Subject: Digital Channel Banks - Modifications for D1D, D2, and D3 to increase carrier failure delay timing

SL: IL 81-02-438

type letter: Information Letter

date: February 20, 1981

distribution lists: NSV 079, 119, 144, 206

sl: IL 81-02-438

file no. related letters:

other: EL4246
Topical Index Code 1S3.160

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to: Division Managers - Network Maintenance and Maintenance Engineering

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Description: Reviews carrier failure alarm delay timing for digital terminal equipment, and provides ordering information for modifications to change most of the early channel banks to agree with current design. Application considerations are reviewed.

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With the introduction of the No. 4 ESS Digroup Terminal and the D4 Channel Bank, the time delay between carrier failure detection and trunk processing was increased to about two seconds. The increased timing together with hit integration and forced off-hook or signaling "freeze", results in fewer call disconnects from short duration carrier failures. Modifications to add these features to earlier channel banks have been developed. The attached memorandum provides additional details on the operation of carrier failure alarms, reviews the considerations involved in modifying the older banks to extend the alarm timing interval, and provides information for ordering modifications and new plug-in units.

Questions should be directed to R. R. Heacox (201-221-4431) or B. A. Fralick (201-221-4427).

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(NE&CP)
310.080403 - Information Letters (IL's) IL 81-02-438
310.080404 - Engineering Letters (EL's) EL 4246
235.0701 - T-Carrier Terminal Equipment

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Document review date.....
(Red stamp denotes official file copy.)

St. Louis, October 20, 1981

A blind transmittal
No recommendation
action or guidance
provided.

GENERAL MANAGER-NETWORK - Little Rock:
Topeka:
Oklahoma City:

GENERAL MANAGER-SWITCHED SERVICES - Kansas City:

DIRECTOR-SWITCHED SERVICES - Dallas:

Attached are copies of EL 4246 (IL 81-02-438) which reviews carrier failure alarm delay timing for digital terminal equipment, discusses the considerations involved in modifying the older banks to extend the alarm timing interval and provides information for ordering modifications and new plug-in units.

Questions may be directed to Mr. W. K. Litzinger (Transmission Equipment Engineering) on 314-247-8577, or Mr. H. Holzwarth (Transmission Engineering) on 314-247-7110.

Edward Egizi

Assistant Vice President-
Network Central Office Engineering and
Circuit Provisioning

Attachment

Memorandum

Introduction

Carrier failure alarms and trunk processing functions were included in the original digital terminal design. With the introduction of Digroup Terminals for No. 4 ESS and the D4 channel bank, the time delay (initiate timing) for trunk processing following carrier failure (out-of-frame-condition) has been increased from a nominal 300 milliseconds to approximately 2 seconds. The D4 and current production of D3 alarm control units have the increased timing.

Two seconds nominal initiate timing will be used in all new digital terminal equipment, coupled with hit integration, forced off-hook or signaling freeze, and the use of a 2 second minimum charge delay in switching machines.

This memorandum discusses the major reasons for the decision to change initiate timing, and the circumstances under which consideration should be given to retrofitting older banks with the 2-second alarm delay modifications.

Channel Bank Reframes, Alarms, and Trunk Processing

A channel bank is "out-of-frame" when the receiver circuitry cannot recognize the framing pattern. The need to reframe can be caused by a number of events. T line or channel bank hard failures will cause reframes and CFAs, resulting in trunk processing. Intermittent troubles such as noise, craft activity, marginal equipment performance or improper design can cause reframes, some of which will cause CFAs depending on the duration of the reframe condition. Failures lasting more than 5 minutes account for only 10% or less of the CFAs, so most CFAs are not related to hard system failures.

Carrier failure alarms will rarely be caused by lightning on a properly protected, bonded and grounded cable. Lightning disturbances generally last less than 300 milliseconds.

The time that a bank waits after it begins to receive frame failures before initiating a carrier failure alarm (CFA) and trunk processing is referred to as incoming alarm delay (IAD) or trunk processing initiate timing. In the original design of the older banks, the IAD interval varied from a minimum of about .3 seconds in D1A, B, C and early D3, to a maximum of about .5 in D1D.

In the original D1, D2 and D3, the circuit that generated the IAD recovered much more quickly than the IAD time. Thus, short duration intermittent trouble could continue indefinitely without causing a carrier failure alarm. Hit Integration is a term applied to a system in which the recovery is much longer than the IAD time. An index for Hit Integration is the ratio of the recovery time to the IAD time, each of which should be measured after a bank has been in the initial state long enough for the integrating circuit to have stablized. In cases where loss of framing is intermittent, Hit Integration insures that an alarm will eventually occur.

During the IAD interval, before CFA and trunk processing, initial signaling conditioning occurs. Initial signaling conditioning is needed to prevent service interruptions during the alarm delay period. With long IAD periods, it is desirable to at least force the channels to the busy state during IAD so calls in progress are not dropped. D4 initial signaling conditioning is different than on the earlier designs in that each channel is held in the signaling state it was in when the out-of-frame condition occurred until the bank either reframes or declares a CFA. D1D, D2, and D3 include options to force off-hook.

When a bank has been out-of-frame longer than the trunk processing initiate time, a carrier failure alarm (CFA) occurs. The alarm is in one of two forms: (1) Red, indicating the local receive circuit cannot find the proper framing pattern or, (2) Yellow, indicating the far end receiving circuit has been unable to find a proper framing pattern. When a CFA has been declared, trunk processing occurs and office alarms are initiated. In order to notify the distant terminal that CFA has occurred, digit 2 is deleted from the outgoing bit stream. Trunk processing actions are taken at both ends to release established connections, make outgoing trunks appear busy, make incoming trunks appear idle, and prevent noise from entering the office trunk circuits.

Factors Related to CFA Initiate Timing

There are a number of factors that must be weighed when considering a change in CFA initiate timing, such as cut-off and false charging, equipment and maintenance cost trade-offs, end-to-end compatibility, trouble recognition and location procedures, special service/trunk mixture, and Indexes.

Service

With increased alarm delay timing, reframes from causes other than hard failures are not as likely to cause trunk processing and customer disconnects. With the new circuits, reframe condition must exist for 2 seconds before alarms and trunk processing occur. Based on several field evaluations, the disconnect rate using .3 sec timing (1 in 7,840 calls) is 3.5 times more than the rate with 2 second timing (1 in 28,011 calls). So with 2 second timing about 72 percent fewer calls are disconnected due to isolated carrier reframes. Reducing cut-offs will reduce the probability of charging for interrupted calls.

The economics and benefits of retrofitting banks for 2 second timing depend on a number of factors that may be difficult to evaluate. Following are some typical figures and other important considerations:

Refunds

Based on data gathered in 1973-1974, the average T-1 system experience about 5 CFAs per month. If 20 channel units are installed and assuming 10 are in use at the time of the CFA, then 50 disconnects per system occur each month. Experience shows that about 25% of the customers disconnected request a refund, resulting in about 17 refunds. Since refunds average $1, each system causes about $17 in refunds a month. Keep in mind that the refund processing effort usually costs much more than the refund. Assuming a reduction of CFAs by 50% with 2 second timing, about $8 a month (not including processing) or $96 annually would be saved. These savings should be weighed against the costs of converting to the new timing interval.

Compatibility

Channel banks with different CFA timing are end-to-end compatible. However, the timing in the bank that senses the framing failure will determine the trunk process timing for that particular failure. Both banks will process trunks at about the same time, but the timing for the system will depend on which bank detects the failure (see Figure 1). Forced off-hook and hit integration features will only be effective in those cases where they exist in the bank sensing the failure.

Index

As discussed above, increasing IAD time to two seconds is expected to reduce CFA activity on the older banks by about 50%. In some cases, improvement in the CFA component will result in a substantial improvement in the T-carrier index. While it should be recognized that CFA timing can bias the T-carrier Index, we do not expect that you will find that improvement of the Index alone is important enough to warrent the cost of the modifications.

Direct Interface

With the development of direct carrier to switching system interface arrangements, in many cases it will be necessary (as in No. 4 and No. 1 ESS with DCT) or convenient to assign switched and non-switched services to separate digital terminals. Most switched services will require trunk processing functions; non-switched services may not. Where a mixture of services or switching systems is served by the same bank, options have been provided to allow flexibility in selecting the specific trunk processing functions, if any, employed.

Since two second timing may blind the maintenance forces to short duration outages that seriously degrade data services, introduction of two second timing delay makes line maintenance more important.

Line Switching

Where digital radio or higher-order multiplexed lines with switched back-up facilities are used, the digital terminal alarm initiate timing delay must be longer than the line facility switching interval. Otherwise, trunk processing would occur before or during line switching. If CFA occurs before the line switch, the terminal will remain out of service for 10 to 15 second after the switch is completed and the terminal has reframed.

D Bank Alarm System Summary

The following table summarizes the basic features of all modified and unmodified D banks:

Bank	Alarm Initiate Timing	Hit Integration Index	Initial Signal Conditioning	Comments
D1A,B,C	0.3 sec.	No	Random	
D1D	0.5	No	Off-Hook	Y option not recommended (ACU)
D1D (modified)	2.0	9	Off-Hook	Y option not recommended (ACU)
D2	0.4	No	Off-Hook	
D2 (modified)	2.0	8	Off-Hook	
D3	0.3	No	Off-Hook	C option recommended (IU)
D3 (modified)	2.0	8	Off-Hook	C option recommended (IU)
D4	2.5	5	Frozen	Locked to state prior to out of frame condition

Figure 1 shows the timing sequence for all W.E. D3 compatible banks. On the Figure, time is normalized to the moment office alarms and trunk processing occur at the terminal that has lost framing.

Modifications

The Modifications currently planned for alarm initiate timing are as follows:

D1A, B, C - No action is planned to design a 2-second IAD or forced off-hook initial signaling conditioning.

D1D - There are two models of Alarm Control Units existing, the J98711Y-1 and J98711Y-2. The latter is current manufacture. Each is modified by removing some components and adding an applique printed wiring board. Both Y1s and Y2s will be modified at the Merrimac Valley Works, and the change for Y2 is in the new product. SD-3C150-01, Issue 8B will show the new circuits. The following data apply:

Order Wording	Approximate Price Each	Availability
(Qty) J98711Y-1 L5 (NON X)	$12.60	26 Weeks WEE 16 Weeks TCE RTO Now
(Qty) J98711Y-1 LA (NON X)	1.20	" "
(Qty) J98711Y-1 LB (NON X)	1.42	" "
(Qty) J98711Y-1 LC (NON X)	.75	" "
(Qty) J98711Y-2 L2	310.00	" "
(Qty) J98711Y-2 L3 (NON X)	9.27(EST.)	" "
(Qty) J98711Y-2 L4	363.00	" "
(Qty) J98711Y-2 LA	.61	" "

Identification of Units with Two Sec. Timing	CLE*
J98711Y1,L1 and L5; Mod A, B, C, D	T1AC432EAA
J98711Y1,L1, 5 & A; Mod A, B, C, D	T1AC432EAB
J98711Y1,L1, 5 A & B; Mod A, B, C, D	T1AC432EAC
J98711Y1,L1, 5, A, B & C; Mod A, B, C, D	T1AC442EAA
J98711Y2,L2, 3; Mod A and B	T1AC442EAB
J98711Y2,L2, 3 & A; Mod A and B	T1AC442EAC
J98711Y2,L4	T1AC442EAD

D2 - There are two Alarm Control Units, DM17 (Manufacture Discontinue) and DM57. The same applique circuit is used to modify both units. Modifications will be done by the Merrimack Valley works.

The Common Signaling Receiving Unit DM13 must also be modified to provide the forced off-hook feature.

The applique circuits and related changes are shown on SD-99478-01 Issue 16B. Modifications may be ordered as follows:

Order Wording	Approximate Price Each	Availability
(Qty) Pack, Circuit DM 13 (Conversion)	$20.00	Non-Stock 4 Weeks ARO RTO Now
(Qty) Pack, Circuit DM 57 (Conversion)	70.00	" "
(Qty) Pack, Circuit DM 17 (Conversion)	44.00	Non-Stock 4 Weeks ARO RTO 11-3-80

Identification of Units with Two Sec. Timing	CLE*
DM13	D2CPA13AAA
DM17	D2CPA17AAA
DM57	D2CPA57AAA

* For Information Only - Common Language Codes should be obtained from Bell System Practices 795 Series when approved for use.

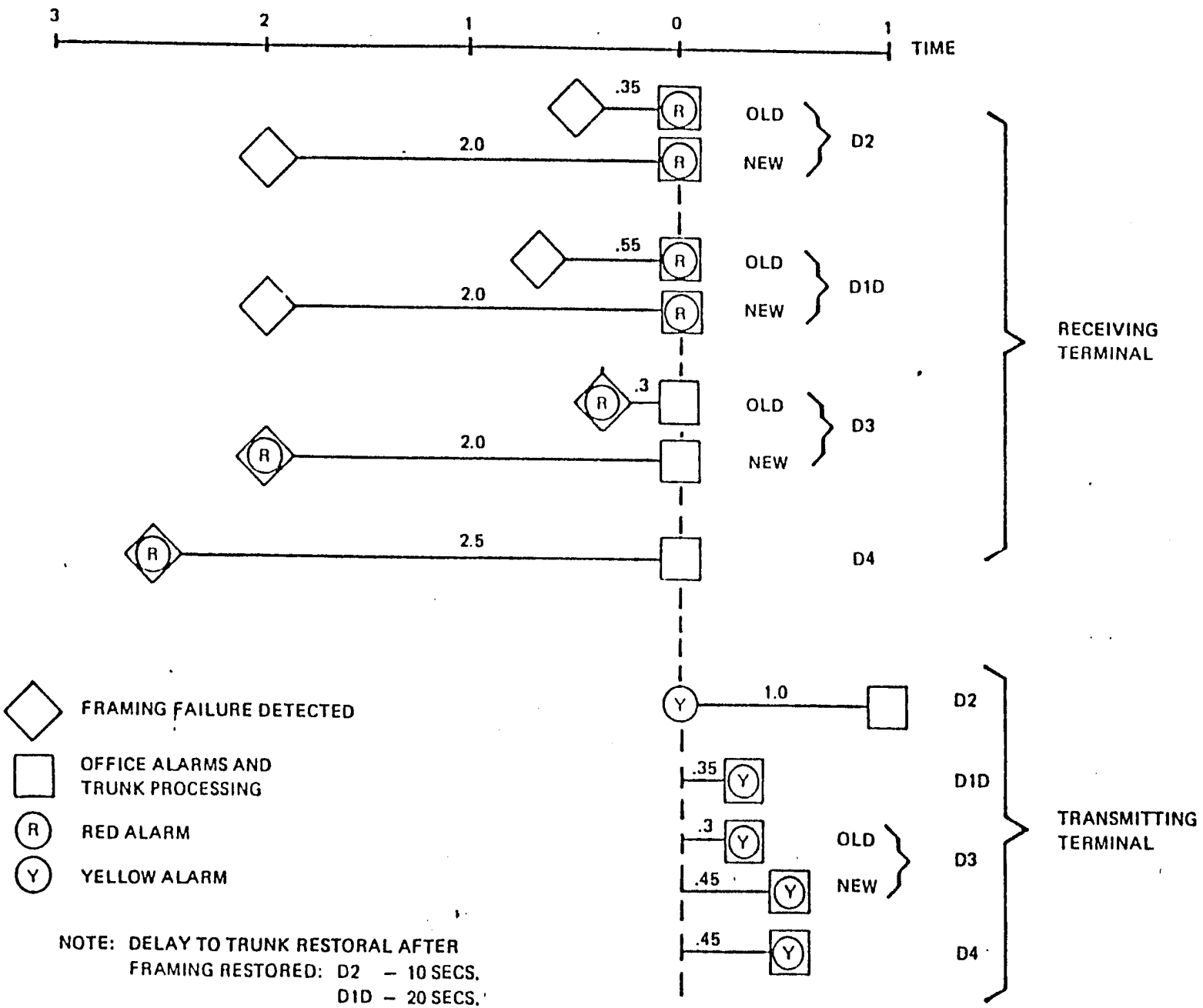
D3 - The Alarm Control Units currently in manufacture provide 2-second alarm delay. The Interface Units have an option screw (c) which is in the down or off-hook position at shipment and should be left in that position to obtain proper initial signal condition. There is no plan to provide a 2 second timing modification for the old ACUs.

D4 - No modifications are required since the D4 bank has always featured 2.5 second IAD and initial signal conditioning.

Summary

The modifications described above are intended to improve service by reducing cut-offs due to short-duration loss of framing. In addition, these modifications will eliminate many terminal alarms that generally have little or no significance in T-carrier line or terminal maintenance. By eliminating alarms that do not contribute significantly to locating troubles, attention is drawn to alarms that are useful in correcting service effecting problems.

ALARM AND TRUNK PROCESSING TIMING FOR D-TYPE CHANNEL BANKS – EL4246



NOTE: DELAY TO TRUNK RESTORAL AFTER FRAMING RESTORED: D2 – 10 SECS.
D1D – 20 SECS.
D3 – 14 SECS.
D4 – 15 SECS.

FIGURE 1