WWG PF-45

DS1 / DS3 Analyzer

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Description and Operating Manual

PF-45 DS3/DS1 Analyzer

BN 9402/01
BN 9402/02 Series I...

Wandel & Goltermann

Electronic Measurement Technology

INTRODUCTION - **READ ME FIRST!**

Your PF-45 comes with the following written resources:

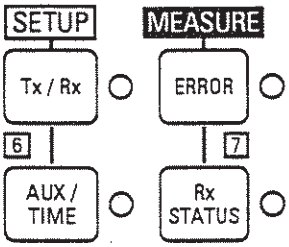
Use these to get started, and for normal use:

(this) INTRODUCTION
SHORT OPERATION MANUAL (in slide-out drawer under instrument)

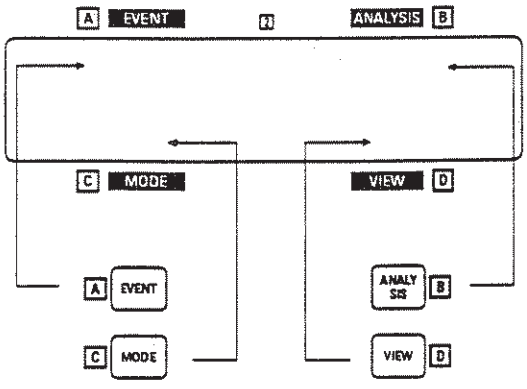
Use these for a reference, and for advanced features:

Chapter 1 - Detailed Specifications
Chapter 2 - Safety and initial turn-on
Chapter 3 - Complete operation of PF-45
Chapter 4 - Applications:
How to perform certain common measurements
Other helpful measurement hints
Overview of PF-45 features and operation
Chapter 5 - Quick functional checkout
Appendix A - Short tutorial on PCM
Appendix B - Remote control

Learn these two "secrets": and you're ready to begin operation of the PF-45 with the help of the SHORT OPERATION MANUAL



these keys control the **display category**.



these keys correspond to the **four quadrants** of the display, and are used to change the value displayed in that quadrant.

Now you are ready to start using the PF-45 with the help of the SHORT OPERATION MANUAL. Good luck!

FIGURES

1.1 OPERATION MODES

1.1.1 Test (Out-of-Service) Modes

Tx3 -> Rx3

Transmit rate/jack . . . . . DS3 Tx
Receive rate/jack . . . . . DS3 Rx
Pattern/Rate . . . . . PRBS/digital word, at DS3
M13 C-bits . . . . . 7-in-18 pattern (001001001001001011...), no stuffing or destuffing
C-Parity C-bits . . . . . 1st C-bit of M-subframe 1 =1, C-bits of M-subframe 3 = parity, C-bits of M-subframe 4 = FEBE, (nominally 111), all other C-bits = 1, no stuffing or destuffing

Tx1->Rx1

Transmit rate/jack . . . . . DS1 Tx
Receive rate/jack . . . . . DS1 Rx
Pattern/Rate . . . . . PRBS/QRSS/digital word, at DS1

Tx1->Rx^3_1

Transmit rate/jack . . . . . DS1 Tx
Receive rate/jack . . . . . DS3 Rx
Pattern/Rate . . . . . PRBS/QRSS/digital word, at DS1
Rx DS1 . . . . . dropped from Rx DS3
Select . . . . . (dropped) DS1 # 1-28
DS3 Destuffing . . . . . according to received C-bits for M13, stuck destuffing for C-Parity
DS2 Destuffing . . . . . according to received C-bits
DS3 Tx Jack . . . . . transmits a Tx^3_1-type "keep-alive" signal
Tx^3_1 Keep Alive . . . . . 28 copies of the Tx1 signal are muxed to DS3

Tx^3_1->Rx1

Transmit rate/jack . . . . . DS3 Tx
Receive rate/jack . . . . . DS1 Rx
Pattern/Rate . . . . . PRBS/QRSS/digital word, at DS1, or external DS1
Tx Signal . . . . 28 identical DS1 test patterns are multiplexed to DS3 (M13/C-Parity compatible)
DS3 Stuffing . . . . . stuffed according to 7-in-18 pattern for M13, or stuck stuffing for C-Parity
DS2 Bitrate . . . . . determined by DS3 bitrate, and DS3 stuffing pattern
DS2 Stuffing . . . . . dynamic stuffing, determined by DS2 and DS1 bitrates

Tx^3_1->Rx^3_1

Transmit rate/jack . . . . . DS3 Tx
Receive rate/jack . . . . . DS3 Rx
Pattern/Rate . . . . . PRBS/QRSS/digital word, at DS1, or external DS1
Tx Signal . . . . 28 identical DS1 test patterns are multiplexed to DS3 (M13/C-Parity compatible)
Rx DS1 . . . . . dropped from Rx DS3
Select . . . . . (dropped) DS1 # 1-28
DS3 Stuffing . . . . . stuffed according to 7-in-18 pattern for M13, or stuck stuffing for C-Parity
DS2 Bitrate . . . . . determined by DS3 bitrate, and DS3 stuffing pattern
DS2 Stuffing . . . . . dynamic stuffing, determined by DS2 and DS1 bitrates
DS3 Destuffing . . . . . according to received C-bits for M13, stuck destuffing for C-Parity
DS2 Destuffing . . . . . according to received C-bits

1.1.2 Monitor Modes

MON3

Receive rate/jack . . . . . DS3 Rx
In-service monitoring of DS3
Pattern . . . . . defaults to "Live", ie, no pattern
. . . . . however, DS3 test patterns can be selected in the Pattern Select Page
. . . . . in which case the PF-45 searches monitored DS3 for selected Rx pattern
C-bits . . . . . no destuffing

MON1

Receive rate/jack . . . . . DS1 Rx
In-service monitoring of DS1
Pattern . . . . . defaults to "Live", ie, no pattern
. . . . . however, DS1 test patterns can be selected in the Pattern Select Page
. . . . . in which case the PF-45 searches monitored DS1 for selected Rx pattern

MON^3_1

Receive rate/jack . . . . . DS3 Rx
In-service monitoring of DS3/DS2/DS1
Monitored DS1 . . . . . dropped from Rx DS3
Select . . . . . (dropped) DS1 # 1-28
Pattern . . . . . defaults to "Live", ie, no pattern
. . . . . however, DS1 test patterns can be selected in the Pattern Select Page
. . . . . in which case the PF-45 searches monitored DS1 for selected Rx pattern
DS3 Destuffing . . . . . according to received C-bits for M13, stuck destuffing for C-Parity
DS2 Destuffing . . . . . according to received C-bits

(Additional MON$^{3}_{1}$ features with E1 Drop/Analysis Option)
In-service monitoring of . . DS3, dropped DS2E (CCITT G.747) and E1 (2.048Mb/s CEPT Level 1)
Select . . . . . (dropped) channel # 1-28
Identity of channel as DS1 or E1 . . . . . automatically determined upon channel selection

1.1.3 Through Modes

THRU3
Receive rate/jack . . . . . DS3 Rx
Transmit rate/jack . . . . . DS3 Tx
In-service monitoring of DS3
Pattern . . . . . defaults to "Live", ie, no pattern
. . . . . however, DS3 test patterns can be selected in the Pattern Select Page
. . . . . in which case the PF-45 searches DS3 for selected Rx pattern

THRU1
Receive rate/jack . . . . . DS1 Rx
Transmit rate/jack . . . . . DS1 Tx
In-service monitoring of DS1
Pattern . . . . . defaults to "Live", ie, no pattern
. . . . . however, DS1 test patterns can be selected in the Pattern Select Page
. . . . . in which case the PF-45 searches DS1 for selected Rx pattern

THRU$^{3}_{1}$
Receive rate/jack . . . . . DS3 Rx
Transmit rate/jack . . . . . DS3 Tx
In-service monitoring of DS3/DS2/DS1
Pattern . . . . . defaults to "Live", ie, no pattern
. . . . . however, DS1 test patterns can be selected in the Pattern Select Page
. . . . . in which case the PF-45 searches DS1 for selected Rx pattern
Monitored DS1 . . . . . dropped from Rx DS3
Select . . . . . (dropped) DS1 # 1-28
DS3 Destuffing . . . . . according to received C-bits for M13, stuck destuffing for C-Parity
DS2 Destuffing . . . . . according to received C-bits

1.1.4 Drop & Insert Modes

(Hitless Drop & Insert is performed, ie. no DS2s are disrupted and no DS1s other than the inserted channel are affected.)

Int $D\&I^3_1$

(Internal Drop & Insert)

Transmit rate/jack . . . . . DS3 Tx
Receive rate/jack . . . . . DS3 Rx
Pattern source/sink . . . . . "Internal" PF-45 DS1 Pattern Generator/Receiver
Pattern/Rate . . . . . PRBS/QRSS/digital word, at DS1
Select . . . . . (dropped/inserted) DS1 # 1-28
DS3 Destuffing . . . . . according to received C-bits for M13, stuck destuffing for C-Parity
DS2 Destuffing . . . . . according to received C-bits
DS2 Stuffing . . . . . dynamic stuffing, determined by DS2 and DS1 bitrates
Rx: DS1 for analysis . . . . . Dropped DS1

Ext $D\&I^3_1$

(External Drop & Insert)

Transmit rate/jack . . . . . DS3 Tx
Receive rate/jack . . . . . DS3 Rx
Pattern source . . . . . (rear panel) DS1 Insert jack
Pattern sink . . . . . (rear panel) DS1 Drop jack
Pattern rate DS1
Pattern . . . . . defaults to "Live", ie, no pattern
. . . . . however, test patterns can be selected in the Pattern Select Page
. . . . . in which case the PF-45 searches monitored DS1 for selected Rx pattern
Select . . . . . (dropped/inserted) DS1 # 1-28
DS3 Destuffing . . . . . according to received C-bits for M13, stuck destuffing for C-Parity
DS2 Destuffing . . . . . according to received C-bits
DS2 Stuffing . . . . . dynamic stuffing, determined by DS2 and DS1 bitrates
Rx: DS1 for analysis . . . . . Dropped DS1

INS^3_1->Rx1

(Insert DS1 into live DS3)

Transmit rate/jack . . . . . DS3 Tx
Receive rate/jack . . . . . DS3 Rx
Pattern source/sink . . . . . "Internal" PF-45 DS1 Pattern Generator/Receiver
Pattern/Rate . . . . . PRBS/QRSS/Digital Word, at DS1
Select . . . . . (inserted) DS1 # 1-28
DS3 Destuffing . . . . . according to received C-bits for M13, stuck destuffing for C-Parity
DS2 Destuffing . . . . . according to received C-bits
DS2 Stuffing . . . . . dynamic stuffing, determined by DS2 and DS1 bitrates
Rx1: (DS1 for analysis) receive rate/jack . . . . . DS1 at Rx jack [14]

1.2 MEASUREMENTS

1.2.1 Simultaneous Measurements

DS3 or DS1 Bit (Logic) Errors and BPVs (each)
Error Count
Errors Per Second/Max. Errors Per Second
Dribbling Error Count
Current Error Ratio/Max. Current Error Ratio
Average Error Ratio
Dribbling Error Ratio
Errored Seconds

	DS3	DS1
Threshold ErrSecs	<E-6	<E-5
Threshold ErrSecs	≥E-6	≥E-5
Threshold ErrSecs	≥E-5	≥E-4
Threshold ErrSecs	≥E-4	≥E-3
Threshold ErrSecs	≥E-3	≥E-2

% Error-Free Seconds

DS3, DS2 and DS1 Frame Errors* (each)
Error Count
Errors Per Second/Max. Errors Per Second
Current Error Ratio/Max. Current Error Ratio (DS3 only)
Average Error Ratio
Errored Seconds

	DS3	DS2/DS1
Threshold ErrSecs	<E-4	<E-3
Threshold ErrSecs	≥E-4	≥E-3
Threshold ErrSecs	≥E-3	≥E-2
Threshold ErrSecs	≥E-2	≥E-1

% Error-Free Seconds

* DS3 Frame Errors: F & M-bit errors
DS2 Frame Errors: F & M-bit errors
DS1 D4/SF Frame Errors: F & M-bit errors
DS1 ESF Frame Errors: F-bit errors
DS1 SLC-96/CCIS Frame Errors: F-bit errors

DS3 Parity, C-Parity and FEBE Errors (each)
Error Count
Errors Per Second/Max. Errors Per Second
Current Error Ratio/Max. Current Error Ratio (Estimated BER)
Average Error Ratio (Estimated BER)
Errored Seconds

	DS3
Threshold ErrSecs	<E-6
Threshold ErrSecs	≥E-6
Threshold ErrSecs	≥E-5
Threshold ErrSecs	≥E-4

% Error-Free Seconds

DS1 CRC-6 Errors
Error Count
Errors Per Second/Max. Errors Per Second
Current Error Ratio/Max. Current Error Ratio (Estimated BER)
Average Error Ratio (Estimated BER)
Errored Seconds
SevErrSecs: ≥320 err/sec
% Error-Free Seconds

DS3 Rx Status
No Signal Seconds
No Frame Sync Seconds
Pattern Sync Loss Seconds
AIS/Blue Seconds
X-bit Seconds
Idle Seconds

DS2 Rx Status
No Signal Seconds
No Frame Sync Seconds
AIS Seconds
X-bit Seconds

DS1 Rx Status
No Signal Seconds
No Frame Sync Seconds
Pattern Sync Loss Seconds
AIS Seconds
Yellow Alarm Seconds
Excess Zeros Seconds

PF-45 Operating Manual Errata Sheet

June 2, 1993

Description of Problem

The PF-45 may report an incorrect reading for the DS1 Peak Voltage, if you manually reset the instrument during power-up. This problem only occurs if you have the Signal Analysis option installed. You can manually reset the PF-45 to its factory default settings by holding down both Data Entry keys while the instrument is powering up. This procedure is described in section 2.3.8. of the *PF-45 Operating Manual.*

Work-around

Because the PF-45 remembers its settings when the power is switched off or interrupted and then restores the settings when the power is re-applied, it is normally not necessary to manually reset the PF-45 to its factory default settings.

If you need to perform the manual reset, you can avoid the problem described above by temporarily setting the operation mode to TX31->RX31 after the manual reset. Then you can change any of the settings without adversely affecting the DS1 Peak Voltage reading. Setting the operation mode is described in section 3.4.1. of the *PF-45 Operating Manual.*

1.10.2 Store/Recall
(Additional feature with IEEE 488/RS-232 Remote Control Option)

Setups stored 16
Storage method ..... EEPROM (no backup battery required)
Store/Recall accessed via..... [Tx/Rx] Setup Page, IEEE-488, or RS-232 Remote Control
Stored Setup values ..... Mode, Tx/Rx Level, Frm, Clk, Pattern, Cont/Timed Run, AutoPrint Selection
Write Protection ..... available via IEEE-488 or RS-232
Preview of stored values ..... via built-in printer

3.13 STORE/RECALL OPERATION
(Additional feature with IEEE 488/RS-232 Remote Control Option)

The STORE/RECALL feature is available when an IEEE 488/RS-232 Remote Control Option card is installed in a PF-45. The EEPROM on this card provides the nonvolatile memory for this function.

Front panel access of STORE/RECALL is found within the [Tx/Rx] Setup Page. Normal PF-45 Mode selection is performed by pressing the [C] key, and then "executing" the setup with the [D] key.

```
A                B
Setup:New Mode
Tx3->Rx3   Execute
C                D
```

Recall
Press [A] to bring up the Setup Recall Page seen below. The "**" after Recall is a null-location, eliminating the possibility of accidentally recalling a stored setup.

```
A                B
Setup:Recall
Recall:**
C                D
```

Press the [C] key to select the desired Recall position, 1-16. Press the [D] key to "execute" the recall. If the Recall position does not contain a stored setup, the display field associated with [D] will show "empty" after [D] is pressed.

```
A                B
Setup:Recall
Recall:01 Execute
C                D
```

Before "executing", *the recalled setup can be previewed* by pressing the [MAN PRINT] key. The PF-45 will print the stored setup. Here is an example:

```
PF45:Print Setup #01
Mode: Tx->Rx1
Code:AMI      Rx:Term
Frm1:D4/SF   Clk1:Int
Ptn:QRSS20
Error Insert:    @DS1
Aux Err:     Loopback
Test Duration: Cont.
Clock:       08:12:03
Date:        Dec01'93
AutoPrint:        Off
PF45:   End of Setup
```

Store

Press [A] to bring up the Setup Store Page seen below. The "**" after Store is a null-location, eliminating the possibility of overwriting an important stored setup accidentally.

```
 A                B
┌──────────────────┐
│Setup:Store       │
│                  │
│Store:**          │
└──────────────────┘
 C                D
```

Press the [C] key to select the desired Storage position, 1-16. Press [D] to "execute" the storage process. If the selected storage position is *write protected*, the store will be aborted, and the printer will print "Setup #xx Recall Error".

Before "executing" the store, *the existing stored setup can be reviewed* by pressing the [MAN PRINT] key. The PF-45 will print the existing stored setup. If the stored setup is *write-protected*, the first line of the setup printout will be "Protected Location".

```
 A                B
┌──────────────────┐
│Setup:Store       │
│                  │
│Store:01  Execute │
└──────────────────┘
 C                D
```

Delete

Though not shown on the front panel display, a delete (erase) function is available. Press the two [down arrow] keys simultaneously to delete the currently selected stored setup(s). If "**" is selected, all setups that are not *write-protected* will be deleted.

1.1.4 Drop & Insert Modes

Ext D&I$^3_1$

(Additional ExtD&I$^3_1$ features with E1 Drop/Analysis Option)

In-service monitoring of . . . DS3, dropped DS2E (CCITT G.747) and E1 (2.048Mb/s CEPT Level 1)

Select . . . . . (dropped) channel # 1-28

Identity of channel as DS1 or E1 . . . . . automatically determined upon channel selection

E1 Insertion . . . . . performed when dropped channel is identified as "E1",

. . . . . otherwise normal DS1 "external" insertion is performed.

E1 Source . . . . . (rear panel) E1 Insert jack [60]

THRU$^3_1$

(Additional THRU$^3_1$ features with E1 Drop/Analysis Option)

In-service monitoring of . . . DS3, dropped DS2E (CCITT G.747) and E1 (2.048Mb/s CEPT Level 1)

Select . . . . . (dropped) channel # 1-28

Identity of channel as DS1 or E1 . . . . . automatically determined upon channel selection

1.2.6 G.821 Analysis

G.821 type error analysis is performed simultaneously with all normal analysis.

Events for G.821 Analysis

	With Pattern Sync			Without Pattern Sync		
Rx3 Modes: (DS3 Frame)	M13	Unframed	CPar	M13	Unframed	CPar
	Bit3	Bit3	Bit3	Par	N/A	CPar
			FEBE			FEBE
Rx1 Modes: (DS1 Frame)	D4	Unframed	ESF	D4	Unframed	ESF
	Bit1	Bit1	Bit1	Frm1	N/A	CRC

Rx$^3_1$ Modes: (DS3 Frame) (DS1/E1 Frame)

With Pattern Sync						Without Pattern Sync					
M13			CPar			M13			CPar		
D4	Unframed	ESF	D4	Unframed	ESF	D4/ FAS	Unframed	ESF/ CRC	D4/ FAS	Unframed	ESF/ CRC
Bit1	Bit1	Bit1	Bit1	Bit1	Bit1	Par	Par	Par	CPar	CPar	CPar
Par	Par	Par	CPar	CPar	CPar	Frm1		CRC	FEBE	FEBE	FEBE
			FEBE	FEBE	FEBE				Frm1		CRC

Simultaneous Analysis types

ES (Errored Second) . . . . . any second with ≥ 1 error, or alarm

SES (Severely Errored Second)

Bit3 . . . . . any second with >44 errs, or DS3 alarm (≥1E-6)

Bit1 . . . . . any second with >1536 errs, or DS1 alarm (≥1E-3)

Par . . . . . any second with >44 errs, or DS3 alarm (≥1E-6)

CPar . . . . . any second with >44 errs, or DS3 alarm (≥1E-6)

FEBE . . . . . any second with >44 errs , or DS3 alarm (≥1E-6)

CRC (DS1) . . . . . any second with ≥320 errs, or DS1 alarm (≥1E-3)

CRC4 (E1) . . . . . any second with ≥915 errs, or E1 alarm (≥1E-3)

Frm1 (DS1) . . . . . any second with ≥8 errs (D4), or DS1 alarm (≥1E-3)

Frm1 (E1) . . . . . any second with ≥4 errs, or E1 alarm (≥1E-3)

DM (Degraded Minute)

Bit1 . . . . . 60 contiguous seconds, minus SES's and UAS's,with ≥92 errors (≥1E-6)

CRC (DS1) . . . . 60 contiguous seconds, minus SES's and UAS's,with ≥92 errors (≥1E-6)

CRC (E1) . . . . 60 contiguous seconds, minus SES's and UAS's,with ≥115 errors (≥1E-6)

UAS (Unavailable Second) . . . . . a period of unavailable time (UAS) begins when . . . . . a Severely Errored Second (SES) occurs for ten consecutive seconds. . . . . These ten seconds are unavailable. The period of unavailable time . . . . . terminates with a period of ten consecutive non Severely Errored Seconds. . . . . These ten seconds are Available Seconds (AS)

AS (Available Seconds) . . . . . Measurement Run seconds which are not unavailable

Operation . . . . . press Measure [Error] key to toggle between normal and G.821 results pages . . . . . Events and Analysis are then selected as usual

Results . . . . . displayed after 10 second wait period

1.3 TEST PATTERNS

DS3 and DS1 . . . . . 2^{23}-1 (inv.), 2^{20}-1, 2^{15}-1 (inv.), 2^{11}-1, 2^{9}-1, 1111^{++}

DS3 only . . . . . 1000^{+}, 1100 (not IDLE), 1010 (not AIS), 100^{+}

DS1 only . . . . . QRSS20 (2^{20}-1 w/max. 14 zeros), QRSS11 (2^{11}-1 w/max. 7 zeros)

. . . . . 1-in-8^{*+}: [F]01000000...

. . . . . 2-in-8^{+}: [F]01000010...

. . . . . 3-in-24^{*+}: [F]010001000000000000000100...

Programmable Digital Words

Select . . . . . DigWrd1 or DigWrd2

Available in . . . . . all test modes, IntD&I, Ins$^{3}_{1}$->Rx1

Length . . . . . 2,3,4,5,6,8,10,12,16,20, or 24 bits

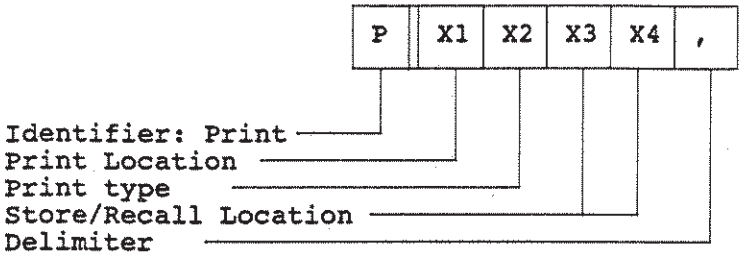
Received . . . . . as generic 16, 20, or 24-bit repeating pattern

Live . . . . . default pattern for MON, THRU, and ExtD&I modes. When selected, no "Bit" event or . . . . . No Pattern Sync Seconds are available, and all Pattern Sync LEDs remain off.

InsDS1 . . . . . available only in Tx$^{3}_{1}$ modes, PF-45 uses externally sourced DS1 applied to . . . . . DS1 Insert Jack [34] as the DS1 test signal. When selected, no "Bit" event or . . . . . No Pattern Sync Seconds are available, and all Pattern Sync LEDs remain off.

[P] Printer String

The print commands select the print destination, print type, and store/recall position:

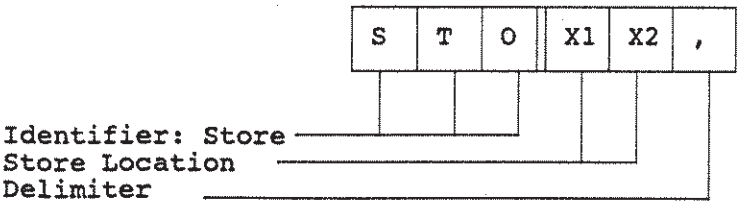



```
X1 = 0  to print to the PF-45 thermal printer
     1  to print to the IEEE/RS-232 controller

X2 = 0  for a SUMMARY PRINT
     1  for a G.821 SUMMARY PRINT
     2  for a PRINT SETUP
     3  for a Store/Recall Setup PRINT

X3 X4 = 01 - 16
```

STORE/RECALL Remote Control Commands

[STO] Store String

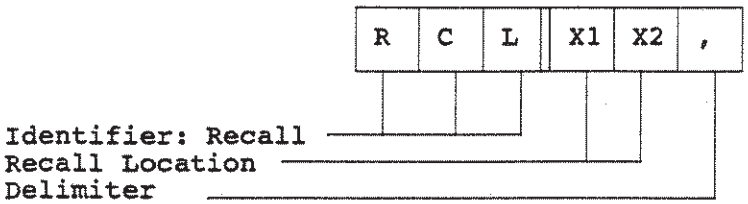
The current PF-45 setup will be stored, *write-protected,* at the designated location. Completion is indicated by a Status =1. Attempting to store to a write-protected location will give an execution error.




```
X1 X2 = 01 - 16
```

[RCL] Recall String

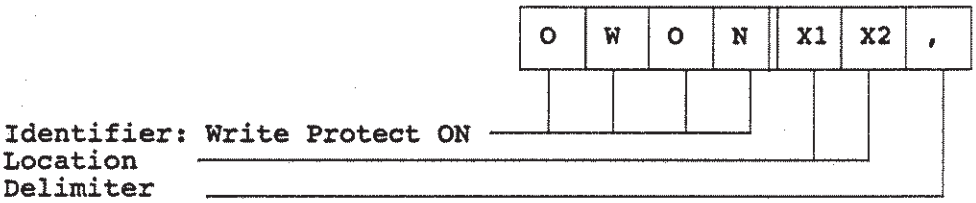
The setup stored at the designated location will be recalled . Completion is indicated by a Status =1. Recalling an empty location will give an execution error.



X1 X2 = 01 - 16

[OWON] Write Protect ON String

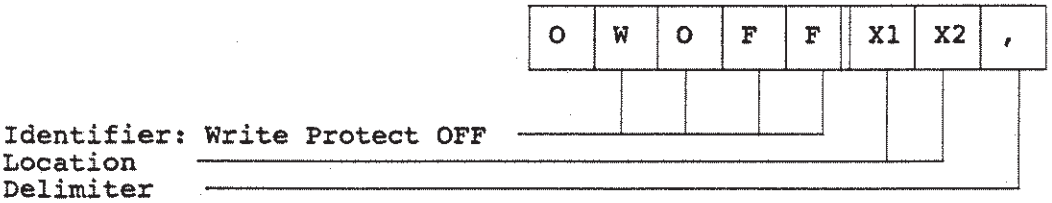
Turns ON write protection for any selected Store/Recall position. When write protected, a user cannot save a setup over the position from the keyboard or from remote control. Completion is indicated by a Status =1.



X1 X2 = 01 - 16

[OWOFF] Write Protect OFF String

Turns OFF write protection for selected Store/Recall position. Completion is indicated by a Status =1.



X1 X2 = 01 - 16

16/20/24BitWrd . . . . . available only in Mon,Thru,ExtD&I Modes,these are receive-only selections
. . . . . which allow the PF-45 to receive any 16/20/24 bit repeating patterns.

(*) Do not cause SF Yellow Alarm or Excess Zeros when framed.

(+)Received as generic 24-bit repeating pattern.

(++)Received as generic 16-bit repeating pattern.

1.4.2 Auxiliary "AUX" Insert

DS1 ESF DataLink Loopback Codes

Available in . . . . . Tx1, Tx^{3}_{1}, and IntD&I Modes when Frm1=ESF

Loopback codes . . . . . inserted in transmitted ESF DataLink

[SINGLE] . . . . . 10 repetitions of codeword

[CONTIN] . . . . . continuous transmission of codeword

[BURST] . . . . . transmission of codeword for programmed Burst length

DataLink Codewords (right-most bit transmitted first)

DL LLpUP . . . . . (DataLink) Line Loop Up: 0 000111 0 11111111

DL LLpDn . . . . . (DataLink) Line Loop Down: 0 011100 0 11111111

DL PLpUp . . . . . (DataLink) Payload Loop Up: 0 001010 0 11111111

DL PLpDn . . . . . (DataLink) Payload Loop Down: 0 011001 0 11111111

DL NLpUp . . . . . (DataLink) Network Loop Up: 0 001001 0 11111111

DL NLpDn . . . . . (DataLink) Network Loop Down: 0 010010 0 11111111

1.4.5 Error Insertion Selection

	MODE										
TYPE	Tx3	Tx1	Tx31	THRU3	THRU1	THRU31 (DS1)	THRU31 (E1)+++	IntD&I Ins31	ExtD&I (DS1)	ExtD&I (E1)+++	NOTES:
BIT	Bit3	Bit1	Bit1	Bit3	Bit1	Bit1		Bit1	Bit1	Bit1 **	Tx^{3}_{1} MODES: Errors are inserted in the DS1 Chan # selected in "ERROR INSERT" or Tx^{3}_{1}:XX THRU$^{3}_{1}$ MODE: Errors are inserted in the dropped DS1 channel THRU$^{3}_{1}$:XX
BPV	BPV3	BPV1	BPV3	BPV3	BPV1	BPV3	BPV3	BPV3	BPV3	BPV3	
PAR/	Par *	CRC +	Par *	Par *	CRC +	Par *	Par *	Par *	Par *	Par *	
CRC	CPar *		CPar *	CPar *		CPar *	CPar *	CPar *	CPar *	CPar *	
	FEBE *		FEBE *	FEBE *		FEBE *	FEBE *	FEBE *	FEBE *	FEBE *	
			CRC +			CRC +		CRC +			
FRM	Frm3	Frm1	Frm3	Frm3	Frm1	Frm3	Frm3	Frm3	Frm3	Frm3	
			Frm2			Frm2	Frm2E++	Frm2	Frm2	Frm2E++	
			Frm1			Frm1		Frm1			
AUX	DS3Fbit	DS1Fbit	DS3Fbit	DS3Fbit	DS1Fbit	DS3Fbit	DS3Fbit	DS3Fbit	DS3Fbit	DS3Fbit	Tx^{3}_{1} MODES: DS1/DS2 AUX error patterns and Alarms inserted in all DS1/DS2's. (Indicated by: Tx^{3}_{1}:**)
	DS3Mbit	DS1Loop	DS3Mbit	DS3Mbit	DS1Loop	DS3Mbit	DS3Mbit	DS3Mbit	DS3Mbit	DS3Mbit	
	DS3Xbit		DS3Xbit	DS3Xbit		DS3Xbit	DS3Xbit	DS3Xbit	DS3Xbit	DS3Xbit	
	DS3Cbit		DS3Cbit			DS1Loop	DS2EPar	DS1Fbit	DS1Loop	DS2EPar	
			DS2Fbit					DS1Loop			
			DS2Mbit								
			DS2Xbit								
			DS2Cbit								
			DS1Fbit								
			DS1Loop								
ALM	DS3AIS	DS1AIS	DS3AIS	DS3AIS	DS1AIS	DS3AIS	DS3AIS	DS3AIS	DS3AIS	DS3AIS	
	DS3Idle	DS1Yel	DS3Idle	DS3Idle	DS1Yel	DS3Idle	DS3Idle	DS3Idle	DS3Idle	DS3Idle	
	DS3X=00		DS3X=00	DS3X=00		DS3X=00	DS3X=00	DS3X=00	DS3X=00	DS3X=00	
			DS2X=0			DS2X=0	DS2A=1	DS2X=0	DS2X=0	DS2A=1	
			DS1AIS					DS1AIS			
			DS1Yel					DS1Yel			

Note: Due to the logical constraints of Parity and CRC, no matter how high a selected ratio:
* The maximum insertable Par, CPar, FEBE error ratio is: 1.06E-04.
+ The maximum insertable CRC error ratio is: 2.17E-04.

+++ for PF-45s equipped with E1 Option:
** All E1 bits (including overhead) are available for erroring.
++ DS2E (G.747) Frame Word Error

1.10 OPERATIONAL FEATURES

Manual Print

Display = MEASURE ERROR or RX STATUS . . . . . on-demand summary of current results
Display = SETUP . . . . . on-demand print of instrument setup
Display = G.821 MEASURE ERROR . . . . . on-demand summary of (completed) G.821 results

1.10.1 Auto Setup

During Auto Setup, the PF-45 determines the type of signal applied to the receive test jacks, and then selects the appropriate operating mode for that signal. The PF-45 then configures itself to match the frame, line-code and pattern of the incoming signal.

Operation

Auto Setup ON . . . . . Simultaneously press [AUX/TIME] & [RxSTATUS] keys
Auto Setup RESTART . . . . . upon repressing "Auto Setup" keys, or loss of line signal
Channel# . . . . DS1 (& DS0 if equipped) Chan#s can be selected while Auto Setup is active
Volume . . . . . (if equipped) DS0 volume can be set while Auto Setup is active
Display during Auto Setup:

Auto Setup OFF . . . . . Press any key
. . . . . (except [MODE]/[VIEW]/[DATAENTRY] keys for Channel & Volume Select)

Auto Mode Select

If the PF-45 was set to a Test or Mon Mode at the start of Auto Setup:
. . . . . the appropriate Monitor Mode: Mon3, Mon1, or Mon^3_1 is selected
If the PF-45 was set to a Thru or D&I Mode at the start of Auto Setup:
. . . . . the appropriate Thru Mode: Thru3, Thru1, or $Thru^3_1$ is selected

Other Setup Parameters determined during Auto Setup

. . . . . DS3/DS1 Frame Format
. . . . . DS1 Line Code
. . . . . PRBS/QRSS Pattern or 16/20/24 Bit Word

Auto Setup with E1 Option installed

If received DS3 contains either DS2s or DS2Es . . Mon^3_1/$THRU^3_1$ mode, "mixed" DS3 selected
Other Auto Setup Parameter . . . . . E1 Frame Format

1.18 SIGNAL ANALYSIS OPTION

Frequency/Bitrate Measurement

- Signals for measurement . . . . . Rx DS3, Rx DS2, Rx DS1, External TTL (Ext1)
- Accuracy . . . . . +/- 2ppm
- Resolution 1Hz
- DS3 Rx bps Range . . . . . 44736kHz +/- $1x10^{-3}$
- DS2 Rx bps Range . . . . . 6312kHz +/- $0.5x10^{-3}$
- DS1 Rx bps Range . . . . . 1544kHz +/- $1x10^{-3}$
- Ext1 Frequency Range . . . . . 1Hz to 50MHz

+/- Peak Volts

- DS3 Range . . . . . 25 mV to 1.5V
- DS3 Accuracy . . . . . +/- 4%, +/- 5mV
- DS1 Range . . . . . 150 mV to 6V
- DS1 Accuracy . . . . . +/- 4%, +/- 10mV
- Resolution . . . . . 1 mV

DS3 Delay

- Delay measurement method . . . . . X-bit pattern "1001" is sent once from transmitter, ... receiver monitors its return, and the transit time is measured
- Accuracy . . . . . +/- 0.050 micro-seconds
- Resolution . . . . . 0.02 micro-seconds
- Range . . . . . 0 to 999 mSec

DS1 Delay

- Delay measurement method . . . . . 2-out-of-6 Ft error pattern is sent once from transmitter, ... receiver monitors its return, and the transit time is measured
- Accuracy . . . . . +/- 1 micro-second
- Resolution . . . . . 1 micro-second
- Range . . . . . 0 to 999 mSec

DS1 Slips

- Reference clock . . . . . recovered from rear-panel DS1 Insert Jack [34]
- Slips counted . . . . . during measurement run
- Definitions
  - +Bit Slip . . . . . +360deg phase shift of DS1 under test compared to reference
  - -Bit Slip . . . . . -360deg phase shift of DS1 under test compared to reference
  - +Frame Slip (estimated) . . . . . each cumulative occurrence of +193 bit slips
  - -Frame Slip (estimated) . . . . . each cumulative occurrence of -193 bit slips
- Measurement Types
  - Bit Slips . . . . . current algebraic sum of bit slips
  - Peak Slips . . . . . maximum + and - bit slips counts
  - Frame Slips . . . . . counts of + and - frame slips

External Event Count

Signals for event counting . . . . . Ext Event 1 [40], Ext Event 2 [41]
Input Jack Characteristics . . . . . 75 ohms, TTL, BNC
Max. count rate 50kHz
Event Counts . . . . . total counts during measurement run
Event Seconds . . count of the number of seconds, asynchronous to the event, in which at least one event of the type selected, occurred.

Signal Analysis Selection

TYPE	MODE: Tx3-> Rx3	Tx1,Tx31 ->Rx1	Tx1-> Rx31	Tx31-> Rx31	THRU3 MON3	THRU1 MON1	THRU31,MON31 IntD&I,ExtD&I,Ins31
DS3 RxBps	x		x	x	x		x
DS2 RxBps			x	x			x
DS1 RxBps		x	x	x		x	x
DS3 +Vpeak	x		x	x	x		x
DS3 -Vpeak	x		x	x	x		x
DS1 +Vpeak		x				x	
DS1 -Vpeak		x				x	
DS3 Delay*	x			x			
DS1 Delay*		x	x	x			
DS1 BitSlp		x	x	x		x	x
DS1 PkSL		x	x	x		x	x
DS1 FrSL		x	x	x		x	x
Ext1 Freq	x	x	x	x	x	x	x
Ext1 Count	x	x	x	x	x	x	x
Ext1 Event Seconds	x	x	x	x	x	x	x
Ext2 Count	x	x	x	x	x	x	x
Ext2 Event Seconds	x	x	x	x	x	x	x

* Framed only, with Error Insertion Off,

1.19 DS0 Option

Allows user to listen to live traffic, and to perform channelized Drop & Insert via a VF test set, DDS test set, or Protocol Analyzer. The type of D&I is determined by the DS0 operating mode. ESF Data Link D&I is also supported.

For all DS0 operating modes

DS0 availability . . . . . in MON31,MON1,THRU31,THRU1,ExtD&I modes, when pattern = "Live"
DS0 channel # select . . . . . via [VIEW]/Data Entry keys, similar to DS1 chan.# selection
VF Coding/Decoding . . . . . mu-law, $7^5/_6$ coding
Speaker volume control . . . . . via Data Entry keys when Data Entry LED is off

Rx Signaling Bits . . . . . AB (D4)/ABCD (ESF) bits displayed under [RxSTATUS]
Rx 8-bit Word . . . . . displayed under [RxSTATUS]
DS0 Insertion . . . . . available in THRU modes, selected via rear-panel DIP switch [65] #1
DS0 Operating Mode selection . . . . . via rear-panel DIP switch [65] #2-5

VF Mode
VF Mode Select . . . . . set rear-panel DIP switch [65] #s 2,3,4,5 to "1000"
VF Drop . . . . . from rear-panel Bantam jack [63], 600 ohms, balanced, 0dBm = 0dBm0
VF Insert . . . . . from rear-panel Bantam jack [64], 600 ohms, balanced, 0dBm = 0dBm0
Signaling Bit Insertion
Availablity . . . . . when VF Insertion is active
Selection . . . switch [65] #8: ON=Signaling Bit Insert, OFF=Signaling Bits are passed THRU
Value . . . . . set via rear-panel DIP switch [65] #3-6 (ABCD)

DDS Mode
DDS Mode Select . . . . . set rear-panel DIP switch [65] #s 2,3,4,5 to "0100"
Drop & Insert interface . . . . . DDS test set (KS-20909/20908) compatible
DS0 Drop . . . . . from rear-panel Bantam jack [63], TTL-compatible NRZ data on connector tip
. . . . . set DDS test set receiver to FAR LOGIC
DS0 Insert . from rear-panel Bantam jack [64], will receive TTL-compatible NRZ on connector tip
. . . . . set DDS test set transmitter to FAR LOGIC
DDS Clock . . . . . TTL-level clocks provided via male DB-9 connector [66]
64kHz clock . . . . . Pin 3
8kHz clock . . . . . Pin 4
+5V DC . . . . . Pin 1
GND . . . . . Pin 2

64kb/s DS0 Mode
64kb/s Mode Select . . . . . set rear-panel DIP switch [65] #s 2,3,4,5 to "0010"
Drop & Insert interface . . . . . synchronous RS-232 (no handshaking) or TTL clock/data
RS-232/TTL selection . . . . . rear-panel DIP switch [65] #6: ON=RS-232, OFF=TTL
RS-232 Pinout using supplied DB-9/DB-25 Adaptor
Type . . . . . DCE, DB-25 female
Drop NRZ Data BB (from PF-45) . . . . . Pin 3
Drop Clock DD (from PF-45) . . . . . Pin 17
Insert NRZ Data BA (from PF-45) . . . . . Pin 2
Insert Clock DB (from PF-45) . . . . . Pin 15
TTL Pinout
Drop NRZ Data (from PF-45) . . . . . Pin 3
Drop Clock (from PF-45) . . . . . Pin 1
Insert NRZ Data (to PF-45) . . . . . Pin 5
Insert Clock (from PF-45) . . . . . Pin 4
PF-45 samples Insert TTL NRZ . . . . . on rising edge of Insert Clock

56kb/s DS0 Mode

64kb/s Mode Select . . . . . set rear-panel DIP switch [65] #s 2,3,4,5 to "0001"

Features/controls . . . . . same as 64kb/s, but bit 8 of DS1 timeslot is ignored

ESF Data Link Drop & Insert

Select . . . . . ESF/VF Mode, set DIP switch [65] #s 2,3,4,5 to "1000"

DL Drop Availability . . . . . in any PF-45 mode that receives a DS1, when Frm1=ESF

DL Originate Availability . . . . . in Tx1,Tx31,IntD&I,Ins31 modes, when Frm1=ESF

DL Insert . . . . . THRU1,THRU31 modes, when Frm1=ESF and DIP switch [65] #7 is ON

RS-232/TTL Selection and Pinout . . . . . same as for 64&56kb/s DS0 modes

PF-45 samples Originate/Insert TTL NRZ . . . . . on falling edge of Insert Clock

3.2.12 Auto Setup Operation

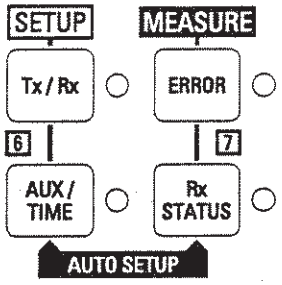
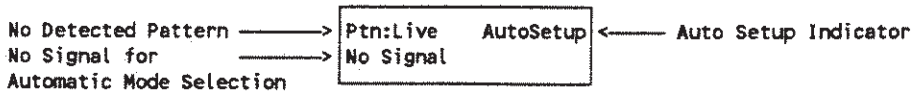


Figure 3-13a: Auto Setup Keys

In Auto Setup the PF-45 makes all the setup decisions that are normally required to do basic in-service and out-of-service monitoring of DS3s, DS1s, and DS1s embedded in DS3. For the experienced user this leads to quick setup when switching between various DS3 and DS1 systems. For the novice user this means that the most typical monitoring tasks can be performed without venturing into the normal setup pages.

To start Auto Setup, press the two "Auto Setup Keys" shown above.

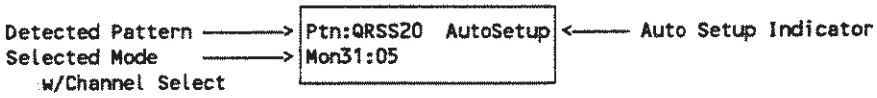
The display below appears, informing the user that Auto Setup is active, but no valid line signal has been applied to either the DS3 Rx jack [12] or the DS1 Rx jack [14].



Insert the signal to be monitored.

In the example below:

- The PF-45 determined that the input signal is a DS3.
- It determined the DS3 frame format (shown on the front panel Tx/Rx LEDs).
- Starting with the previously selected channel, it has scanned through the demultiplexed DS2s until it found one that contained DS2 framing, and it selected the first DS1 of that DS2 to monitor.
- If no framed DS2s were found, the PF-45 would have considered the DS3 "unchannelized", and so selected Mon3 mode.
- The PF-45 determined the frame format of the dropped DS1, (shown on the front panel Tx/Rx LEDs)
- It determined the PRBS or QRSS20 pattern contained within the DS1.
- If pattern sync was not detected, the PF-45 would have continued to show "Live" pattern.



If the PF-45 is in a Thru or Drop & Insert mode at the start of Auto Setup, the appropriate Thru mode is automatically selected, to maintain the through-connectivity of an existing hookup. Auto Setup remains ON while selecting channels. For $Thru^3_1$ and Mon^3_1 modes, the user can select dropped DS1 channels while Auto Setup continues.

Auto Setup can be "Restarted" either by pressing the "Auto Setup Keys" again, or by removing the line signal being tested. Most Auto Setup parameters will follow changes in the input signal, such as changes of frame format or pattern. However, the automatic mode selection and the DS1 line-code switch from AMI to B8ZS only occur once, so the process may need to be "restarted" for a new signal. In most cases, a new signal applied to the PF-45 will also cause a "No Signal" condition on the line. This will automatically restart Auto Setup. Under some conditions, such as electronic switching, or reconfiguration of a line card, a "No Signal" condition may not occur. For these and related cases, press the "Auto Setup Keys" again to restart the Auto Setup process.

To stop Auto Setup, press any key.

Any key press will turn the Auto Setup feature off. The [START] key is commonly used at this point to start a measurement run. When starting a measurement directly from Auto Setup, the Rx Status measurement page "Total ErrSecs=" is displayed. This allows the user to immediately detect the occurrence of any error counts, and also the shows the Rx Status LED history.

A Quick Measurement Scheme:

1). Start Auto Setup, by pressing the two "Auto Setup Keys"
2). [Start] the measurement run.

3). Press [MAN PRINT] key to print out results.

Select DS1/DS0 Channels while Auto Setup remains on

While Auto Setup is active, the DS1 (and E1 or DS0 if equipped) channels can be selected. This allows the user to scroll through all 28 DS1s, while the PF-45 automatically determines the frame type and pattern, if any. Since the DS0 channel select and volume controls also remain active during Auto Setup, the user can listen to channel activity for each selected DS1.

3.6.1 Set DS1 Channel Number

Channel Number selection on mode change is carried over from previous mode:

For Test, Monitor and THRU modes the channel remains as selected from the last mode. This is true for AUTO SETUP as well. This means that AUTO SETUP can be used to identify and auto configure on a particular channel, and then the desired mode, such as Test or THRU can be selected, maintaining the channel choice and other setup parameters.

For D&I modes the channel number is set to "00", ie. "no channel".

Received Channel Number is 'Live' during selection:

For all modes, the received channel number displayed is the actual channel being dropped, even while the channel number is blinking. This is true even during AUTO SETUP. This allows the user to easily scan through the received DS1s (perhaps looking for a particular frame format or pattern) using only the Up or Down Arrow Data Entry keys.

Tx^{3}_{1} Error Insert Channel Number is 'Live' during selection:

The channel number displayed for error insertion is the actual channel used, even while the channel number is blinking. This allows the user, while making a measurement run, to sequentially insert errors in each DS1 channel while monitoring a particular received channel for errors, thus showing continuity.

Received Channel cannot be changed during a Measurement Run:

The received channel is blocked during a run to protect the accumulated measurement data. Stop the run to gain access to the received channel number.

For D&I Modes the Received Channel Number is 'Live', but Insertion is Off during Selection:

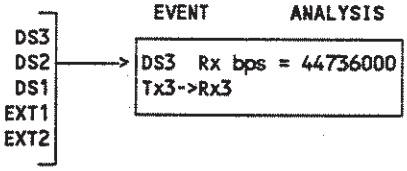
Like other modes, the user can scan through the received DS1s, looking for the desired signal. The channel insertion however is only performed after the [MODE] key is pressed to "enter" the channel and stop the selection process.

3.11 SIGNAL ANALYSIS OPTION OPERATION

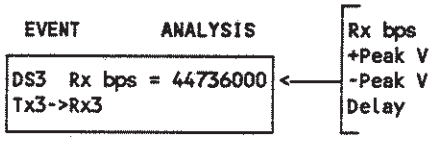
With the Signal Analysis option installed, the PF-45 has three (or four if equipped with DS0 option) pages under RxStatus:

Page 1: RxStatus Seconds
Page 2: Elapsed Time
Page 3: Signal Analysis
Page 4: DS0

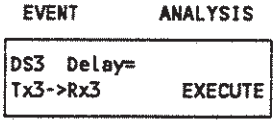
With the [RxSTATUS] key, bring up the Signal Analysis page.



DS3 Signal Analysis

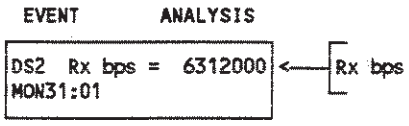


When DS3 is selected, the analyses shown above are available. Rx bps and +/-Peak Voltage measurements take a second or two, and show "counting" and "measure" respectively during this process.



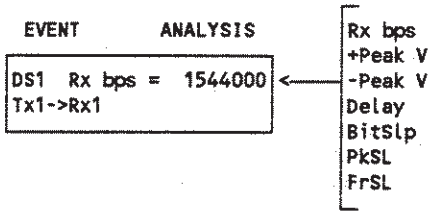
Delay measurements require the loopback of a PF-45 generated test signal, and so are only available in framed Test Modes. Press the [D] key to start the delay measurement. This sends the DS3 X-bit 1001 pattern which is used to measure the delay. If the X-bit pattern is not received within 1 second, the PF-45 will show "timed out".

DS2 Signal Analysis

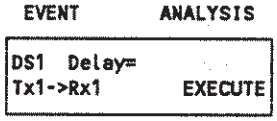


Rx bps is the only signal analysis choice for DS2, and is available in any mode which receives a channelized DS2.

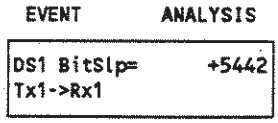
DS1 Signal Analysis



When DS1 is selected, the analyses shown above are available. Rx bps and +/-Peak Voltage measurements take a second or two, and show "counting" and "measure" respectively during this process.

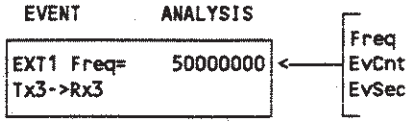


Delay measurement requires the loopback of a PF-45 generated test signal, and is only available in framed Test Modes. Press the [D] key to start the delay measurement. This sends a 2-in-6 DS1 Ft-bit error pattern which is used to measure the delay. If the error pattern is not received within 1 second, the PF-45 will show "timed out".



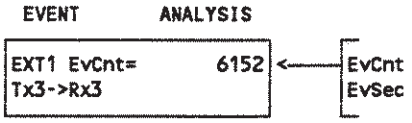
Bit Slips measurements compare the phase (frequency) of two DS1s, the DS1 under test, and the rear-panel "reference DS1". If the reference DS1, or the DS1 under test or has a NO SIGNAL condition, the measurement cannot be made, and the PF-45 will display a "NoSignal" or "NoRef" message in the results display. If a total bit slips count exceeds +/- 32767 during a measurement, or >1 frame-slip in any second, the PF-45 will display a "LostSync" message.

EXT1 Signal Analysis



When EXT1 is select, the analyses above are available. Frequency measurements up to 50MHz are provided at any time, and like Rx bps, shows "counting" during the initial gating period. Event Count (max. 50kHz) and Event Seconds are only counted during a measurement run.

EXT2 Signal Analysis



When EXT2 is selected, Event Count and Event Seconds results are available.

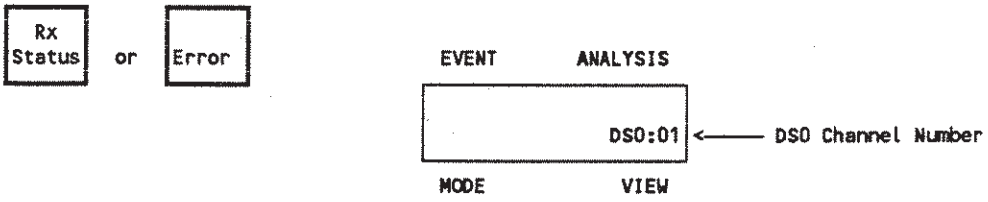
3.12 DS0 OPTION OPERATION

Use AutoSetup to activate the DS0 option:

The AutoSetup function will properly configure the PF-45 for all DS0 monitoring tasks. While AutoSetup is active, the DS1 and DS0 channels can be selected, as well as the speaker volume.

Manually activate the DS0 option:

1) Set PF-45 mode to MON31, MON1, THRU31, THRU1, or ExtD&I
2) Leave Pattern set to default value "Live"
3) DS0 Channel Number is placed in VIEW field
   whenever the display is in the Error or RxSTATUS category.



Set the DS0 Channel Number:

1) Press [VIEW] key
2) DS0 Chan. No. in display and Data Entry LED blink
3) Select desired Chan. No. with Data Entry keys
4) Press [VIEW] key again to "enter" the DS0 Chan. No.

Set the speaker volume:

Use the Data Entry keys for volume adjustment whenever the Data Entry LED is not on or blinking.

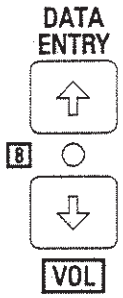
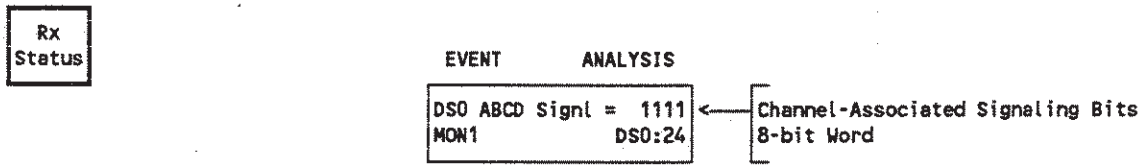


Figure 3-22: Data Entry keys for Volume Adjustment

Display the Received Signaling Bits and 8-bit Word:



With the DS0 option installed, the PF-45 has three (or four if Signal Analysis option is also installed) pages of RxStatus:

Page 1: RxStatus Seconds
Page 2: Elapsed Timed
Page 3: Signal Analysis (if installed)
Page 4: DS0 Results

Rear-Panel:

Use the control switches and jacks on the rear-panel for Drop & Insert to VF test sets, DDS test sets, and protocol analyzers. Pinouts of jack [66] change by DS0 "mode", and are given in Section 1.19.

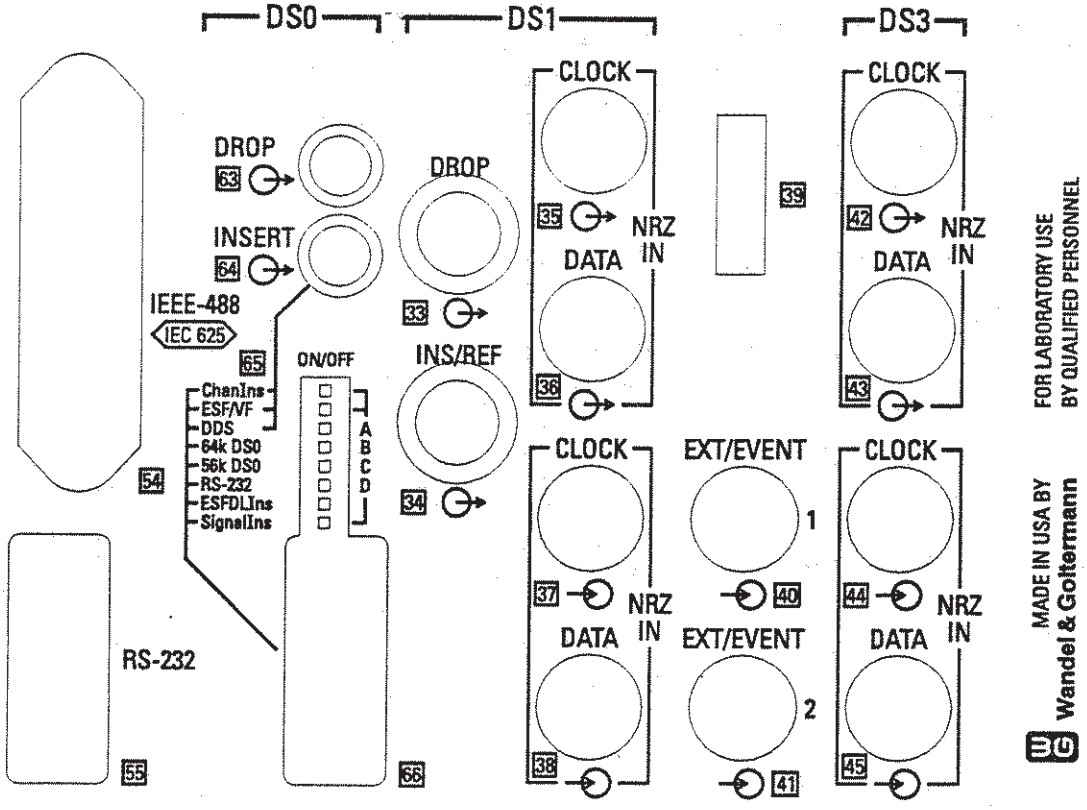


Figure 3-23: PF-45 Rear-Panel with DS0 Option Installed

VF Operation:

Set the rear-panel DIP switch [65] #s to:

ChanIns = OFF
ESF/VF = ON
DDS = OFF
64k DS0 = OFF
56k DS0 = OFF
RS-232 = OFF
ESFDLIns = OFF
SignalIns = OFF

When configured for VF operation, the DS0 option will port the decoded channel contents to the rear-panel output jack [63]. This signal is suitable for direct measurement with any standard 600 ohm balanced VF test set.

To insert a VF signal within the channel, set the PF-45 mode to ExtD&I, and set:

ChanIns = ON

When VF insertion is on, but the Signaling Insertion switch #8 is OFF, the received signaling bits are passed through the PF-45. To insert user selected signaling bits along with the VF signal, set the PF-45 mode to ExtD&I, and set: (notice that switches 3-7 are redefined as A,B,C,D when switches 1,2, & 8 are ON)

ChanIns = ON
ESF/VF = ON
A = (user selected value)
B = (user selected value)
C = (user selected value)
D = (user selected value)
ESFDLIns = OFF
SignalIns = ON

DDS Operation:

Set the rear-panel DIP switch [65] #s to:

ChanIns = OFF
ESF/VF = OFF
DDS = ON
64k DS0 = OFF
56k DS0 = OFF
RS-232 = OFF
ESFDLIns = OFF
SignalIns = OFF

When configured for DDS operation, the PF-45 will port the received DS0 data bits to the rear-panel Bantam jack [63], as a 64kbs TTL-compatible NRZ data on the connector tip. A pair of TTL-compatible clocks is provided on the male DB-9 connector [66]. These signals are compatible with KS-style DDS test set receivers, when set to FAR LOGIC.

The rear-panel insert jack [64] is compatible with DDS test set transmitters, when set to FAR LOGIC. To insert a DDS signal within the channel, set the PF-45 mode to ExtD&I, and set:

ChanIns = ON

ESF Data Link Insertion, and Signaling Insertion are unavailable during DDS operation.

64kb/s DS0 Operation:

Set the rear-panel DIP switch [65] #s to:

ChanIns = OFF
ESF/VF = OFF
DDS = OFF
64k DS0 = ON
56k DS0 = OFF
RS-232 = ON
ESFDLIns = OFF
SignalIns = OFF

When configured for 64kb/s DS0 operation, the DS0 option will port the complete channel contents to the rear-panel output jack [66]. The output levels can be set to TTL or RS-232 with switch #6. When set to RS-232, and connected via the DB-9/DB-25 connector provided with the option, this signal is suitable for direct connection with any protocol analyzer capable of working at 64kb/s with synchronous RS-232, no handshaking.

!WARNING: the supplied DB-9/DB-25 connector is a custom adaptor! IBM AT-compatible computers often are equipped with a DB-9 serial port, and come with a standard DB-9/DB-25 connector. The PF-45 connector is for synchronous RS-232, whereas the PC-AT connector is for asynchronous RS-232. They are not the same.

To insert a 64kb/s DS0 signal within the channel, set the PF-45 mode to ExtD&I, and set:

ChanIns = ON

ESF Data Link Insertion, and Signaling Insertion are unavailable during DS0 operation.

56kb/s DS0 Operation:

Set the rear-panel DIP switch [65] #s to:

ChanIns = OFF
ESF/VF = OFF
DDS = OFF
64k DS0 = OFF
56k DS0 = ON
RS-232 = ON
ESFDLIns = OFF
SignalIns = OFF

When configured for 56kb/s DS0 operation, the DS0 option will port the upper seven bits of the channel contents to the rear-panel output jack [66]. The output levels can be set to TTL or RS-232 with switch #6. When set to RS-232, and connected via the DB-9/DB-25 connector provided with the option, this signal is suitable for direct connection with any protocol analyzer capable of working at 56kb/s with synchronous RS-232, no handshaking.

To insert a 56kb/s DS0 signal within the channel, set the PF-45 mode to ExtD&I, and set:

ChanIns = ON

ESF Data Link Insertion, and Signaling Insertion are unavailable during DS0 operation.

ESF Data Link Operation:

ESF DL D&I is independent of normal DS0 functionality, other than the necessity of setting the DS0 "mode" to ESF/VF. Set the rear-panel DIP switch [65] #s to:

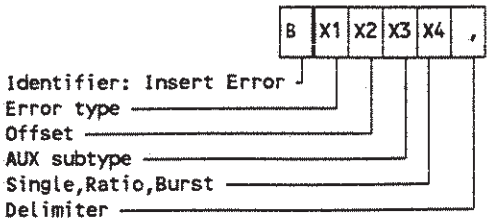
ChanIns = OFF
ESF/VF = ON
DDS = OFF
64k DS0 = OFF
56k DS0 = OFF
RS-232 = ON or OFF
ESFDLIns = OFF
SignalIns = OFF

When configured for ESF Data Link operation, the DS0 option will port the 4kbs ESF Data Link contents to the rear-panel output jack [66]. This dropped signal is present for all modes that receive a DS1, when the DS1 frame is set to ESF. The output levels can be set to TTL or RS-232 with switch #6. When set to RS-232, and connected via the DB-9/DB-25 connector provided with the option, this signal is suitable for direct connection with any protocol analyzer capable of working at 4kb/s with synchronous RS-232, no handshaking.

In all modes in which the PF-45 originates an ESF DS1 test signal (Tx1, Tx31, IntD&I, Ins31->Rx1 modes) the default transmitted Data Link value of "01111110" can be replaced by the inserted pattern. Or, in THRU1 and THRU31 modes, the external ESF Data Link can be inserted in the live signal. Set the rear-panel DIP switch [65] #s to:

ChanIns = OFF
ESF/VF = ON
DDS = OFF
64k DS0 = OFF
56k DS0 = OFF
RS-232 = ON or OFF
ESFDLIns = ON
SignalIns = OFF

[B] Error Insertion String



Error Type (X1)	Offset (X2)	Aux Subtype (X3)
X1: 0 = No Error	X2: ---	X3: ---
X1: 1 = BIT	X2: ---	X3: ---
X1: 2 = BPV	X2: ---	X3: ---
X1: 3 = CRC/PAR	X2: 0 = Parity	X3: ---
	X2: 1 = C-Parity	X3: ---
	X2: 2 = FEBE	X3: ---
	X2: 3 = CRC	X3: ---
X1: 4 = FRM	X2: 0 = Frm3	X3: ---
	X2: 1 = Frm2	X3: ---
	X2: 2 = Frm1	X3: ---
X1: 5 = AUX	X2: 0 = Loopback	X3: 0 = CSU Up
		X3: 1 = CSU Dn
		X3: 2 = NI Up
		X3: 3 = NI Dn
		X3: 4 = DL LLpUp
		X3: 5 = DL LLpDn
		X3: 6 = DL PLpUp
		X3: 7 = DL PLpDn
		X3: 8 = DL NLpUp
		X3: 9 = DL NLpDn
	X2: 1 = DS3 Fbit	X3: 0 = 2/2
		X3: 1 = 2/3
		X3: 2 = 3/3
		X3: 3 = 3/15
		X3: 4 = 3/16
		X3: 5 = 3/17
	X2: 2 = DS3 Mbit	X3: 0 = 1/1
		X3: 1 = 2/2
		X3: 2 = 2/3
		X3: 3 = 3/3
	X2: 3 = DS3 Xbit	X3: 0 = 00
		X3: 1 = 01
		X3: 2 = 10
	X2: 4 = DS3 Cbit	X3: 0 = Col1
		X3: 1 = Col2
		X3: 2 = Col3
	X2: 5 = DS2 Fbit	X3: 0 = 2/6
		X3: 1 = 2/5
		X3: 2 = 2/4
		X3: 3 = 3/3
		X3: 4 = 2/2
	X2: 6 = DS2 Mbit	X3: 0 = 1/1
		X3: 1 = 2/2
		X3: 2 = 2/3
		X3: 3 = 3/3
	X2: 7 = DS2 Xbit	X3: 0 = 0
	X2: 8 = DS2 Cbit	X3: 0 = Col1
		X3: 1 = Col2
		X3: 2 = Col3

```
                        X2: 9 = DS1 Fbit          X3: 0 = Ft 2/6
                                                  X3: 1 = Ft 2/5
                                                  X3: 2 = Ft 2/4
                                                  X3: 3 = Fs 2/4
                                                  X3: 4 = Fts 2/4
                        X2: : = DS2E Par X3: ---

X1: 6 = ALM             X2: 0 = DS3 AIS           X3: ---
                        X2: 1 = DS3 IDLE          X3: ---
                        X2: 2 = DS1 AIS           X3: ---
                        X2: 3 = DS1 YELLOW        X3: ---
                        X2: 4 = DS3 X=00          X3: ---
                        X2: 5 = DS2 X=0           X3: ---
                        X2: 6 = DS2E A-bit        X3: ---
X4: 0 = No Error
    1 = Single Error Insert
    2 = Ratio ON
    3 = Ratio OFF
    4 = Burst Error Insert
```

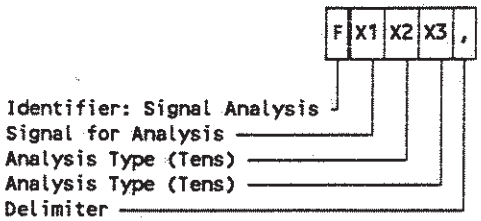
"---" means value of character is disregarded (don't care).

Sample IEEE command (HP-BASIC for HP-85):

```
10 OUTPUT 701;"B5621," !This sends a single group of 2/3 DS2 M-bit errors.
```

[F] Signal Analysis String

The entire 20-character top line of the display is sent. Following the last of the 20 ASCII data characters is a Line Feed character (OAH). The PF-45 also sends an EOI (End or Identify) along with the Line Feed character. Therefore, the controller can terminate data reception on either the EOI command or the Line Feed character, when reading the Signal Analysis result display.



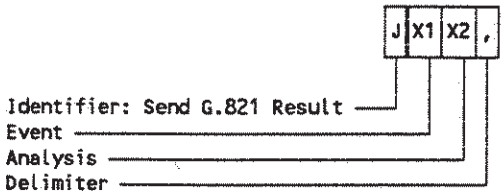
Signal for Analysis X1:	0 = DS3 1 = DS2 2 = DS1 3 = EXT1 4 = EXT2
Analysis Type X1 X2:	00 = Rx bps 01 = Peak Volt + 02 = Peak Volt - 03 = Delay 04 = Bit Slips 05 = Peak Bit Slips 06 = (Estimated) Frame Slips 11 = Frequency 12 = Event Count 13 = Event Seconds

Sample IEEE command (HP-BASIC for HP-85):

```
10 OUTPUT 701;"F203,"      !This selects the RxSTATUS display category, and sets the [EVENT]
                           !to DS1, and the [ANALYSIS] to Delay, then it activates "EXECUTE".
```

[J] G.821 Error Measurement String

The entire 20-character top line of the display is sent. Following the last of the 20 ASCII data characters is a Line Feed character (0AH). The PF-45 also sends an EOI (End or Identify) along with the Line Feed character. Therefore, the controller can terminate data reception on either the EOI command or the Line Feed character, when reading the measurement result display.



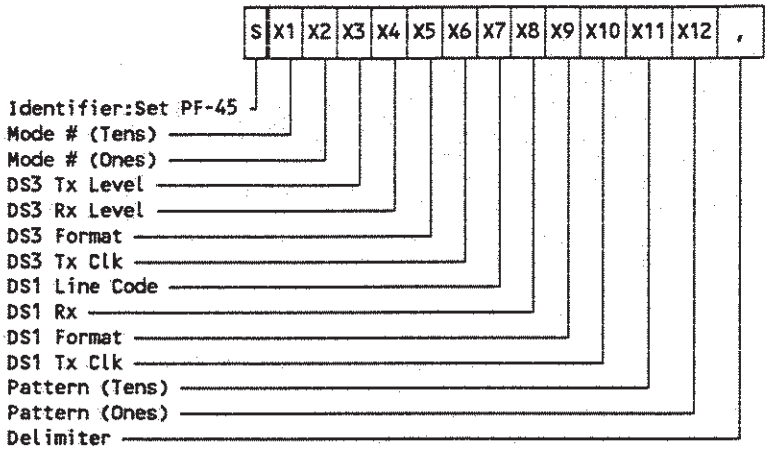

```
Event   X1:     0 = Bit
                1 = Par
                2 = C-Par
                3 = FEBE
                4 = CRC
                5 = Frm1
                6 = CRC4

Analysis X2:    0 = ES (Errored Second)
                1 = SES (Severely Errored Second)
                2 = AS (Available Second)
                3 = UAS (UnAvailable Second)
                4 = DM (Degraded Minute)
```

Sample IEEE command (HP-BASIC for HP-85):

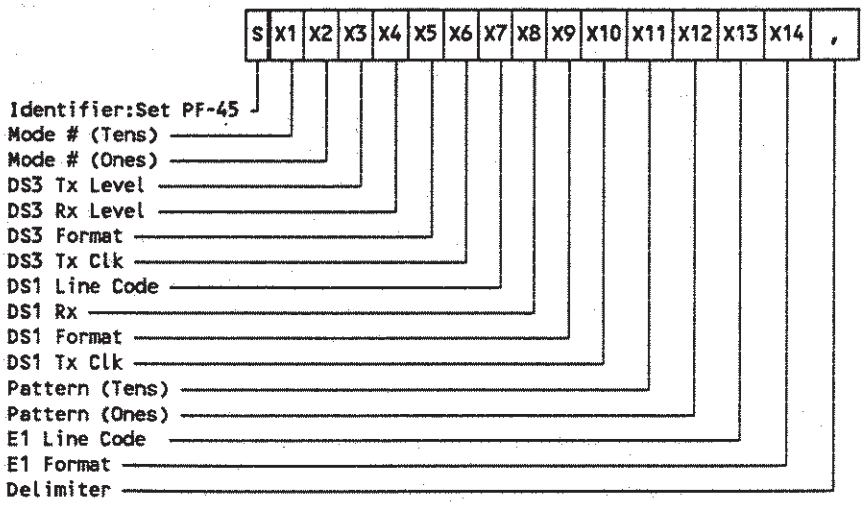
```
10 OUTPUT 701;"J01,"  !This selects the G.821 ERROR MEASUREMENT display category, and sets
                      ! the [EVENT] to Bit, and the [ANALYSIS] to Severely Errored Seconds.
```

[S] Setup String

Use this once, initially to set the operating parameters of the instrument, and later to make subsequent changes.



Or for operation with the E1 Drop/Analysis Option:



Mode X1 X2: 00 = Tx3->Rx3
01 = Tx1->Rx1
02 = Tx1->Rx^3_1
03 = Tx^3_1->Rx1
04 = Tx^3_1->Rx^3_1
05 = MON3
06 = MON1
07 = MON^3_1
08 = THRU3
09 = THRU1
10 = $THRU^3_1$
11 = $IntD\&I^3_1$
12 = $ExtD\&I^3_1$
13 = INS^3_1->Rx1

DS3 Tx Level X3: 0 = Tx3 HI
1 = Tx3 DSX
2 = Tx3 LO

DS3 Rx Level X4: 0 = Rx3 H/L
1 = Rx3 DSX
2 = Rx3 NRZ Up
3 = Rx3 NRZ Down

DS3 Format X5: 0 = Frm3 M13
1 = Frm3 C-Par
2 = Frm3 Unfrm
3 = Frm3 M-Mix (S-string must be 14 chars. long)
4 = Frm3 C-Mix (S-string must be 14 chars. long)

DS3 Tx Clk X6: 0 = Clk3 Int
1 = Clk3 Ext
2 = Clk3 Loop

DS1 Line Code X7: 0 = Code AMI
1 = Code B8ZS

DS1 Rx X8: 0 = Rx1 Term
1 = Rx1 Brdg
2 = Rx1 NRZ Up
3 = Rx1 NRZ Down

DS1 Format X9:
0 = Frm1 D4/SF
1 = Frm1 ESF
2 = Frm1 Unfrm
3 = Frm1 SLC

DS1 Tx Clk X10:
0 = Clk1 Int
1 = Clk1 Ext
2 = Clk1 Ref
3 = Clk1 Loop

Pattern X11 X12:	DS3	DS1
	00 = 1111	00 = QRSS20
	01 = 2E23-1	01 = 2E23-1
	02 = 2E20-1	02 = 2E20-1
	03 = 2E15-1	03 = 2E15-1
	04 = 2E11-1	04 = 2E11-1
	05 = 2E9-1	05 = 2E9-1
	06 = 1010	06 = 11111111
	07 = 1100	07 = 1-in-8
	08 = 1000	08 = 2-in-8
	09 = 100	09 = 3-in-24
	10 = Live	10 = QRSS11
	11 = DigWrd1	11 = Live
	12 = DigWrd2	12 = InsDS1
	13 = 16-bit Rx Word	13 = DigWrd1
	14 = 20-bit Rx Word	14 = DigWrd2
	15 = 24-bit Rx Word	15 = 16-bit Rx Word
		16 = 20-bit Rx Word
		17 = 24-bit Rx Word

E1 Line Code X13:
0 = CodeE1:AMI
1 = CodeE1:HDB3

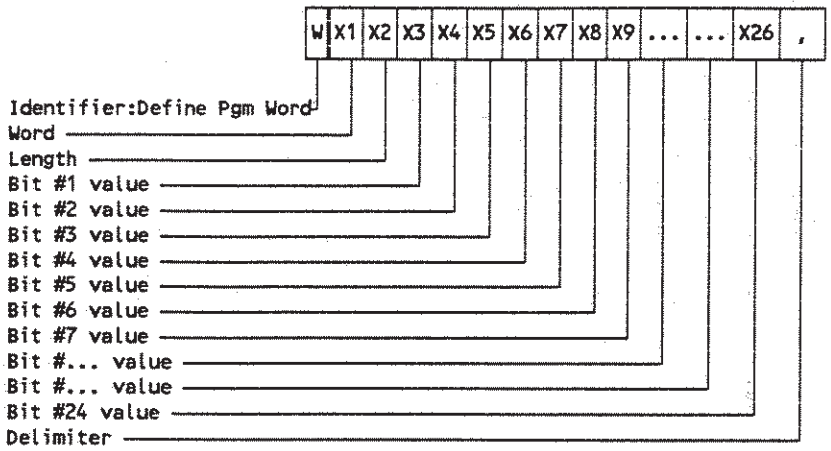
E1 Format X14:
0 = FrmE1:FAS
1 = FrmE1:CRC4
2 = FrmE1:Unfrm

Sample IEEE command (HP-BASIC for HP-85):

```
10 OUTPUT 701;"S041110001009,"  !This sets up Tx31->Rx31 mode, Tx3:DSX, Rx3:DSX, Frm3:CPar,
                                !Clk3:Int, Code:AMI, Frm1:ESF, Clk1:Int, Pattern:3-in-24.
```

[W] Programmable Word String

This command is used to setup the size and content of the selected programmable word.




```
Word X1:          1 = Programmable Word 1
                  2 = Programmable Word 2

Length X2:        0 = 2 bits
                  1 = 3 bits
                  2 = 4 bits
                  3 = 5 bits
                  4 = 6 bits
                  5 = 8 bits
                  6 = 10 bits
                  7 = 12 bits
                  8 = 15 bits
                  9 = 20 bits
                  : = 24 bits

Bit values X3-X26:        0 or 1 only
```

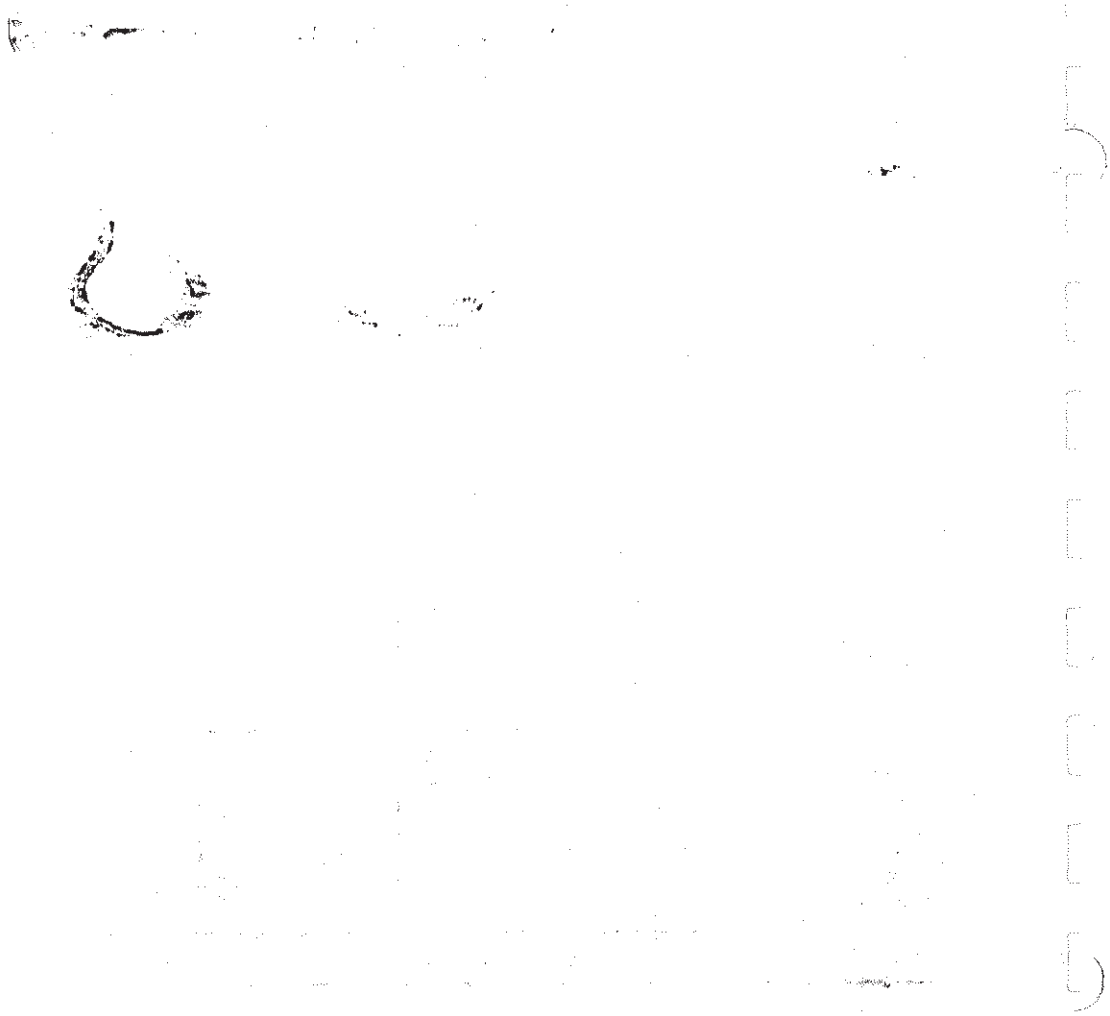
Notes: Actual pattern used by PF-45 must be selected using the S-string. Once the programmable word has been selected as the pattern, the W-string can be used over and over to change the pattern (the S-string does not need to be resent to activate the new word). The W-string will fill in a "too short" string with 1s.

Sample IEEE commands (HP-BASIC for HP-85):

```
10 OUTPUT 701;"W01100,"     !Command Error

10 OUTPUT 703;"W11100,"     !Programmable Word 1 = 3 bits long, pattern 100

10 OUTPUT 702; "W111,"      !Programmable Word 1 = 3 bits long, pattern 111
```

Available Analyses for each Event

	Bit3	Bit1	BPV3	BPV1	Par	CPar	Febe	Par2 DS2E	CRC DS1	CRC4 E1	Frm3	Frm2 DS2/ DS2E	Frm1 DS1/ E1
ErrCnt	x	x	x	x	x	x	x	x	x	x	x	x	x
DrbCnt	x	x	x	x									
Err/S	x	x	x	x	x	x	x	x	x	x	x	x	x
MaxES	x	x	x	x	x	x	x	x	x	x	x	x	x
CurBER	x	x	x	x	x	x	x	x	x	x	x		
AvgBER	x	x	x	x	x	x	x	x	x	x	x	x	x
DrbBER	x	x	x	x									
ErrSec	x	x	x	x	x	x	x	x	x	x	x	x	x
<E-6ES	x		x		x	x	x	x		x			
<E-5ES		x		x									
<E-4ES											x		
<E-3ES												x	x
≥E-6ES	x		x		x	x	x	x		x			
≥E-5ES	x	x	x	x	x	x	x	x		x			
≥E-4ES	x	x	x	x	x	x	x	x		x	x		
≥E-3ES	x	x	x	x							x	x	x
≥E-2ES		x		x							x	x	x
≥E-1ES												x	x
SES									x				
%EFS	x	x	x	x	x	x	x	x	x	x	x	x	x
ES	x	x			x	x	x		x	x			x
SES	x	x			x	x	x		x	x			x
AS	x	x			x	x	x		x	x			x
UAS	x	x			x	x	x		x	x			x
DM		x							x	x			



PF-45 Status
No Power Seconds
Total Errored Seconds
Total Alarm Seconds

(Additional simultaneous measurements with E1 Drop/Analysis Option)

DS2E Frame-Word Errors, E1 FAS-Word Errors (each)
Error Count
Errors Per Second/Max. Errors Per Second
Average Error Ratio
Errored Seconds
Threshold ErrSecs.....<E-3
Threshold ErrSecs.....≥E-3
Threshold ErrSecs.....≥E-2
Threshold ErrSecs.....≥E-1
% Error-Free Seconds

DS2E Parity Errors
Error Count
Errors Per Second/Max. Errors Per Second
Current Error Ratio/Max. Current Error Ratio (Estimated BER)
Average Error Ratio (Estimated BER)
Errored Seconds
Threshold ErrSecs.....<E-6
Threshold ErrSecs.....≥E-6
Threshold ErrSecs.....≥E-5
Threshold ErrSecs.....≥E-4
% Error-Free Seconds

E1 CRC-4 Errors
Error Count
Errors Per Second/Max. Errors Per Second
Current Error Ratio/Max. Current Error Ratio (Estimated BER)
Average Error Ratio (Estimated BER)
Errored Seconds
Threshold ErrSecs.....<E-5
Threshold ErrSecs.....≥E-5
Threshold ErrSecs.....≥E-4
Threshold ErrSecs.....≥E-3
% Error-Free Seconds

DS2E Rx Status (Selected DS2E embedded in DS3)
No Signal Seconds
No Frame Sync Seconds
AIS Seconds
A-bit Alarm Seconds

E1 Rx Status (Selected E1 embedded in DS3)
No Signal Seconds
No Frame Sync Seconds
AIS Seconds
Remote Alarm Seconds

1.2.2 Error Counting

Bit Error Count and No Pattern Sync Seconds Count are inhibited for the entire measurement run when pattern synchronization is not established at the start of the measurement, or when "Live" or "InsDS1" pattern is selected.

Bit Error Counter inhibited while any of the following conditions exist:
. . . . . No Signal, No Frame Sync (ignored for "UNFRAMED" setup),
. . . . . No Pattern Sync, DS3 AIS/BLUE, DS1 AIS, DS1 Yellow (SF only)

When rear-panel DIP switch # 7 is set ON:
. . . . a DS3 bit error is counted for each clock period during a DS3 No Signal condition

Parity, C-Parity, FEBE, CRC-6, and Frame Error Counters inhibited while any of the following conditions exist: . . . . . No Signal, No Frame Sync, DS1 AIS (CRC-6 only)

BPV Counters inhibited while the following condition exists . . . . . No Signal

1.2.3 Dribbling Analysis

DS3 Dribbling Error Count: . . . . . total count of errors that
. . . . . occur within seconds which have a BER less than 1E-6

DS3 Dribbling Error Ratio: . . . . . total (average) BER for those seconds
. . . . . each of which have a BER of less than 1E-6

DS1 Dribbling Error Count: . . . . . total count of errors that
. . . . . occur within seconds which have a BER less than 1E-5

DS1 Dribbling Error Ratio: . . . . . total (average) BER for those seconds
. . . . . each of which have a BER of less than 1E-5

1.2.4 Estimated BER

For DS3 Parity, C-Parity, FEBE, and DS1 ESF CRC-6 (DS2E Parity and E1 CRC with E1 Option):
Current and Average error ratios are calculated to provide an "estimated" Bit-Error-Ratio (BER). This is done by considering each parity, C-parity, FEBE, or CRC error to have been caused by a single "data-bit" error. The resulting Current or Average "data-bit" error ratio is the "estimated" BER.

1.2.5 Maximum (Peak)

MaxE/S . . . . . peak value of Errors Per Second during a measurement is displayed at end of run

MaxBER . . . peak value of Current Error Ratio during a measurement is displayed at end of run

1.3 TEST PATTERNS

DS3 and DS1 . . . . . 2^{23}-1 (inv.), 2^{20}-1, 2^{15}-1 (inv.), 2^{11}-1, 2^{9}-1, 1111^{++}

DS3 only . . . . . 1000^{+}, 1100 (not IDLE), 1010 (not AIS), 100^{+}

DS1 only . . . . . QRSS20 (2^{20}-1 w/max. 14 zeros), QRSS11 (2^{11}-1 w/max. 7 zeros)

. . . . . 1-in-8^{*+}: [F]01000000...

. . . . . 2-in-8^{+}: [F]01000010...

. . . . . 3-in-24^{*+}: [F]010001000000000000000100...

Live . . . . default pattern for MON, THRU, and ExtD&I modes. When selected, no "Bit" event or No Pattern Sync Seconds are available, and all Pattern Sync LEDs remain off.

InsDS1 . . . . available only in Tx^{3}_{1} modes, PF-45 uses externally sourced DS1 applied to DS1 Insert Jack [34] as the DS1 test signal. When selected, no "Bit" event or No Pattern Sync Seconds are available, and all Pattern Sync LEDs remain off.

(*) Do not cause SF Yellow Alarm or Excess Zeros when framed.

(+)Received as generic 24-bit repeating patterns. The PF-45 receiver will achieve pattern sync and count errors on any repeating 24-bit pattern when set to one of these patterns.

(++)Received as generic 16-bit repeating pattern.

1.3.1 Pattern Re-sync Criteria

PRBS/QRSS . . . . . BER > approx. 22% over 5000 bits

DS3 1010, 1100 . . . . . BER > approx. 22% over 5000 bits

DS3/DS1 All 1's . . . . . BER > approx. 5.5% over 5000 bits

Other Patterns . . . . . BER > approx. 2.5% over 5000 bits

Pattern Sync . . . . . requires approx. 110 (DS3) or 220 (DS1) unerrored bits

1.4 ERROR INSERTION

1.4.1 Standard Error Types* (Single, Ratio, Burst)

Bit (Tx3/THRU3 modes) . . . . . DS3 data-bit (logic) error,
. . . . (creates a parity error if an odd number of errors occurs within a DS3 multiframe)
Bit (Tx1/THRU1/IntD&I/Ins$^3_1$ modes) . . . . . DS1 data-bit (logic) error,
. . . . . (for ESF, creates a CRC-6 error for 100% of multiframes containing a single error
. . . . . and for multiframes with more errors, 98.4% will cause CRC-6 errors)
Bit (Tx$^3_1$/THRU$^3_1$ modes) . . . . . DS1 data-bit (logic) error in selected channel,
. (creates a DS3 parity error if an odd number of errors occurs within a DS3 multiframe,
. . . . . for ESF, creates a CRC-6 error for 100% of multiframes containing a single error
. . . . . and for multiframes with more errors, 98.4% will cause CRC-6 errors)
Bit (ExtD&I mode and Ins DS1 Pattern) . . . . . DS1 error in selected channel
BPV (DS3) . . . . . B0V sent instead of 00V, or vice versa, (no bit errors inserted)
BPV (DS1 B8ZS) . . . . . violation placed outside of B8ZS byte, (no bit errors inserted)
Frame (DS3) . . . . . F and M-bit errors
Frame (DS2) . . . . . F and M-bit errors
. (creates a DS3 parity error if an odd number of errors occurs within a DS3 multiframe)
Frame (DS1 D4/SF) . . . . . Ft and Fs errors, (for Tx$^3_1$ and THRU$^3_1$ modes,
. creates a DS3 parity error if an odd number of errors occurs within a DS3 multiframe)
Frame (DS1 ESF) . . . . . Ft errors, (for Tx$^3_1$ and THRU$^3_1$ modes,
. creates a DS3 parity error if an odd number of errors occurs within a DS3 multiframe)
Parity (DS3 M13 and C-Parity) . . . . . both P-bits of a single multiframe are inverted
C-Parity (DS3 C-Parity) . . . . . all 3 C-bits of m-subframe (row) 3 are inverted
FEBE (DS3 C-Parity) . . . . . all 3 C-bits of m-subframe (row) 4 are set = "0"
CRC-6 (DS1 ESF) . . . . . a single checksum bit is errored, (for Tx$^3_1$ and THRU$^3_1$ modes,
. creates a DS3 parity error if an odd number of errors occurs within a DS3 multiframe)
Error Insertion Ratios . . . . . $1.0x10^{-2}$ to $1.0x10^{-9}$ (mantissa in 1, 2, 5 steps)
Error Insertion Ratios for Parity,C-Parity,FEBE,CRC-6 . . . . . produce "estimated" BER at set ratio
Burst: (gated insertion of error ratio or alarm) . . . . . 1 ms to 6 sec (1 ms resolution)
*In Tx$^3_1$, THRU$^3_1$ and D&I modes, the errors are inserted in the selected channel only.

1.4.2 Auxiliary "AUX" Insert* (Single, Continuous, Burst)

DS1 Inband Loopback Codes . . . . . CSU Loop Up (10000...)
. . . . . CSU Loop Down (100...)
. . . . . Network Interface Loop Up (11000...)
. . . . . Network Interface Loop Down (11100...)
Single . . . . . six second burst
DS1 Frame Bits . . . . . overwrite pattern for framed operation
*In Tx$^3_1$ modes, the AUX pattern is inserted in all DS1s. In THRU$^3_1$ mode, the DS1 AUX pattern is inserted in the selected channel only.

1.4.3 Auxiliary "AUX" Error Types* (Single)

"AUX" error insertion is different in character and intent from the standard (Bit, BPV, Par/CRC, and Frm) error insertion types. The AUX error types are meant to be "single-shots" of various error patterns, each of which has unique function in testing the DS1/DS2/DS3 multiplex hierarchy. Each of these single-shots occurs with respect to the transmitted multiframe position, and lasts (with the exception of X-bit) for one multiframe. For AUX error insertion, the [SINGLE] key triggers the error insertion, while the [RATIO] selects "Ext2", which allows the user to trigger the error insertion from an external source.

DS3 frame-bit errors . . . . . 2 or 3 consecutive F-bit or M-bit, or (3-in-15) to (3-in-17) F-bit

The AUX DS3 Fbit and Mbit insertion allows the user to choose from the following list of preset error-patterns where the pattern always starts at the beginning of a multiframe. The bits shown are the F-bits or M-bits only, and the inserted errors are marked E.

```
(Unerrored F3:) 1  0  0  1    1  0  0  1    1  0  0  1    1  0  0  1    1  0  0  1   ...................
        F3:2/2  E  E  F0 F1   F1 F0 F0 F1   F1 F0 F0 F1   F1 F0 F0 F1   F1 F0 F0 F1  remainder unerrored
        F3:2/3  E  F0 E  F1   F1 F0 F0 F1   F1 F0 F0 F1   F1 F0 F0 F1   F1 F0 F0 F1  remainder unerrored
        F3:3/3  E  E  E  F1   F1 F0 F0 F1   F1 F0 F0 F1   F1 F0 F0 F1   F1 F0 F0 F1  remainder unerrored
        F3:3/15 E  F0 F0 F1   F1 F0 F0 E    F1 F0 F0 F1   F1 F0 E  F1   F1 F0 F0 F1  remainder unerrored
        F3:3/16 E  F0 F0 F1   F1 F0 F0 F1   E  F0 F0 F1   F1 F0 F0 E    F1 F0 F0 F1  remainder unerrored
        F3:3/17 E  F0 F0 F1   F1 F0 F0 F1   E  F0 F0 F1   F1 F0 F0 F1   E  F0 F0 F1  remainder unerrored
(Unerrored M3:) 0  1  0
        M3:1/1  E  M1 M0
        M3:2/2  E  E  M0
        M3:2/3  E  M1 E
        M3:3/3  E  E  E
```

DS2 frame-bit errors . . . . . 2 or 3 consecutive F-bit, 1,2 or 3 consecutive M-bit

. . . . . 2-in-3 M-bit, (2-in-4) to (2-in-6) F-bit

The AUX DS2 Fbit and Mbit insertion allows the user to choose from the following list of preset error-patterns where the pattern always starts at the beginning of a multiframe. The bits shown are the F-bits or M-bits only, and the inserted errors are marked E. AUX DS2 Fbit insertion does not cause DS3 parity errors.

```
(Unerrored F2:)     1  0  1   0  1   0  1   0
          F2:2/2    E  E  F1  F0 F1  F0 F1  F0
          F2:3/3    E  E  E   F0 F1  F0 F1  F0
          F2:2/4    E  F0 F1  E  F1  F0 F1  F0
          F2:2/5    E  F0 F1  F0 E   F0 F1  F0
          F2:2/6    E  F0 F1  F0 F1  E  F1  F0
(Unerrored M2:)     0  1  1
          M2:1/1    E  M1 M1
          M3:2/2    E  E  M1
          M3:2/3    E  M1 E
          M3:3/3    E  E  E
```

DS1 frame-bit errors . . . . . (2-in-4) to (2-in-6) Ft-bit
. . . . . (2-in-4) Fs or (Ft and Fs)-bits

The AUX DS1 Fbit insertion allows the user to choose from the following list of preset error-patterns where the pattern always starts at the beginning of a multiframe. The bits shown are the F-bits only, and the inserted errors are marked E. AUX DS1 Fbit insertion does not cause DS3 parity errors.

D4 (Superframe Format)

```
(Unerrored F1:)      1  0  0  0  1  1  0  1  1  1  0  0
          Ft: 2/4    E  Fs Ft Fs Ft Fs E  Fs Ft Fs Ft Fs
          Ft: 2/5    E  Fs Ft Fs Ft Fs Ft Fs E  Fs Ft Fs
          Ft: 2/6    E  Fs Ft Fs Ft Fs Ft Fs Ft Fs E  Fs
          Fs: 2/4    Ft E  Ft Fs Ft Fs Ft E  Ft Fs Ft Fs
          Fts:2/4    E  Fs Ft E  Ft Fs Ft Fs Ft Fs Ft Fs
```

ESF (Extended Superframe Format)

```
(Unerrored F1:)      0  0  1  0  1  1
          Ft: 2/4    E  Ft Ft E  Ft Ft
          Ft: 2/5    E  Ft Ft Ft E  Ft
          Ft: 2/6    E  Ft Ft Ft Ft E
```

DS3 or DS2 C-bit errors . . . . . 1st, 2nd or 3rd C-bit of each M-subframe (row)

The AUX DS3 and DS2 Cbit insertion gives the user a single multiframe of errored C-bits in the following patterns. AUX DS3 and DS2 Cbit insertion does not cause DS3 parity errors.

```
C3:Col1    The first C-bit of each row is errored.
C3:Col2    The second C-bit of each row is errored.
C3:Col3    The third C-bit of each row is errored.
C2:Col1    The first C-bit of each row is errored.
C2:Col2    The second C-bit of each row is errored.
C2:Col3    The third C-bit of each row is errored.
```

DS3 X-bits = 01 or 10 . . . . . single occurrence of X= 01 or 10
DS3 X-bits = 00 . . . . . one second burst
DS2 X-bit = 0 . . . . . one second burst
*In Tx^3_1 modes, the DS2 and DS1 AUX errors are inserted in all DS2s and DS1s. In $THRU^3_1$ and D&I modes, the DS2 and DS1 AUX errors are inserted in the selected channel only.

1.4.4 Alarm Types* (Continuous, Burst, Single+)

DS3 AIS . . . "1010..." with "1" directly after each overhead bit, and stuck stuffing: all C-bits = 0
DS3 Idle . . . . . "1100..." with 1st "1" directly after each overhead bit, Row 3 C-bits = 000
DS3 X3=00 (Yellow) . . . . . DS3 Xbits = 00
DS2 X2=0 . . . . . DS2 Xbits = 0
DS1 AIS . . . . . unframed, all 1's
DS1 Yellow (D4/SF) . . . . . bit 2 of each channel timeslot = 0
DS1 Yellow (ESF) . . . . . DL = "1111111100000000..."
*In Tx^3_1 modes, the DS1 and DS2 Alarms are inserted in all channels.
+Single available only for X-bit insertion. Gives a one second burst.

1.4.5 Error Insertion Selection

	MODE								
TYPE	Tx3	Tx1	Tx^3_1	THRU3	THRU1	$THRU^3_1$	IntD&I Ins31	ExtD&I	NOTES:
BIT	Bit3	Bit1	Bit1	Bit3	Bit1	Bit1	Bit1	Bit1	Tx^3_1 MODES: Errors
BPV	BPV3	BPV1	BPV3	BPV3	BPV1	BPV3	BPV3	BPV3	are inserted in the
PAR/	Par *	CRC +	Par *	Par *	CRC +	Par *	Par *	Par *	DS1 Chan # selected
CRC	CPar *		CPar *	CPar *		CPar *	CPar *	CPar *	in "ERROR INSERT"
	FEBE *		FEBE *	FEBE *		FEBE *	FEBE *	FEBE *	or Tx^3_1:XX
			CRC +			CRC +	CRC +		$THRU^3_1$ MODE: Errors
FRM	Frm3	Frm1	Frm3	Frm3	Frm1	Frm3	Frm3	Frm3	are inserted in the
			Frm2			Frm2	Frm2	Frm2	dropped DS1 channel
			Frm1			Frm1	Frm1		$THRU^3_1$:XX
AUX	DS3Fbit	DS1Fbit	DS3Fbit	DS3Fbit	DS1Fbit	DS3Fbit	DS3Fbit	DS3Fbit	Tx^3_1 MODES: DS1/DS2
	DS3Mbit	DS1Loop	DS3Mbit	DS3Mbit	DS1Loop	DS3Mbit	DS3Mbit	DS3Mbit	AUX error patterns
	DS3Xbit		DS3Xbit	DS3Xbit		DS3Xbit	DS3Xbit	DS3Xbit	and Alarms inserted
	DS3Cbit		DS3Cbit			DS1Loop	DS1Fbit	DS1Loop	in all DS1/DS2's.
			DS2Fbit				DS1Loop		(Indicated by:
			DS2Mbit						Tx^3_1:**)
			DS2Xbit						
			DS2Cbit						
			DS1Fbit						
			DS1Loop						
ALM	DS3AIS	DS1AIS	DS3AIS	DS3AIS	DS1AIS	DS3AIS	DS3AIS	DS3AIS	
	DS3Idle	DS1Yel	DS3Idle	DS3Idle	DS1Yel	DS3Idle	DS3Idle	DS3Idle	
	DS3X=00		DS3X=00	DS3X=00		DS3X=00	DS3X=00	DS3X=00	
			DS2X=0			DS2X=0	DS2X=0	DS2X=0	
			DS1AIS				DS1AIS		
			DS1Yel				DS1Yel		

Note: Due to the logical constraints of Parity and CRC, no matter how high a selected ratio:
* The maximum insertable Par, CPar, FEBE error ratio is: 1.06E-04.
+ The maximum insertable CRC error ratio is: 2.17E-04.

1.4.6 External Error Insertion

Input Jack, Levels, Max.Speed . . . . . Ext/Event [41], 75 ohm, TTL-compatible, 6MHz typical

Selection . . . . . scroll insertion ratio to "Ins Ext 2" in VIEW field

1.5 Rx STATUS MONITORING

1.5.1 Rx Status Criteria

DS3 NO SIGNAL . . . . . 175 +/- 75 consecutive line or decoded zeros
DS2 NO SIGNAL . . . . . 175 +/-75 consecutive zeros
DS1 NO SIGNAL . . . . . 32 consecutive decoded zeros
DS3 Loss of F-bit frame-sync . . . . . 3-out-of-16 F-bits in error
DS3 Loss of M-bit frame-sync . . . . . 2-out-of-3 M-bits in error
DS2 Loss of F-bit frame-sync . . . . . 2-out-of-4 F-bits in error
DS2 Loss of M-bit frame-sync . . . . . 2-out-of-3 M-bits in error
DS1 Loss of frame-sync . . . . . 2-out-of-4 Ft-bits in error
DS3 C-Parity . . . . . 1st C-bit of m-subframe (row) 1 is always "1"
DS3 AIS/Blue . . . . . data = "1010", with "1" directly after each overhead bit
. . . . . or stuck stuffing: all C-bits = "0", or both
DS2 AIS . . . . . unframed, all 1's
DS1 AIS . . . . . unframed, all 1's
DS3 IDLE . . . . . data = "1100", with 1st "1" directly after each overhead bit
DS1 Yellow (D4/superframe format) . . . . . bit "2" of each channel set to "0"
DS1 Yellow (ESF) . . . . . repeated "1111111100000000.. " in 4kbit/s data link
DS3 X-bit . . . . . X1 X2 not equal to "11"
DS2 X-bit . . . . . X (M4) not equal to 1
DS1 Excess Zeros* (AMI) . . . . . $\geq$ 16 consecutive line zeros at DS1 Rx jack [14]
DS1 Excess Zeros* (B8ZS) . . . . . $\geq$ 8 consecutive line zeros at DS1 Rx jack [14]
PF-45 No Power . . . . . loss of instrument power during measurement
* Excess Zeros only available when DS1 for analysis is input to (bipolar) DS1 Rx Jack [14]

(Additional Rx Status Criteria with E1 Drop/Analysis Option)
DS2E NO SIGNAL . . . . . 175 consecutive zeros
E1 NO SIGNAL . . . . . 32 consecutive zeros
DS2E Loss of frame-sync . . . . . 4 consecutive frame words in error
E1 Loss of FAS frame-sync . . . . . 3 consecutive FAS words in error
DS2E AIS . . . . . unframed, all 1's
E1 AIS . . . . . unframed, all 1's
DS2E A-bit Alarm . . . . . A-bit equal to 1
E1 Remote Alarm . . . . . A-bit in 3 consecutive non-align frames equal to 1

1.5.2 Rx Status LEDs

DS3 LEDs . . . . . No Signal, No Frame Sync, C-Parity, AIS/Blue, Idle, X-bit

DS1 LEDs . . . . . No Signal, No Frame Sync, AIS, Yellow, Excess Zeros

Pattern Sync LEDs (off for "Live" and "InsDS1" patterns)

DS3 Green . . . . . DS3 Pattern Sync

DS3 Red . . . . . No DS3 Pattern Sync

DS1 Green . . . . . DS1 Pattern Sync

DS1 Red . . . . . No DS1 Pattern Sync

(Additional Rx Status LED functionality with E1 Drop/Analysis Option)

E1 LEDs: when dropped channel is E1, then E1 NoSignal, NoFrame, AIS, and Remote Alm use DS1 NoSignal, NoFrame, AIS, and Yellow LEDs, respectively.

1.5.3 Rx Status Seconds

Event Seconds . . . . .count of the number of seconds, asynchronous to the event, in which at least one event, of the type selected, occurred. (For unframed operation, the red "No Frame" LED is lit, but "No Frame" event seconds are not counted.)

Total ErrSecs . . . . .count of the number of seconds, asynchronous to the event, in which at least one error, of any type below, occurred.

DS3: Bit, BPV, Par, CPar, FEBE, Frame

DS2: Frame

DS1: Bit, BPV, CRC, Frame

DS2E: Parity, Frame (with E1 Option)

E1: CRC, Frame (with E1 Option)

Total AlmSecs. . . . . count of the number of seconds, asynchronous to the event, in which at least one alarm, of any type below, occurred.

DS3: No Signal, No Frame, No Pattern, AIS, Idle

DS2: No Signal, No Frame, AIS

DS1: No Signal, No Frame, No Pattern, AIS, Yellow

DS2E: No Signal, No Frame, AIS, A-bit Alarm (with E1 Option)

E1: No Signal, No Frame, AIS, Remote Alarm (with E1 Option)

1.6 DS3 INTERFACE

Frame format . . . . . Unframed, M13 Frame, C-Parity
Max. Avg. Frame Acquisition Time . . . . . 5.5 mSec
Jitter . . . . . meets Jitter Tolerance/Generation requirements of TR-TSY-000499
Tx Clock . . . . . 44.736 MHz,+/-20 ppm (Int),
. . . . . or external TTL clock (Ext), or Rx recovered clock (Loop)
Input/Output . . . . . 75 ohms, unbalanced
Jacks . . . . . WECO 358 compatible (or WECO 440A or BNC, selectable at factory)
Line coding B3ZS
Output levels (switchable)
DS HI . . . . . 0.909Vp +/- 0.5dB, rectangular pulse
DSX3 . . . . . HI + simulated 450 feet 728A cable
DS LO . . . . . HI - 13.8 dB
or in lieu of DS LO (selectable at factory)
DS 900 . . . . . HI + simulated 900 feet 728A cable
Outputs 3
Optional outputs (rear-panel) . . . . . 3 additional, delayed 11 bits from front panel outputs
Input levels (switchable)
HI/LO . . . . . +6 to -26 dB from nominal HI
DSX . . . . . +6 to -26 dB from nominal DSX
Input return loss . . . . . 1 to 50 MHz: >20 dB

1.7 DS1 INTERFACE

Frame format . . . . . Unframed, D4 (SF), ESF, (SLC-96/CCIS - MONITOR Mode only)
DS1 Max. Avg. Frame Acquisition Time . . . . . 9 mSec
(DS2 Max. Avg. Frame Acquisition Time . . . . . 12.5 mSec)
ESF Frame acquisition . . . . . verified with CRC-6
ESF Data Link contents . . . . . "01111110..."
Jitter . . . . . meets Jitter Tolerance/Generation requirements of TR-TSY-000499
Tx Clock . . . . . 1544 kHz,+/-20 ppm (Int,)
. . . . . or recovered clock from DS1 rear-panel bipolar Insert/Reference input (Ref),
. . . . . or external TTL clock (Ext), or from Rx recovered clock (Loop)
Input/Output . . . . . 100 ohms, balanced (Bridging provided for DS1 Rx [14])
Jacks . . . . . WECO 310 compatible (or Bantam, selectable at factory)
Output waveform, level . . . . . DSX1 compatible
Line coding . . . . . AMI or B8ZS
Input waveform, level . . . . . DSX, +6 to -26 dB
Input return loss . . . . . 0.1 to 3.5 MHz: >20dB

1.8 AUXILIARY INPUTS

DS3 Rx NRZ and Clock [45], [44] . 75 ohms, TTL, BNC (falling clock edge in center of NRZ data)
DS1 Rx NRZ and Clock [38], [37] . 75 ohms, TTL, BNC (rising clock edge in center of NRZ data)
DS3 External Tx Clock [53] . . . . . 75 ohms, TTL, BNC
DS1 External Tx Clock [37] . . . . . (same jack as DS1 Rx Clock). . . 75 ohms, TTL, BNC
DS1 Insert/Ref [34] . . . . . DSX1/Monitor-compatible jack,
. . . . . for inserting an external DS1 into DS3 in Ext D&I31 Mode and InsDS1 Pattern
. . . . . Also used for Reference input for "Clk1:Ref" DS1 Tx clock setting

1.9 AUXILIARY OUTPUTS

DS3 Tx NRZ and Clock [43], [42] . . . . . 75 ohms, TTL, BNC
DS1 Tx NRZ and Clock [36], [35] . . . . . 75 ohms, TTL, BNC
DS1 Drop [33] . . . . DSX1-compatible, containing DS1 dropped from DS3 in all applicable modes
Bit Error Event Out [22] . . . . 75 ohms, TTL, BNC, nominal pulse-width: 11nS (DS3), 324nS (DS1)

1.10 OPERATIONAL FEATURES

Measurement run
controlled with . . . . . [START/STOP] push button
Type . . . . . Timed or Continuous measurement run
Pause . . timed run can be manually STOPped, then continued by following display prompts
Duration . . . . . 1 sec. to 1000 hrs, settable in 1 sec. increments
Display . . . . . (2x20) character VFD with green filter
Internal clock/calendar . . . . . battery backed-up
Non-volatile memory . . . . . all memory, (such as current measurement run data,
. . . . . and instrument setup) is battery backed-up
Backup Battery . . . . . (3 x AAA) Nicad, charged while PF-45 is on
History LED
RxSTATUS Display Page . . . . . History LED is lit continuously and all Rx STATUS LEDs are lit
. . . . . which have a non-zero count since start of measurement or last RESET
All other Display Pages . . . . . History LED blinks if any non-zero count
. . . . . of errors or RxStatus exists since start of measurement or last RESET
RESET . . . . . Reset "History" by simultaneously pressing both Data Entry Keys
Elapsed Measurement Run Time . . . . . Elapsed Seconds or Elapsed Time (HH:MM:SS)
Built-in printer (standard feature) . . . . . 24-column thermal printer
Print modes
Manual . . . . . On-demand summary of current results
Summary . . . . Automatic summary print at: 5,15 min, 1,2,6,12,24 hr intervals, or at End of Run
Print All Events . . . . . Timestamped printout of all errors and alarms
Print All Alarms . . . . . Timestamped printout of all alarms
Print On Event . . . . . Timestamped printout of a selected event/error threshold and all alarms
Print-On-Event Squelch . . . . . printing squelched after 10 consecutive print seconds,
. . . . . squelch cleared after 10 consecutive non-print seconds
Beep on Bit Error . . . . . when rear-panel switch [39] #8 is on

1.11 DC POWER OPTION

DC Power (factory installed, in addition to standard AC supply)
. . . . . Range: 21 to 56 V DC, polarity independent
Max.Current . . . . . $\leq$ 2A

1.12 DS3 OUTPUT OPTION

DS3 Output . . . . . 3 additional rear panel bipolar Tx jacks, with 11-bit delay from 3 front
. . . . . panel jacks, and same output level as front-panel DS3 Tx jacks [11]

1.13 DATA LINK/MULTIFUNCTION OPTION

Option allows Drop & Insertion of various DS3 overhead bits, including the FEAC, DL5, DL6, DL2/7, and N_a (C12) C-Parity data links, D&I of the DS1 ESF data link, and provides auxiliary outputs for numerous live error and alarm detection signals listed below.

Multipole Connector [58]
Physical type . . . . . Rear-panel 25 pole D-type
Electrical characteristics . . . . . HCMOS compatible, Z_o = 250 ohms nom., Z_i > 5000 ohms
Function: Config. 1A . . . simultaneous DS3 C-Parity and DS1 ESF Data Link D&I, DS3 X-bit D&I
Config. 1B . simultaneous DS3 C-Parity Data Link D&I, DS3 X-bit, P-bit and FEBE D&I
Config. 2 . . . . . Parallel Auxiliary Output of the following signals:
. . . . . DS3: Parity Errors, CParity Errors, FEBE events, Frame Errors,
. . . . . DS3: No Signal, No Frame, AIS, Idle, No Pattern: (all inverted),
. . . . . DS2: Frame Errors, No Frame (inv.) and All 1s (inv.),
. . . . . DS1: CRC Errors, Frame Errors,
. . . . . DS1: No Signal, No Frame, All 1s, No Pattern: (all inverted),
. . . . . DS3 and DS1 Transmit and Receive Multiframe Sync

Output Jacks [56], [57]
Physical type . . . . . Rear-panel BNC (x2)
Electrical characteristics . . . . . capable of driving 75 ohm load to TTL-compatible level
Function . . . . . assignable output of one (each) of the following signals:
Jack [56] . . . . . DS3 Rx M-Sync, DS1 Rx M-Sync, Rx3 FEAC CLK, Rx3 DL2/7 CLK,
. . . . . Rx3 DL5 CLK, Rx3 DL6 CLK, Rx3 C12 CLK, Rx1 ESF DL CLK
Jack [57] . . . . . DS3 Tx M-Sync, DS1 Tx M-Sync, Alarm/Error Composite, 5 MHz CLK,
. . . . . Rx3 X1 Valid, DS3 Rx OH, Rx1 ESF DL, Burst time
Alarm/Error Composite . . . . . logical "OR"ing of any combination of the following signals:
. . . . . Bit Error, No Pattern Sync
. . . . . DS3: BPV, Parity, C-Parity, FEBE, or Frame Error,
. . . . . DS2 Frame Error,
. . . . . DS1: BPV, CRC, or Frame Error,
. . . . . DS3: No Signal, No Frame, AIS, Idle,
. . . . . DS1: No Signal, No Frame, AIS,
Control . . . . . via DIP switches located on option board,
. . accessible by removing PF-45 top cover (4 Allen screws) with attached wrench

1.14 E1 DROP/ANALYSIS OPTION

In Mon^3_1 mode, option allows E1 (2.048Mb/s CEPT Level 1) channels to be dropped from DS3, and simultaneous live performance monitoring is performed on the received DS3 and the dropped DS2E (CCITT G.747) and E1.

DS2E Max. Avg. Frame Acquisition Time 0.53mSec

E1 Interface

Frame Format . . . . . Unframed, FAS only, CRC-4 & FAS
E1 Max. Avg. Frame Acquisition Time . . . . . 500 uSec (+ 4 additional mSec for CRC)
Jitter tolerance/generation . . . . . CCITT G.823 (Rx), G.742 (Tx)
Input/Output impedance . . . . . 120 ohm balanced
Jacks . . . . . WECO 310 compatible (or Bantam, selectable at factory)
Output waveform, level . . . . . CCITT G.703 compatible
Line coding . . . . . AMI, or HDB3
Input waveform, level . . . . . per G.703, +6 to -26 dB
Input Return Loss . . . . . 0.1 to 3.5 MHz > 20 dB

1.15 REMOTE CONTROL OPTION

IEEE-488 . . . . . SH1,AH1,T6,TE0,L4,LE0,SR1,RL1,PP0,DC1,DT1,C0,E2
RS-232
- Connector . . . . . Rear-panel DB-9
- Pinout . . . . . DTE
- Handshake . . . . . Xon/Xoff
- Set DTR on RI . . . . . Enable/Disable
- Echo . . . . . On or Off
- Baud Rates 110, 300, 1200, 2400, 4800, 9600
- Parity/Data Bits/Stop Bits . . . . . N,8,1 / E,8,1 / O,8,1 / N,8,2 / N,7,2
  (N = No Parity E = Even Parity O = Odd Parity)

1.16 GENERAL SPECIFICATIONS

AC Power Supply . . . . . 90-250V, 47-65Hz, 40VA max.
Operating Temperature . . . . . +5degC to +40degC
Dimensions (wxhxd) . . . . . 13.75 in. X 6.25 in. X 14 in.
. . . . . (319 mm x 159 mm x 357 mm)
Approximate Weight . . . . . 15 lbs. (6.8 kg)
Safety Class . . . . . CSA Safety Class 3631 01
. . . . . for Electronic Development and Test Equipment
. . . . . Registration No. LR 81320

1.17 ORDERING INFORMATION

PF-45 DS3/DS1 Analyzer . . . . . **BN 9402/01**
Stnd. Accessories: line cord, 5 rolls printer paper, operation manual, short operation manual, fuse
Connector Selection for BN 9402/01
DS-3 Tx/Rx WECO 358 compatible . . . . . Standard
or WECO 440A compatible option (no extra charge, factory installed) . . . . . BN 9402/00.01
or BNC option (no extra charge, factory installed) . . . . . See BN 9402/02
DS1 Tx/Rx WECO 310 . . . . . Standard
DS1/E1 Tx/Rx Bantam connectors instead of WECO 310
(no extra charge, factory installed) . . . . . BN 9402/00.03

PF-45 DS3/DS1 Analyzer (Versacon®9 version) . . . . . **BN 9402/02**
Stnd. Accessories: line cord, 5 rolls printer paper, operation manual, short operation manual, fuse
Connector Selection for BN 9402/02
DS3 Tx/Rx BNC compatible . . . . . Standard
DS1 Tx/Rx WE 310 . . . . . Standard
DS1/E1 Tx/Rx Bantam connectors instead of WECO 310
(no extra charge, factory installed) . . . . . BN 9402/00.03

For both versions:

DS 900 instead of DS Lo DS3 output levels (no extra charge, factory installed) . . . BN 9402/00.04

Options (charged extra)
DC Power Option . . . . . BN 9402/00.06
DS3 Output Option (specify only one connector type)
WECO 440A compatible . . . . . BN 9402/00.07
or WECO 358 compatible . . . . . BN 9402/00.08
or BNC . . . . . BN 9402/00.09
Data Link/Multifunction Option* . . . . . BN 9402/00.10
E1 Drop/Analysis Option* . . . . . BN 9402/00.11
IEEE 488/RS232C Remote Control . . . . . BN 9402/00.12
*Data Link and E1 Options occupy the same motherboard slot, and so are mutually exclusive.

Accessories (charged extra)
AT-53 carrying case . . . . . BN 2015/00.03
SD-930 protective covers (front and back) . . . . . BN 0960/00.01
Thermal printer paper (5 rolls) . . . . . BN 9402/00.13

Bellcore CLEI No. DMTE 4218 AA (CPR No. 574609)
PF-45 accepts 2.25 " wide SEIKO TP201-211-25C thermal printer paper or equivalent

2.1 UNPACKING THE INSTRUMENT

The PF-45 is shipped in a special packing case, which has been subject to comprehensive material strength tests at Wandel & Goltermann. This guarantees that the instrument will arrive without damage, even if subjected to rough treatment. The instrument should be lifted carefully out of the packing materials as indicated on the package. We recommend that the original packing materials be saved for possible subsequent shipment.

2.1.1 Shipping Notes

Shipping of the PF-45 without damage can be guaranteed only if correctly designed packing materials are used. We recommend saving the original carton and packing materials for this use.

2.2 IMPORTANT SAFETY INSTRUCTIONS

AC mains (line) voltage

Before switching on the equipment, make sure that it is set to the voltage of the power supply.

Protective earth conductor

Before the instrument is connected to the measuring circuit, a protective ground connection shall be made. If the protective ground conductor of the AC mains can serve for this purpose, then plug the instrument into the mains first. If the measuring circuit has its own protective ground conductor, then this should connected to the instrument casing before the rest of the test circuit is connected.

Safety procedure for damaged or malfunctioning instruments

If the instrument

- shows visible damage
- fails to perform the intended measurements
- has been subjected to damp conditions

it shall be considered a hazard, and shall be made inoperative and secured against any unintended operation.

Fuses

Only the specified fuses shall be used.

Opening the instrument

It may be necessary to remove the instrument covers to carry out repairs, maintenance and adjustments. This may expose live circuits, so the instrument shall be disconnected from all power sources before it is opened. Repair, maintenance and calibration of the opened equipment under voltage shall be carried out by a skilled person who is aware of the hazard involved.

Repairs
Repairs must be made by competent technicians. Care must be taken to ensure that the safety characteristics of the instrument are not altered. In particular, the dimensions of clearances and creepage distances and insulation must not be modified.

Spare parts
If spare parts other than those specified are used, then always ensure that the safety specifications of the instrument are retained.

Safety tests after repairs and maintenance
Protective ground conductor test:
Check the cable for visible signs of damage and poor connections. Measure the resistance of the protective ground conductor between the AC mains plug contact and the instrument casing. The resistance should be <0.5 Ω. Shake the cable during the measurement; resistance variations mean that the cable is faulty.

Insulation test:
Measure the insulation resistance between the mains conductor terminals (shorted together) and the protective conductor terminal of the instrument using a 500 V dc insulation tester. Ensure that the mains switch of the instrument is in the "ON" position. The insulation resistance must > 2 MΩ.

2.3 INSTALLING THE INSTRUMENT

2.3.1 Use as a Benchtop Unit
The instrument can be used as a benchtop unit in a horizontal position or, by folding down the handle, at a slight angle (front panel approximately 30 deg. from the vertical).

2.3.2 Use When Set on its Rear-Feet
The instrument may be placed on its rear-feet, with the front-panel facing straight up. In this position the built-in printer may bind if the paper roll diameter is too large. This can happen on standard 2.25 inch rolls which are not purchased through Wandel & Goltermann, Inc. To fix this, simply strip off a length of paper from the paper roll to decrease its diameter, thus stopping the printer from binding.

2.3.3 Operating Conditions
The operating characteristics of the PF-45 specified in section 1 "Technical Specifications" are valid only if the nominal operating conditions specified there are observed. The nominal operating temperatures are: +5degC to +40degC. The PF-45 must not be operated under conditions where condensation is likely to form. If condensation does form, e.g. when a cold instrument is brought into a warmer room, the instrument should be allowed to dry before being switched on.

2.3.4 Mains Connection and Fuses

Mains frequency and voltage

The instrument can be operated from a.c. mains supplies with frequencies between 48 and 65 Hz. The nominal mains voltage must not vary by more than +/-10%.

Setting the mains voltage

Before connecting the instrument to the a.c. mains supply, check that the mains voltage selector is set to the correct value and that the correct fuses are fitted. When the instrument leaves the factory it is set for operation from 115 V supplies, unless otherwise specified on the order form. For connection to supplies with voltages of 230 V, the mains voltage selector on the rear of the PF-45 must be set by re-positioning the small switch accessible from the rear panel.

Fuses

We specify the following fuse values and types:

115V: T 1.0 A (anti-surge)
230V: T 0.5 A (anti-surge)
DC: T 3.0 A (anti-surge)

2.3.5 Switch-On

Mains switch

The PF-45's mains-switch is at the bottom right-hand corner of the front panel. A red panel in the switch-face shows that it is in the ON position. NOTE: this switch affects AC-power operation only! See Section 3.3.1 "Power".

Functional checkout

See Chapter 5 for a quick back-to-back functional checkout.

2.3.6 Loading Printer Paper

(These instructions apply to 2.25" wide SEIKO TP201-211-25C paper)

Gently pull plastic printer housing [4] out from the PF-45 front-panel, and swing it down approx. 45 degrees. Lift the lid, exposing the print-head mechanism and the paper-roll bin. Remove the aluminum spindle. Prepare the paper-roll by removing the cardboard tube from inside the roll. Place the aluminum spindle in the paper-roll. Position the paper-roll so the paper feeds from the bottom of the roll when viewed from the front of the PF-45. (Only one side of the thermal paper can be printed on). Pull out a few inches of paper, and make a clean cut across the end if it is ragged. Place the paper-roll with spindle in the paper-roll bin. Feed the paper down into the print-head slot closest to the paper-roll until it stops. Use the line-feed key to advance the paper through the print-head mechanism. Close the printer housing lid, lift the housing back up to vertical, and gently push it back into the front panel until it is seated.

The SEIKO paper provided is sized to give maximum paper length within the printer housing. Occasionally, a roll may be slightly oversized in diameter, and may cause the printer mechanism to bind when the printer housing lid is closed, or when the PF-45 is positioned on its rear-feet. In this case, remove a few feet of paper to decrease the paper-roll diameter, and eliminate the binding.

2.3.7 Batteries for Non-Volatile Memory

The PF-45 contains (3) AAA NiCad batteries. When fully charged they will maintain PF-45 settings and results for one month. The batteries are recharged whenever the instrument is turned on, and fully charge within 14 hours of operation. If the battery voltage is too low to maintain RAM, on turn-on the PF-45 will sense this, reset the instrument to its default settings, and display:

```
PF-45 System-Reset!
Battery LOW
```

If the PF-45 detects RAM errors on turn-on, the instrument will be reset to its default settings, and display:

```
PF-45 System-Reset!
RAM Data Corrupted
```

If the batteries fail to charge, (possibly indicated by RAM errors), they may need replacement. To do this, remove the right-hand rear-panel. Remove the fourth board from the right (from the rear). Remove the battery-clip, replace the 3 NiCads, replace the battery-clip, pc-board, and rear-panel.

2.3.8 Manual System-Reset

To clear all data-results and bring PF-45 back to its default settings, hold down both Data Entry keys while powering-up the instrument. The display will then show:

```
PF-45 System-Reset!
Manual Reset
```

2.3.9 Firmware Revision and Release Date

On power-up, the PF-45 will light all the display pixels for approx. one second, then display the following for approx. one second, where "XX" is the installed firmware revision number.

```
PF-45 Analyzer
    Rev XX
```

After a PF-45 System Reset (see Sections 2.3.7 and 2.3.8 above) the real-time clock will be set to 00:00:00, and the date will be set to the firmware release date.

2.3.10 CPU Switch Settings

Occasionally, new firmware for the PF-45 will be released for updating older units. When EPROMS are changed on the CPU card (card with green pull-tab) it is possible that the switch settings on that card may be inadvertently changed. If the PF-45 fails to operate after installing new firmware, make sure that switch #9 is set OFF, and that all other switches are set ON!

2.3.11 Display Burn-In

On power up the PF-45 will first light all LEDs and display pixels for approx. one second. This allows for a checkout of the display and LEDs, and also exercises the VFD. Due to the nature of the PF-45 display messages and the Vacuum Fluorescent Display, certain pixels are rarely used, and may become dim with time. This is reversable by occasionally turning those pixels on. This is now performed at turn-on.

If a PF-45 is left on, or rarely powered up, the routine described above will not provide enough "on" time for some of the pixels. In this case, if the display appears mottled, the user may activate a steady-state "all-pixels-on" routine in the PF-45 firmware. This is done by holding down the two leftmost keys, [SINGLE] and [Down Arrow] while powering up the unit. All display pixels and front panel LEDs will now remain on until the unit is powered down again. Leave the unit on until all the displayed pixels are of the same brightness. This should take an hour or two, but no harm will come by leaving the unit in this state for a longer time. Powering up once again will bring the PF-45 back to normal operation.

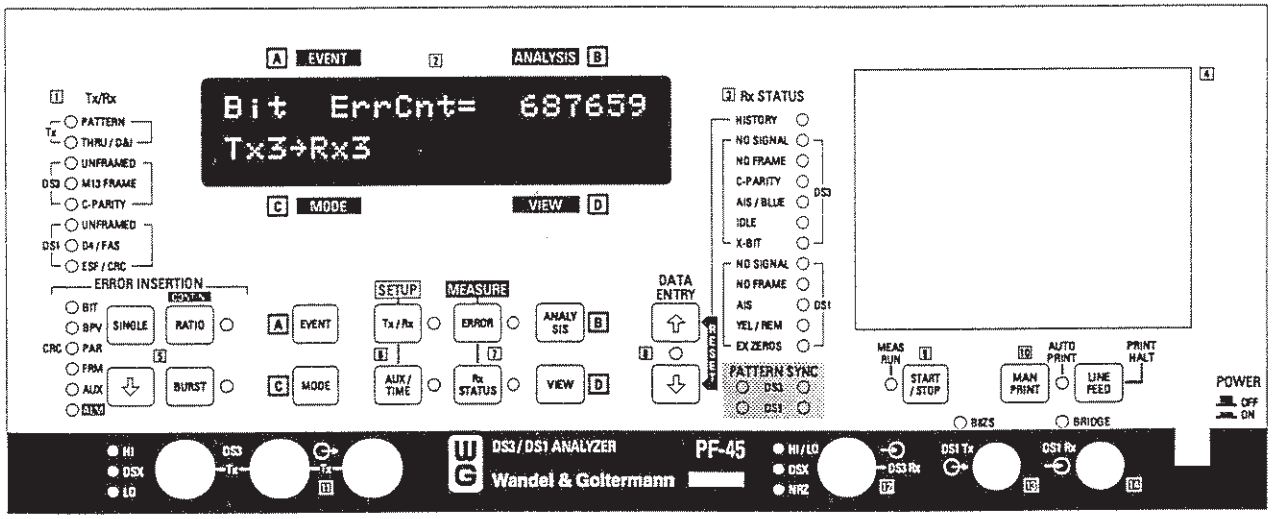


Fig. 3-1: Front View

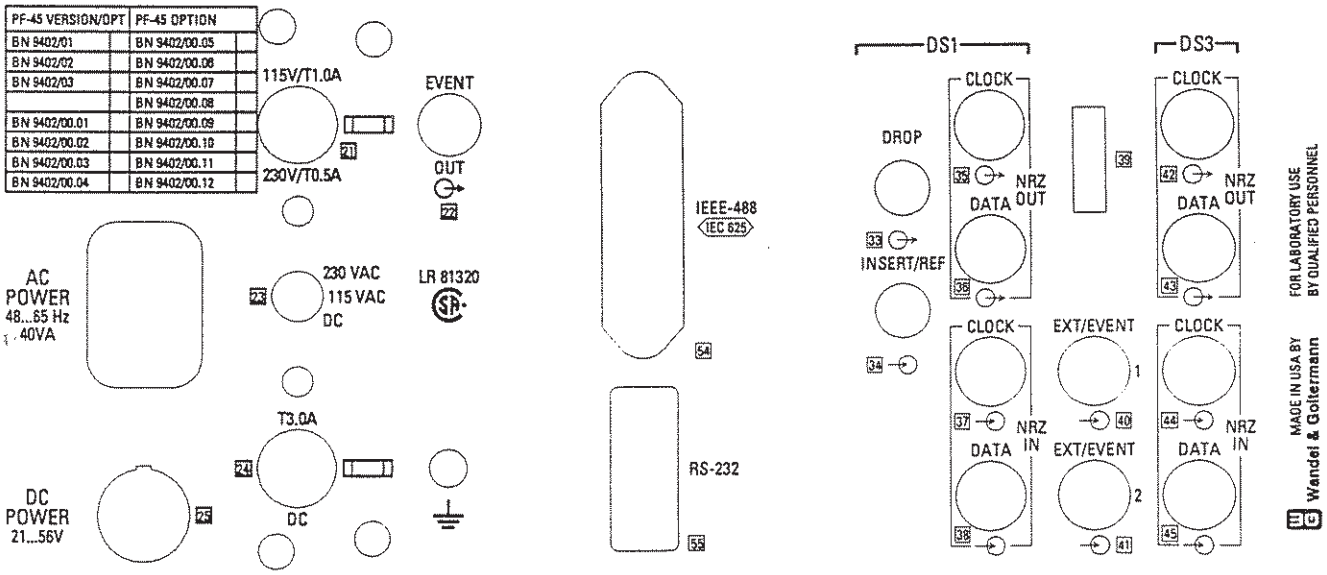


Fig. 3-2: Rear View

3.1 OVERVIEW

All important controls, displays and connectors are on the front panel of the PF-45. Other inputs and outputs are on the back panel. Refer to Figs 3.1 and 3.2 for the meaning of the code numbers used to describe the PF-45's controls, displays and connectors. All controls, displays, and connectors are described below.

3.2 CONTROLS, INDICATORS, AND CONNECTORS ON THE FRONT PANEL

The codes below correspond to the codes printed on the front panel of the PF-45.

3.2.1 Display Categories [6], [7]: See Fig 3-3.

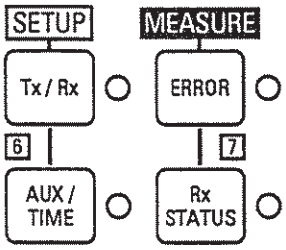


Figure 3-3: Display Category Select Keys

The display [2] is in 1 of 4 categories, indicated by the LED adjacent to one of the four display category keys [6] or [7]. Select the desired display category by pressing the appropriate key. Repeated pressing of these keys will cycle through additional pages if available. Use the two SETUP [6] keys, [Tx/Rx] and [AUX/TIME], to configure PF-45. Use the two MEASURE [7] keys, [ERROR] and [Rx STATUS], to read measurement results. The choice of display category does not affect the measurement process.

3.2.2 Softkeys [A], [B], [C], [D]: See Fig 3-4.

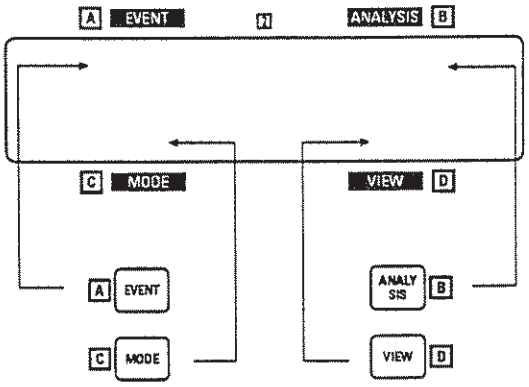


Figure 3-4: Softkeys

Each key has an associated display field, marked in blue for SETUP and gray for MEASURE. Press a softkey to change the parameter or value in its field. This will either cycle through the available choices, or enable the Data Entry keys [8].

3.2.3 Tx/Rx [1]: See Fig 3-5.

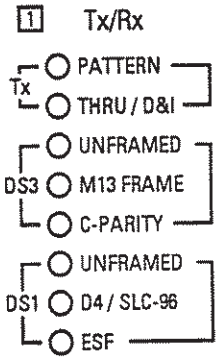


Figure 3-5: Tx/Rx LEDs

Tx: The PATTERN LED is on when the Tx signal is (or contains) an internally generated test pattern.
The THRU/D&I LED is on when the Tx signal is a live signal from receiver.
DS3: DS3 frame format, selected from [Tx/Rx] SETUP.
DS1: DS1 frame format, selected from [Tx/Rx] SETUP.

3.2.4 Rx STATUS [3]: See Fig 3-6.

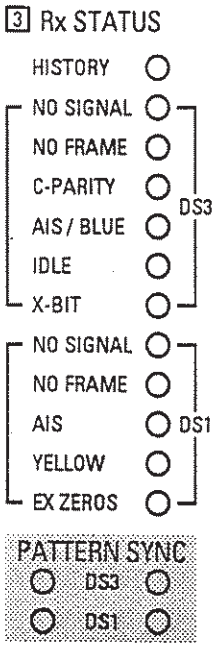


Figure 3-6: Rx STATUS LEDs

The LEDs show live DS3, DS1 and Pattern Sync status (appropriate for the selected operating mode). When the display is in any category other than [Rx Status], the History LED will blink if any event/alarm has been logged since the last History RESET, or the start of the measurement run. When the display is in the [Rx Status] category, the HISTORY LED is lit, and each LED corresponding to a status-event-second count of 1 or more since the start of the measurement or the last History RESET is lit.

3.2.5 Data Entry [8]: See Fig 3-7

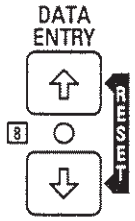


Figure 3-7: Data Entry Keys

Select the display field for change with the appropriate softkey. The changeable parameter and DATA ENTRY LED will blink, showing that the Data Entry keys are active. Press the Data Entry keys to select the desired value. (When setting the BURST time, hold down the key to quickly scroll through the available values). Then press the softkey again to "enter" the selected value, and stop the blinking.

RESET "History" by pressing the two Data Entry Keys simultaneously (see front escutcheon markings). This effects the LEDs that are lit under RxStatus, and the blinking of the History LED, but does not effect the measurement results.

3.2.6 [START/STOP] [9]: See Fig 3-8.

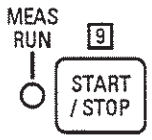


Figure 3-8 [START/STOP] Key

(Set Timed or Continuous measurement run with [AUX/TIME] SETUP).
CONTINUOUS: Press key [9] to Start/Stop measurement.
TIMED: Use key, follow display prompts.

The PF-45 performs measurements on either a continuous or timed basis. In either case, the measurement is initiated by pressing the [START/STOP] key and is stopped by again pressing the same key, or by a change of SETUP. Data accumulated during a measurement interval can be examined or printed after the measurement has been stopped, as well as during the measurement run.

For a CONTINUOUS measurement, when the [START/STOP] key is toggled ON, all stored data is erased and a new measurement is initiated. In the case of a TIMED measurement that has been stopped before the total measurement time has elapsed, the user has the opportunity to either continue the measurement after a pause, or restart the measurement from the beginning. If CONTINUE is selected, the previously stored data is retained and the elapsed measurement time re-commences from the point at which the measurement was halted.

The procedure for "pause" is as follows: if, during a timed measurement, the user wishes to interrupt a measurement and continue at a later time, [START/STOP] should be toggled OFF. When the measurement is to be continued, [START/STOP] is again toggled ON. At this point, the following display appears:

```
START        CONTINUE
"START" ERASES DATA
```

If the user desires to CONTINUE the measurement from the point at which it was halted, softkey [B] is depressed and the measurement continues after a "pause". If the intention is to abort the previous measurement and to begin anew, softkey [A] is depressed and a new timed measurement begins.

This procedure reduces the likelihood of inadvertently stopping a timed measurement and being unable to continue.

3.2.7 DS3 Tx [11]: See Fig 3-9.

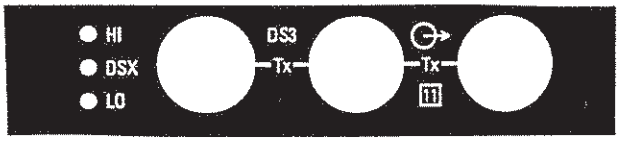


Figure 3-9: DS3 Transmit Jacks

3 in-phase DS3 transmit jacks. Select the output level with [Tx/Rx] SETUP. See Chapter 4.5.2 "Notes for DS3 DSX use" for guidance on the choice of Tx level.

3.2.8 DS3 Rx [12]: See Fig 3-10.

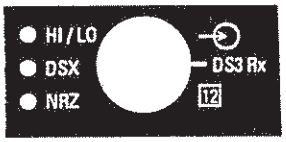


Figure 3-10: DS3 Receive Jack

DS3 receive jack. Select expected receive level with [Tx/Rx] SETUP. Automatically adjusts to MONITOR level. NRZ refers to rear-panel data and clock BNC input jacks. NRZ↑ uses the clock rising edge, while NRZ↓ uses the falling edge. See Chapter 4.5.2 "Notes for DS3 DSX use" for the proper selection of expected Rx level.

3.2.9 DS1 Tx [13] and Rx [14]: See Fig 3-11.

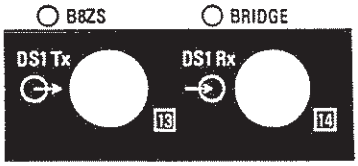


Figure 3-11: DS1 Transmit and Receive Jacks

DSX1-compatible test jacks. With [Tx/Rx] SETUP select B8ZS or AMI, and Rx Terminated or Bridged. Rx automatically adjusts to MONITOR level. NRZ refers to rear-panel data and clock BNC input jacks. NRZ↑ uses the clock rising edge, while NRZ↓ uses the falling edge.

3.2.10 Printer [4]: See Fig 3-12.

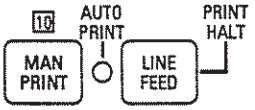


Figure 3-12: Printer Control Keys

Press [Manual Print] [10] key for an immediate printout of current measurement results, see example below. Press [LINE FEED] for a single line of paper feed, or to halt a current printout. Select AUTO PRINT with [AUX/TIME] SETUP.

3.2.11 Error Insertion [5]: See Fig 3-13.

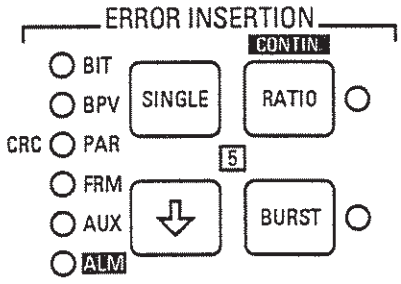


Figure 3-13: Error Insertion Keys

Set display to [ERROR] or [Rx STATUS] category. Select error type for insertion with down-arrow key. Further information on the error type is shown in VIEW field. Certain parameters in VIEW (such as inserted error ratio) may be changed by pressing [VIEW], using Data Entry keys, pressing [VIEW] again.

To preset [RATIO] or [BURST] values, press the [RATIO] or [BURST] key when no error type is currently selected. The ratio or burst time will appear in VIEW, and can be changed with [VIEW] and the DATA ENTRY keys.

BIT,BPV,PAR/CRC,FRM:

SINGLE: 1 error.
RATIO: continuous insertion of error ratio shown in [VIEW].
BURST: timed burst of error ratio.

AUX INSERT: (of DS1 In-Band Loopback Codes)

SINGLE: 6 second burst
CONTIN.: continuous loopback code insertion
BURST: timed burst of loopback code
Select loopback type using [VIEW] and the Data Entry keys.

AUX ERRORS:

SINGLE only.
Select AUX category in [Tx/Rx] SETUP.
Select error type using [VIEW] and the Data Entry keys.

ALM:

CONTIN.: continuous insertion of alarm shown and selected in [VIEW].
BURST: timed burst of alarm.

3.3 CONTROLS, INDICATORS, AND CONNECTORS ON THE REAR PANEL

3.3.1 Power

A.C. Power: Line cord jack, suitable for 48Hz to 65 Hz operation. Switch between nominal AC voltage 110VAC and 220 VAC or DC operation with switch [23]. Fuse [21] must be T1.0A for 110 VAC use, and T0.5A for 220 VAC use.

D.C. Power (Option): Use supplied cable BN 9402-8528.00 to connect to any D.C. power source 21..56 VDC. The two leads are not polarity sensitive, and are floating with respect to ground. The power switch [23] is used to switch DC Power on.

3.3.2 IEEE-488/RS-232 Connectors (Option) [54], [55]:

24-pin D-type for IEEE-488 [54]. DB9 RS-232 [55] (9-pin male jack).

3.3.3 DS1 Drop & Insert Jacks [33], [34]

Dedicated DSX1-compatible jacks for DS3 to DS1 Drop & Insert. Factory equipped 310 or Bantam (same as front-panel test jacks). Line code (AMI or B8ZS) is set the same as the front panel DS1 test jacks. No Rx Bridging (high-Z) is available. The Drop jack contains selected DS1 dropped from DS3 in any suitable operation mode. The Insert/Reference jack accepts any DSX1-compatible or DSX1-monitor signal for insertion into a DS3 in ExtD&I$^{3}_{1}$ mode. The recovered clock from this signal is also used as a network timing reference for the DS1 Tx clock when set to "Clk1:Ref".

3.3.4 DS1 NRZ Ports [35], [36], [37], [38]:

4 BNC jacks, 75 ohms: NRZ OUT Clock [35] and Data [36], NRZ IN Clock [37] and Data [38]. Whenever the PF-45 is in a mode in which it creates a DS1 test signal, NRZ OUT contains that signal and Tx clock. In any mode that analyzes a DS1 signal at DS1 (such as Rx1, THRU1, or MON1), the NRZ IN ports may be selected under [Tx/Rx] Setup (DS1 page) to replace the front panel DSX1 Rx jack. Rx1:NRZ↑ uses the rising edge of the clock, Rx1:NRZ↓ uses the falling edge. The NRZ IN Clock jack also doubles as the DS1 External Clock input, which is selectable from the same DS1 setup page as "Clk1:Ext".

3.3.5 External Event Input Jacks [40], [41]:

Ext/Event jack [41] is used for external error insertion (See Section 1.4.6). Ext/Event jack [40] is reserved for future features.

3.3.6 DS3 NRZ Ports [42], [43], [44], [45]:

4 BNC jacks, 75 ohms: NRZ OUT Clock [42] and Data [43], NRZ IN Clock [44] and Data [45]. Whenever the PF-45 is in a mode in which it creates a DS3 test signal, NRZ OUT contains that signal and Tx clock. In any mode that analyzes a DS3 signal at DS3 (such as Rx3, THRU3, or MON3), the NRZ IN ports may be selected under [Tx/Rx] Setup (DS3 page) to replace the front panel DSX3 Rx jack. Rx3:NRZ↑ uses the rising edge of the clock, Rx3:NRZ↓ uses the falling edge.

3.3.7 DS3 Additional Outputs [50], [51], [52] (Option):

3 jacks provide the identical signal as the front-panel DS3 Tx jacks [11], but delayed by 11 DS3 clock periods.

3.3.8 DS3 External Tx Clock Input [53]:

BNC jack, 75 ohms, used for DS3 Transmit clock when selected from DS3 [Tx/Rx] Setup Page: Clk3:Ext.

3.3.9 Event Out [22]:

BNC jack sends TTL-level pulses on BIT errors.

3.3.10 Rear Panel DIP Switch #7: Measuring DS3 No Signal Duration

This provides a means of measuring DS3 No Signal duration. The function is available in Tx3--Rx3, Mon3, and Thru3 modes and is invoked by setting the rear panel dip switch #7 ON (set switch to the left position). When configured in this way, the PF45 logs one bit error for each DS3 clock transition during the No Signal condition (Normally bit error counting is inhibited during DS3 No Signal).

DS3 No Signal is declared after 175+/-75 contiguous zeros and is terminated upon receipt of a one. Normal bit error counting persists during the first 175 bits of the missing signal, switching over to counting clock transitions when No Signal is declared. With cessation of No Signal, counting is inhibited until pattern synchronization is achieved. Therefore, the bit error count accumulated during No Signal is an excellent measure of the time during which the DS3 signal is absent. The greatest uncertainty lies in the number of errors counted during the 175 bits preceding declaration of No Signal. If, for example, the pattern in use is All Ones, each bit following No Signal will result in an error and the total count will accurately represent the total number of missing timeslots from the first zero to the first one. If a PRBS signal is being used, only about half of the 175 bits will be counted as errors.

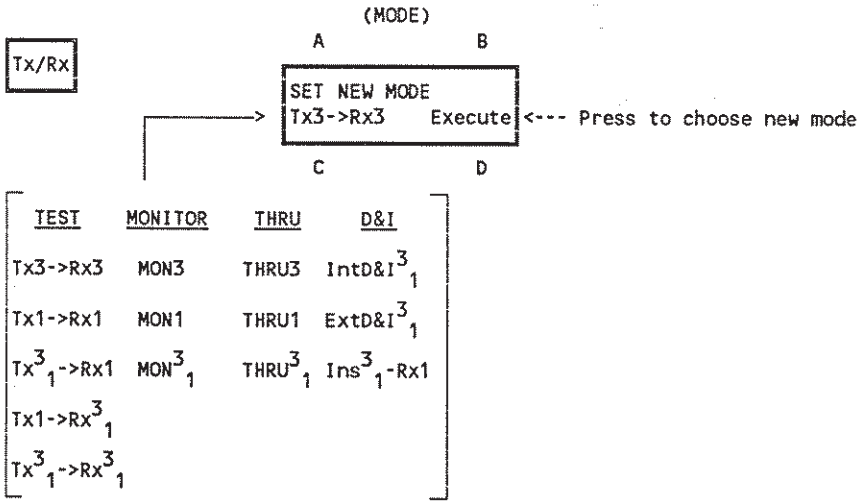
In the unframed mode, each recorded bit error will represent 1/44736000 = 22.35 nSec. In a framed mode, the PF45 measures bit errors over payload (non overhead) bits. In this case each bit error will represent 85/84(22.35) = 22.62 nSec. Taking into account the uncertainties discussed in the previous paragraph, No Signal measurement error will not exceed +75/-175 time slots or +1.7/-4.0 microseconds. The longest measurable time interval is $2.14X10^9$ time slots or about 47 seconds. This limitation results from the maximum count capacity of the PF45.

3.3.11 Rear Panel DIP Switch #8: Beep on Bit Error

Set rear-panel DIP switch #8 ON (set switch to the left position) for a single beep for each bit error. In this case, the beeps are not suppressed during No Signal, No Frame, Alarms, etc., so the beeps are a clear indication of "something wrong".

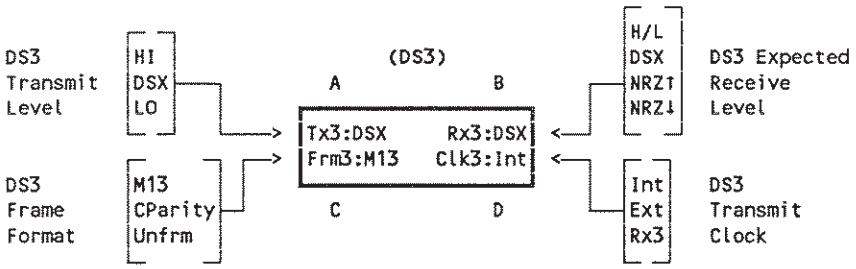
3.4 [Tx/Rx] SETUP

3.4.1 Set New Mode Page:



Press [C] to scroll through the list of operation modes. When the desired new mode has been displayed, press [D] to "EXECUTE" the mode change. The original operation mode is not changed until "EXECUTE" has been performed. When a new mode is executed the present measurement run is stopped, the previous measurement data is erased, the last-set values of the setup parameters are implemented, and the PF-45 is ready to start a new measurement run.

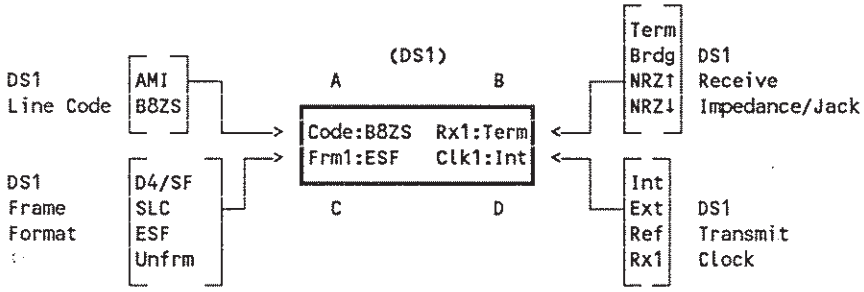
3.4.2 DS3 Setup Page:



The DS3 Setup Page appears for all operation modes which transmit or receive DS3. Each of the four display quadrants contains the present value for a particular setup parameter. Press the appropriate softkey to scroll through the list of setup choices. The displayed choice is implemented immediately. The setup page may be viewed without affecting a measurement run, however, if a setup parameter is changed while a measurement run is taking place, the measurement will STOP, and all error-insertion will be shut off. If the choice of frame format is changed, the PF-45 must change the available measurement "Events", and in the process will also erase the previous measurement results.

"Tx3" is the DS3 transmit level for the three front-panel (and three opt. rear-panel) jacks.
"Rx3" is the expected receive level for the front panel DS3 Rx jack, or selects the rear-panel DS3 NRZ IN ports (with selectable clock edges).
"Frm3" is the selected frame format for the DS3 transmitter and receiver.
"Clk3" is the selected source of the DS3 transmit clock.

3.4.3 DS1 Setup Page:



The DS1 Setup Page appears for all operation modes which transmit or receive DS1. Each of the four display quadrants contains the present value for a particular setup parameter. Press the appropriate softkey to scroll through the list of setup choices. The displayed choice is implemented immediately. The setup page may be viewed without affecting a measurement run, however, if a setup parameter is changed while a measurement run is taking place, the measurement will STOP, and all error-insertion will be shut off. If the choice of frame format is changed, the PF-45 must change the available measurement "Events", and in the process will also erase the previous measurement results.

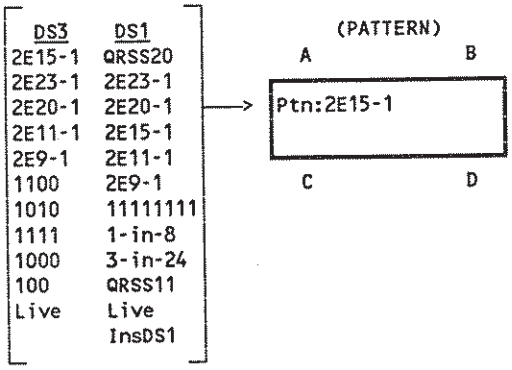
"Code" is the DS1 line code for the front-panel DS1 Tx and Rx jacks and the rear-panel Drop and Insert jacks.

"Rx1" is the selected DS1 receive-source: the front-panel DS1 Rx jack (terminated with 100 ohms or bridged) or the rear-panel DS1 NRZ IN jacks (with selectable clock-edges).

"Frm1" is the selected frame format for the DS1 transmitter and receiver.

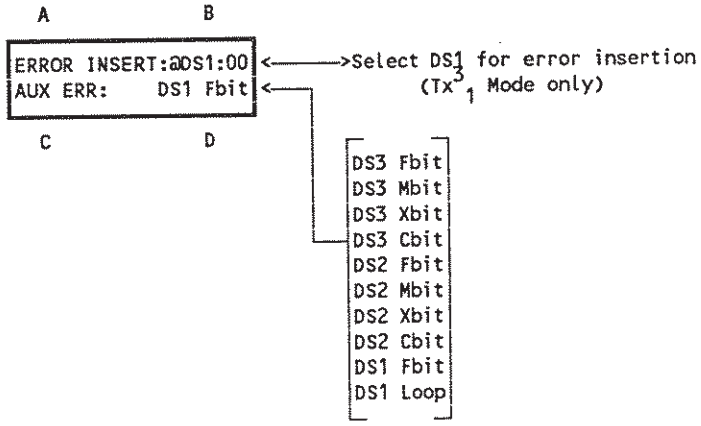
"Clk1" is the selected source of the DS1 transmitter clock.

3.4.4 Pattern Select Page:



Field [A] displays the current transmit and receive test pattern. Scroll through the available DS3 or DS1 patterns by pressing key [A]. The displayed pattern is implemented immediately. The setup page may be viewed without affecting a measurement run, however, if the test-pattern is changed while a measurement run is taking place, the measurement will STOP, and all error-insertion will be shut off.

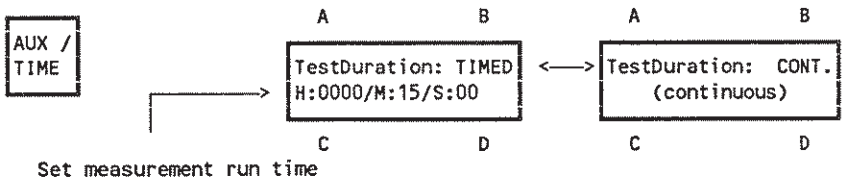
3.4.5 AUX Error Insert Select Page:



Field [D] displays the current category for AUX error insertion. Scroll through the available categories by pressing [D]. The list of error-patterns in the selected category will be found in the VIEW field when the "AUX" error insertion LED is again lit. Field [B] displays the selected DS1 (channel number) for error insertion. This is only shown when in a Tx^{3}_{1} mode.

3.5 [AUX/TIME] SETUP

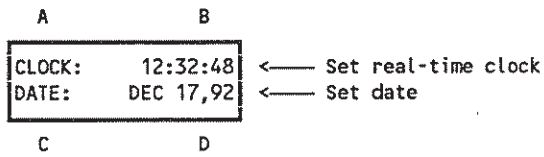
3.5.1 Test Duration Setup Page:



Field [B] displays the current status of Test Duration: Timed or Continuous measurement. If TIMED has been selected, then a measurement-run time from 1 second to 1000 hours can be set up. Pressing [C] once will cause the four "hours" digits to blink. While blinking, they can be set with the Data Entry "up/down" arrow keys (hold down the key to quickly scan to the desired value). Press [C] a second time to blink and set the test duration minutes. Press [C] a third time to set seconds. A fourth pressing of [C] completes the measurement-run-time setup.

The Test-Duration Setup Page can be viewed during a measurement run, but cannot be changed while the "Measurement-Run" LED is lit.

3.5.2 Real-Time Clock and Date Setup Page:



The real-time clock and date are used for time-stamping certain printer events. To view and/or change the clock/date setting, press the [AUX/TIME] setup key until the above display is brought up.

To set the real-time clock:

Press key [B]. The leftmost digit of the set time will blink in conjunction with the Data entry LED. Select the desired number and press [B] again. The next digit now blinks, and so on. To finish the clock setup, "walk" the blinking digit toward the right of the display, and finally off the display.

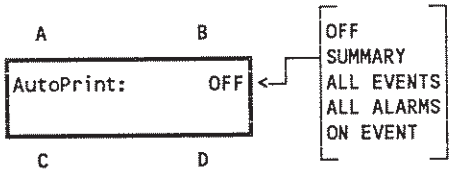
To set the date:

Press key [D], and set the date in the same way as the clock was set.

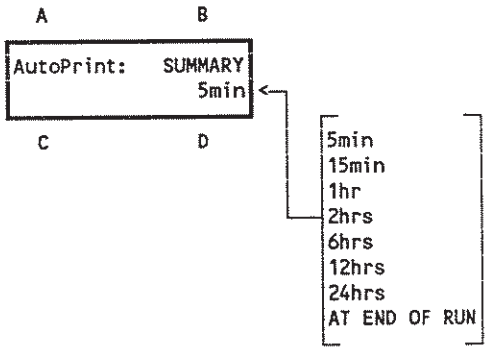
3.5.3 Printer Setup Page:

Field [B] shows the current status of Auto Print. The AUTO PRINT LED is lit for all choices except OFF. The Printer Setup Page can be viewed during a measurement run, but cannot be changed while a measurement is in progress (while the "Measurement-Run" LED is lit), or while the printer is printing.

Manual print via the [MAN PRINT] key is always available, even when Auto Print is on. However, in the Print-On-Event modes, the manual print will not start until the printer buffer is empty, and the Print-On-Event function will be disabled while the Manual print is printing.

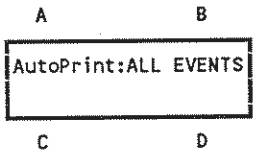


Summary Print

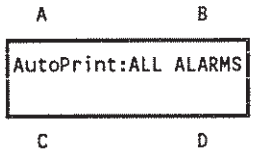


When SUMMARY is selected, the PF-45 automatically prints a summary of the current measurement results at the end of each time interval. Field [D] provides a choice of the desired time interval. Each summary print-out contains the same printed information and format as a Manual Print-out, that is, the data printed is the total (cumulative) data for the measurement run from "start" until the printout has begun. (The measurement run is NOT restarted at the beginning of each time interval.)

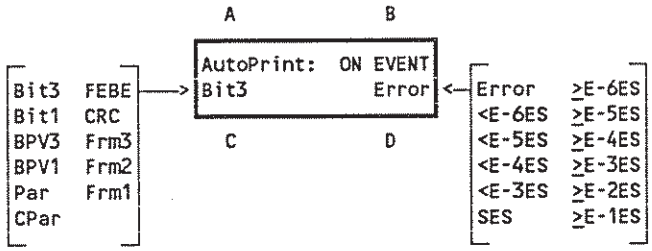
Print-On-Event



Print On All Events will cause a date and time-stamped printout for any:
Error event: Bit3, Bit1, BPV3, BPV1, Par, CPar, FEBE, CRC, Frm3, Frm2, Frm1
Alarm event: DS3: No Signal, No Frame, No Pattern Sync, AIS, Idle
DS2: No Signal, No Frame, AIS
DS1: No Signal, No Frame, No Pattern Sync, AIS, Yellow
Rx Status event: DS3 Xbit, DS2 Xbit, DS1 Excess Zeros, PF-45 No Power



Print On All Alarms will cause a date and time-stamped printout for any:
Alarm event: DS3: No Signal, No Frame, No Pattern Sync, AIS, Idle
DS2: No Signal, No Frame, AIS
DS1: No Signal, No Frame, No Pattern Sync, AIS, Yellow
Rx Status event: PF-45 No Power



Print On (Selected) Event will cause a date and time-stamped printout for:
A selected Event/Threshold second (ie: BPV3 Error, or CRC SES) and, will also print for any of the following:

Alarm event: DS3: No Signal, No Frame, No Pattern Sync, AIS, Idle
DS2: No Signal, No Frame, AIS
DS1: No Signal, No Frame, No Pattern Sync, AIS, Yellow
Rx Status event: PF-45 No Power

Print-On-Event Results

In order to eliminate redundancy in the printout, the PF-45 does not print every event possible each second, but instead prints the subset of meaningful events only.

An example may help: in an Rx^{3}_{1} mode there is a second with DS3, DS2 and DS1 No Signal, DS3, DS2 and DS1 No Frame, Loss of Pattern Sync, DS3, DS2 and DS1 Frame Errors, Par, C-Par, CRC and Bit1 Errors. The PF-45 will print only "ALARM: DS3 No Signal". This is because the remaining alarms and errors are inevitably caused by the DS3 No Signal condition, and so, the other events and alarms add no useful information about the signal condition.

Error Events will show the time, date, the event type, and the number of errors that occurred during the errored second (Err/Sec).

Print-On-Event Squelch

For Print-On-Event, the printout will be squelched after ten consecutive seconds of events to be printed. The printer will print the ten seconds of data, followed by:

(time)/(date)
Printer:SQUELCHED

After ten consecutive seconds without events to be printed, the printer will print:

(time)/(date)
Printer: ENABLED

and the Auto Print feature will continue. During the squelch period, the PF-45 will continue to log all errors and events as usual, but no events will be stored to the printer buffer, or printed.

Print Buffer Overflow

The built-in printer in the PF-45 can print approximately one line per second. Multiple events to be printed may occur during any second, and it is possible that the printer buffer may fill up and overflow in a high-error situation. For Print-On-Event, when 70 lines of print are queued in the printer buffer, the PF-45 will place a time-stamped message:

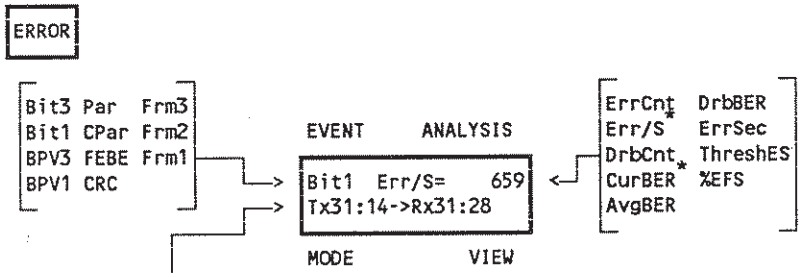
Buffer: OVERFLOW

in the buffer, and will stop loading new lines in. The printer will then print the 70 lines followed by the buffer overflow message (with the time when the buffer ceased to be loaded). The printer will then print the current time and date followed by:

Buffer: CLEARED

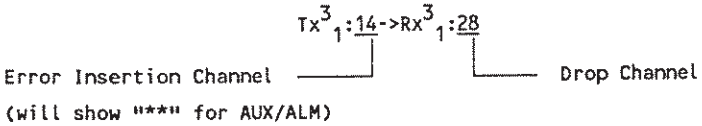
Normal operation of Print-On-Event is then resumed. As with the printer squelch, the PF-45 continues to log all errors and events as usual during the overflow time, but no events will be stored to the printer buffer, or printed.

3.6 MEASURE [ERRORS]



Set Tx (Error Insert) and Rx (Drop DS1) Channel Numbers:

1) Press [MODE] key
2) Tx^{3}_{1} Chan.No.in display & Data Entry LED blink
3) Select Channel for Error Insertion with Data Entry keys
4) Press [MODE] key again to "enter" Error Insertion Chan.No.
5) Rx^{3}_{1} Chan.No.in display & Data Entry LED blink
6) Select Drop Channel (for analysis) with Data Entry keys
7) Press [MODE] key again to "enter" Drop Channel No. and exit



* At end of measurement run, Err/S becomes MaxE/S, and CurBER becomes MaxBER.

The Error Measurement display category shows the current measurement data. While a measurement run is taking place, the displayed values are continually updated. After a measurement run is through, the displayed values are the stored, final results of that measurement. The "measurement process" is not affected by the display category selected. The [EVENT]/[ANALYSIS] selection is a matrix of measurement results, but not all analyses are applicable for every event. In these cases, the analysis will be displayed as "N/A" ie: "Not Applicable" or "Not Available".

3.6.1 Set DS1 Channel Number

When a new mode containing DS1 analysis (other than D&I) is set, the default DS1 channel number is "01".

When a D&I mode is set, the default DS1 channel number is "00", which means NO CHANNEL IS SELECTED! This allows the user to setup the mode completely, monitor the DS3 status, and then perform the Drop & Insert function by selecting a non-zero DS1 channel number. The new DS1 channel number is only activated when the [MODE] key is pressed a second time, stopping the blinking of the channel number in the display and the DATA ENTRY LEDs.

3.6.2 DS2 Channel Numbers

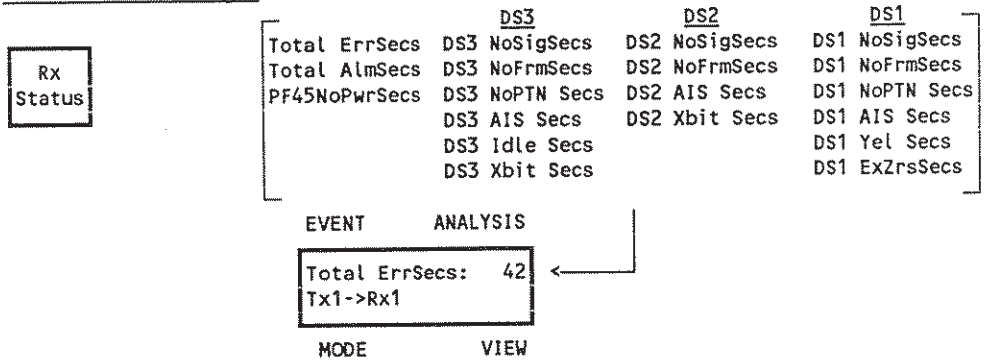
Each DS1 is multiplexed into DS3 via a DS2. Each DS1 channel therefore has a DS2 that contains it. For Tx^{3}_{1} modes, a DS1 channel number is also selectable for error insertion. The DS2 that carries the selected DS1 is also available for error insertion (see 3.4.5 "AUX Error Insert Select Page"). The DS1 channel numbers and their associated DS2 channel numbers are as follows:

DS1 #	DS2 #
1-4	1
5-8	2
9-12	3
13-16	4
17-20	5
21-24	6
25-28	7

3.7 MEASURE [Rx STATUS]

Two display pages are available by pressing the [RxSTATUS] key. The RxStatus Page provides status seconds counts of the individual status events, and of certain composite events. Pressing the [RxSTATUS] key again will toggle to the Elapsed Time Page, which provides the elapsed measurement run time in either seconds or hours/minutes/seconds.

3.7.1 RxStatus Page:



Like the [ERROR] measurement display category, the Rx STATUS page contains constantly updated values during a measurement run, and stored values for that run, when the measurement has stopped.

History LED

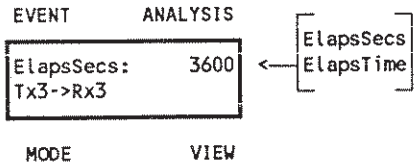
When the Rx STATUS page is selected, the History LED is continuously lit, and any LED that has been lit since the start of the measurement run, or the last History Reset, is now lit again to show the Rx Status "history".

For any display category or page other than the Rx STATUS page, the History LED will blink when a count has occured in the RxStatus Page since the start of the measurement run or the last History Reset. THE BLINKING HISTORY LED IS AN IMMEDIATE INDICATION THAT AN ERROR OR ALARM EVENT HAS OCCURRED. Since Total Errored Seconds and Total Alarm Seconds are provided, the user can quickly determine whether the History LED is blinking to show error events and/or alarm events.

Zero Count Suppression

The Total Errored Seconds and Total Alarm Seconds are always available for display. However, to simplify operation, all other alarms and events with zero-counts are suppressed from the display list. This means that, with the exception of Total ErrSecs and Total AlmSecs, when scrolling through the results with key [B], only those alarms and events which have occurred during the measurement run will be displayed along with their non-zero event-second count.

3.7.2 Elapsed Time Page:



Press key [B] to toggle between the measurement run Elapsed Seconds and Elapsed Time (in hours/minutes/seconds format).

3.8 MAKING SENSE OF MEASUREMENT RESULTS

Consequences of the Error-Count Inhibit:

The "Error-Count Inhibit Feature" (see Section 1.2.2) is a powerful tool for error analysis. Essentially, it inhibits error-counting whenever the conditions for making a particular measurement are not met.

In other, less sophisticated instruments, error-counting continues regardless of the receive signal status. So, for instance, a momentary loss-of-signal could result in millions of DS3 "bit" errors being counted. These errors can swamp the previous error-count, and for most purposes make the error-count data meaningless. The only meaningful data recorded by such an instrument is the loss-of-signal occurrence.

The PF-45 however will, in the instance of a DS3 loss-of-signal, detect the loss-of-signal and immediately inhibit the error-counter. Since the DS3 loss-of-signal is detected within 175 +/- 75 zeros, a relatively small "bit" error count will be accumulated due to it. The PF-45 waits until the signal is restored before re-enabling the counter, then continuing the measurement process. In this case, the PF-45 user has more meaningful data: the loss-of-signal occurrence, and the "bit" error count (and ratios, thresholds, etc.) that occurred while the DS3 signal was present.

Due to this difference in error-count inhibit, the PF-45 user must be aware of the following:

The error-performance of the system-under-test must be judged by a combination of the "Measure Errors" results and the "Measure Rx STATUS"!

Always look at the Rx STATUS results to validate the measurement run results. A bit error count of zero could mean that the system is error-free, OR it could mean that the signal was never present, or the receiver never achieved frame-sync or pattern-sync.

The built-in printer is very helpful for this, because it shows the entire range of error and Rx Status results.

3.9 DATA LINK/MULTIFUNCTION OPTION OPERATION

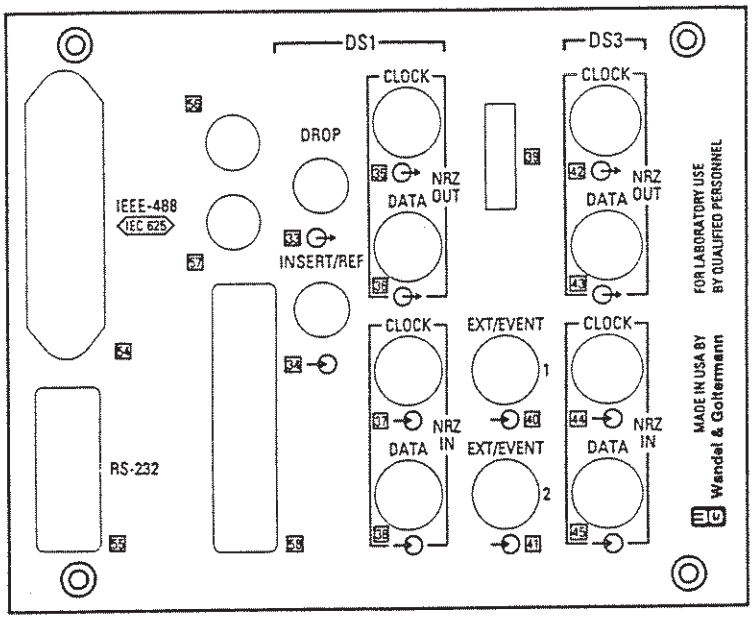


Figure 3-14: Rear View with Data Link/Multifunction Option Installed

OVERVIEW

The Data Link/Multifunction Option Card offers three distinct functions: (1) Transmit (Insert) and Receive access to several DS3 C-Parity Data Links and to the DS1 ESF Data Link. (2) Parallel output of eighteen detected errors and alarm conditions as well as DS3 and DS1 Transmit and Receive M-sync. (3) Two BNC rear panel jacks with assignable outputs.

Functions (1) and (2) share a 25 pole rear panel connector; the desired configuration is selected by the user via an internal DIP switch. The BNC outputs are also assigned via internal DIP switches (see Figure 3-17). The DIP switches are accessible from the top of the option board by removing the top cover (four Allen screws).

DATA LINK ACCESS

The Data Link Configuration provides access to the DS1 ESF Transmit and Receive Facility Data Link as well as a number of present and planned DS3 C-Parity data links. Transmit and Receive access to other selected DS3 overhead bits is also possible. The Data Link configuration is selected by DIP Sw 6 #1 = OFF.

DS3 C-Parity Data Link Drop and Insert

The option provides external access to five DS3 C-Parity data links, making it possible to drop one or more data links from the received C-Parity Formatted signal and to insert one or more data links simultaneously into the transmitted signal. Access is via the 25 pole rear panel connector [58]. The C-bit data links defined below can be accessed in C-Parity frame format:

(1) C12: N_a (9.4 kbit data link not currently assigned)
(2) C13: FEAC (9.4 kbit Far End Alarm & Control)
(3) Row 5: (DL5--28.2 kbit data link) C51,C52, & C53
(4) Row 6: (DL6--28.2 kbit data link) C61,C62, & C63
(5) Rows 2&7: (DL2/7--56.4kbit) C21,C22,C23,C71,C72, &C73

Separate Transmit and Receive "clock" signals are provided for each of the data links defined above; eg, Tx3 DL5 Clk or Rx FEAC Clk.

DS3 X-Bit Drop and Insert

Access to individual Transmit and Receive X bits is provided by means of X1 and X2 clocks, analogous to the C-data link clocks described above. Separate Transmit and Receive clock signals are provided for individual X1 and X2 bits (9.4 k-bit); eg, Tx3 X1 Clk or Rx3 X2 Clk.

DS3 FEBE Access

Access to the FEBE bits is provided by means of Transmit and Receive FEBE clocks that define the location of the three FEBE C-bits (28.2 kbit); eg, Tx3 FEBE Clk.

DS3 P-Bit Access

Access to the P-bits is provided by means of Transmit and Receive P Bit clocks that define the locations of both P bits (18.8kbit); eg, Tx3 P Clk (P1+P2).

DS3 Receive Data Link Drop

The positive transitions of each of the DS3 Receive clock signals discribed above fall in the middle of the corresponding Overhead bit of the Receive Overhead signal (Rx3 OH OUT). This permits individual data links to be extracted from the Overhead. See Figure 3-16.

DS3 Transmit Data Link Insert

Externally sourced DS3 data link and overhead bit insertion is available in the following modes: Tx3->Rx3, Tx^3_1->Rx^3_1, Tx^3_1->Rx1, THRU3, $THRU^3_1$, IntD&I, ExtD&I, and Ins^3_1->Rx1. To insert information into one or more transmitted DS3 data links, an output clock is provided for each of the possible candidates. Transmit clock signals serve two functions: The positive transitions provide a synchronous demand clock for the external data source and the positive clock state is used as the Overhead bit Insert Valid signal to the PF45. The externally sourced data and relevant clock are input to the PF45 multipole connector [58]: Tx3 EXT OH IN (pin 8) and Tx3 USER CLK IN (pin 11). If two or more external data links are to be inserted, each individual data signal must first be logically ANDed with it's clock and then combined (logical OR) with other data signals to form the input to EXT OH IN. Similarly, the individual clocks for each data link must be ORed and input to USER CLK IN. Figure 3-15 is an example of the circuitry required to simultaneously insert both DL6 and FEAC into the transmitted C-bits.

DS3 Timing

Figure 3-16 shows clock timing for the DS3 Receive and Transmit clocks. Receive clock timing is illustrated by Rx3 DL5 CLK (pin 13) relative to Rx3 OH OUT (pin 22). Transmit clock timing depicts the signals for the example shown in Figure 3-16. The maximum delay allowed between an output Tx DL Clock, say Tx DL5 CLK, and the corresponding USER CLK IN or EXT OH IN is 500 nSec.

DS3 Insert Validation

To prevent unintended overhead data insertion, the desired Transmit clocks must be enabled by internal dip switches. Any combination of nine clocks may be enabled by switching the appropriate switch ON:

DS3 Insert Validation

M13 C-bit Ins	Sw 5 #8*
FEAC	Sw 5 #7
C12	Sw 5 #6
DL5	Sw 5 #5
DL6	Sw 5 #4
DL2/7	Sw 5 #3
X1	Sw 5 #2
X2	Sw 5 #1
FEBE**	Sw 6 #8
(P1+P2)**	Sw 6 #7

*Switch 5, position #8 is normally set to OFF enabling the five Tx3 C-Bit and FEBE clocks only in the C-Parity frame format. If position #8 is closed (ON), the clocks will be enabled in M13 frame as well. This may result in erroneous DS2 demultiplexing. Sw#8 does not affect other overhead bit clocks. DS3 Overhead Insertion takes priority over the front panel Error Insertion insofar as overhead bits are concerned. For example, FEBE errors cannot be inserted on top of externally sourced FEBE bits.

**FEBE and P-Bit clocks are available on the rear connector [58] only for configuration B which excludes DS1 ESF data link access. Configuration B is selected by positioning a socketed SIP resistor pack as shown in Figure 3-18.

DS1 ESF Data Link Drop and Insert

For ESF Data Link operation, set the option board to Configuration #1A by setting DIP Switch 6 #1 OFF and placing the socketed SIP resistor pack as shown in Figure 3-18.

In Configuration #1A, any time the PF-45 is receiving and analyzing an ESF DS1 signal, that DS1's 4Kbs data link (Rx1 DL OUT) is output from pin 21 of the 25 pole rear-panel D-type connector as NRZ data. A 4kHz clock (Rx DL CLK OUT) is output from pin 23. Either clock edge can be used to sample the NRZ data, though the falling edge which lies in the nominal center of the data will provide the most robust results (the rising edge occurs nominally 650nS after the data transition). ESF Data Link insertion is activated by setting the PF-45 rear-panel DIP Switch [39] #6 ON.

Insertion of an externally-sourced data link is available in the following modes: Tx1->Rx1, Tx1->Rx^3_1, Tx^3_1->Rx1, Tx^3_1->Rx^3_1, THRU1, $THRU^3_1$, $IntD\&I^3_1$, and Ins^3_1->Rx1. (Note: in the two THRU modes, a momentary "hit" will be placed on the (selected) DS1 as the PF-45 reroutes the signal to accommodate the insertion.)

A 4kHz demand clock for the inserted data link (Tx1DL CLK OUT) is provided at pin 16 of the rear-panel connector. The data to be inserted should be input to pin 15 (Tx1 DL IN). Use the falling edge of the clock as the synchronous clock for the data link source, as the PF-45 samples the input data at approximately the same time as the rising edge of the clock.

DS1 Transmit Yellow Alarm insertion overwrites the externally sourced ESF data link insertion.

Alarm/Error output

The Alarm/Error output configuration is selected by setting DIP Sw 6 #1 ON. This configuration assigns the pins of the 25 pole connector [58] as shown for Configuration 2 below. Errors are output positive true while alarms are negative true. Thus power failure to the PF45 will cause all alarms to go active.

25 Pole Rear Connector

I/O Signals associated with the Alarm/Data Link Option make their appearance at a 25 Pole connector on the rear panel of the PF45. Interface signals are HCMOS compatible. Source resistance is approximately 250 ohms; input resistance is greater than 5000 ohms. Dip Switch 6,#1 selects either the Data Link (Configuration #1) or Alarm/Error (Configuration #2) signals to be accessed via the 25 pole connector. In the Data Link mode, one of two slightly different pin configurations may be selected, depending on the positioning of a SIP resistor network (see Figure 3-18). Configuration #1B replaces DS1 ESF data link access (#1A) with DS3 FEBE and Pbit access. The connector pinout for the different configurations is shown below:

Pin	DATA LINK MODE		ALARM/ERROR MODE	
	Config #1A	Config#1B	Config#2A	Config#2B
1	+5 volts		+5 volts	
2	Tx3 DL2/7 CLK		DS3 ParErr	
3	Tx3 FEAC CLK		DS3 CParErr	
4	Tx3 DL5 CLK		DS3 FEBE	
5	Tx3 DL6 CLK		DS3 Frm Err	
6	Rx3 X2 CLK		DS3 LOS (inv.)	
7	Tx3 X1 CLK		DS3 OOF (inv.)	
8	Tx3 EXT OH IN		DS3 AIS (inv.)	
9	Rx3 X1 CLK		DS3 IDLE (inv.)	
10	Rx3 DL2/7 CLK		DS1 CRC Err	
11	Tx3 USER CLK IN		DS1 Frm Err	
12	Rx3 DL6 CLK		DS1 LOS (inv).	
13	Rx3 DL5 CLK		DS1 OOF (inv.)	
14	RESERVED		DS1 AllOnes	
15	Tx1 DL IN	Tx3 Pbit CLK	DS1 Rx M-Sync	RESERVED
16	Tx1 DL CLK OUT	Rx3 Pbit Clk	DS3 Tx M-Sync	RESERVED
17	Rx3 FEAC CLK		DS2 OOF (inv.)	
18	Tx3 C12 CLK		DS2 AllOnes (inv.)	
19	Tx3 X2 CLK		DS1 PatLoss (inv.)	
20	Rx3 C12 CLK		DS3 PatLoss (inv.)	
21	Rx1 DL OUT	Tx3 FEBE CLK	DS3 Rx M-Sync	RESERVED
22	Rx3 OH OUT		DS2 Frm Err	
23	Rx1 DL CLKOUT	Rx3 FEBE CLK	DS1 Tx M-Sync	RESERVED
24	Ground		Ground	
25	Ground		Ground	

ASSIGNABLE REAR PANEL BNC JACKS

Regardless of the multipole [58] configuration selected, the option board also provides two TTL compatible BNC Output jacks [56] & [57], with assignable outputs and capable of driving 75 ohm loads. A number of internal signals are accessible via internal dip switches. As delivered, [56] outputs the DS3 Rx M-Sync pulse and [57] outputs DS3 Tx M-Sync. Other possibilities are:

	BNC [56]				BNC [57]		
SIGNAL	A2	A1	A0	SIGNAL	B2	B1	B0
SW1	#3	#2	#1	SW1	#7	#6	#5
DS3 Rx M-Sync	0	0	0	DS3 Tx M-Sync	0	0	0
DS1 Rx M-Sync	0	0	1	DS1 Tx M-Sync	0	0	1
Rx3 FEAC CLK	0	1	0	Alm/Err Comp*	0	1	0
Rx3 DL2/7 CLK	0	1	1	5 Mhz Clock	0	1	1
Rx3 DL5 CLK	1	0	0	Rx3 X1 Valid	1	0	0
Rx3 DL6 CLK	1	0	1	DS3 Rx OH	1	0	1
Rx3 C12 CLK	1	1	0	Rx1 ESF DL	1	1	0
Rx1 ESF DL CLK	1	1	1	Burst time	1	1	1
SW1 #4 ON=INVERT [56]				SW1 #8 ON=INVERT [57]			

*Alarm / Error Composite is a signal comprised of selected alarms and errors combined by logical OR. Any combination of eighteen signals may be selected using the internal dip switch array illustrated in Figure 3-18 and listed below:

ERRORS

SW2 #2 ON	Bit Error
SW2 #1 ON	DS3 BPV
SW3 #8 ON	DS3 Parity Error
SW3 #7 ON	DS3 C-Parity Error
SW3 #6 ON	DS3 FEBE
SW3 #5 ON	DS1 CRC6 Error
SW3 #4 ON	DS3 Frm Error
SW3 #3 ON	DS2 Frm Error
SW3 #2 ON	DS1 Frm Error
SW3 #1 ON	DS1 BPV

ALARMS

SW4 #8 ON	DS3 No Signal
SW4 #7 ON	DS3 No Frame
SW4 #6 ON	DS3 AIS
SW4 #5 ON	DS3 IDLE
SW4 #4 ON	DS1 No Signal
SW4 #3 ON	DS1 No Frame
SW4 #2 ON	DS1 AIS
SW4 #1 ON	No Pattern Sync

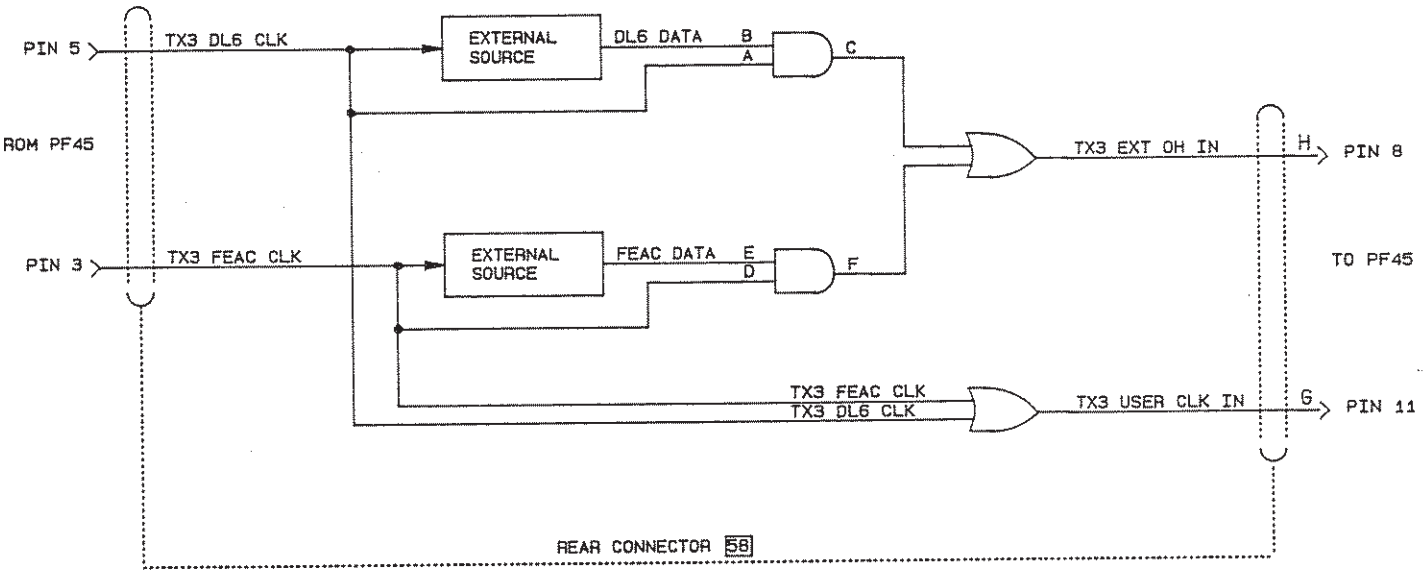


Figure 3-15: DS3 Overhead-Bit Drop & Insert (Data Link/Multifunction Option)
Example: Insert DL6 and FEAC

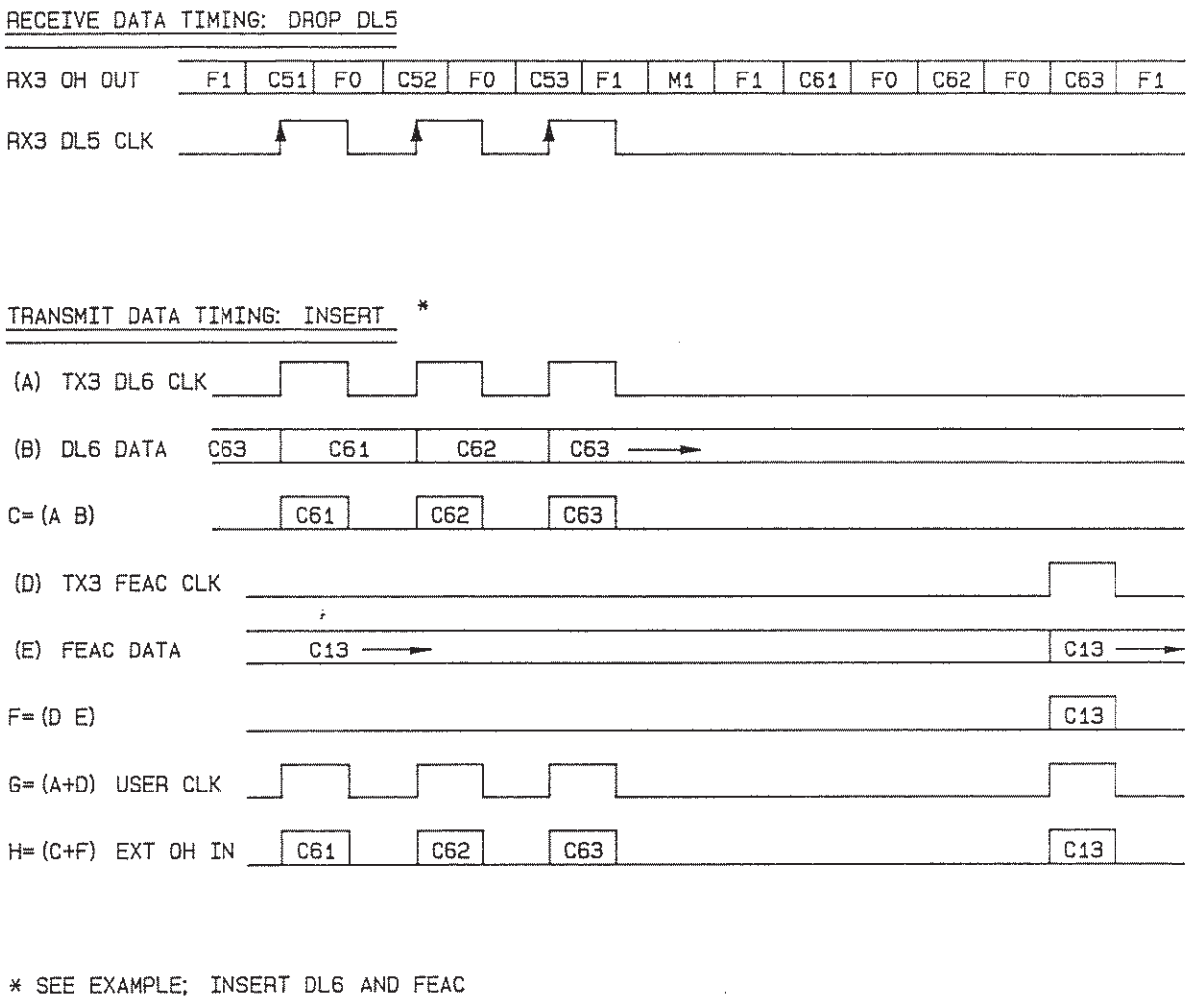


Figure 3-16: DS3 Overhead-Bit Drop & Insert (Data Link/Multifunction Option)
Rx/Tx Data Timing

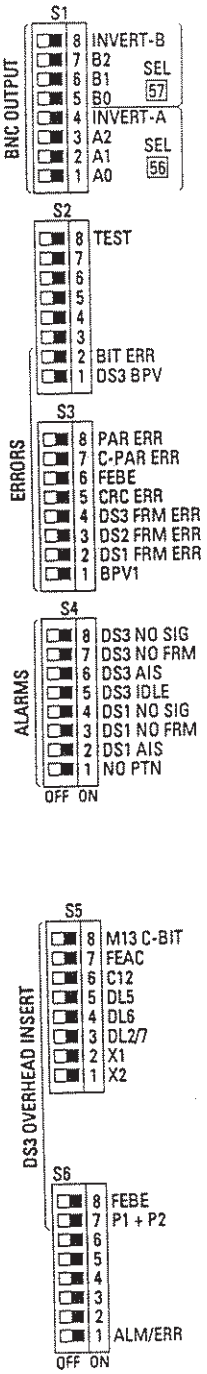


Figure 3-17: Data Link/Multifunction Option Setup Switches

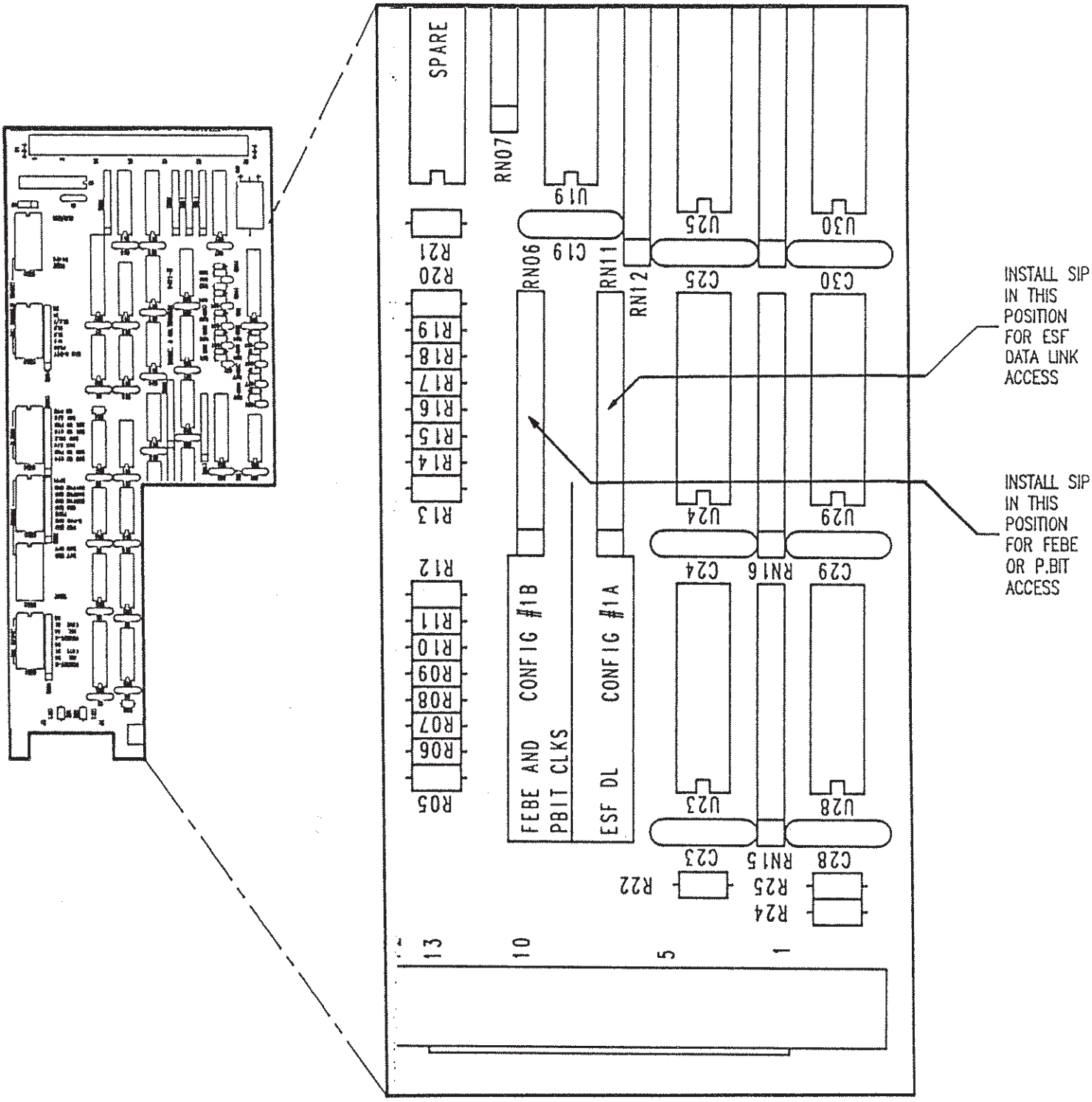


Figure 3-18: SIP Position for Configuration 1A/1B (Data Link/Multifunction Option)

3.10 E1 DROP/ANALYSIS OPTION OPERATION

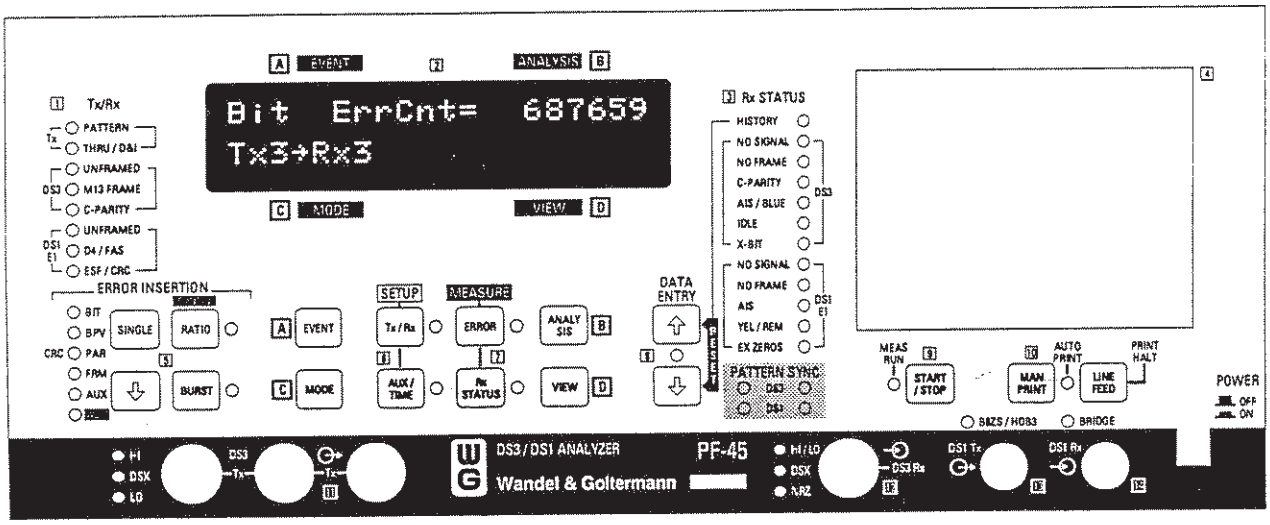


Figure 3-19: Front View with E1 Drop/Analysis Option Installed

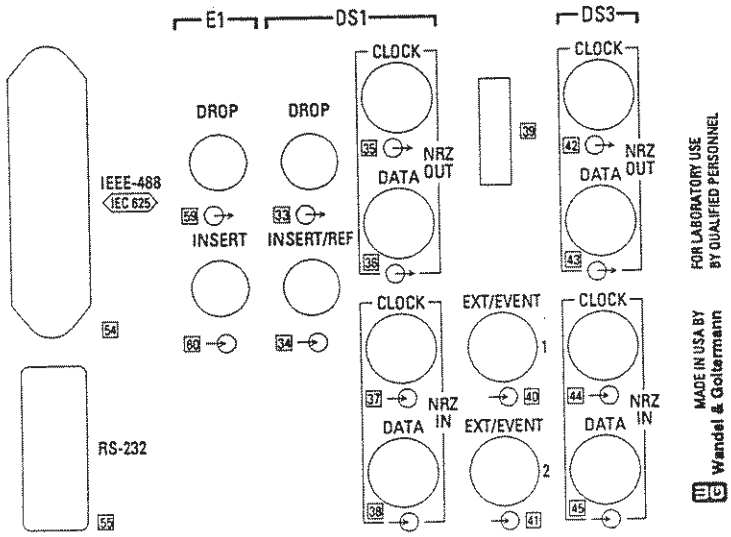
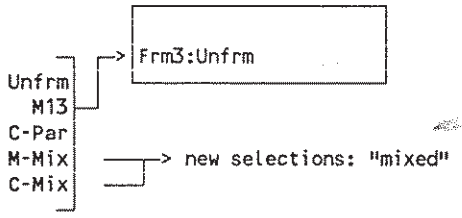
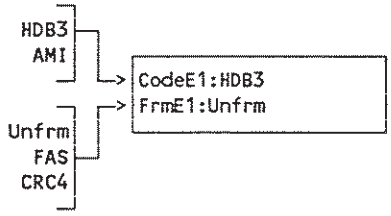


Figure 3-20: Rear View with E1 Drop/Analysis Option Installed

Mon$^3_1$ Setup:



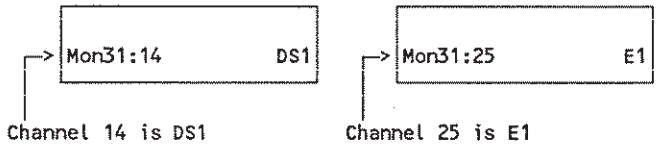
If the E1 D&I Option is installed, then the user can select a "mixed" DS3 frame format in the DS3 Setup Page. "Mixed" tells the PF-45 that the DS3 can contain both DS1's and E1's, and that the PF-45 should act accordingly. "M-Mix" is for M13 format DS3, while "C-Mix" is for C-Parity format DS3.



If a mixed format is selected, then the E1 Setup Page is now included in the Tx/Rx setup list. Select the desired E1 Line Code and E1 Frame Format in the usual way.

Channel Selection:

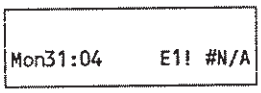
The user selects a drop (DS1/E1) channel number 00-28 from the front panel as usual. The PF-45 monitors the dropped DS2 (corresponding to the selected channel number), determines if it is a DS2 or DS2E, and respectively displays "DS1" or "E1" in the VIEW display.



The channel numbers are mapped to the DS1s and E1s as follows:

DS2/DS2E	DS1	E1	
0	00	00	(no channel selected)
1	01	01	
	02	02	
	03	03	
	04	N/A	
2	05	05	
	06	06	
	07	07	
	08	N/A	
3	09	09	
	10	10	
	11	11	
	12	N/A	
4	13	13	
	14	14	
	15	15	
	16	N/A	
5	17	17	
	18	18	
	19	19	
	20	N/A	
6	21	21	
	22	22	
	23	23	
	24	N/A	
7	25	25	
	26	26	
	27	27	
	28	N/A	

If a channel number that is not available (N/A) for E1 has been selected, and the DS2 has been determined to be a DS2E, the following message is displayed in VIEW: "E1! #N/A". Like channel "00", this is non-existent.



PF-45 E1 Operation while Measurement Run is Off:

While the Measurement Run is OFF, the PF-45 continues to evaluate the E1/DS1 status of the dropped channel, and will change according to the input signal. When the mode is originally selected, the default E1/DS1 status is E1. However, once a valid E1/DS1 status has been determined, that status will be maintained until the opposite status has been determined.

For example, if the selected receive channel is E1, and the PF-45 displays "E1" in the VIEW display, then during a subsequent period of DS3 No Signal, the PF-45 will still display "E1" as the status of the dropped channel. Only when a new signal is found and the dropped channel is determined to be DS1 will the PF-45 change its status to "DS1".

If the selected channel is DS1, then the PF-45 behaves normally. ("DS1" is displayed in the VIEW field).

If the selected channel is E1, then immediately:

- The E1 is dropped to the E1 Drop jack
- The DS1 RxStatus LEDs now apply to E1:

No Signal:	E1 No Signal
No Frame:	E1 No Frame
AIS:	E1 AIS
Yellow:	E1 Remote Alarm
Ex Zeros:	N/A (off)
PatnSync:	N/A (both off)

- The previous measurement results remain on the display, and are available for printing and/or IEEE/RS-232 access.

PF-45 E1 Operation while Measurement Run is On:

While the Measurement Run is ON, the E1/DS1 status is frozen in the state found when the run was started.

If the selected channel is DS1, then the PF-45 behaves normally. ("DS1" is displayed in the VIEW field).

If the selected channel is E1, then upon starting the new measurement run:

- DS2 error events are replaced with:

DS2E Frame Errors	"Frm2"
DS2E Parity Errors	"Par2"

- DS2 alarm events are replaced with:

DS2E No Signal Seconds	"DS2 NoSigSecs"
DS2E No Frame Seconds	"DS2 NoFrmSecs"
DS2E AIS Seconds	"DS2 AIS Secs"
DS2E A-bit Alarm Seconds	"DS2 Abit Secs"

- Bit1 error events and No Pattern Sync seconds are "N/A"
- DS1 error events are replaced with:

E1 FAS Errors (FAS or CRC format)	"Frm1"
E1 CRC4 Errs (CRC format)	"CRC4"

- DS1 alarm events are replaced with:

E1 No Signal Seconds	"E1 NoSigSecs"
E1 No Frame Seconds	"E1 NoFrmSecs"
E1 AIS Seconds	"E1 AIS Secs"
E1 Remote Alarm Seconds	"E1 R-AlmSecs"

4.1 IN-SERVICE MONITORING:

The PF-45 has three dedicated monitoring modes. [MON3] and [MON$^3_1$] modes (Fig 4-1) measure and analyze simultaneously the following DS3 parameters: DS3 BPV's, DS3 frame, parity, C-parity, and FEBE errors, as well as logging and counting as event seconds: DS3 No Signal, DS3 No Frame Sync, DS3 AIS, DS3 Idle, and DS3 X-bit. Analyses include Error Count, Current and Average Bit Error Ratio, Errored Seconds, Threshold Errored Seconds, and % Error-Free-Seconds. [MON$^3_1$] mode also drops a selected DS1 from the DS3, adding the following DS1 parameters: DS1 frame and CRC-6 errors, and logging DS1 No Signal, DS1 No Frame Sync, DS1 AIS and DS1 Yellow Alarm events. [MON1] mode monitors a DS1 line signal (Fig 4-2), and includes DS1 BPV's in the above list of DS1 parameters.

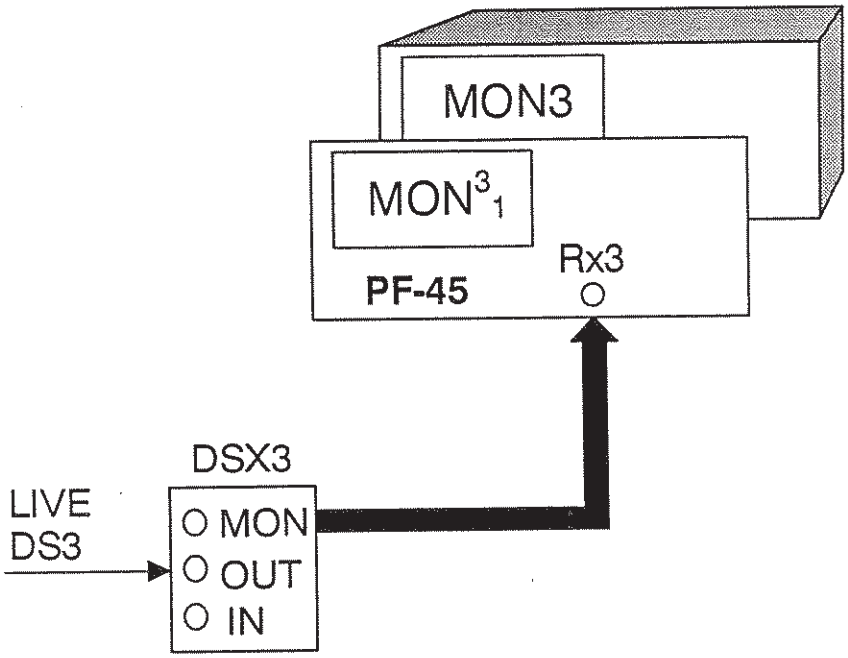


Figure 4-1: MON3 & MON$^3_1$ Modes

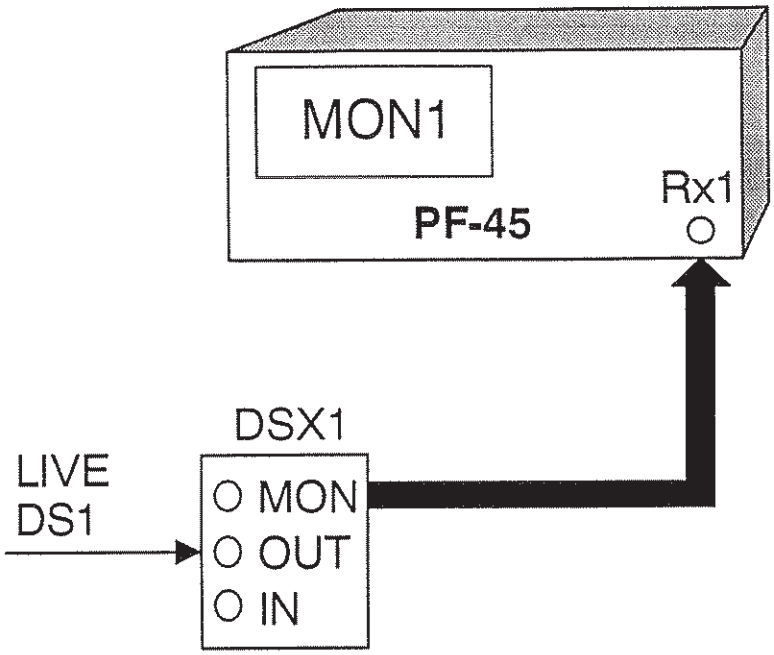


Figure 4-2: MON1 Mode

4.1.1 In-Service Monitoring of DS3

The MON3 mode monitors a DS3 signal for all DS3-related parameters, but ignores the payload, including DS2s and DS1s.

1. - Connect the PF-45 DS3 receive jack [12] to the monitor jack at the DSX cross-connect panel with the appropriate cable, as shown in Figure 4-1.

2. - Press the [Tx/Rx] SETUP key repeatedly until the "Set New Mode" Page is displayed.
   - Press key [C] until "MON3" is in the lower left display quadrant as shown below.
   - "Execute" the mode change by pressing key [D] once.

```
SET NEW MODE
MON3          EXECUTE
```
(Set New Mode Page)

3. - Press the [Tx/Rx] SETUP key once again, bringing up the "DS3 Setup Page".
   - Press key [B] until Rx3:DSX is displayed as shown below.
   - Press key [C] until the desired DS3 frame format is selected. HINT: if the C-PARITY Rx STATUS LED is lit, then set the frame format to "CPar", otherwise set it to "M13". Watch the DS3 No Frame RxSTATUS LED. If it stays on for both "CPar" and "M13" formats, then the DS3 is unframed, and so, set the frame format to "Unfrm".

```
Tx3:OFF       Rx3:DSX
Frm3:M13    Clk3:N/A
```
(DS3 Setup Page)

4. - Press the [Tx/Rx] SETUP key once again, to bring up the "Pattern" Page. The default pattern in monitor modes is "Live", ie., "no pattern". If the DS3 under test contains live traffic, leave the pattern set to "Live".
- If the DS3 under test contains a test pattern, then press key [A] until that pattern is displayed, and the green DS3 Pattern Sync LED is lit. Typically, this will be the 2E15-1 pattern, which is the most widely used DS3 test pattern.

```
Ptn:Live
```
(Pattern Select Page)

5. - Press the [AUX/TIME] SETUP key until the "Test Duration" Page is displayed as shown below.
- If a continuous measurement run is desired, press key [B] to bring up "CONT". Skip the rest of step 5.
- If a timed measurement run (say, 15 minutes) is desired, press key [B] to bring up "TIMED".
- Press key [C] once. The four "Hours" digits blink along with the Data Entry LED. Set the hours to 0000 with the Data Entry keys.
- Press key [C] a second time. The two "Minutes" digits blink along with the Data Entry LED. Set the minutes to 15 with the Data Entry keys.
- Press key [C] a third time. The two "Seconds" digits blink along with the Data Entry LED. Set the seconds to 00 with the Data Entry keys.
- Press key [C] a fourth time. This completes the Test Duration setup.

```
Test Duration: TIMED
H:0000/M:15/S:00
```
(Test Duration Page)

6. - If an automatic Summary print at the end of the measurement run is not desired, then skip step 6, otherwise continue.
- Press the [AUX/TIME] SETUP key to bring up the "Printer" Page.
- Press key [B] until SUMMARY is displayed as shown below.
- Press key [D] until AT END OF RUN is displayed as shown below.

```
AutoPrint:   SUMMARY
       AT END OF RUN
```
(Test Duration Page)

7. - The PF-45 is now setup. Press the [ERROR] Measure key to bring up that display category.
- Before starting the measurement run, make a careful check of the RxSTATUS LEDs. Do we have signal? If a framed signal is expected, are we in frame sync? Is any alarm or idle signal present? If a pattern other than "Live" has been selected, do we have Pattern Sync?
- If the status is as expected, then begin the measurement run by pressing the [START/STOP] key, lighting the "Measurement Run" LED.
- During the measurement run, the user can view the monitored values under MEASURE [ERROR] and [RxSTATUS]. This will not effect the measurement run.
- During the measurement run, do not change any values under SETUP. This will automatically stop the measurement run.
- If the PF-45 is to be left unattended, it is suggested that the [RxSTATUS] key be pressed until Rx Status "Seconds", (rather than "Elapsed" time or seconds), are displayed. Then press key [B] until "Total ErrSecs= XXXXXXXX" is displayed. The PF-45 now shows the number of "any-kind-of" errored seconds, and the RxSTATUS LEDs are in "History" mode. Leave the PF-45 set like this. When the user comes back, the display immediately shows the occurrence of any errors, and the RxSTATUS LEDs show the occurrence of any sync losses, and/or alarms.

```
Total ErrSecs=      0
MON3
```

8. - When the measurement run has timed out, or the [START/STOP] key is pushed again, the measurement run LED will extinguish, the final values for the run are available for viewing, and if the Summary AutoPrint was set, an automatic print-out of the results will start.

4.1.2 In-Service Monitoring of DS1

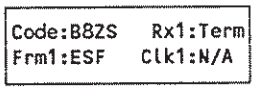
The MON1 mode monitors a DS1 signal for all DS1-related parameters, but ignores the payload, including DS0s.

1. - Connect the PF-45 DS1 receive jack [14] to the monitor jack at the DSX cross-connect panel with the appropriate cable, as shown in Figure 4-2.

2. - Press the [Tx/Rx] SETUP key repeatedly until the "Set New Mode" Page is displayed.
- Press key [C] until "MON1" is in the lower left display quadrant as shown below.
- "Execute" the mode change by pressing key [D] once.

```
SET NEW MODE
MON1          EXECUTE
```
(Set New Mode Page)

3. - Press the [Tx/Rx] SETUP key once again, bringing up the "DS1 Setup Page".
- Press key [B] until Rx1:Term is displayed as shown below.
- Press key [A] to select the DS1 line code. Try B8ZS first. If the DS1 Excess 0s LED stays OFF, and the next step of finding the proper frame format and sync works, then leave the code set to B8ZS, otherwise set AMI.
- Press key [C] until the desired DS1 frame format is selected. HINT: try both the D4/SF and the ESF frame formats. Watch the DS1 No Frame RxSTATUS LED to see which format achieves sync. If the No Frame LED stays on for both "D4/SF" and "ESF" formats, then the DS1 is unframed, and so, set the frame format to "Unfrm". If frame sync cannot be achieved, but the signal is expected to framed, try setting the alternate line code, and start this step again.

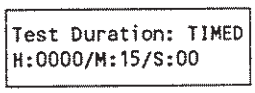


(DS1 Setup Page)

4. - Press the [Tx/Rx] SETUP key once again, to bring up the "Pattern" Page. The default pattern in monitor modes is "Live", ie., "no pattern". If the DS1 under test contains live traffic, leave the pattern set to "Live".
- If the DS1 under test contains a test pattern, then press key [A] until that pattern is displayed, and the green DS1 Pattern Sync LED is lit. Typically, this will be the QRSS20 pattern, which is the most widely used DS1 test pattern.

(Pattern Select Page)

5. - Press the [AUX/TIME] SETUP key until the "Test Duration" Page is displayed as shown below.
- If a continuous measurement run is desired, press key [B] to bring up "CONT". Skip the rest of step 5.
- If a timed measurement run (say, 15 minutes) is desired, press key [B] to bring up "TIMED".
- Press key [C] once. The four "Hours" digits blink along with the Data Entry LED. Set the hours to 0000 with the Data Entry keys.
- Press key [C] a second time. The two "Minutes" digits blink along with the Data Entry LED. Set the minutes to 15 with the Data Entry keys.
- Press key [C] a third time. The two "Seconds" digits blink along with the Data Entry LED. Set the seconds to 00 with the Data Entry keys.
- Press key [C] a fourth time. This completes the Test Duration setup.



(Test Duration Page)

6. - If an automatic Summary print at the end of the measurement run is not desired, then skip step 6, otherwise continue.
- Press the [AUX/TIME] SETUP key to bring up the "Printer" Page.
- Press key [B] until SUMMARY is displayed as shown below.
- Press key [D] until AT END OF RUN is displayed as shown below.

```
AutoPrint:   SUMMARY
       AT END OF RUN
```
(Test Duration Page)

7. - The PF-45 is now setup. Press the [ERROR] Measure key to bring up that display category.
- Before starting the measurement run, make a careful check of the RxSTATUS LEDs. Do we have signal? If a framed signal is expected, are we in frame sync? Is any alarm or idle signal present? If a pattern other than "Live" has been selected, do we have Pattern Sync? Is the Excess 0s LED on when it shouldn't be?
- If the status is as expected, then begin the measurement run by pressing the [START/STOP] key, lighting the "Measurement Run" LED.
- During the measurement run, the user can view the monitored values under MEASURE [ERROR] and [RxSTATUS]. This will not effect the measurement run.
- During the measurement run, do not change any values under SETUP. This will automatically stop the measurement run.
- If the PF-45 is to be left unattended, it is suggested that the [RxSTATUS] key be pressed until Rx Status "Seconds", (rather than "Elapsed" time or seconds), are displayed. Then press key [B] until "Total ErrSecs= XXXXXXXX" is displayed. The PF-45 now shows the number of "any-kind-of" errored seconds, and the RxSTATUS LEDs are in "History" mode. Leave the PF-45 set like this. When the user comes back, the display immediately shows the occurrence of any errors, and the RxSTATUS LEDs show the occurrence of any sync losses, and/or alarms.

```
Total ErrSecs=     0
MON1
```

8. - When the measurement run has timed out, or the [START/STOP] key is pushed again, the measurement run LED will extinguish, the final values for the run are available for viewing, and if the Summary AutoPrint was set, an automatic print-out of the results will start.

4.1.3 In-Service Monitoring of DS1 Embedded in DS3

The MON^3_1 mode monitors a DS3 signal for all DS3-related parameters, and monitors the payload, including a selected DS1 and the DS2 that contains it.

1. - Connect the PF-45 DS3 receive jack [12] to the monitor jack at the DSX cross-connect panel with the appropriate cable, as shown in Figure 4-1.

2. - Press the [Tx/Rx] SETUP key repeatedly until the "Set New Mode" Page is displayed.
   - Press key [C] until "MON^3_1" is in the lower left display quadrant as shown below.
   - "Execute" the mode change by pressing key [D] once.

```
SET NEW MODE
MON31        EXECUTE
```
(Set New Mode Page)

3. - Press the [Tx/Rx] SETUP key once again, bringing up the "DS3 Setup Page".
   - Press key [B] until Rx3:DSX is displayed as shown below.
   - Press key [C] until the desired DS3 frame format is selected. HINT: if the C-PARITY Rx STATUS LED is lit, then set the frame format to "CPar", otherwise set it to "M13". Watch the DS3 No Frame RxSTATUS LED.

```
Tx3:OFF      Rx3:DSX
Frm3:M13   Clk3:N/A
```
(DS3 Setup Page)

4. - Press the [Tx/Rx] SETUP key once again, bringing up the "DS1 Setup Page".
   - Press key [C] until the desired DS1 frame format is selected. HINT: try both the D4/SF and the ESF frame formats. Watch the DS1 No Frame RxSTATUS LED to see which format achieves sync. If the No Frame LED stays on for both "D4/SF" and "ESF" formats, then the DS1 is unframed, and so, set the frame format to "Unfrm".

```
Code:N/A     Rx1:N/A
Frm1:ESF   Clk1:N/A
```
(DS1 Setup Page)

5. - Press the [Tx/Rx] SETUP key once again, to bring up the "Pattern" Page. The default pattern in monitor modes is "Live", ie., "no pattern". If the DS1 under test contains live traffic, leave the pattern set to "Live".
   - If the DS1 under test contains a test pattern, then press key [A] until that pattern is displayed, and the green DS1 Pattern Sync LED is lit. Typically, this will be the QRSS20 pattern, which is the most widely used DS1 test pattern.

```
Ptn:Live
```
(Pattern Select Page)

6. - Press the [AUX/TIME] SETUP key until the "Test Duration" Page is displayed as shown below.
- If a continuous measurement run is desired, press key [B] to bring up "CONT". Skip the rest of step 6.
- If a timed measurement run (say, 15 minutes) is desired, press key [B] to bring up "TIMED".
- Press key [C] once. The four "Hours" digits blink along with the Data Entry LED. Set the hours to 0000 with the Data Entry keys.
- Press key [C] a second time. The two "Minutes" digits blink along with the Data Entry LED. Set the minutes to 15 with the Data Entry keys.
- Press key [C] a third time. The two "Seconds" digits blink along with the Data Entry LED. Set the seconds to 00 with the Data Entry keys.
- Press key [C] a fourth time. This completes the Test Duration setup.

```
Test Duration: TIMED
H:0000/M:15/S:00
```
(Test Duration Page)

7. - If an automatic Summary print at the end of the measurement run is not desired, then skip step 7, otherwise continue.
- Press the [AUX/TIME] SETUP key to bring up the "Printer" Page.
- Press key [B] until SUMMARY is displayed as shown below.
- Press key [D] until AT END OF RUN is displayed as shown below.

```
AutoPrint:   SUMMARY
       AT END OF RUN
```
(Test Duration Page)

8. - Press the [ERROR] Measure key to bring up that display category.
- Select the desired DS1 Channel. First, press [MODE] which will start the displayed channel number blinking along with the Data Entry LED. Use the Data Entry keys to set the desired channel number, then press [MODE] again to exit the channel selection process.
- The PF-45 is now setup. Before starting the measurement run, make a careful check of the RxSTATUS LEDs. Do we have both DS3 and DS1 signal? Do we have DS3 Frame Sync? If a framed DS1 signal is expected, are we in frame sync? Is any alarm or idle signal present? If a pattern other than "Live" has been selected, do we have Pattern Sync? If the status is as expected, then begin the measurement run by pressing the [START/STOP] key, lighting the "Measurement Run" LED.
- During the measurement run, the user can view the monitored values under MEASURE [ERROR} and [RxSTATUS]. This will not effect the measurement run.
- During the measurement run, do not change any values under SETUP. This will automatically stop the measurement run.
- If the PF-45 is to be left unattended, it is suggested that the [RxSTATUS] key be pressed until Rx Status "Seconds", (rather than "Elapsed" time or seconds), are displayed. Then press key [B] until "Total ErrSecs= XXXXXXXX" is displayed. The PF-45 now shows the number of "any-kind-of" errored seconds, and the RxSTATUS LEDs are in "History" mode. Leave the

PF-45 set like this. When the user comes back, the display immediately shows the occurrence of any errors, and the RxSTATUS LEDs show the occurrence of any sync losses, and/or alarms.

```
Total ErrSecs=      0
MON31:28
```

9. - When the measurement run has timed out, or the [START/STOP] key is pushed again, the measurement run LED will extinguish, the final values for the run are available for viewing, and if the Summary AutoPrint was set, an automatic print-out of the results will start.

4.2 OUT-OF-SERVICE TESTING

STAND-ALONE BIT ERROR TESTING OF EVERY MAJOR DS3/DS1 SYSTEM COMPONENT:
The five test modes provide a complete test solution by transmitting and receiving the correct test signal for the network or network equipment under test (Figs 4-3 through 4-7). Other network elements must no longer be pulled out of service to create or access the test signal. Only the system under test need be in the test loop.

4.2.1 Out-Of-Service Testing of DS3

In [Tx3->Rx3] mode (Fig 4.3), a DS3 test pattern (such as 2^{23}-1,2^{20}-1,2^{15}-1,1010,1100, etc.) is transmitted, received and analyzed. The test object could be for instance, a DACS 3/3, a DS3 looped-back signal (as shown), or a straightaway test with a PF-45 at each end of a DS3 circuit.

1. - Connect the PF-45 DS3 receive jack [12] to the monitor jack of the incoming DS3 at the DSX cross-connect panel with the appropriate cable, as shown in Figure 4-3.

2. - Press the [Tx/Rx] SETUP key repeatedly until the "Set New Mode" Page is displayed.
   - Press key [C] until "Tx3->Rx3" is in the lower left display quadrant as shown below.
   - "Execute" the mode change by pressing key [D] once.

```
SET NEW MODE
Tx3->Rx3    EXECUTE
```
(Set New Mode Page)

3. - Press the [Tx/Rx] SETUP key once again, bringing up the "DS3 Setup Page".
   - Press key [A] until Tx3:DSX is displayed as shown below.
   - Press key [B] until Rx3:DSX is displayed as shown below.
   - Press key [C] until the desired DS3 frame format is selected.

```
Tx3:DSX      Rx3:DSX
Frm3:M13   Clk3:N/A
```
(DS3 Setup Page)

4. - Press the [Tx/Rx] SETUP key once again, to bring up the "Pattern" Page.
- Press key [A] until the 2E15-1 pattern is displayed. This is the pattern most typically used for DS3 testing.

```
Ptn:2E15-1
```
(Pattern Select Page)

5. - Press the [AUX/TIME] SETUP key until the "Test Duration" Page is displayed as shown below.
- If a continuous measurement run is desired, press key [B] to bring up "CONT". Skip the rest of step 5.
- If a timed measurement run (say, 15 minutes) is desired, press key [B] to bring up "TIMED".
- Press key [C] once. The four "Hours" digits blink along with the Data Entry LED. Set the hours to 0000 with the Data Entry keys.
- Press key [C] a second time. The two "Minutes" digits blink along with the Data Entry LED. Set the minutes to 15 with the Data Entry keys.
- Press key [C] a third time. The two "Seconds" digits blink along with the Data Entry LED. Set the seconds to 00 with the Data Entry keys.
- Press key [C] a fourth time. This completes the Test Duration setup.

```
Test Duration: TIMED
H:0000/M:15/S:00
```
(Test Duration Page)

6. - If an automatic Summary print at the end of the measurement run is not desired, then skip step 6, otherwise continue.
- Press the [AUX/TIME] SETUP key to bring up the "Printer" Page.
- Press key [B] until SUMMARY is displayed as shown below.
- Press key [D] until AT END OF RUN is displayed as shown below

```
AutoPrint:   SUMMARY
       AT END OF RUN
```
(Test Duration Page)

7. - The PF-45 is now setup. (For the sake of simplicity, the remainder of this section will deal with a looped-back DS3 out-of-service test). The loop-back must now be made and verified.
- Perform the DS3 loop-back.
- Connect the PF-45 DS3 transmit jack [11] to the input jack of the outgoing DS3 at the DSX cross-connect panel with the appropriate cable, as shown in Figure 4-3.
- Make a careful check of the RxSTATUS LEDs. Do we have signal? Are we in frame sync? Is any alarm or idle signal present? Do we have Pattern Sync? If the status is as expected, then continue.
- Now, to verify the proper connection, we will make a short measurement run, by pressing [START/STOP].
- Press the [ERROR] Measure key to bring up that display category. Select the "BIT" Event, and the "ErrCnt=..." Analysis.

- Insert a single bit error by using the Error Insertion [Down Arrow] to select "BIT", and then pressing [SINGLE].
- If the loopback has been made correctly, the Bit Error Count will = 1.
- Press [START/STOP] to stop the measurement run.

8. - The loopback has now been verified.
- Begin the measurement run by pressing the [START/STOP] key, lighting the "Measurement Run" LED.
- During the measurement run, the user can view the monitored values under MEASURE [ERROR] and [RxSTATUS]. This will not effect the measurement run.
- During the measurement run, do not change any values under SETUP. This will automatically stop the measurement run.
- If the PF-45 is to be left unattended, it is suggested that the [RxSTATUS] key be pressed until Rx Status "Seconds", (rather than "Elapsed" time or seconds), are displayed. Then press key [B] until "Total ErrSecs= XXXXXXXX" is displayed. The PF-45 now shows the number of "any-kind-of" errored seconds, and the RxSTATUS LEDs are in "History" mode. Leave the PF-45 set like this. When the user comes back, the display immediately shows the occurrence of any errors, and the RxSTATUS LEDs show the occurrence of any sync losses, and/or alarms.

```
Total ErrSecs=      0
Tx3->Rx3
```

9. - When the measurement run has timed out, or the [START/STOP] key is pushed again, the measurement run LED will extinguish, the final values for the run are available for viewing, and if the Summary AutoPrint was set, an automatic print-out of the results will start.

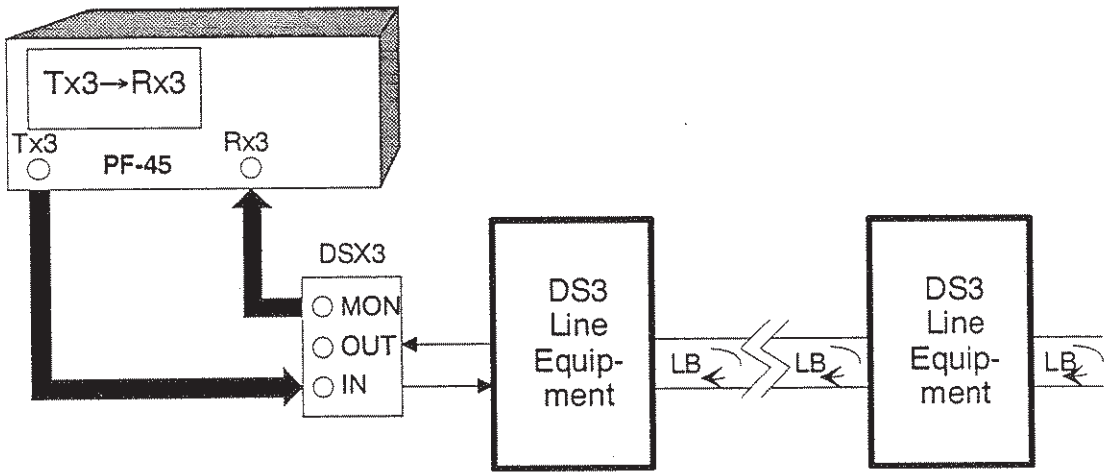


Figure 4-3: Tx3->Rx3 Mode

4.2.2 Out-Of-Service Testing of DS1

[Tx1->Rx1] mode (Fig 4-4), performs DS1 testing at DS1 line rate. The DS1 test patterns include QRSS for standard bit error testing, and digital words such as 1-in-8 and 3-in-24 for stress testing DS1 transmission equipment. The test object can be any portion of a network with DSX1 appearances, such as the CSU loopback test shown.

1. - Connect the PF-45 DS1 receive jack [14] to the monitor jack of the incoming DS1 at the DSX cross-connect panel with the appropriate cable, as shown in Figure 4-4.

2. - Press the [Tx/Rx] SETUP key repeatedly until the "Set New Mode" Page is displayed.
   - Press key [C] until "Tx1->Rx1" is in the lower left display quadrant as shown below.
   - "Execute" the mode change by pressing key [D] once.

```
SET NEW MODE
Tx1->Rx1    EXECUTE
```
(Set New Mode Page)

3. - Press the [Tx/Rx] SETUP key once again, bringing up the "DS1 Setup Page".
   - Press key [D] until Clk1:Int is displayed as shown below.
   - Press key [B] until Rx1:Term is displayed as shown below.
   - Press key [A] to select the DS1 line code.
   - Press key [C] until the desired DS1 frame format is selected.

```
Code:B8ZS   Rx1:Term
Frm1:ESF    Clk1:Int
```
(DS1 Setup Page)

4. - Press the [Tx/Rx] SETUP key once again, to bring up the "Pattern" Page.
   - Press key [A] until the QRSS20 pattern is displayed. This is the most widely used "general-purpose" pattern for DS1, but a typical test sequence will also include a "stress-test" for the T1 line, usually "3-in-24" for AMI, and "1-in-8" for B8ZS systems.

```
Ptn:QRSS20
```
(Pattern Select Page)

5. - Press the [AUX/TIME] SETUP key until the "Test Duration" Page is displayed as shown below.
   - If a continuous measurement run is desired, press key [B] to bring up "CONT". Skip the rest of step 5.
   - If a timed measurement run (say, 15 minutes) is desired, press key [B] to bring up "TIMED".
   - Press key [C] once. The four "Hours" digits blink along with the Data Entry LED. Set the hours to 0000 with the Data Entry keys.
   - Press key [C] a second time. The two "Minutes" digits blink along with the Data Entry LED. Set the minutes to 15 with the Data Entry keys.
   - Press key [C] a third time. The two "Seconds" digits blink along with the Data Entry LED. Set the seconds to 00 with the Data Entry keys.

Set the seconds to 00 with the Data Entry keys.
- Press key [C] a fourth time. This completes the Test Duration setup.

```
Test Duration: TIMED
H:0000/M:15/S:00
```
(Test Duration Page)

6. - If an automatic Summary print at the end of the measurement run is not desired, then skip step 6, otherwise continue.
- Press the [AUX/TIME] SETUP key to bring up the "Printer" Page.
- Press key [B] until SUMMARY is displayed as shown below.
- Press key [D] until AT END OF RUN is displayed as shown below.

```
AutoPrint:   SUMMARY
       AT END OF RUN
```
(Test Duration Page)

7. - The PF-45 is now setup. (For the sake of simplicity, the remainder of this section will deal with a looped-back DS1 out-of-service test). The loop-back must now be made and verified.
- Connect the PF-45 DS1 transmit jack [13] to the input jack of the outgoing DS1 at the DSX cross-connect panel with the appropriate cable, as shown in Figure 4-4.
- Press the [ERROR] Measure key to bring up that display category. Select the "BIT" Event, and the "ErrCnt=..." Analysis.
- Use the Error Insertion [Down Arrow] to select "AUX".
- Press [VIEW], and use the Data Entry keys to select "CSU LpUp", then press [VIEW] a second time to complete the choice.
- Press [SINGLE] to send a six second burst of the in-band CSU Loop Up code.
- After the burst is over, the loop-back should be made, and must be verified.
- Make a careful check of the RxSTATUS LEDs. Do we have signal? Are we in frame sync? Is any alarm or idle signal present? Do we have Pattern Sync? If the status is as expected, then continue, otherwise try the loopback process again.
- Now to verify the loopback, make a short measurement run, by pressing [START/STOP].
- Insert a single bit error by using the Error Insertion [Down Arrow] to select "BIT", and then pressing [SINGLE].
- If the loopback has been made correctly, the Bit Error Count will = 1.
- Press [START/STOP] to stop the measurement run.

8. - The loopback has now been verified.
- Begin the measurement run by pressing the [START/STOP] key, lighting the "Measurement Run" LED.
- During the measurement run, the user can view the monitored values under MEASURE [ERROR] and [RxSTATUS]. This will not effect the measurement run.
- During the measurement run, do not change any values under SETUP. This will automatically stop the measurement run.
- If the PF-45 is to be left unattended, it is suggested that the [RxSTATUS] key be pressed until Rx Status "Seconds", (rather than "Elapsed" time or seconds), are displayed. Then press

key [B] until "Total ErrSecs= XXXXXXXX" is displayed. The PF-45 now shows the number of "any-kind-of" errored seconds, and the RxSTATUS LEDs are in "History" mode. Leave the PF-45 set like this. When the user comes back, the display immediately shows the occurrence of any errors, and the RxSTATUS LEDs show the occurrence of any sync losses, and/or alarms.

```
Total ErrSecs=      0
Tx1->Rx1
```

9. - When the measurement run has timed out, or the [START/STOP] key is pushed again, the measurement run LED will extinguish, the final values for the run are available for viewing, and if the Summary AutoPrint was set, an automatic print-out of the results will start.
- Remove the CSU loopback by selecting "CSU LpDn" under AUX, and sending a [SINGLE] six-second burst of the in-band loop-down code.

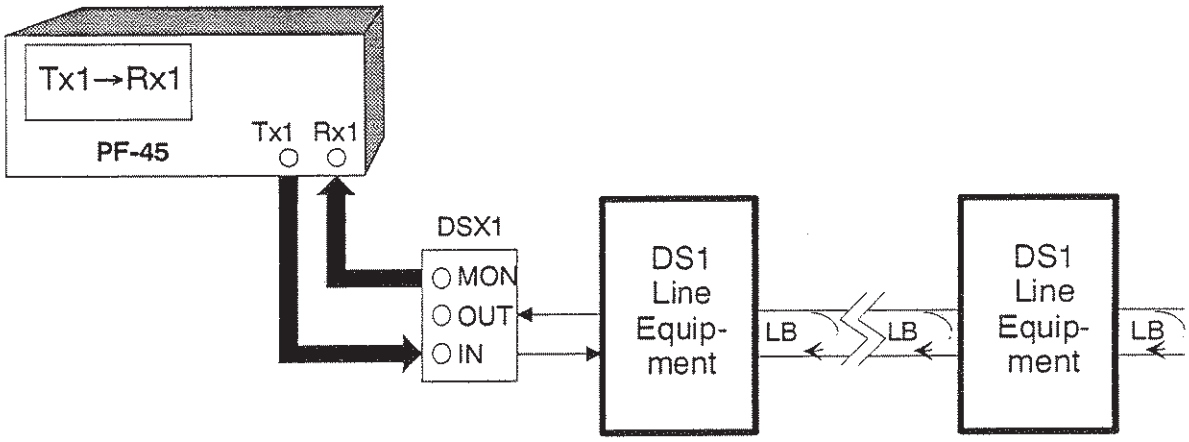


Figure 4-4: Tx1->Rx1 Mode

(The remaining modes are essentially DS1 test modes where the transmitted or receive DS1 test signal, or both, are embedded in a DS3 signal.)

4.2.3 Out-of-Service Testing of DS1 Embedded in DS3: M13 Multiplexer Testing

[Tx1->Rx^3_1] mode (Fig 4-5) shows the testing of an M13 mux, but can also be used to test any portion of a system which can input a DSX1 test signal, but can only provide the returning test signal embedded in a DS3. In this case the system under test may be an M13 mux, or simply perform that function.

1. - Connect the PF-45 DS3 receive jack [12] to the monitor jack of the incoming DS3 at the DSX cross-connect panel with the appropriate cable, as shown in Figure 4-5.

2. - Press the [Tx/Rx] SETUP key repeatedly until the "Set New Mode" Page is displayed.
   - Press key [C] until "Tx1->Rx^3_1" is in the lower left display quadrant as shown below.
   - "Execute" the mode change by pressing key [D] once.

```
SET NEW MODE
Tx1->Rx31    EXECUTE
```
(Set New Mode Page)

3. - Press the [Tx/Rx] SETUP key once again, bringing up the "DS3 Setup Page".
   - Press key [A] until Tx3:DSX is displayed as shown below.
   - Press key [B] until Rx3:DSX is displayed as shown below.
   - Press key [C] until the desired DS3 frame format is selected.

```
Tx3:DSX       Rx3:DSX
Frm3:M13    Clk3:N/A
```
(DS3 Setup Page)

4. - Press the [Tx/Rx] SETUP key once again, bringing up the "DS1 Setup Page".
   - Press key [D] until Clk1:Int is displayed as shown below.
   - Press key [A] to select the DS1 line code.
   - Press key [C] until the desired DS1 frame format is selected.

```
Code:AMI     Rx1:N/A
Frm1:ESF    Clk1:Int
```
(DS1 Setup Page)

5. - Press the [Tx/Rx] SETUP key once again, to bring up the "Pattern" Page.
   - Press key [A] until the QRSS20 pattern is displayed..

```
Ptn:QRSS20
```
(Pattern Select Page)

6. - Press the [AUX/TIME] SETUP key until the "Test Duration" Page is displayed as shown below.
- If a continuous measurement run is desired, press key [B] to bring up "CONT". Skip the rest of step 6.
- If a timed measurement run (say, 15 minutes) is desired, press key [B] to bring up "TIMED".
- Press key [C] once. The four "Hours" digits blink along with the Data Entry LED. Set the hours to 0000 with the Data Entry keys.
- Press key [C] a second time. The two "Minutes" digits blink along with the Data Entry LED. Set the minutes to 15 with the Data Entry keys.
- Press key [C] a third time. The two "Seconds" digits blink along with the Data Entry LED. Set the seconds to 00 with the Data Entry keys.
- Press key [C] a fourth time. This completes the Test Duration setup.

```
Test Duration: TIMED
H:0000/M:15/S:00
```
(Test Duration Page)

7. - If an automatic Summary print at the end of the measurement run is not desired, then skip step 7, otherwise continue.
- Press the [AUX/TIME] SETUP key to bring up the "Printer" Page.
- Press key [B] until SUMMARY is displayed as shown below.
- Press key [D] until AT END OF RUN is displayed as shown below.

```
AutoPrint:   SUMMARY
       AT END OF RUN
```
(Test Duration Page)

8. - Press the [ERROR] Measure key to bring up that display category. Select the "BIT" Event, and the "ErrCnt=..." Analysis.
- Select the desired Rx DS1 Channel. First, press [MODE] which will start the displayed channel number blinking along with the Data Entry LED. Use the Data Entry keys to set the desired channel number, then press [MODE] again to exit the channel selection process.
- Connect the PF-45 DS1 transmit jack [13] to the desired DS1 input jack of the multiplexer at the DSX cross-connect panel with the appropriate cable, as shown in Figure 4-5.
- Make a careful check of the RxSTATUS LEDs. Do we have signal? Are we in frame sync? Is any alarm or idle signal present? Do we have Pattern Sync? If the status is as expected, then continue.
- Now, make a short measurement run, by pressing [START/STOP].
- Use the Error Insertion [Down Arrow] to select "BIT".
- Press [SINGLE].
- If the proper connections have been made, the Bit Error Count will = 1.
- Press [START/STOP] to stop the measurement run.

9. - The DS1 connectivity has now been verified, and the PF-45 is also setup.
- Before starting the measurement run, make a careful check of the RxSTATUS LEDs. Do we

have both DS3 and DS1 signal? Do we have DS3 Frame Sync? If a framed DS1 signal is expected, are we in frame sync? Is any alarm or idle signal present? Do we have Pattern Sync?

- If the status is as expected, then begin the measurement run by pressing the [START/STOP] key, lighting the "Measurement Run" LED.
- During the measurement run, the user can view the monitored values under MEASURE [ERROR] and [RxSTATUS]. This will not effect the measurement run.
- During the measurement run, do not change any values under SETUP. This will automatically stop the measurement run.
- If the PF-45 is to be left unattended, it is suggested that the [RxSTATUS] key be pressed until Rx Status "Seconds", (rather than "Elapsed" time or seconds), are displayed. Then press key [B] until "Total ErrSecs= XXXXXXXX" is displayed. The PF-45 now shows the number of "any-kind-of" errored seconds, and the RxSTATUS LEDs are in "History" mode. Leave the PF-45 set like this. When the user comes back, the display immediately shows the occurrence of any errors, and the RxSTATUS LEDs show the occurrence of any sync losses, and/or alarms.

```
Total ErrSecs=      0
Tx1->Rx31:28
```

10. - When the measurement run has timed out, or the [START/STOP] key is pushed again, the measurement run LED will extinguish, the final values for the run are available for viewing, and if the Summary AutoPrint was set, an automatic print-out of the results will start.

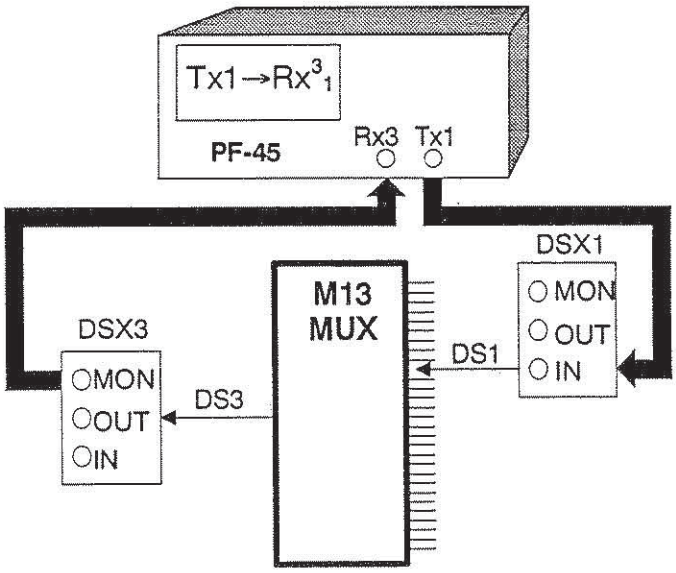


Figure 4-5: Tx1->Rx$^{3}_{1}$ Mode