OPERATION AND MAINTENANCE
MAINTENANCE SUPPORT
DR 6/11-135A AND 135EC
CONTINUOUS PERFORMANCE MONITORING

CONTENTS PAGE

GENERAL

The continuous performance monitoring feature of the DR 6/11-135 systems is the primary tool for determining the quality of digital transmission on the 135-Mb/s radio line. When monitors at each regenerator and terminal site are connected to a centralized alarm-reporting system, out-of-limit performance conditions may be reported to a centralized alarm center on a hop-by-hop basis ◗(see *Note*).◖ The DR 6/11-135 systems are designed to be maintained on a demand maintenance basis using alarms triggered by the performance monitors and other monitors that report hard failures. Understanding the operating modes of the performance monitors is essential for effective system maintenance. After reading this practice, maintenance personnel can choose the proper mode of monitoring to use based on the specific situation.

▶*Note:* This description of continuous performance monitoring is for a frequency diversity/serial alarm-reporting system. Differences between remote alarm-reporting and other systems (e.g., hot standby, discrete alarm reporting) are:

- Frequency Diversity—Serial Alarm Reporting: Performance alarms and status indications are remotely reported on a ***per-channel*** basis.
- Frequency Diversity—Discrete Alarm Reporting: Performance alarms are remotely reported on a ***per-station*** basis only. No performance status points are provided.
- Hot Standby—Serial Alarm Reporting: Performance alarms and status indications are remotely reported on a ***per-digital receiver*** basis.
- Hot Standby—Discrete Alarm Reporting: Performance alarms are remotely reported on a ***per-station*** basis. No performance status points are provided.

This practice is reissued to include discrete alarm reporting. This practice is used in binders 421-101-001, 421-101-060, 421-104-001, and 421-104-060.◀

The continuous performance monitors used in the DR 6/11-135 system operate on a performance-threshold basis. That is, they initiate an alarm or status report whenever the established threshold of a monitored error performance parameter is exceeded. Two basic modes of performance monitoring are possible: a ***normal in-service mode,*** which operates on a continuous basis during normal system operation, and a short-term ***performance test mode,*** which is activated by a remote command signal from the alarm center. This latter mode performs remote reset functions and assists in trouble diagnosis during maintenance activity.

In the ***normal in-service mode,*** the performance monitors are programmed to report alarms whenever one or more of the monitored performance parameter thresholds are exceeded enough times in a 24-hour period to be statistically significant. In the ***performance test mode,*** the performance monitors are sensitized to report single events that exceed the established thresholds over a shorter time interval. This latter mode of monitoring may, in turn, be used either on a manually activated single-observation-interval basis or on an automatic repetitive interval basis.*

The manual single-interval mode using the ***performance test*** command verifies that repairs have been made which cleared problems causing continuous repeating performance alarms. When this mode is used, alarm center personnel can quickly determine if a problem has been eliminated. This manual single-interval mode use of the ***performance test*** command is referred to as the ***performance verify test.***

With automatic repetitive use of the ***performance test*** command, the performance monitors essentially become real-time monitors, reporting each event as it occurs in each repeated test interval. In this mode, the performance monitoring system is useful for isolating intermittent and other unusual system problems that may not bring localizing alarms to the alarm center. When the ***performance test mode*** is used with the automatically repeating test interval, it is referred to as the ***real-time performance test.***

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* The automatic repetitive mode of using the ***performance test*** command is an optional operating mode. To provide this option, the alarm center control system must be programmed to continuously activate the ***performance test*** command prior to the end of each observation interval.

If the alarm and status reports generated while in each mode of performance monitoring are to be used effectively, it is important to know the operating details of each of the three modes. These modes are:

1. Normal In-Service
2. Manual single-interval Performance Verify Test
3. Automatic repeating-interval Real-Time Performance Test.

The details of these modes are given in the following paragraphs.

DESCRIPTION OF PERFORMANCE MONITORING

NORMAL IN-SERVICE MONITORING

Performance monitoring at the terminal and regenerator stations in the DR 6/11-135 digital radio systems is based solely on the performance of the radio line 135-Mb/s data stream. Errors or out-of-frame conditions are detected by the digital processing circuits in a digital receiver. The error and/or out-of-frame signals generated by these circuits are sent to the channel controller in each digital receiver for analysis. The technique used for error detection depends on the type of station and, at regenerator stations, the equipment option used.

At a terminal station, errors are always detected by checking the CRC (cyclic redundancy code) bits inserted into the radio line digital signal. At a regenerator station, either the built-in pseudo-error or the optional CRC error detection technique is used, depending on the option equipped. When the more accurate CRC monitoring option is equipped, CRC errors detected in one hop are not counted in other hops. This makes it easier to identify and isolate a defective hop. To achieve this hop-to-hop error isolation, the first digital receiver to detect a CRC block of bits with an error marks that block with an "error-present" indicator code. This code shows other downstream monitors that the specific CRC block has errors. Thus, subsequent receivers will ignore errors detected in that same CRC block and report only errors detected in other CRC blocks (see *Note*). When pseudo-error detection is used, multiple station detection of the same errors can result, and an analysis to determine the first upstream station reporting the errors is necessary to isolate the source hop.

Note: On systems equipped with CRC monitoring and error correction, an interaction between the CRC and ERROR CORRECTION code bits at the receiving terminal station can result in multiple station alarms being reported for the same problem. When this situation occurs, a second, but false, performance alarm is reported from the terminal station, even though an upstream hop is actually the problem and is reporting correctly. This condition may occur when the problem causes error bursts and is always recognized by the following two conditions:

1. A performance alarm is reported simultaneously from an upstream regenerator station and its associated downstream receiving terminal hop
2. The remote EXCESS parameter status indicator from the reporting upstream regenerator is more severe than that from the reporting receiving terminal.

Regardless of the error detection process used, the channel controller computes an equivalent BER (bit-error rate) and, if applicable, locally displays the exponent of the current calculated BER and/or any of the monitored performance parameters that have exceeded their allowed thresholds. The channel controller also generates the alarm and status information that is sent to the distant alarm center by the station controller and a dedicated data channel.

PERFORMANCE PARAMETERS AND ALARM THRESHOLD TECHNIQUES

The performance monitors are programmed to indicate performance-degrading events that are significant enough to affect system performance. The events used for performance analysis are divided into two classes: events that can cause switching, EXCESS ACTY and EXCESS MFR, and events that are due to background error problems, EXCESS ERR RATE.

The EXCESS ACTY parameter is a high error rate condition that generates a switch request. The EXCESS MFR parameter monitor catches transient or intermittent out-of-frame conditions. And the EXCESS ERR RATE monitoring circuit reports high background bit error rates. Error rate calculations are suspended during out-of-frame conditions. Also, activity in either of the latter two parameters is ignored by the performance monitor during measurement periods with EXCESS ACTY events.

In general, each of the parameters is evaluated by counting and storing the number of times the event defined for each category occurs during a 30-minute observation "subperiod." This count is compared with the "number-of-events" threshold previously established for a subperiod in each parameter category. If this threshold number is reached or exceeded in a subperiod, the subperiod is marked "excessive" within the monitor memory for that parameter. For each of the monitored parameters, the number of subperiods marked excessive in a 24-hour main observation period consisting of 48 subperiods is counted. This number is compared with a 24-hour number-of-events threshold established for each parameter category. If the allocated 24-hour threshold for that parameter is reached or exceeded, the associated ***local*** and ***remote*** status indications of that EXCESS parameter are activated. Whenever one of these EXCESS parameters is activated, a remote performance alarm is also activated and automatically sent to the alarm center.

The 24-hour count is done on a sliding observation basis. This means that each parameter monitor is always evaluating the 24-hour period immediately preceding the current observation subperiod. Thus, as each new observation subperiod is brought inside the 24-hour time window, the oldest of the 48 existing subperiods is dropped from the 48 subperiod sum. Also, each parameter monitor activates its associated EXCESS status indication and a remote performance alarm when the number of subperiods that were marked excessive reaches the allocated 24-hour limit. This is done whether or not a 24-hour interval has elapsed. For example, if the allocated 24-hour threshold is three subperiods with an excess tag, then an alarm state could occur in as little as 1-1/2 hours (3 X 1/2).

An existing alarm condition can also terminate with a sliding 24-hour observation window if the total number of excess periods within the current 24-hour observation period drops below the threshold number when the sliding window moves to pick up the next new subperiod. In this case, the performance alarm and EXCESS status indicators will automatically reset to a nonactive or off state. The state of the old subperiods still left within the current 24-hour observation span are not reset however. This type of sliding window counting can result in a remote alarm condition that toggles on and off in time increments that are multiples of a half-hour. Such on-off alarm reporting would probably result from a sporadic intermittent problem.

IN-SERVICE THRESHOLD DEFINITIONS

The performance monitor alarm thresholds are user selectable in the field for settings consistent with DDS (digital data service) or MTS (message telephone service). The MTS option strap on both the regular and protection transmission equipment shelves is used to select the appropriate thresholds.

The DDS and MTS threshold definitions for each of the monitored performance parameters during NORMAL IN-SERVICE MONITORING are as follows:

a. Operation with DDS sensitivity

- ***EXCESS ACTIVITY:*** At least three 30-minute periods, out of a 24-hour period, detected three or more error bursts greater than 10^{-5}.
- ***EXCESS ERROR RATE:*** At least three 30-minute periods, out of a 24-hour period, detected BERs that exceeded 1×10^{-8} or 3×10^{-10} for systems with or without error correction, respectively.
- ***EXCESS MISFRAME:*** At least three 30-minute periods, out of a 24-hour period, detected two or more isolated misframes. Multiple misframes occurring within a 10-second period are defined as a single event.

b. Operation with MTS sensitivity

- ***EXCESS ACTIVITY:*** At least four 30-minute periods, out of a 24-hour period, detected three or more error bursts greater than 10^{-5}.
- ***EXCESS ERROR RATE:*** Parameter disabled when the MTS option is set.
- ***EXCESS MISFRAME:*** At least four 30-minute periods, out of a 24-hour period, detected two or more isolated misframes. Multiple misframes occurring within a 10-second period are defined as a single event.

LOCAL DISPLAY AND REMOTE INFORMATION

Locally, the EXCESS parameter events are indicated on the faceplate of the channel controller. An EXCESS indication also causes a local COM ALARM and a remote performance alarm. For remote diagnosis to determine which EXCESS indicator caused a performance alarm, the status indicators related to the EXCESS parameter indications may also be read at the alarm center. This is done by sending a status scan request command from the alarm center. The remote indications of EXCESS parameter status are reduced in number by grouping them into two categories. This makes it easier for the alarm center operator to judge the status of the customer's service. The remote status indicators are grouped as follows:

1. The EXCESS ACTY and EXCESS MFR parameters are both sent as a PERFORMANCE INTERMITTENT status indication.
2. The EXCESS ERR RATE parameter is sent as a status indication point under its own name.

In summary, only the performance alarm is automatically sent to the central alarm-reporting point. To determine whether a performance alarm is activated by a performance intermittent or an EXCESS ERR RATE condition, perform a status poll of the station reporting the alarm condition.

The process for sending all alarms and status indications to the remote alarm center is carried out through the station controller and either the built-in service channel or an external transmission circuit. All performance indications are transferred from the channel controller to the station controller unit by a serial data link. The station controller formats this alarm and status information for transmission to the alarm telemetry interface.

MANUAL RESETTING TECHNIQUES

The automatic reset, described above, occurs whenever the 24-hour count for each parameter falls below its respective threshold. There are also ***local*** or ***remote*** manual alarm reset features. The alarms are reset locally with the ALM RST control in the regenerator or terminal bay. The performance alarm and its associated indications are reset, and each of the 48 subperiod counters in the 24-hour channel controller performance data memory is reset to zero.

To perform an alarm reset from a remote location, send a ***performance test*** command. This is normally sent from the alarm and control center. When the command is received by the channel controller, the command processing circuit initiates a 15-minute performance verification interval. At the same time, the controller resets an existing performance alarm and its associated status indications to the nonactive or off state. This reset operation does not initially alter the existing 24-hour data base memory however. The final action with such a remote reset depends on what takes place in the following 15-minute observation interval. One of the following conditions will occur:

- If a single loss-of-frame occurs or an error rate event exceeds the threshold established for the EXCESS ERR RATE parameter during the 15-minute observation interval, a performance alarm is immediately reinstated and the 24-hour data base is left as is.
- If the 15-minute observation period remains quiet, then the 24-hour performance data base memory is also reset to zero.

Only the features and details of the ***performance test*** command that are necessary to understand the remote reset feature are described here. The ***performance test*** mode of monitoring has other features that also make it useful for other maintenance activities. These additional features, and more of the general details of this useful command, are described later in this section.

STATION-TO-STATION SYNCHRONIZATION OF MONITORS

For site-to-site comparison of alarm and status information, the start and stop of the sub and main observation periods are synchronized at all stations within a terminal-to-terminal switch section. This makes it possible to determine if events detected at multiple stations are the same events. The timing clocks in each station are synchronized automatically every 24 hours or whenever the station controller is manually reset.

Whenever a synchronization command is sent from a terminal station, the current observation interval at all stations under control of that terminal is terminated.

PERFORMANCE TEST MODE MONITORING

MODES OF USING THE PERFORMANCE TEST COMMAND

Using the ***performance test*** command for remotely resetting performance monitors has already been described. As noted earlier, two other modes of using the ***performance test*** command are extremely useful during maintenance activity and troubleshooting. Both of these modes, the manual single-interval mode (performance verify test) and the automatic repetitive mode (real-time performance test), take advantage of the features available through the ***performance test*** mode of monitoring. To effectively use the features available with this mode of monitoring, maintenance personnel should become familiar with the details of the operating characteristics of the performance monitoring system while in the ***performance test*** mode. Knowing these characteristics can help them determine the best mode to use for a specific situation.

OPERATING CHARACTERISTICS OF THE PERFORMANCE TEST MODE

As with the remote reset operation, whenever the ***performance test*** command is sent from the remote alarm center, a 15-minute performance observation interval is initiated by the channel controller at the station addressed to receive the command. In addition, any existing performance alarm and associated EXCESS parameter status indicators are immediately reset to the nonactive or off state.

As soon as the 15-minute performance observation interval starts, the channel controller suspends operation of the local EXCESS parameter indicators on its faceplate. The error rate bar-graph on the channel controller faceplate is not disabled during this period however. The active bar-graph provides for the local real-time observation of the current error rate to assist maintenance personnel at the site. The 24-hour monitoring process also continues in the background following the initial activation of the ***performance test*** mode.

Once the 15-minute observation interval begins, the performance-checking circuits will reinstate or activate a remote performance alarm and the remote EXCESS parameter status indication that caused the alarm if:

- A single out-of-frame event occurs (besides activating the performance alarm, this event also activates the performance-intermittent remote status indication)
- Errors occur that result in an error rate exceeding the error rate threshold for the applicable normal in-service EXCESS parameter subperiod (see *Note*).

  Note: For DDS applications, the error rate threshold is that established for the excess error rate parameter subperiod. The EXCESS ERR RATE remote status indication is activated.

  For MTS applications, the threshold is the error rate threshold established for the excess activity observation subperiod and the activated remote status indication is performance-intermittent.

If either of these two events occurs, the monitor is programmed to latch the resulting performance alarm for the duration of the 15-minute observation period. The performance-intermittent and EXCESS ERR RATE status indications are not permanently latched to permit quasi real-time remote status monitoring. The remote status indications are held active for 20 seconds to ensure that short events are captured by the remote telemetry system during scanning. This approach enables the maintenance personnel at the remote alarm center to determine the severity of a problem by observing the repetition rate of the remote status indication.

If neither of these events occur, the performance monitor and the 24-hour data base are reset to zero just as described for the remote reset operation.

The ***performance test*** command mode also has an interrupt feature that permits both enhanced manual and repetitive use of this valuable maintenance tool. If the ***performance test*** command is sent while the 15-minute performance evaluation period is still active, a new 15-minute test period begins immediately. This feature is used to generate the automatic repetitive ***performance test*** mode. The automatic repetitive mode is achieved by programming the alarm center control circuits to repetitively issue the ***performance test*** command. Therefore, a continuous almost-real-time monitoring mode can be established by a command from the alarm center. While in this monitoring mode, continuous analysis of the remote alarm and status indications from all stations in the section makes it possible to isolate intermittent system problems to a single radio hop. Manually using this interrupt feature speeds up performance analysis following repairs or replacements that were made to eliminate problems of a continuous nature. The alarm center can help maintenance personnel at the problem site by

monitoring performance during troubleshooting that is being done by the replace-and-retest process. The ability to start a new 15-minute interval at will can reduce the time to isolate a defective unit, especially if the defective unit is at the transmit end of a radio hop.

SELECTING THE PERFORMANCE TEST MODE TO USE

The choice of which ***performance test*** mode to use depends largely on the situation requiring maintenance.

The manual single-interval performance verify test mode is used to quickly evaluate repairs or replacements that were made to eliminate problems of a continuous nature. Activating this monitoring mode after each repair attempt will help locate the problem once the suspected radio hop and/or station has been isolated.

This mode is especially useful if the performance problem is at the transmit end of a hop and if craft is available at that end only. Alarm center personnel can use the performance verify test to observe the performance by the performance monitor at the receive end and inform the maintenance personnel at the transmit end of the results of each attempt to isolate and eliminate the problem. It is also the final test used to verify that a fix has indeed been found for problems that require only the one 15-minute observation to verify elimination.

The primary use of the automatic repeating-interval mode real-time performance test is to locate the intermittent problems and then to verify their elimination following maintenance activity. Such problems may be due to intermittent equipment troubles or propagation problems that occur infrequently enough to escape detection by the normal in-service monitoring mode. The near real-time reporting capability makes this mode especially well suited to pinpointing the location of these problems. By continuously using this monitoring mode simultaneously at all stations in a terminal-to-terminal section, the hop causing an intermittent problem can usually be located as soon as the intermittent problem occurs again. When fading or propagation problems are suspected, activating and carefully analyzing the reported results during the suspected fading periods will usually result in isolating the source station. Similarly, after replacements and/or repairs, the repetitive mode may be used to verify that the problem has been solved. The repetitive mode must be used over a long enough interval to verify that the original problem was eliminated. This monitoring mode can be used to evaluate the entire system at initial turnup time or at any time this evaluation is desired.

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