be complete before initiating a test.
- Step 5. Press the **Back** soft key.

- Step 6. Press the **Measure BERT** soft key. If **Measure BERT** is not one of the options, press **MEAS/DISP** to access the top-level screen. Then press the **BERT** soft key. **Measure BERT** may now be selected.
- Step 7. Press the **Measure Duration** soft key. The Measurement Duration screen should appear showing the currently selected duration value.
- Step 8. Using the Up/Down arrow keys, select the desired measurement duration. Selecting **MANUAL** will allow a test to run up to two days until manually terminated. Press **ENTER** to accept the value.
- Step 9. If the histogram measurement screen is not displayed, press the **Display Raw Data/Histogram** soft key to select the histogram screen.
- Step 10. Press **Time Scale**. The Histogram Resolution screen will appear. Use the Up/Down arrow keys to select a horizontal scale resolution for the histogram display. Selection of **AUTO** will usually result in the optimum scaling for the selected time duration of the test. Press **ENTER** to accept the value.
- Step 11. Press the **Start/Stop Measure** soft key to start the test.
- Step 12. Press the **Insert Errors** soft key to verify test continuity through the circuit. Press **Start/Stop Measure** twice to clear the errors and restart the test.
- At any time before, during, or after the test is complete, pressing the Display Raw Data/Histogram soft key toggles between the two display formats.*
- Step 13. Allow the measurement to complete or press the **Start/Stop Measure** soft key again to terminate the test. Examine the results. Errors detected during the test are displayed. The results may be compared to the standards set for the service provided to the customer. Any errors detected in a short term test of a few minutes or less should be pursued to determine the cause.
- Step 14. Press **MEAS/DISP** to return to the top level T1 Tester menu.
- Step 15. Ask the technician at the far end to remove the loopback patch cord, restoring the circuit to its normal state.

Testing to a Network Activated Loopback

Quick, single-person testing is possible when the network is equipped with terminating devices capable of being remotely looped. Note that this capability may be blocked by network equipment in the central office. If that is the case, you have no choice but to enlist the aid of another technician at the far end site.

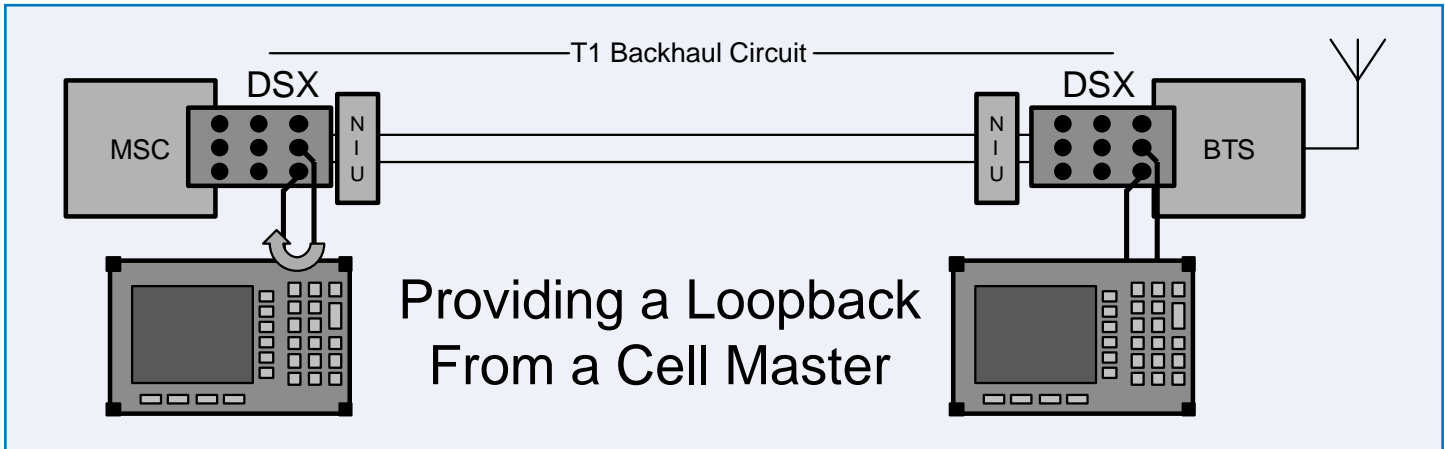


- Step 1. Connect patch cables from the Rx and Tx jacks of the Cell Master to the Out and In jacks respectively of the local DSX or other point of circuit access. At the DSX, be sure to select the jacks which access in the direction of the outgoing circuit, not those accessing toward the local equipment.
- Step 2. Press the **BERT** soft key.
- Step 3. Press the **Setup BERT** soft key and perform the steps beginning on page 8. These must be complete before initiating a test. Check especially the current setup of the Loop Code by observing its display at the bottom of the screen: Loop Code = xxxx. If the current loop code does not correspond to the type of device you intend to loop up, then perform steps 17-19 above in **Setup BERT**.
- Step 4. Press the **Measure BERT** soft key. (If **Measure BERT** is not visible, press **MEAS/DISP**, then **BERT**. **Measure BERT** should now be a soft key selection.)
- Step 5. Press the **More** soft key.
- Step 6. Press **Remote Loop Up**. Watch the display for the confirmation message "Remote Loop Up Succeeded." A message "Remote Loop Up Failed" indicates a failure to activate the loopback.
- Step 7. Press **Back** to access the main testing soft keys.
- Step 8. Press the **Measure Duration** soft key. The Measurement Duration screen should appear showing the currently selected duration value.
- Step 9. Using the Up/Down arrow keys, select the desired measurement duration. Selecting **MANUAL** will allow a test to run up to two days until manually terminated. Press **ENTER** to accept the value.
- Step 10. If the histogram measurement screen is not displayed, press the **Display Raw Data/Histogram** soft key to select the histogram screen.
- Step 11. Press **Time Scale**. The Histogram Resolution screen will appear. Use the Up/Down arrow keys to select a horizontal scale resolution for the histogram display. Selection of **AUTO** will usually result in the optimum scaling for the selected time duration of the test. Press **ENTER** to accept the value.
- Step 12. Press the **Start/Stop Measure** soft key to start the test.
- Step 13. If desired press the **Insert Errors** soft key to verify test continuity through the circuit. Observe that the errors are indicated on the display. This verifies that the loopback is properly established. Press the **Start/Stop Measure** soft keys twice to clear the errors and restart the test.

At any time before, during, or after the test is complete, pressing the Display Raw Data/Histogram soft key toggles between the two display formats.
- Step 14. Allow the measurement to complete, or press the **Start/Stop Measure** soft key again to terminate the test. Examine the results. Errors detected during the test are displayed. The results may be compared to the standards set for the service provided to the customer. Any errors detected in a short term test of a few minutes or less should be analyzed to determine the cause.
- Step 15. When testing is complete, press the **More** soft key. If **More** is not currently visible, then perform steps 2 and 3 above.
- Step 16. Press **Remote Loop Down**. Watch the display for the confirmation message "Remote Loop Down Succeeded." A message "Remote Loop Down Failed" indicates a failure to remove the loopback. Failure means that the circuit is not restored to its normal service state.
- Step 17. Press **MEAS/DISP** to return to the top level T1 Tester menu.

Providing a Loopback from a Cell Master

During the course of testing, the technician at the far end may request that you provide a local loopback so that he may perform a single-ended test from his end of the circuit. This is easily provided by executing the loopback from within the Cell Master.



- Step 1. Connect patch cables from the Rx and Tx jacks of the Cell Master to the Out and In jacks respectively of the local DSX or other point of circuit access. At the DSX be sure to select the jacks which access in the direction of the outgoing circuit, not those accessing toward the local equipment.
- Step 2. From the T1 Tester menu, press the **BERT** soft key.
- Step 3. Press the Measure **BERT** soft key.
- Step 4. Press the **More** soft key.
- Step 5. Press the **Self Loop Up** soft key. This connects the local Tx to Rx, looping the circuit back toward the far end tester.
- Step 6. Direct the technician at the far end to proceed with the test.
- Step 7. When notified that the test is complete, press the **Self Loop Down** soft key.
- Step 8. Press **MEAS/DISP** to return to the top level T1 Tester menu.

Making a Peak to Peak Voltage Measurement

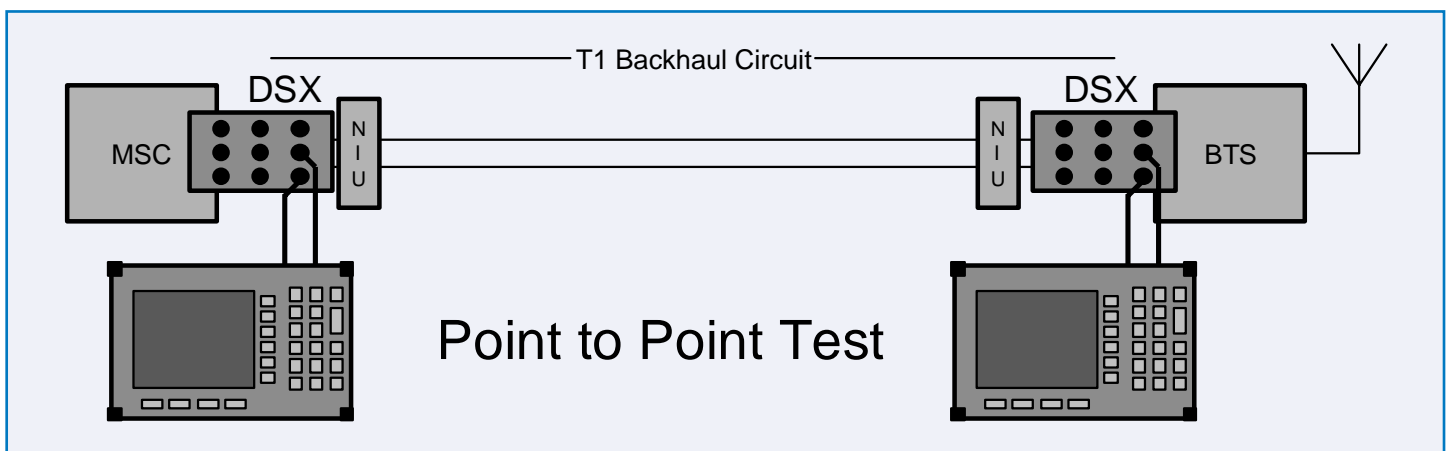
If errors are occurring on a circuit, the fault may lie with a piece of local equipment. It is a good practice to check the amplitude of the transmitted signal to verify that a robust signal is being sent.

- Step 1. Connect the Rx input of the Cell Master to the circuit to be tested. This may be done at the Tx jack of a DSX or piece of transmission equipment, or with a special cable with clip leads that may be connected into the circuit at some intermediate point in the local wiring.
- Step 2. From the T1 Tester menu, press the **Measure Vpp** soft key.
- Step 3. If the circuit is accessed via a jack, press the **Terminate/Bridged** soft key to select the Terminate state. Note that the state will be indicated at the lower left corner of the screen. If the circuit is accessed using clip leads to patch into some other part of the wiring, press the **Terminate/Bridged** soft key to select the bridged state.
- Step 4. Press the **Start/Stop Measure** soft key to start the voltage measurement.
- Step 5. Note the voltage reading displayed on the screen. For a circuit with a signal originating in properly functioning local equipment, the expected voltage should be approximately 6 volts.
- Step 6. Press **Start/Stop Measure** again to stop the measurement.
- Step 7. Press **MEAS/DISP** to return to the top level T1 Tester menu.

*Note that the voltage display will remain on the screen until either **Setup BERT** or **Measure BERT** is selected.*

Point to Point T1 Testing

Having verified that a circuit is down, the quickest way to isolate the problem is a point to point test requiring a service technician at each end of the circuit segment – each equipped with a Cell Master or a compatible testing device capable of performing bit error rate measurements.



Step 1. At each end of the circuit, connect patch cables from the Rx and Tx jacks of the Cell Master to the Out and In jacks respectively of the local DSX or other point of circuit access. At the DSX be sure to select the jacks which access in the direction of the outgoing circuit, not those accessing toward the local equipment.

Unless otherwise specified, all of the following steps must be performed at both ends of the circuit if a bi-directional test is desired.

Step 2. Press the **BERT** soft key.

Step 3. Press the **Setup BERT** soft key and perform the steps beginning on page 8. These must be complete before initiating a test. If a pattern is selected, the same pattern should be selected at both ends of the circuit.

Step 4. Press the **Back** soft key.

Step 5. Press the **Measure BERT** soft key. If **Measure BERT** is not one of the options, press **MEAS/DISP** to access the top-level screen. Then press the **BERT** soft key. **Measure BERT** may now be selected.

Step 6. Press the **Measure Duration** soft key. The Measurement Duration screen should appear showing the currently selected duration value.

Step 7. Using the Up/Down arrow keys, select the desired measurement duration. Selecting **MANUAL** will allow a test to run up to two days until manually terminated. Press **ENTER** to accept the value.

Step 8. If the histogram measurement screen is not displayed, press the **Display Raw Data/Histogram** soft key to select the histogram screen.

Step 9. Press **Time Scale**. The Histogram Resolution screen will appear. Use the Up/Down arrow keys to select a horizontal scale resolution for the histogram display. Selection of **AUTO** will usually result in the optimum scaling for the selected time duration of the test. Press **ENTER** to accept the value.

Step 10. Press the **Start/Stop Measure** soft key to start the test.

Step 11. Press the **Insert Errors** soft key to verify test continuity through the circuit. Errors inserted at one point should register at the other end of the circuit. Press **Start/Stop Measure** twice to clear the errors and restart the test.

*At any time before, during, or after the test is complete, pressing the **Display Raw Data/Histogram** soft key toggles between the two display formats.*

Step 12. Allow the measurement to complete, or press the **Start/Stop Measure** soft key again to terminate the test. Examine the results. Errors detected during the test are displayed. The results may be compared to the standards set for the service provided to the customer. Any errors detected in a short term test of a few minutes or less should be analyzed to determine the cause.

Step 13. Press **MEAS/DISP** to return to the top level T1 Tester menu.

Summary

Anritsu Cell Master is the pre-eminent tool for installing and testing antennas, transmission lines and RF equipment. However, cellular service quality is also dependent upon the wired backhaul facilities used to interconnect the BTS and MSC. Testing these facilities has before now required that the service technician carry another piece of complex test equipment. Cell Master, in a package smaller than most T1 transmission test sets, now can be the one box solution to both wireless and wired testing needs.

Although the wired connections are leased from the local service provider, it is not a good strategy to be entirely dependent on that provider for trouble analysis, service restoration and verification of service quality. The ability to analyze service quality and pinpoint a fault location quickly may avoid needless revenue loss.

This note reviews the basics of digital telephony as it applies to the wireless service provider. It can serve as the starting point for the experienced RF technician to begin troubleshooting the wired digital transmission problems that can adversely affect the quality of service seen by end users.

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