39 SNA

```
                               ** Layer Setup **

                                          Selections          Packages Loaded
DRIVE: HRD   Layer 1 Package: NO PACKAGE          NO PACKAGE
DRIVE: FD1   Layer 2 Package: SNA                 NO PACKAGE
DRIVE: HRD   Layer 3 Package: NO PACKAGE          NO PACKAGE
DRIVE: HRD   Layer 4 Package: NO PACKAGE          NO PACKAGE
DRIVE: HRD   Layer 5 Package: NO PACKAGE          NO PACKAGE
DRIVE: HRD   Layer 6 Package: NO PACKAGE          NO PACKAGE
DRIVE: HRD   Layer 7 Package: NO PACKAGE          NO PACKAGE

Depress XEQ Key To Load The Selected Packages

Select Layer
  F 1      F 2      F 3      F 4       F 5      F 6      F 7      F 8
LAYER-1  LAYER-2  LAYER-3  LAYER-4   LAYER-5  LAYER-6  LAYER-7  PROTSEL
```

Figure 39-1 The *SNA* personality package for Layer 2 is loaded from the Layer Setup screen.

```
                    ** SNA/SDLC Frame Level Setup **

Idle Timeout:               1.0  sec
Emulate:                     PRIMARY
Mode of Operation:          MOD 8
Window Size:                7
Using LU 6.2?               NO
Host Port:                  DCE
Emulation Addressing:         MULTI-DROP

DROP  ADDR        DROP  ADDR        DROP  ADDR        DROP  ADDR
 0     __          4     __          8     __          12    __
 1     __          5     __          9     __          13    __
 2     __          6     __          10    __          14    __
 3     __          7     __          11    __          15    __

Select Emulation Addressing
  F 1      F 2      F 3      F 4       F 5      F 6      F 7      F 8
 PT-PT    MULTI
```

Figure 39-2 Protocol Configuration screen for SNA.

39 SNA

SNA is a "layer personality package" of functions that are loaded into memory from disk via the Layer Setup screen. Figure 39-1 shows the Layer Setup screen configured to load in the SNA package from floppy-disk drive #1. Refer to Section 8 for details on operating the Layer Setup screen.

The SNA package consists of the following:

- A special SNA Frame Level Setup screen that controls certain parameters when the unit is emulating SDLC or tracing SNA and SDLC.
- Multi-drop or point-to-point operation.
- A group of conditions and actions at Layer 2 on the Protocol Spreadsheet that facilitate SDLC programming. *This is the same set of conditions and actions that is documented in Section 38 of this manual.* Refer to Section 38 for a discussion of the spreadsheet conditions and actions that are specific to the SDLC and SNA layer-2 packages.
- A protocol trace (illustrated in Figure 39-3) that distills from SNA data the SDLC and SNA events that have protocol significance. This trace is accessible by softkey in Run mode at all times.

39.1 Frame-Level Setup

The parameters on the SNA Frame Level Setup screen must be configured correctly for an accurate trace display and for proper emulation. Use this screen also to enable multi-drop operation.

To bring up this screen, first go to the Layer Setup screen (press PROGRAM, F5). Execute the SNA selection at Layer 2: **SNA** should appear in the **Packages Loaded** column. Press F8 (labeled PROTSEL) to bring up a prompt to **Select Protocol Configuration Screen**. Then press F2 (LAYER-2) to call up the SNA Frame Level Setup screen.

The six parameter fields on this screen are shown in Figure 39-2. **Idle Timeout**, **Emulate**, **Mode of Operation**, **Window Size**, **Emulation Addressing**, and **ADDR** are covered in Section 38.1 and will not be discussed here.

Using LU 6.2? allows you to set up the SNA trace to monitor LU 6.2 sessions correctly. The default selection in this field is NO.

Selection of DTE or DCE in the **Host Port** field allows the SNA protocol trace to distinguish properly between two kinds of FMD headers—NS headers and FM headers—in SNA Request Units.

39.2 SDLC Conditions and Actions

The same set of special conditions and actions documented for the SDLC Layer 2 package is implemented on the Protocol Spreadsheet in SNA. Refer to subsections 38.3 through 38.7.

39.3 Protocol Trace

The SNA package includes an automatic real-time trace that summarizes link-level, TH, RH, and RU activity. This trace mode is enabled whenever the unit is in Run mode, both real-time and frozen.

While the unit is in Run mode, press the softkey for L2TRACE ([F2] on the primary rack of display-mode softkeys) to bring the protocol trace for SNA to the screen. Figure 39-3 is an example of this trace display. Each horizontal row in the trace represents a frame.

In both Run and Freeze modes, the trace may be displayed as either hexadecimal data or text code data. The text code will be that selected on the Line Setup menu. Press [HEX] to toggle between the two display formats. You may print the Protocol Trace from Freeze mode in either hexadecimal or text code format. (See also Section 15.)

(A) The Protocol Trace in Freeze Mode

Press [FREEZE] to prevent the addition of new data to *all* the display buffers, including the trace buffers. The frozen trace display may be scrolled through or paged through. The top line always is the cursor line (though there is no actual cursor on the trace display). Pressing [ROLL FWD] or [↓] moves the viewing "window" down relative to the data to add one line of fresher data to the bottom of the screen. Pressing [ROLL BACK] or [↑] moves the viewing window up to add a line of older data to the top of the screen.

Depression of the [NEXT PAGE] key adds sixteen lines—one full page—of newer trace data to the frozen trace screen. Depression of [PREV PAGE] adds sixteen lines of older data.

The frame displayed on the top line of frozen trace-data will appear as the first frame in the raw-data or data-plus-leads display. To view the raw data that generated a particular line in the trace display, use [ROLL FWD] or [ROLL BACK] (or [↑] or [↓]) to move the line in question to the top of the screen. Then press one of the data softkeys.

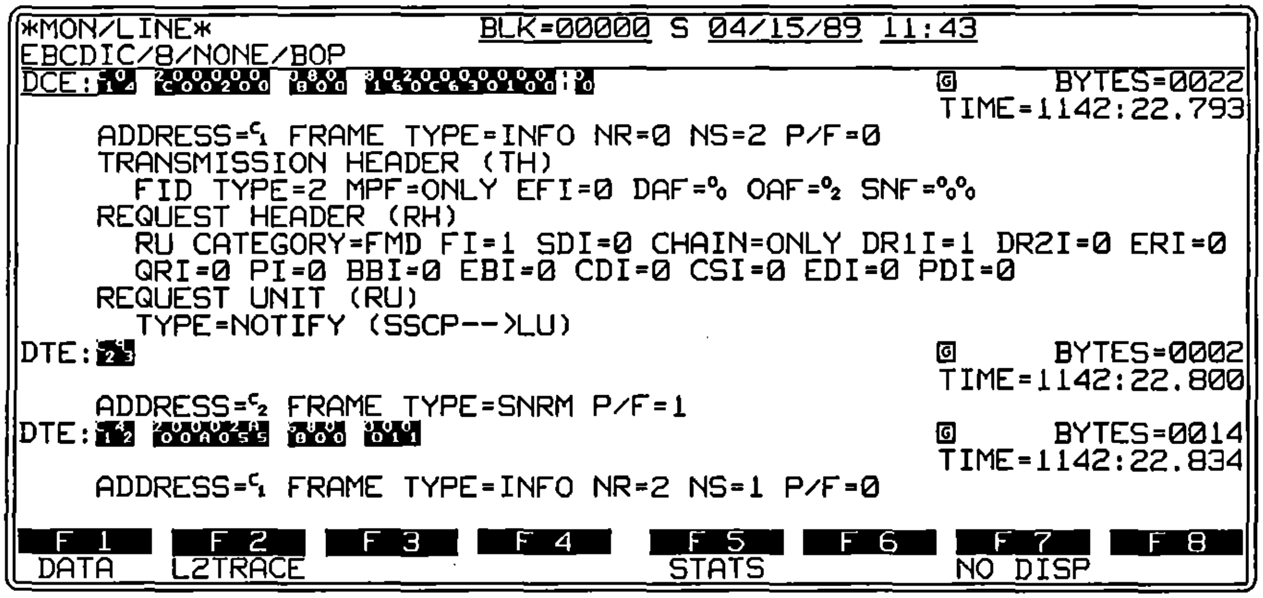


Figure 39-3 Each *DTE* or *DCE* entry on the SNA trace marks the beginning of a frame.

(B) Trace Fields Common to All Frames

1. *Source*. On the initial line in each frame expansion, the source of the frame (DTE or DCE) is identified. This is the only field on the frame-trace that begins at the left border of the screen, and it acts as a visible separator of frame expansions that take up varying amounts of display space. Note on the screen in Figure 39-3 that two whole frame expansions and part of a third are presented.

   In the leftmost ("Source") column in the trace, DCE is always underlined.

2. *Character data*. Character data decoded in hexadecimal is presented in reverse video immediately following the source field. See Figure 39-3. Character data is presented in blocks separated by spaces. These blocks correspond to the following protocol fields:

   - Frame header
   - Transmission header (TH)
   - Request/response header (RH)
   - Request/response unit (RU)

   When an individual block is longer than ten bytes, another separator is used: the vertical bar (¦). Bars occur after every ten bytes within a block. Note the bar in the RU block of the DCE frame at the top of Figure 39-3.

The hex-character display does not exceed two lines on the trace, or 70 bytes of RU.

Note that the four protocol blocks may not be present in every unit. Non-Info frames have only the frame header. Middle- and last-segment messages lack the RH block. Many response messages lack the RU.

3. *Frame checking*. An SDLC frame ends as soon as a 7E flag or seven 1-bits in a row are detected. If a flag ends the frame, a frame check is performed and the result is posted both to the data display and to the BCC field on the first trace line for the frame. The symbol G denotes a good frame check, while B symbolizes a bad frame. A for abort is posted to the displays when a frame is ended by seven 1-bits.

4. *Size*. The number of bytes in each frame is given in the BYTES= field in four decimal digits. The count begins with the address byte and excludes the two-byte FCS. Frames without I-fields show a byte-count of two.

5. *Time*. The time of the arrival of the *end of the frame* at the DTE or DCE monitor is provided by a 24-hour clock and posted to the trace display. The clock is accurate to the millisecond.

   When Time Ticks: ON is selected on the Front-End Buffer Setup screen (see Section 9), time values are incorporated into the data itself. As a result, times posted to the trace display are the original times and will not be affected when recorded data is played back, even at varying speeds.

   If Time Ticks: OFF was selected instead during live recording, times on the trace during playback will reflect the current "clock on the wall" and will be influenced by conditions such as playback speed, idle suppression, etc.

6. *Address*. The address byte is given as a hexadecimal character (from 00 to FF) in the ADDRESS= field.

7. *Frame type*. The mnemonic (abbreviated) name for the frame type is given in the FRAME TYPE= field.

8. *P/F*. The status of the poll or the final bit is given in the P/F= field.

(C) Other Trace Fields

Most of the fields on the SNA trace are not common to all frames, but are specific to the type of frame (Info, for example), FID type, request messages, response messages, RU type, and so forth. These fields are included in Table 39-1.

Table 39-1
Fields in SNA Trace Display

Mnemonic	Name	Data Columns *# cols in field*	 *value each column*	Meaning
Frame header				
(SOURCE=)			ASCII	DTE, DCE
(BCC=)		1	symbol	$\boxed{G}$, $\boxed{B}$, $\boxed{A}$
BYTES=		4	0-9	
TIME=		9	0-9	time of end of frame, given as hhmm:ss.mmm
ADDRESS=		1	$^0_0$–^F_F	
FRAME TYPE=			ASCII	SNRM, INFO, etc.
NR= (mod 8)	number (next) receive frame	1	0-F	present only if frame type=info, rr, rnr, rej, or srej
NR= (mod 128)	number (next) receive frame	2	0-F	present only if frame type=info, rr, rnr, rej, or srej
NS= (mod 8)	number (frame) sent	1	0-F	present only if frame type=info
NS= (mod 128)	number (frame) sent	2	0-F	present only if frame type=info
P/F=	poll/final	1	0-1	
Transmission header, FID 0 or 1				
FID TYPE=0, 1	format identifier			10-byte th
MPF=	mapping field		ASCII	MIDDL, LAST, FIRST, ONLY
EFI=	expedited flow indicator	1	0-1	0=normal 1=expedited
DAF=	destination address field	2	$^0_0$–^F_F	
OAF=	origin address field	2	$^0_0$–^F_F	
SNF=	sequence number field	2	$^0_0$–^F_F	
DCF=	data count field	2	$^0_0$–^F_F	
Transmission header, FID 2				
FID TYPE=2	format identifier			6-byte th
MPF=	mapping field		ASCII	MIDDL, LAST, FIRST, ONLY
EFI=	expedited flow indicator	1	0-1	0=normal 1=expedited
DAF=	destination address field	1	$^0_0$–^F_F	
OAF=	origin address field	1	$^0_0$–^F_F	
SNF=	sequence number field	2	$^0_0$–^F_F	
Transmission header, FID 3				
FID TYPE=3	format identifier			2-byte th
MPF=	mapping field		ASCII	MIDDL, LAST, FIRST, ONLY
EFI=	expedited flow indicator	1	0-1	0=normal 1=expedited
SESSION=			ASCII	SSCP-PU, SSCP-LU, RESERVD, LU-LU
LAF=	local address field	6	0-1	

Table 39-1 (continued)

Mnemonic	Name	Data Columns *# cols in field*	 *value each column*	Meaning

Transmission header, FID 4

Mnemonic	Name	# cols in field	value each column	Meaning
FID TYPE=4	format identifier			26-byte th
TGSI=	transmission group sweep indicator	1	0-1	1=plu order maintained in tg
VRSI=	er & vr support indicator	1	0-1	1=one or more nodes does not support er, vr
VRPCI=	virtual route pacing count indicator	1	0-1	0=vr pacing count not equal to zero
NP=	network priority	1	0-1	1=plu flows at network priority, not tpf
IERN=	initial explicit route number	1	0-F	same as vrn
ERN=	explicit route number	1	0-F	ern + vrn + tpf = vrid
VRN=	virtual route number	1	0-F	
TPF=	transmission priority field	1	0-3	0=low 1=medium 2=high
VRCWI=	vr change window indicator	1	0-1	0=increment 1=decrement
TGNFI=	tg non-fifo indicator	1	0-1	0=tg fifo required
VRSTI=	vr sequence & type indicator	1	0-3	0=nonseq, nonsupv 1=nonseq, supv 2=singly seq
TGSNF=	tg sequence number field	3	0-F	used when tgnfi=0
VRPRQ=	virtual route pacing request	1	0-1	1=vr pacing response requested
VRPRS=	virtual route pacing response	1	0-1	1=vr pacing response sent in response to vrprq=1
VRCWRI=	vr change window reply indicator	1	0-1	when vrprs=1, 0=increment 1=decrement
VRRWI=	virtual route reset window indicator	1	0-1	0=do not reset 1=reset window to minimum size
VRSSN=	virtual route send sequence number	3	0-F	plu sequencing for vrsti=2
DSAF=	destination subarea address field	4	$^0{}_0-{}^F{}_F$	dsaf + osaf + vrn = vr
OSAF=	origin subarea address field	4	$^0{}_0-{}^F{}_F$	
SNAI=	sna indicator	1	0-1	0=destination is non-sna device, convert to fid 0
MPF=	mapping field		ASCII	MIDDL, LAST, FIRST, ONLY
EFI=	expedited flow indicator	1	0-1	0=normal 1=expedited
DEF=	destination element field	2	$^0{}_0-{}^F{}_F$	dsaf + def = destination network address
OEF=	origin element field	2	$^0{}_0-{}^F{}_F$	osaf + oef = origin network address
SNF=	sequence number field	2	$^0{}_0-{}^F{}_F$	blu sequence number, segments have same snf
DCF=	data count field	2	$^0{}_0-{}^F{}_F$	blu or blu segment length for plu blocking

Transmission header, FID F

Mnemonic	Name	# cols in field	value each column	Meaning
FID TYPE=F	format identifier			26-byte th
CF=	command format	1	$^0{}_0-{}^F{}_F$	$^0{}_1$
CT=	command type	1	$^0{}_0-{}^F{}_F$	$^0{}_1$=tg snf wrap acknowledgment
CSN=	command sequence number	2	$^0{}_0-{}^F{}_F$	
DCN=	data count number	2	$^0{}_0-{}^F{}_F$	

Table 39-1 (continued)

Mnemonic	Name	Data Columns # cols in field	value each column	Meaning
Request header				
RU CATEGORY=			ASCII	FMD, NC, DFC, SC
FI=	format indicator	1	0-1	ru category=fmd, lu-lu session: 1=fm header follows ru category=fmd, sscp session: 0=character-coded ru 1=field-formatted ru ru category=nc, dfc, sc: fi always = 1
SDI=	sense data indicator	1	0-1	1=sense data included
CHAIN=			ASCII	MIDDL, LAST, FIRST, ONLY
DR1I=	definite response 1 indicator	1	0-1	0=no response requested (but may be requested by dr2i) 1=response requested
DR2I=	definite response 2 indicator	1	0-1	0=no response requested (but may be requested by dr1i) 1=response requested
ERI=	exception response indicator	1	0-1	if response requested by dr1i or dr2i 0=definite response 1=exception response
QRI=	queued response indicator	1	0-1	0=bypass tc queues
PI=	pacing indicator	1	0-1	1=pacing request
BBI=	begin bracket indicator	1	0-1	1=begin bracket
EBI=	end bracket indicator	1	0-1	configured for non-LU 6.2 (see Sec. 39.1), 1=end bracket
CDI=	change direction indicator	1	0-1	1=change direction
CSI=	code selection indicator	1	0-1	0=code 0 1=code 1
EDI=	enciphered data indicator	1	0-1	1=ru is enciphered
PDI=	padded data indicator	1	0-1	1=ru was padded before encipherment
CEBI=	conditional end bracket indicator	1	0-1	configured for lu 6.2, 1=conditional end bracket
Response header				
RU CATEGORY=			ASCII	FMD, NC, DFC, SC
FI=	format indicator	1	0-1	ru category=fmd, lu-lu session: 1=fm header follows ru category=fmd, sscp session: 0=character-coded ru 1=field-formatted ru ru category=nc, dfc, sc: fi always = 1
SDI=	sense data indicator	1	0-1	1=sense data included
CHAIN=			ASCII	ONLY
DR1I=	definite response 1 indicator	1	0-1	1=dr1i response
DR2I=	definite response 2 indicator	1	0-1	1=dr2i response
RTI=	response type indicator	1	0-1	0=positive response 1=negative response
QRI=	queued response indicator	1	0-1	0=response bypasses tc queues 1=enqueue response in tc queues
PI=	pacing indicator	1	0-1	1=pacing response

Table 39-1 (continued)

Mnemonic	Name	Data Columns *# cols in field*	 *value each column*	Meaning
Request unit				
(REQUEST CODE=)			ASCII	ACTLU, BIND, etc. (present if ru category=no, dfc, or sc)
(FMD NS HEADER=)			ASCII	CONTACT, NOTIFY, etc. (sscp session only: present if ru category=fmd and fi=1)
(FM HEADER) TYPE=		1	0-9	lu-lu session only: present if ru category=fmd and fi=1
(BIND TYPE=)			ASCII	NEGOTIABLE, NONNEGOTIABLE (this field and remaining request-unit fields present only if request code=bind)
FM PROFILE =		1	$^{0}{}_{0}$–$^{F}{}_{F}$	
TS PROFILE=		1	$^{0}{}_{0}$–$^{F}{}_{F}$	
FM USAGE PRIMARY LU PROTOCOLS FOR FM DATA=		1	$^{0}{}_{0}$–$^{F}{}_{F}$	
FM USAGE SECONDARY LU PROTOCOLS FOR FM DATA=		1	$^{0}{}_{0}$–$^{F}{}_{F}$	
FM USAGE COMMON LU PROTOCOLS=		2	$^{0}{}_{0}$–$^{F}{}_{F}$	
TS USAGE=		6	$^{0}{}_{0}$–$^{F}{}_{F}$	
MAX RU FROM SLU=		6	0-9, UNKNOWN	
MAX RU FROM PLU=		6	0-9, UNKNOWN	
PS PROFILE=		1	$^{0}{}_{0}$–$^{F}{}_{F}$	
PS CHARACTERISTICS		11	$^{0}{}_{0}$–$^{F}{}_{F}$	
USER COUNT		1	$^{0}{}_{0}$–$^{F}{}_{F}$	length of user data in bind ru
Response unit				
(REQUEST CODE=)			ASCII	ACTLU, BIND, etc. (present if ru category=nc, dfc, or sc)
(FMD NS HEADER=)			ASCII	ADDLINK, CDINIT, etc. (present if ru category=fmd and fi=1)
SENSE DATA=		4	$^{0}{}_{0}$–$^{F}{}_{F}$	this and the following 3 fields present only if sdi=1
CATEGORY=			ASCII	USER SENSE DATA ONLY, REQUEST REJECT, REQUEST ERROR, STATE ERROR, RH USAGE ERROR, PATH ERROR
MODIFIER=		1	$^{0}{}_{0}$–$^{F}{}_{F}$	
SENSE INFORMATION=		2	$^{0}{}_{0}$–$^{F}{}_{F}$	

40 DDCMP Layer 1

DDCMP is a "layer personality package" of functions loaded into memory from disk via the Layer Setup screen. Figure 40-1 shows the Layer Setup screen with the DDCMP package loaded in from the hard-disk drive. Refer to Section 8 for information on operating the Layer Setup screen.

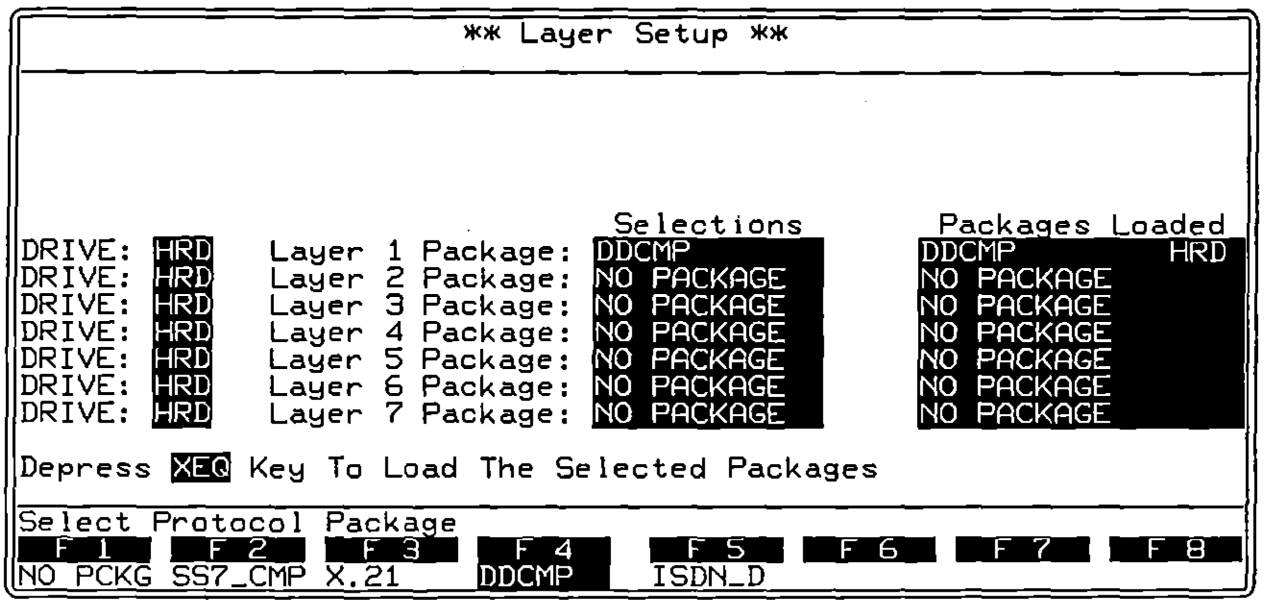


Figure 40-1 DDCMP is a "layer-personality package" of softkey functions at Layer 1.

The DDCMP package takes control of two functions that normally are configured by the user on the Line Setup menu: outsync and block checking. Control of these functions from the Line Setup menu is disabled when the DDCMP package is loaded in.

40.1 Outsync

In synchronous format, the sync pattern is selectable by the user in the Sync Char field on the Line Setup menu. Outsync parameters are not selectable. Outsync cannot be turned off. A receiver will go out of sync at the end of a message unless the first byte of the new message is $^{S}_{H}$, $^{E}_{Q}$, or $^{D}_{L}$ with the correct parity.

40.2 Block Checking

Screen display of good and bad BCCs is automatic when DDCMP is loaded in at Layer 1, and cannot be disabled on the Line Setup screen. The BCC setup for DDCMP cannot be modified or controlled in any way from the BCC Setup menu.

The results of both header and data block checks are displayed on the screen. If you want your program to detect good or bad BCCs, you may use the BCC selections on the trigger menus and at Layer 1 of the Protocol Spreadsheet to interrogate the header block check only.

If you want to detect a good or bad data block check, you must use one of the following C event variables:

```
extern fast_event fevar_gd_bcc2_td;
extern fast_event fevar_gd_bcc2_rd;
extern fast_event fevar_bd_bcc2_td;
extern fast_event fevar_bd_bcc2_rd;
```

Here is a program that counts bad DTE BCCs for both header and data:

```
{
  extern fast_event fevar_bd_bcc2_td;
}
LAYER: 1
  STATE: count_all_bad_dte_bccs
     CONDITIONS: DTE BAD_BCC
     ACTIONS: COUNTER t_bdbcc INC
     CONDITIONS:
     {
       fevar_bd_bcc2_td
     }
     ACTIONS: COUNTER t_bdbcc INC
```

Note to C programmers: the DDCMP Layer 1 package takes every message and places it in an IL buffer for use at Layer 2 and above. At the same time, it triggers the event *m_lo_ph_prmtv* and updates the variables associated with upward-going monitor-path primitives at Layer 2 (see Table 66-3). As a result, the OSI condition PH_TD_DATA IND (or PH_RD_DATA IND) comes true at Layer 2.

41 ISDN D Channel

```
                              ** Layer Setup **

                                         Selections          Packages Loaded
DRIVE: HRD    Layer 1 Package: ISDN_D              NO PACKAGE
DRIVE: HRD    Layer 2 Package: NO PACKAGE          NO PACKAGE
DRIVE: HRD    Layer 3 Package: NO PACKAGE          NO PACKAGE
DRIVE: HRD    Layer 4 Package: NO PACKAGE          NO PACKAGE
DRIVE: HRD    Layer 5 Package: NO PACKAGE          NO PACKAGE
DRIVE: HRD    Layer 6 Package: NO PACKAGE          NO PACKAGE
DRIVE: HRD    Layer 7 Package: NO PACKAGE          NO PACKAGE
Depress XEQ Key To Load The Selected Packages
Select Layer
   F 1      F 2      F 3      F 4       F 5      F 6      F 7      F 8
LAYER-1  LAYER-2  LAYER-3  LAYER-4   LAYER-5  LAYER-6  LAYER-7  PROTSEL
```

Figure 41-1 The ISDN_D personality package is loaded from the Layer Setup screen.

41 ISDN D Channel

The Basic Rate ISDN service provides an aggregate data rate of 192 Kbps, with 144 Kbps available to users: two 64 Kbps B-channels and one 16 Kbps D-channel per interface (2B+D). The additional 48 Kbps are used for framing and maintenance. The INTERVIEW 7000 Series, with the ISDN TIM and its multiplexer board in place (OPT-951-15-1 or OPT-951-15-2), supports Basic Rate ISDN testing. (See Section 51.) Primary Rate ISDN data is carried over T1 (Section 52) and G.703 (Section 53) circuits.

ISDN_D is a "layer personality package" of functions loaded into memory from disk at Layer 1 via the Layer Setup screen. Figure 41-1 shows the Layer Setup screen configured to load in the ISDN_D package from the hard drive. Refer to Section 8 for information on operating the Layer Setup screen.

The ISDN_D package consists of a set of three C-language event variables and two C routines (see Section 79). These variables and routines allow the C programmer to construct Q.921 (LAPD) and Q.931 functions for use on the D channel. The ISDN trace application package (available as OPT-951-35) is built upon the D-channel variables and routines provided at Layer 1 by the ISDN_D package.

The ISDN_D layer package allows the user to send, receive, and monitor frames on the D channel via an application program written in C. Meanwhile, the line setup, data display, and layer packages can be focused on channel B1 or B2, whichever is selected on the ISDN Interface Setup menu (Section 51.5). For Primary Rate ISDN in T1 or G.703, the ISDN_D layer package is also loaded at Layer 1 for the same use on the D channel as in Basic Rate ISDN; the B channel is selectable on their respective Interface Control screens.

> NOTE: The ISDN_D package should *not* be loaded when the D channel is selected for single-channel monitoring or emulating; that is, when the D channel is selected in the **Channel:** field on the ISDN Interface Setup menu.

42 LAPD

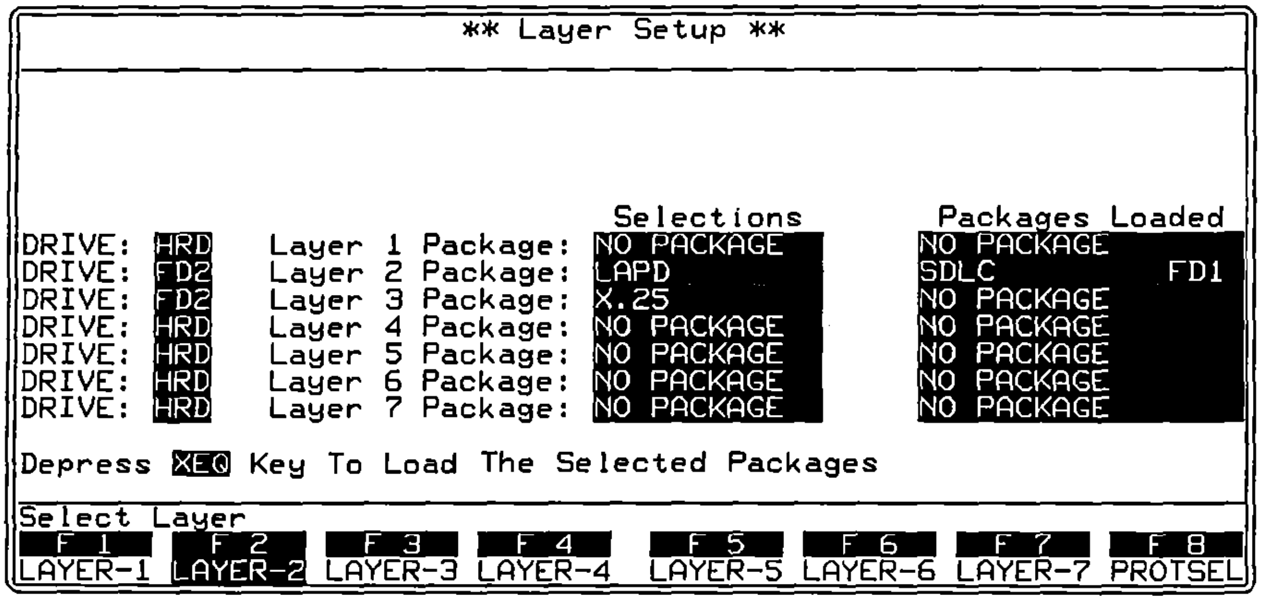


Figure 42-1 The LAPD personality package is loaded from the Layer Setup screen.

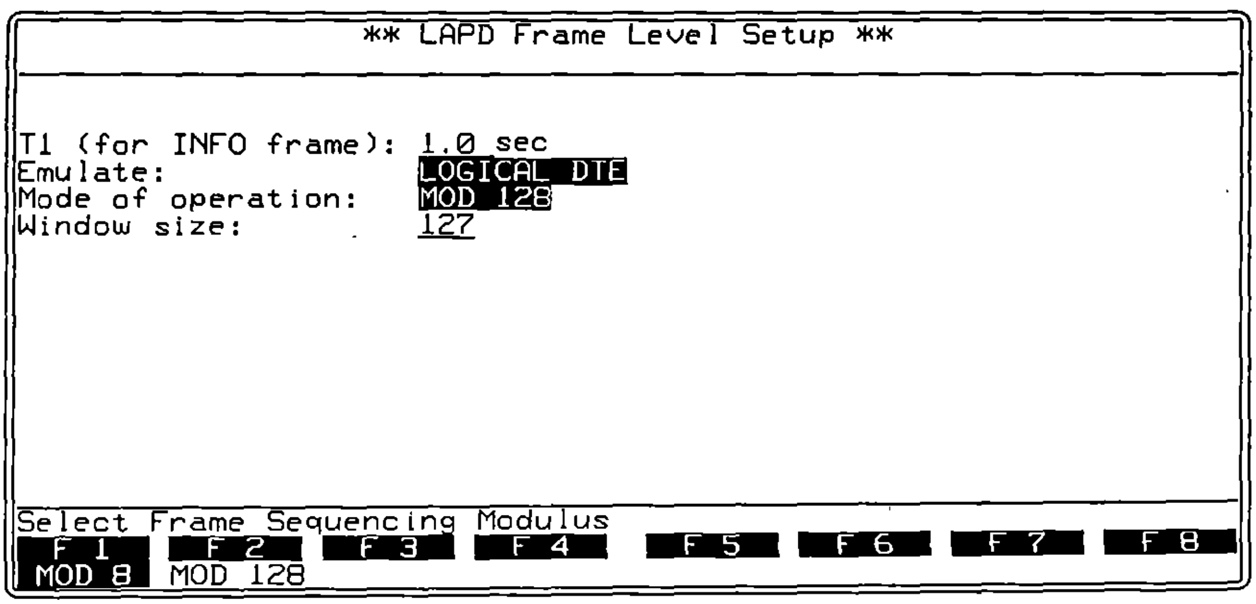


Figure 42-2 Protocol Configuration screen for LAPD.

42 LAPD

LAPD is a "layer personality package" of functions that are loaded into memory from disk via the Layer Setup screen. Figure 42-1 shows the Layer Setup screen configured to load in the Layer 2 LAPD package from floppy-disk drive #2. Refer to Section 8 for details on operating the Layer Setup screen.

The LAPD package consists of the following:

- A special LAPD Frame Level Setup screen that controls certain parameters when the unit is tracing or emulating LAPD.
- A protocol trace (illustrated in Figure 42-3) that distills from LAPD data the Level 2 events that have protocol significance. This trace is accessible by softkey in Run mode at all times.
- A group of conditions and actions at Layer 2 on the Protocol Spreadsheet that facilitate LAPD programming. Figure 42-5 shows the softkey path to the first rack of condition softkeys when the LAPD package is loaded in at Layer 2.

42.1 Frame-Level Setup

The parameters on the LAPD Frame Level Setup screen must be configured correctly for an accurate trace display and for proper emulation.

To bring up this screen, first go to the Layer Setup screen (press [PROGRAM], [F5]). Execute the LAPD selection at Layer 2: **LAPD** should appear in the **Packages Loaded** column. Press [F8] (labeled PROTSEL) to bring up a prompt to **Select Protocol Configuration Screen.** Then press [F2] (LAYER-2) to call up the LAPD Frame Level Setup screen.

The four parameter fields on this screen are shown in Figure 42-2. **T1**, **Emulate**, and **Window Size** apply to interactive (emulate) tests only. **Mode of Operation** must be configured correctly for the protocol trace as well as for proper emulation.

(A) T1

Enter a four-digit (including decimal point) T1 timeout value in this field. The largest valid entry is 65.5 seconds. The smallest entry is .001 second, or 1 millisecond.

T1 is the name given to the retransmission timer for INFO frames. When a value is entered in the **T1** field on this menu, the layer 2 package will handle T1 timings correctly, as follows:

- Whenever the INTERVIEW sends an I-frame at Layer 2 and *there are no previous frames sent by the INTERVIEW currently outstanding (unacknowledged)*, the timer starts timing down from the value entered on the Frame Level Setup screen.
- An acknowledgment by the device under test of the most recent frame transmitted by the INTERVIEW *stops* the timer (so that it does not expire).
- An acknowledgment by the device under test of a frame that is not the most recent frame transmitted by the INTERVIEW—an "incomplete" acknowledgment—restarts the T1 timer to the value selected on the configuration screen.

Expiration of this Frame Level Setup timeout can only be detected by a T1_EXPIRED condition on the Protocol Spreadsheet at Layer 2. This particular timeout cannot be detected by a generic condition of TIMEOUT T1.

According to the protocol, a T1_EXPIRED condition should result in a RESEND action.

(B) Emulate Logical DTE/DCE

There are two selections in the **Emulate** field on the LAPD Frame Level Setup screen, LOGICAL DTE and LOGICAL DCE. Usually a logical DTE represents the user side of a link and a logical DCE is the network side of the link.

Use the **Mode** selection (EMULATE DTE or EMULATE DCE) on the Line Setup menu to regulate the *physical* interface—whether to use pin 2 or pin 3 to transmit, and so on.

(C) Mode of Operation

The **Mode of Operation** field refers to the mode of numbering INFO and supervisory frames. There are two options, MOD 8 and MOD 128.

MOD 8 uses sequence numbers 0–7. MOD 128 adds an extra byte to the control field in INFO, RR, RNR , and REJ frames. See Figure 42-4. This extra byte allows sequence numbers in a range of 0–127.

The correct "modulus" must be selected in this field in order to program successfully in Monitor mode and also to generate an accurate LAPD trace.

(D) Window Size

Any window size may be entered up to the current modulus minus one: 7 or 127. The window size is the maximum number of unacknowledged I-frames that Layer 2 will buffer for retransmission. When the limit is reached, any further INFO frames that are named in SEND actions triggered at Layer 2 will be passed to Layer 1 for transmission but not buffered for retransmission.

The window is a queue that buffers frames for retransmission in case one or more transmissions are lost or in error. A RESEND action will resend the first (earliest) frame in the window. Successive RESENDs will send successive frames until there are no more frames to resend; or until the window is reset by an acknowledgment or by a RESEND FIRST action.

42.2 Protocol Trace

The LAPD package includes an automatic frame-trace display that summarizes link-level activity. This trace mode is enabled whenever the unit is in Run mode, both real-time and frozen.

While the unit is in Run mode, press the softkey for L2TRACE to bring the protocol trace for LAPD to the screen. (If the Q.931 package for Layer 3 is also loaded in, the L2TRACE softkey will appear after you have pressed PROTOCL, [F2] on the primary rack of display-mode softkeys.)

Figure 42-3 is an example of the Layer 2 trace display. Each horizontal row in the trace represents a frame.

(A) The Protocol Trace in Freeze Mode

Press [FREEZE] to prevent the addition of new data to *all* the display buffers, including the trace buffers. The frozen trace display may be scrolled through or paged through. The top line always is the cursor line (though there is no actual cursor on the trace display). Pressing [ROLL FWD] or [↓] moves the viewing "window" down relative to the data to add one line of fresher data to the bottom of the screen. Pressing [ROLL BACK] or [↑] moves the viewing window up to add a line of older data to the top of the screen.

Depression of the [NEXT PAGE] key adds fifteen lines—one full page—of newer frames to the frozen trace screen. Depression of [PREV PAGE] adds fifteen lines of older frames.

The frame displayed on the top line of frozen trace-data will appear as the first frame in the raw-data or data-plus-leads display. To view the raw data that generated a particular line in the trace display, use [ROLL FWD] or [ROLL BACK] (or [↑] or [↓]) to move the line in question to the top of the screen. Then press one of the data softkeys.

MON/LINE BLK=00000 S 06/23/89 09:15
ASCII/8/NONE/BOP

SRC	SAPI	TEI	C/R	TYPE	Nr	Ns	P/F	SIZE	TIME	BCC
DCE	04	1A	1	DISC			0	0003	0915:08.021	G
DTE	04	1A	1	UA			0	0003	0915:08.172	G
DTE	04	1A	0	SABM			1	0003	0915:08.212	G
DCE	04	1A	0	UA			1	0003	0915:08.440	G
DTE	04	1A	0	INFO	0	0	0	0007	0915:08.482	G
DCE	04	1A	1	INFO	0	0	0	0008	0915:08.723	G
DTE	04	1A	1	RR	1		0	0003	0915:08.842	G
DCE	04	1A	0	RR	1		0	0003	0915:08.915	G
DTE	04	1A	0	INFO	1	1	0	0019	0915:08.916	G
DCE	04	1A	0	RR	2		0	0003	0915:08.959	G
DCE	04	1A	1	INFO	2	1	0	0006	0915:09.033	G
DTE	04	1A	1	RR	2		0	0003	0915:09.362	G
DCE	04	1A	1	INFO	2	2	0	0018	0915:09.505	G
DTE	04	1A	1	RR	3		0	0003	0915:09.667	G
DTE	04	1A	0	INFO	3	2	0	0006	0915:09.747	G

F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8
L2TRACE	L3TRACE						

Figure 42-3 Each horizontal row on the trace display represents a frame.

(B) Trace Columns

The columns in the protocol trace for Layer 2 LAPD are explained below.

1. *Source.* The SRC column identifies the lead on which the frame was monitored, TD (DTE) or RD (DCE). This column identifies the *physical* source of the frame, not the *logical* source. The physical DTE uses the TD lead to transmit. The physical DCE uses RD to transmit.

   Just as on the data display, RD data is underlined.

2. *SAPI.* The Service Access Point Identifier (SAPI) is given in the next column. The SAPI is a network link-station address that appears in a six-bit field in the first frame-address byte: see Figure 42-4.

   The SAPI is presented on the trace display as two hex digits, with the righthand digit expressing the four low-order bits of the SAPI and the lefthand digit expressing the two remaining bits.

3. *TEI.* The Terminal Endpoint Identifier (TEI) is the address of a link station on the user side. It occupies seven bits in the second frame byte inside the leading flag (see Figure 42-4).

   The TEI is presented on the trace display as two hex digits, with the righthand digit expressing the four low-order bits of the TEI and the lefthand digit expressing the three remaining bits.

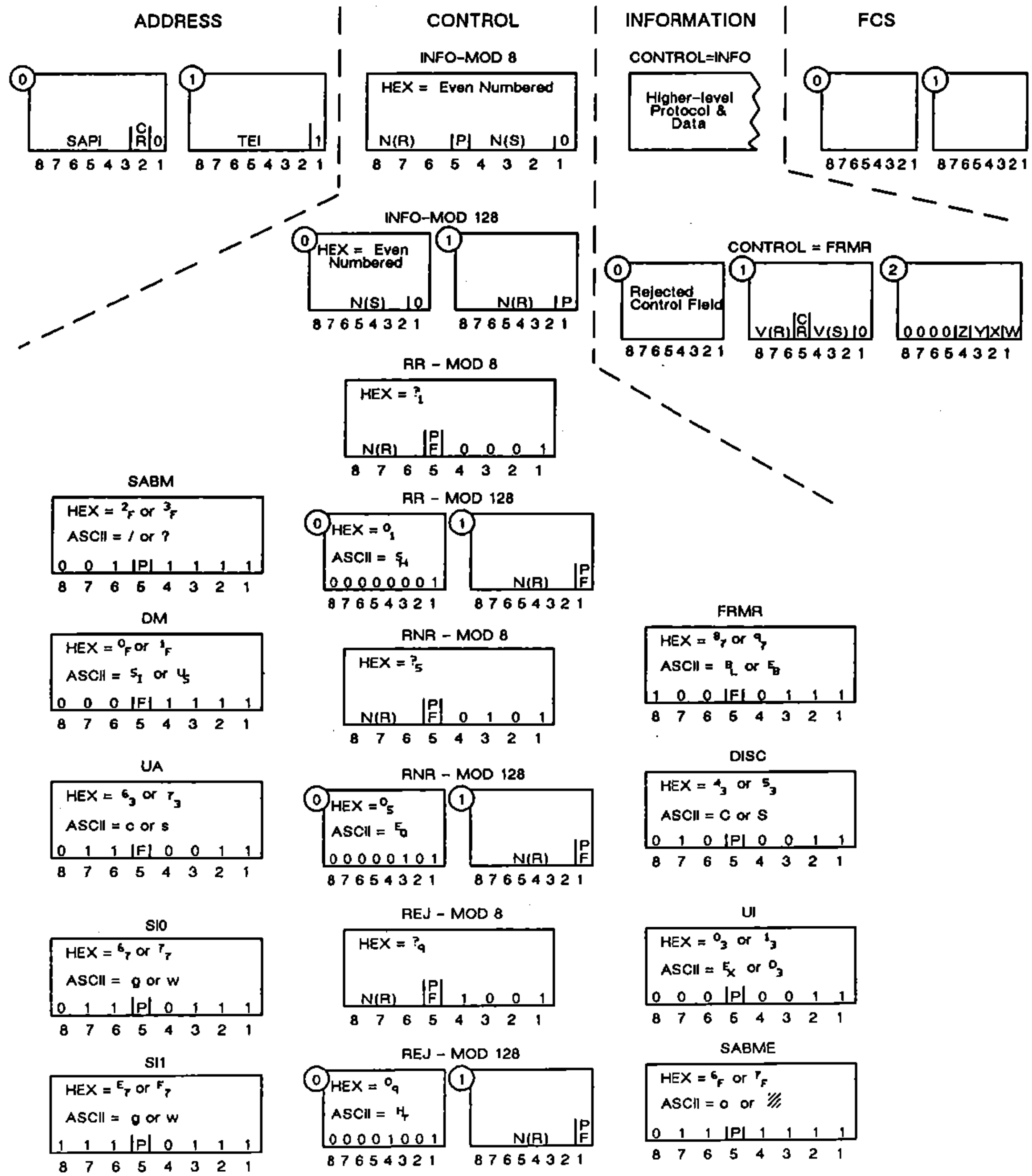


Figure 42-4 Frame fields in LAPD.

4. *C/R.* The Command/Response (**C/R**) column identifies the logical DTE (user side) and the logical DCE (network side). The logical DTE uses C/R 0 for INFO frames and other command frames, and C/R 1 for responses. The logical DCE uses C/R 1 for INFO frames and other commands, and C/R 0 for responses.

5. *Type.* The mnemonic (abbreviated) names for thirteen frame types as they appear in the **TYPE** column of the protocol trace are shown in Figure 42-4 under "CONTROL." The control field, therefore, indicates the frame type. If a control octet does not fit any of the patterns in the figure, the frame is listed in the **TYPE** column as **UNKWN** followed by the hexadecimal value of the control byte: **UNKWN=47.**

   If the number of bytes in the frame is below the required minimum, the frame is posted as **INVALID.**

6. *N(R) and N(S).* One column on the frame-level trace is devoted to N(R) values, and one column to N(S). The frame types that include N(R) or N(S) fields in their control fields are indicated in Figure 42-4. N(R) and N(S) occupy three bits each in modulo 8, seven bits each in modulo 128.

   N(R) and N(S) values are presented in decimal format in modulo-8 traces. Each column displays a single digit that represents a 3-bit binary value. For modulo 128, the values $^{0}_{0}$ to $^{7}_{F}$ are given in "character" format, where the columns contain a two-digit hexadecimal character.

7. *P and F.* The status of the poll or the final bit is given in the **P/F** column. Whether this bit is the P or F bit is indicated for most frame types in Figure 42-4 (under "CONTROL").

   The setting of the P bit in an INFO frame often denotes the retransmission of an unacknowledged frame following a T1 timeout.

8. *Size.* The number of bytes in each frame is given in this column in four decimal digits. The count begins with the first address byte and excludes the two-byte FCS. Frames without I-fields show a count of three (MOD 8).

9. *Time.* The time of the arrival of the *end of the frame* at the DTE or DCE monitor is provided by a 24-hour clock and posted to the trace display. The clock is accurate to the millisecond.

   When **Time Ticks:** ON is selected on the Front-End Buffer Setup screen (see Section 9), time values are incorporated into the data itself. As a result, times posted to the trace display are the original values and will not be affected when recorded data is played back, even at varying speeds.

   If **Time Ticks:** OFF was selected instead during live recording, times on the trace during playback will be "wall time" and will be influenced by local conditions such as playback speed, idle suppression, etc.

10. *Frame Checking*. A LAPD frame ends as soon as a flag or seven 1-bits in a row are detected. If a flag ends the frame, a frame check is performed and the result is posted both to the data display and to the BCC column of the trace display. The symbol G denotes a good frame check, while B symbolizes a bad frame.

    A for abort is posted to the displays when a frame is ended by seven 1-bits.

42.3 Monitor Conditions

When the LAPD personality package is loaded in (via the Layer Setup screen), a set of conditions checks DTE and DCE leads. This set of conditions is accessed by the DTE and DCE selections on the first rack of condition softkeys at Layer 2. See Figure 42-5.

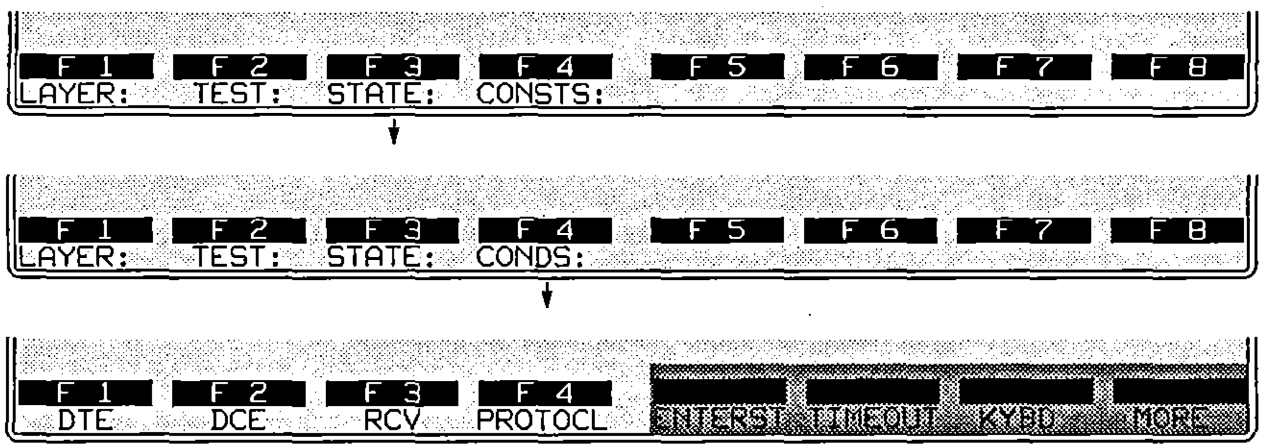


Figure 42-5 The softkeys for *DTE* and *DCE* are used to monitor LAPD protocol events at Layer 2.

After the keyword DTE (or DCE) is written to the spreadsheet, a rack of softkeys appears that represent *types* of frames: INFO, SABM, UA, and so forth.

(A) Frame Types

The softkeys for INFO, supervisory, unnumbered, sequenced information, and "other" frames are illustrated in Figure 42-6. Press a softkey to write one of these frame types to the Layer 2 spreadsheet. DTE or DCE followed by a frame-type mnemonic—DTE INFO, for example, or DCE SABM—is a complete condition and will come true if a matching frame is monitored. SAPI, TEI, C/R, poll/final, and BCC conditions may be appended to the simple frame mnemonic, but they are optional.

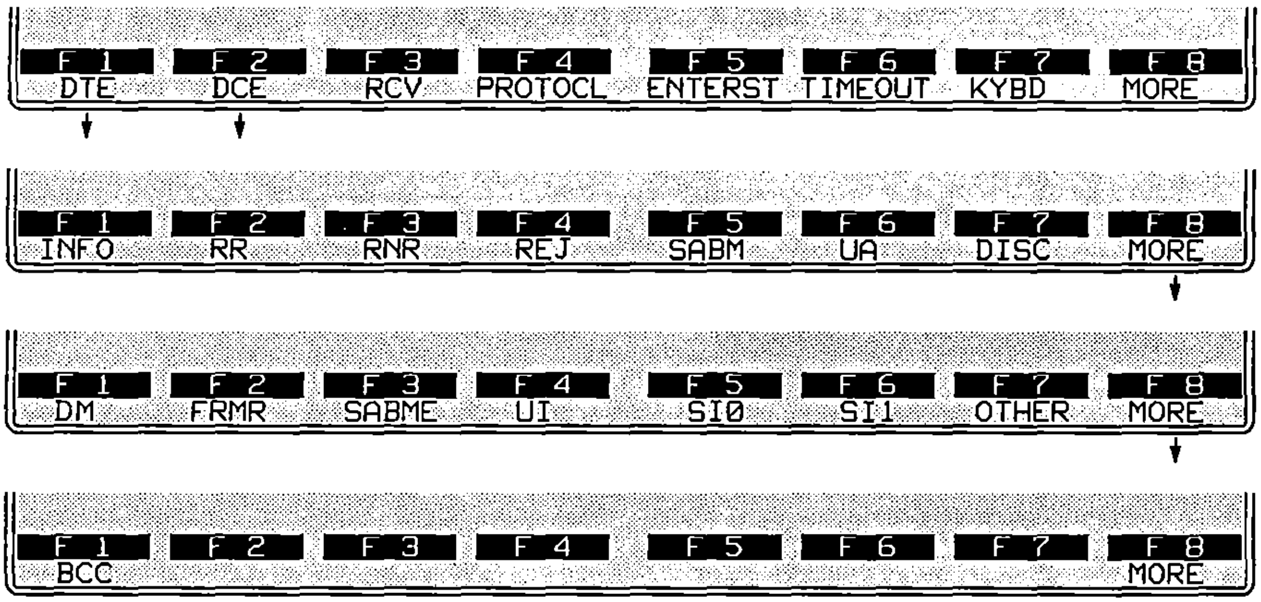


Figure 42-6 **Frame type or block-check type may be specified as a complete condition for *DTE* or *DCE*.**

1. *Info frames.* INFO frames differ for MOD 8 and MOD 128 numbering schemes. (See Figure 42-4.) For spreadsheet conditions to match I-frames accurately, the correct numbering system (**Mode of Operation**) should be selected on the LAPD Frame Level Setup screen.

2. *Supervisory frames.* The three supervisory-frame types that can be searched for on the data leads are RR (Receive Ready), RNR (Receive Not Ready), and REJect. These frames always contain N(R) fields (see Figure 42-4) and serve mainly to acknowledge or reject INFO frames.

   Like INFO frames, supervisory frames are constructed differently according to the numbering scheme, MOD 8 or MOD 128.

3. *Unnumbered frames.* Unnumbered frames generally assist in link-setup and takedown.

4. *Sequenced information frames.* Sequenced information frames (SI0 and SI1) have a 1-bit sequence-numbering field that toggles 0 (SI0) and 1 (SI1). (See Figure 42-4.) These frames are used instead of INFO frames in MOD 2 operation where the limit for outstanding information frames is 1.

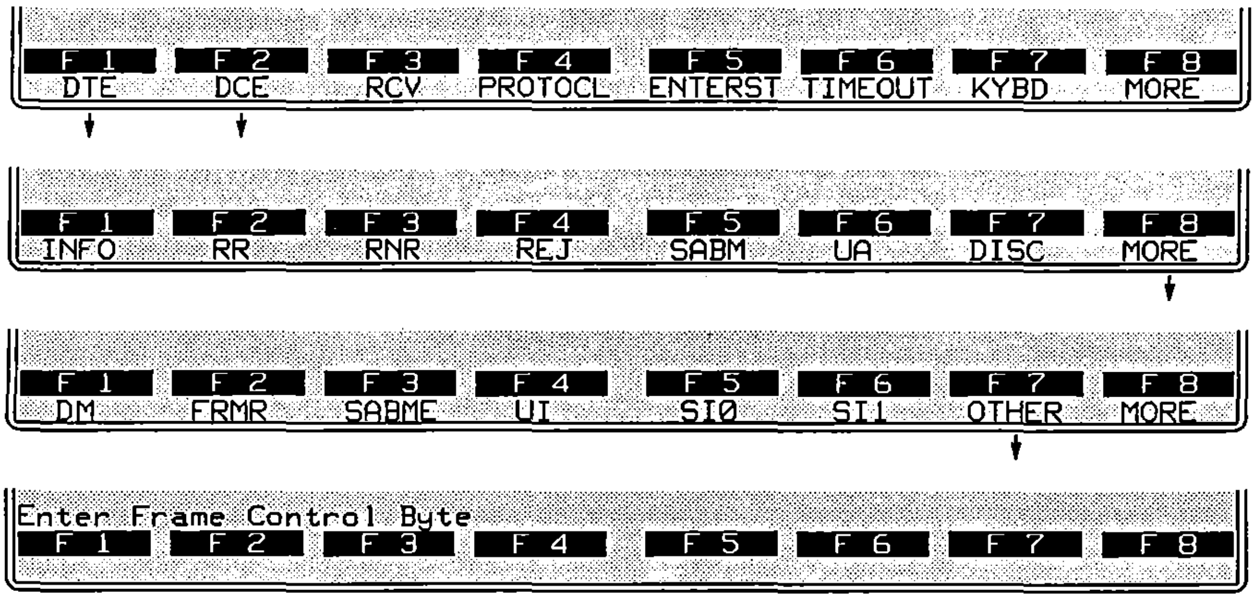


Figure 42-7 The hex value of any frame may be specified under *OTHER*.

5. *Other frames*. Any frame type may be entered as a hexadecimal value instead of by name. Press the softkey for OTHER. See Figure 42-7. Then enter the hex byte in the form of two alphanumerics. Here, for example, is a SABM (with the P bit set) entered as a hexadecimal:

CONDITIONS: DCE OTHER 3F

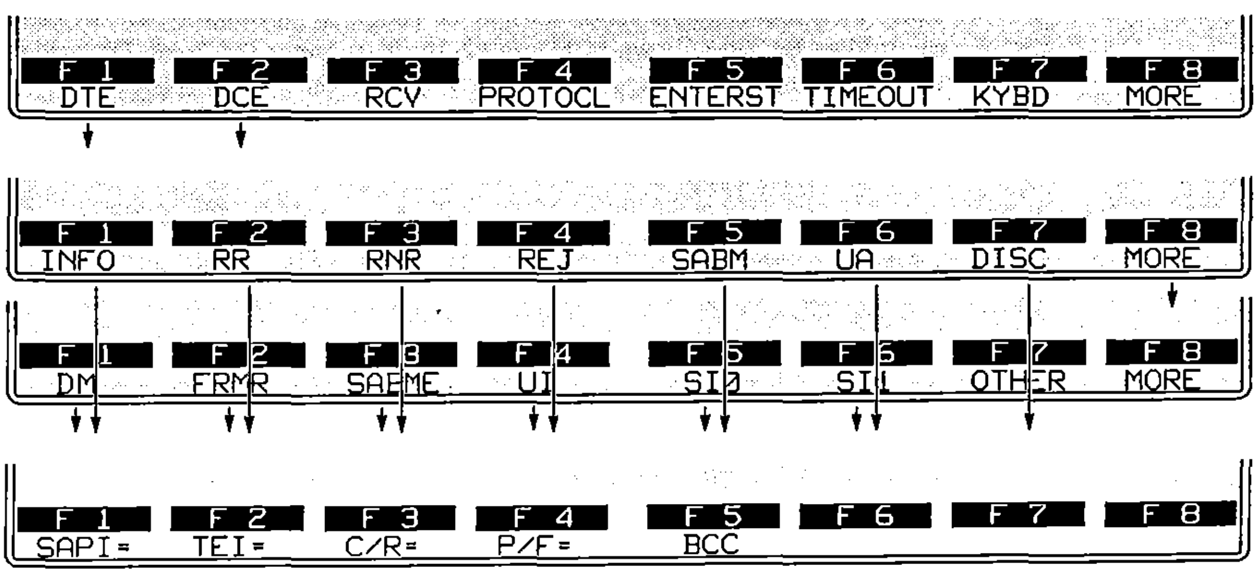


Figure 42-8 The bottom softkey rack shows conditions that may be linked to frame-type conditions.

SAPI, TEI, C/R, P/F, and BCC conditions may be appended to OTHER conditions (see Figure 42-8). In MOD 8, the P/F bit is already specified in the hex entry, and a P/F condition will be ignored.

6. *SAPI.* A SAPI condition may be added to all frame types. Press the softkey for SAPI=, shown in Figure 42-9. Then enter the 6-bit SAPI value as two hex digits in a range from 00 to 3F. (Do *not* use the HEX key.) The entry will appear as in this example:

CONDITIONS: DTE INFO SAPI= 15

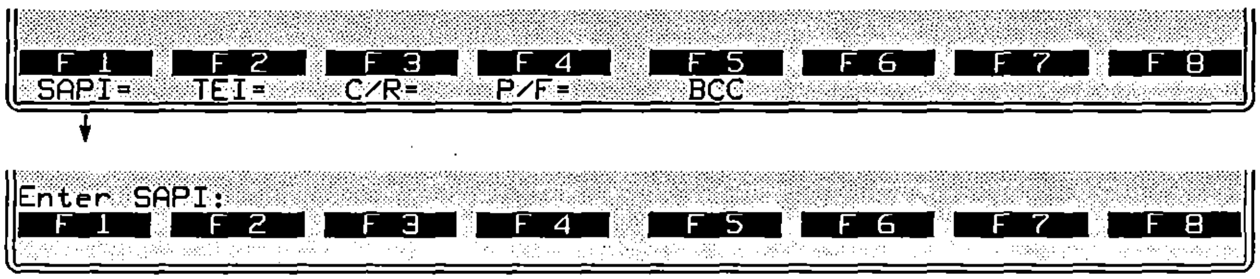


Figure 42-9 The hex value of the SAPI is entered as two alphanumerics.

To bypass the SAPI= selection (as well as the other options on the same rack of softkeys in Figure 42-9) press DONE.

7. *TEI.* Like SAPI, a TEI condition may be added to all frame types. Press the softkey for TEI=, shown in Figure 42-10. Then enter the 7-bit TEI value as two hex digits in a range from 00 to 7F. (Do *not* use the HEX key.)

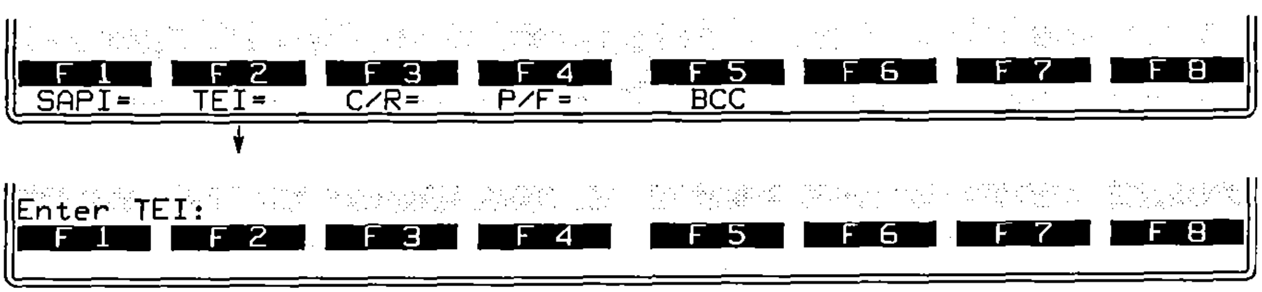


Figure 42-10 The TEI is an optional condition within all frame-type conditions.

8. *C/R.* A C/R value of 0 or 1 may be entered as an optional condition added to any frame-type condition.

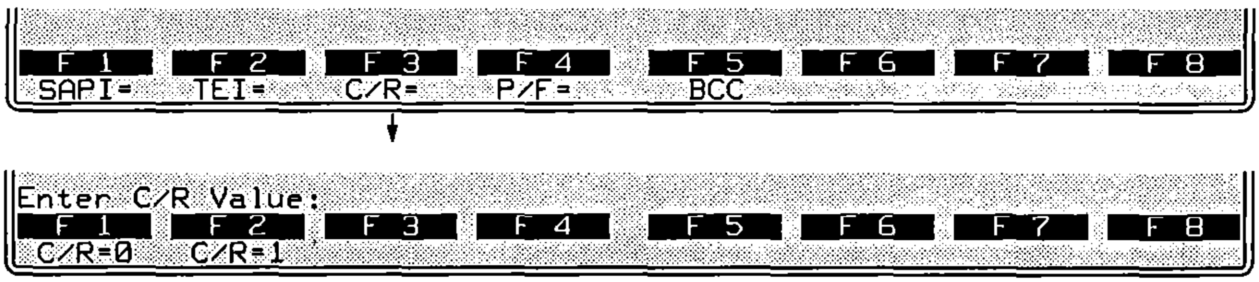


Figure 42-11 The value of the C/R bit may be chosen as a condition.

Press DONE to bypass the C/R= condition and the other conditions on the same softkey level in Figure 42-11.

9. *Poll/final bit.* P/F conditions are optional for all frame types. P/F values of 0 or 1 are entered by the softkey sequence in Figure 42-12.

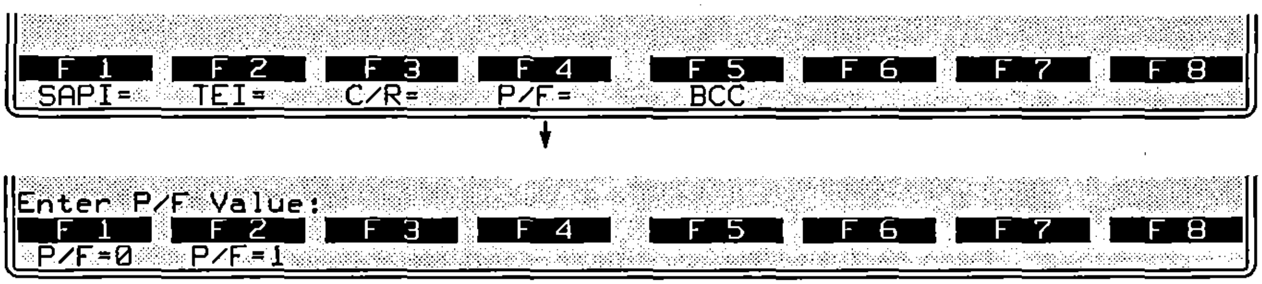


Figure 42-12 The value of the P/F bit may be chosen as a condition for any frame type.

Press DONE to bypass the P/F= condition and the other conditions on the same softkey level in Figure 42-12.

(B) BCC Conditions

DTE and DCE frames may be monitored for good and bad frame checks and for aborts. *All* DTE or DCE frames may be monitored with respect to frame checking, as in this example:

CONDITIONS: DTE BDBCC

The softkey sequence for this spreadsheet entry is given in Figure 42-13.

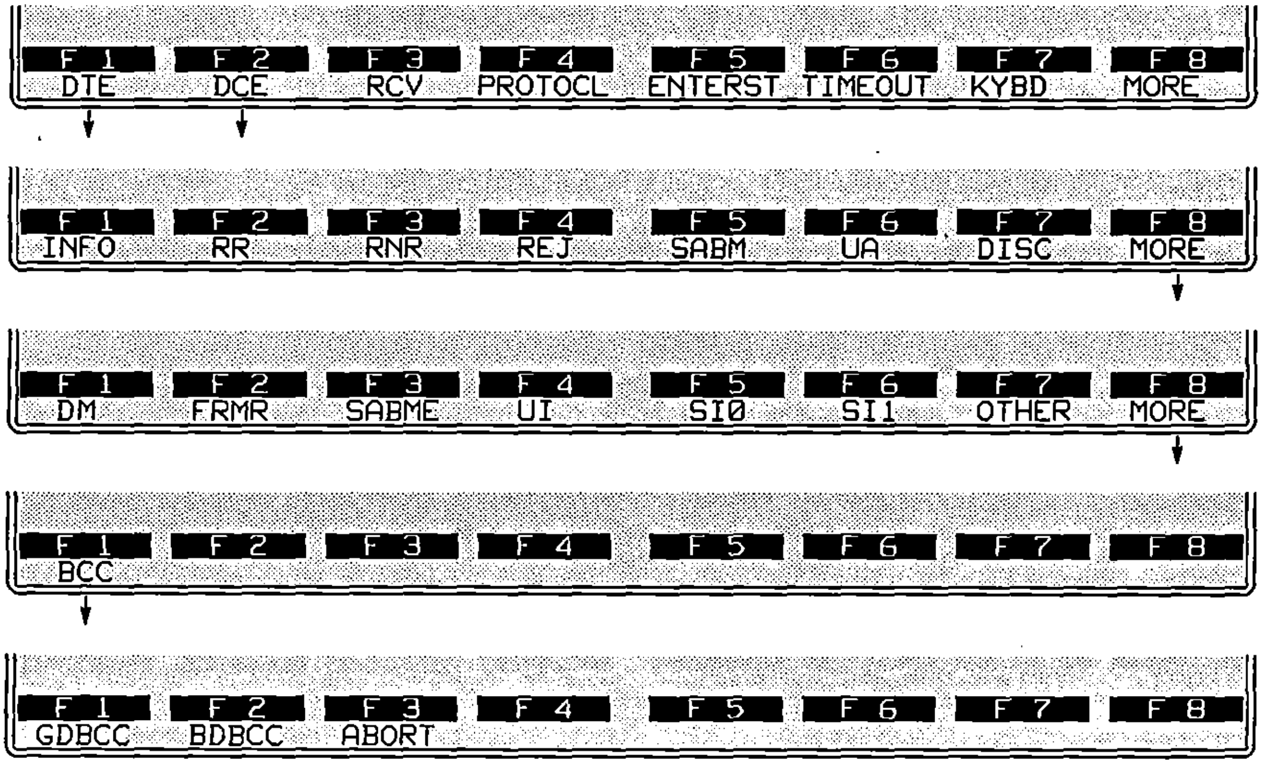


Figure 42-13 A condition may search for *all* good, bad, or aborted frames.

Or a particular *type* of frame may have a BCC or abort condition appended to it:

CONDITIONS: DCE INFO ABORT

42.4 Emulate-Mode Conditions

The remaining conditions are functional only when the Line Setup menu is configured for **Mode:** EMULATE DTE or EMULATE DCE .

(A) Receive Conditions

Like DTE and DCE conditions, RCV conditions monitor a data lead for LAPD frame types. RCV conditions operate only in emulate modes, and they check only the data lead that the INTERVIEW is not using to transmit. While a RCV condition may look like a DTE or DCE condition—RCV INFO P/F=1 looks the same as DCE INFO P/F=1—there are important differences that are noted below.

1. *Valid frame sequencing.* To satisfy RCV conditions, numbered frames must have correct N(R) and N(S) sequencing.

2. *Good BCC.* RCV conditions cannot match frames with bad frame checks, nor can they match aborted frames. (Emulate-mode conditions are designed for ease of programming, and the assumption is that as a LAPD emulator, you are not required to acknowledge—or negative-acknowledge—bad or aborted frames.)

   If you wish to count bad BCCs or aborts, use DTE or DCE conditions instead of RCV conditions.

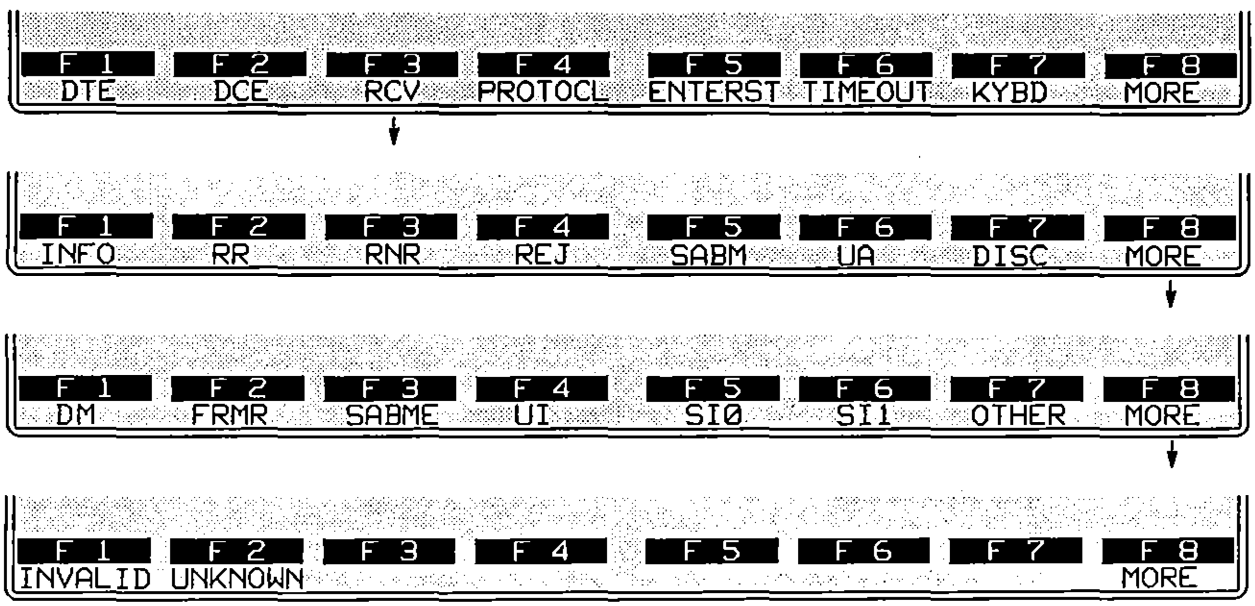


Figure 42-14 *INVALID* and *UNKNOWN* are frame types for *RCV* conditions.

3. *Type invalid.* RCV conditions can detect frames that are invalid "types"—the control field is missing, for example, or the I-field is missing in an I-frame. The Protocol Spreadsheet entry for this condition is RCV INVALID, and the softkey sequence is illustrated in Figure 42-14.

4. *Type unknown.* A frame may be valid in all respects but have a control field that indicates a nonstandard frame type. Such a frame may be matched by a RCV UNKNOWN condition (Figure 42-14).

(B) N(S) Error

As a Layer 2 emulator, you do respond to INFO frames that have N(S) errors. These are detected as NS_ERR conditions, not as RCV INFO conditions.

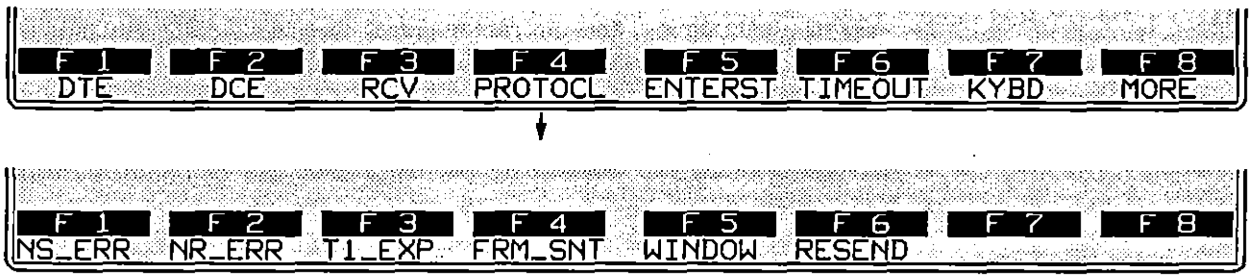


Figure 42-15 The *PROTOCL* key brings up six LAPD emulate conditions.

NS_ERRs apply only to frames received when you are emulating. The same frame that triggers an NS_ERR condition also may satisfy a DTE INFO or DCE INFO condition—but not a RCV INFO condition.

NS_ERR will come true for any received INFO frame whose N(S) value is not one higher than the previous N(S).

NS_ERR will not come true for out-of-sequence SI0 and SI1 frames.

In the first rack of condition softkeys at Layer 2, press PROTOCL. Then press the softkey for NS_ERR. See Figure 42-15.

(C) N(R) Error

Received INFO or supervisory frames may have N(R) errors. Such errors are detected as NR_ERR conditions, not as RCV INFO or RR (or RNR or REJ) conditions.

A valid N(R) is any value that (1) acknowledges a frame that is *outstanding* (waiting for acknowledgment); or (2) repeats the last acknowledgment. Any other N(R) value is detected as an error.

(D) T1 Expired

This condition detects the expiration of the T1 timeout-timer that is regulated on the LAPD Frame Level Setup screen. See Section 42.1(A), above.

(E) Frame Sent

This condition is true when, as a result of a SEND or RESEND action, a frame has been passed down to Layer 1.

(F) Window Conditions

The size of the Layer 2 retransmit window is configured on the LAPD Frame Level Setup screen. See Section 42.1(D). There are four conditions that test the current status of this window. They are WINDOW FULL, WINDOW EMPTY, WINDOW NOT_FULL, and WINDOW NOT_EMPTY. The softkey sequence for the WINDOW options is shown in Figure 42-16.

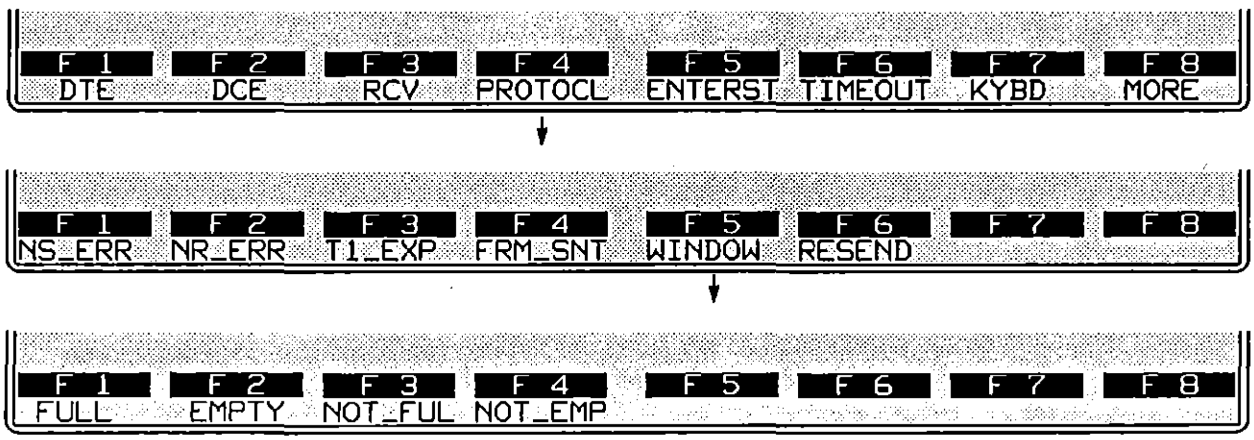


Figure 42-16 When the retransmit window fills, Layer 2 stops buffering frames for retransmission.

WINDOW FULL is true when the window is full of unacknowledged frames and the Layer 2 protocol package will not buffer additional frames until some acknowledgment is received.

Each time an acknowledgment is received, the window is flushed to the extent of the acknowledgment. WINDOW EMPTY means that the latest acknowledgment was complete and left no frames outstanding (unacknowledged). If an RR response is received and the acknowledgment is only partial, this condition will be true:

```
CONDITIONS: RCV RR
  WINDOW NOT_EMPTY
```

CAUTION: Window conditions are status conditions (see Section 30.2) and must *always be used in combination with a transitional condition such as a RCV condition.*

(G) More to Resend

Frames in the window may have to be resent, usually as the result of a T1 timeout or a Reject frame. One RESEND action retransmits one frame in the window, beginning with the earliest. Subsequent RESEND actions retransmit subsequent frames. The MORE_TO_RESEND and NO_MORE_TO_RESEND conditions allow you to retransmit the entire window, as in the "recover" state in this example:

```
   CONDITIONS: RCV REJ
   NEXT_ST: recover
STATE: recover
   CONDITIONS: ENTER_STATE
   ACTIONS: RESEND FIRST
   CONDITIONS: FRAME_SENT
      MORE_TO_RESEND
   ACTIONS: RESEND NEXT
   CONDITIONS: FRAME_SENT
      NO_MORE_TO_RESEND
   NEXT_ST: xfer
```

MORE_TO_RESEND and NO_MORE_TO_RESEND conditions may be written to the Protocol Spreadsheet by the softkeys shown in Figure 42-17.

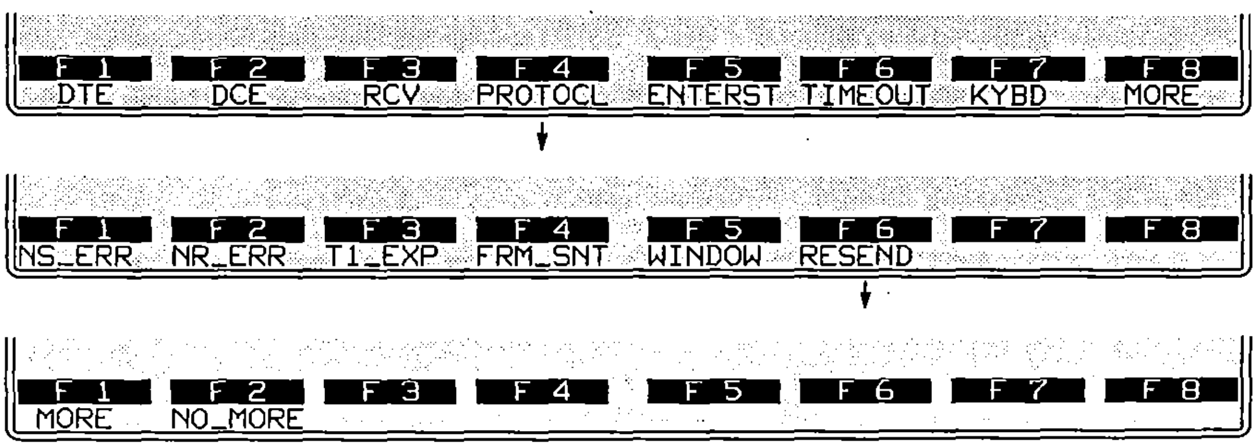


Figure 42-17 The *MORE_TO_RESEND* condition allows you to resend the entire window of frames and then stop when there are *NO_MORE_TO_RESEND*.

CAUTION: MORE_TO_RESEND and NO_MORE_TO_RESEND are status conditions (see Section 30.2) and must always be used in combination with a transitional condition such as FRAME_SENT.

42.5 Emulate Actions

When you have completed a block of conditions in a Protocol Spreadsheet test at Layer 2, press [DONE] to access the set of actions that can be taken as a result of the block of conditions coming true. The set of actions that are specific to the LAPD personality package are shown in the racks of softkeys in Figure 42-18. Except for ENHANCE and SUPPRES, the actions shown have meaning only when the INTERVIEW is emulating DTE or DCE, and not when it is monitoring the line passively.

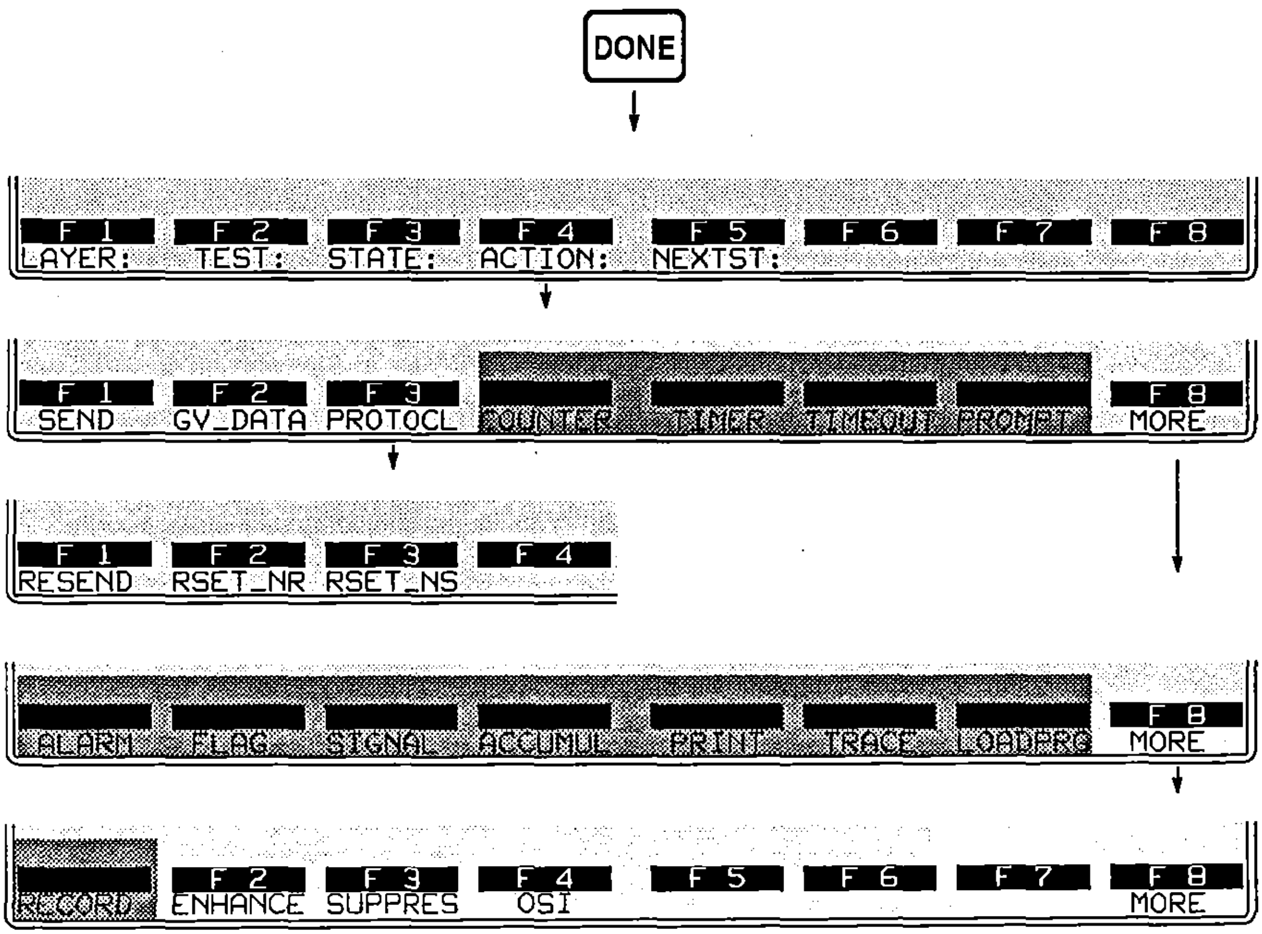


Figure 42-18 Action softkeys specific to LAPD.

(A) Send Actions

Press the softkey for SEND to access two racks of softkeys with names of frame types that may be named in SEND actions. All data generated by the LAPD package must be enclosed in a frame that is identified in a SEND action by *type*.

(Only at Layer 1 can data be generated as a simple character string without any protocol building blocks.) The complete set of frame types is given in Figure 42-19.

When conditions are true for a SEND action, frames are sent immediately down to Layer 1 to be transmitted there.

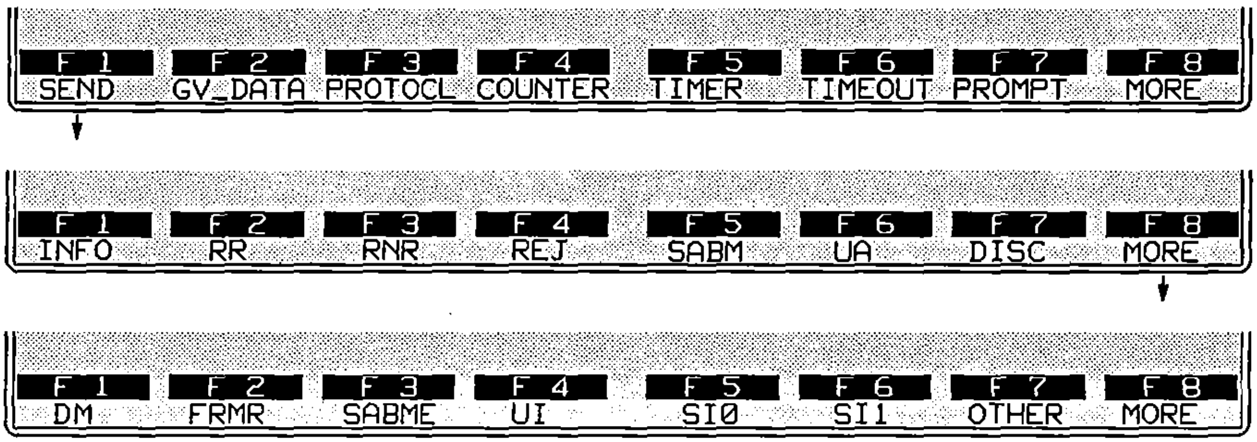


Figure 42-19 ***SEND*** **actions always specify a frame type.**

1. *INFO frames.* SEND INFO is a complete action-entry. SAPI, TEI, command-bit, poll-bit, N(R), N(S), string, and BCC parameters may be added to an INFO frame, but they are optional.

   If a Layer 3 package is installed and Layer 3 data is being handed down to Layer 2, the following condition-and-action trigger will accept this data and convey it properly to Layer 1:

   CONDITIONS: DL_DATA REQ
   ACTIONS: SEND INFO " ((DL_DATA)) "

   SEND INFO actions pass the INFO frame immediately to the next layer down. If the retransmit window is full, the frame is still sent—but it is not buffered in the window and can not be *re*sent.

   An INFO frame will be buffered for retransmission regardless of the status of the window if a specific value is entered for the NS= parameter (see "*N(S)*," below). The specific N(S) value will clear the window and the INFO frame will be buffered in the first window position.

2. *Supervisory frames.* SEND RR, SEND RNR, and SEND REJ are complete action entries. SAPI, TEI, C/R-bit, P/F-bit, N(R), string, and BCC parameters may be added to the SEND action, but they are optional.

3. *Unnumbered frames.* SAPI, TEI, C/R-bit, P/F-bit, string, and BCC parameters values may be included as adjuncts to a SEND action for an unnumbered frame.

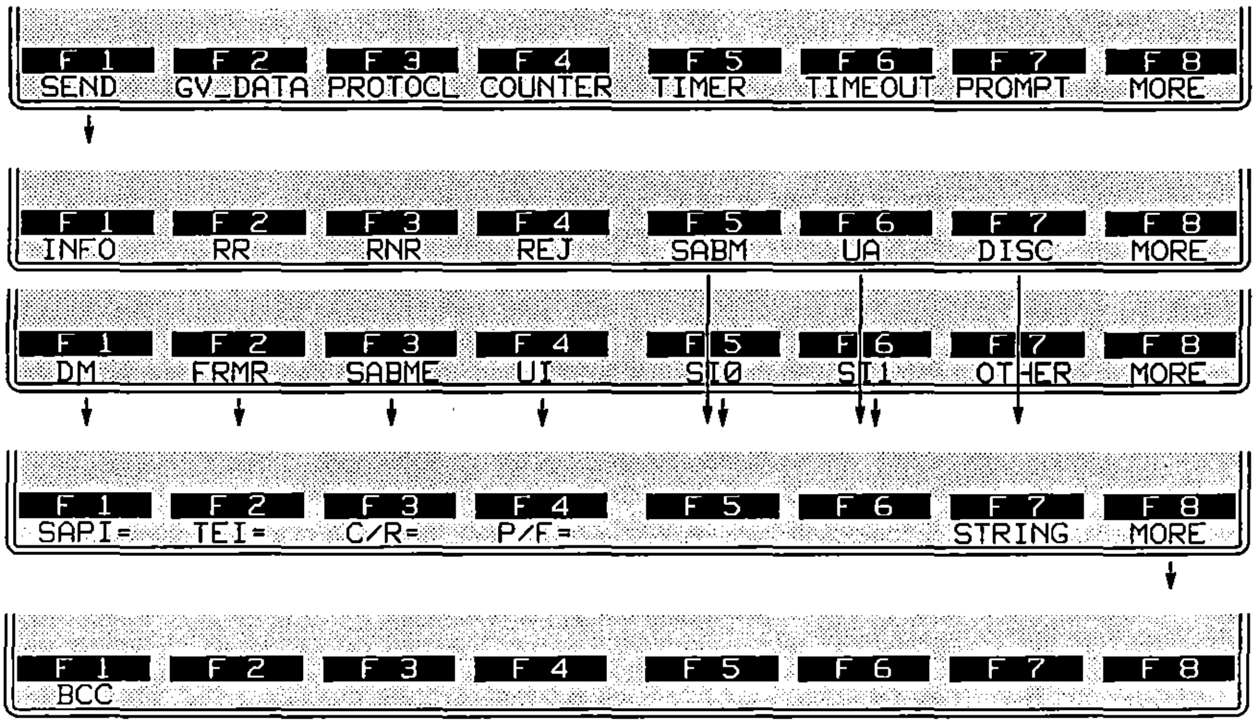


Figure 42-20 SAPI, TEI, C/R, P/F, string, and BCC options may be added to *SEND* unnumbered-type and SI-type actions.

4. *Sequenced information frames.* SAPI, TEI, C/R-bit, P/F-bit, string, and BCC values also may be added to SEND SI0 and SEND SI1 actions.

   Figure 42-20 shows the optional fields that may be specified inside of unnumbered and SI send-actions.

5. *Other frames.* Any frame type may be entered in a SEND action as a hexadecimal value instead of by name. Press the softkey for OTHER, on the bottom rack in Figure 42-19.

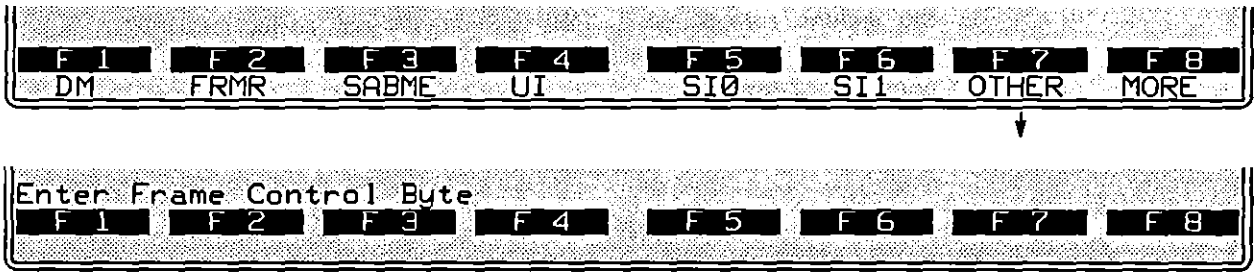


Figure 42-21 *SEND OTHER* **actions always specify a** *type* **value in hex.**

Enter the hex value in the form of two alphanumerics. Here is a DISConnect command entered as a SEND OTHER action:

SEND OTHER 43 SAPI= 04 TEI= 1A C/R= 0

Note that P/F, N(R), and N(S) fields are implied already in the user-entered hexadecimal control field. In MOD 128, P/F is not included in the hex entry and is a valid optional entry.

6. *SAPI.* An SAPI may be specified for all frame types. The SAPI= entry is always typed as two hex digits, with the right-hand digit expressing the four low-order bits of the SAPI and the left-hand digit expressing the two remaining bits. The SAPI field 000100, for example, appears as follows:

   SEND RR SAPI= 04 TEI= 1A

7. *TEI.* A TEI may be specified for all frame types. The TEI= entry is always typed as two hex digits, with the right-hand digit expressing the four low-order bits of the TEI and the left-hand digit expressing the three remaining bits. The TEI field 0011010 is illustrated in the SEND RR example above.

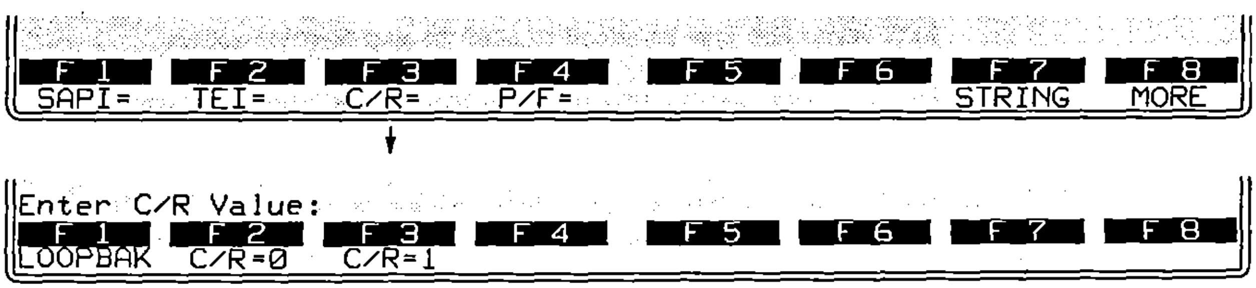


Figure 42-22 The correct Command/Response bit will depend on the logical emulation.

8. *Command/response bit.* The C/R bit may be specified for all frame types. The logical DTE uses C/R 0 for INFO frames and other command frames, and C/R 1 for responses. The logical DCE uses C/R 1 for INFO frames and other commands, and C/R 0 for responses. Since the response bit echoes the command bit, a C/R= LOOPBACK selection is provided (see Figure 42-22).

9. *Poll/final bit*. The P/F bit is an optional entry in all SEND actions. P/F values of 0, 1, or LOOPBAK are entered by the softkeys in Figure 42-23. If P/F= LOOPBAK, the bit will echo the last P/F bit received. (Looping the P/F bit is appropriate for UAs and supervisory frames.)

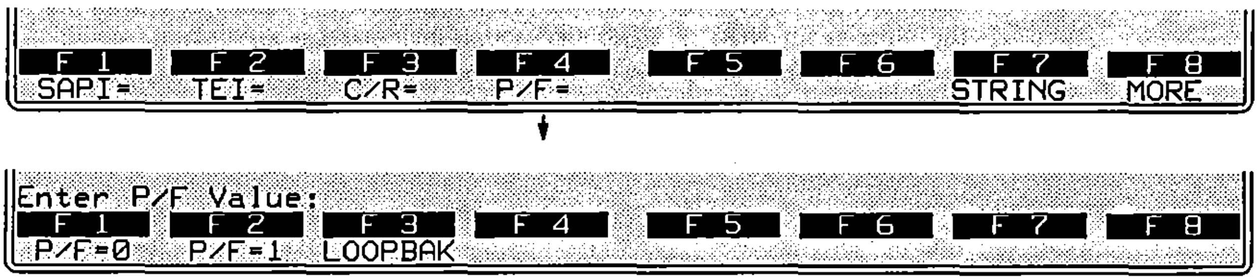


Figure 42-23 A P/F value is optional in all *SEND* entries.

10. *N(R)*. N(R) fields are transmitted in INFO and supervisory frames.

To specify an N(R) value, press the softkey for NR= (see Figure 42-24). Enter a hexadecimal value written as one or two alphanumeric digits. For example, an entry that represented the highest valid N(R) in MOD 8 would be NR= 7. The highest valid entry in MOD 128 would be NR= 7F.

Other N(R) options are ACK_NS, LAST_NR, and AUTO. (See Figure 42-24.) ACK_NS means that your N(R) will acknowledge (that is, it will be *one higher than*) the last N(S) value you received. Normally this will be the correct N(R), except in cases where the last N(S) received was erroneous. The NR= ACK_NS selection allows you to overlook N(S) errors.

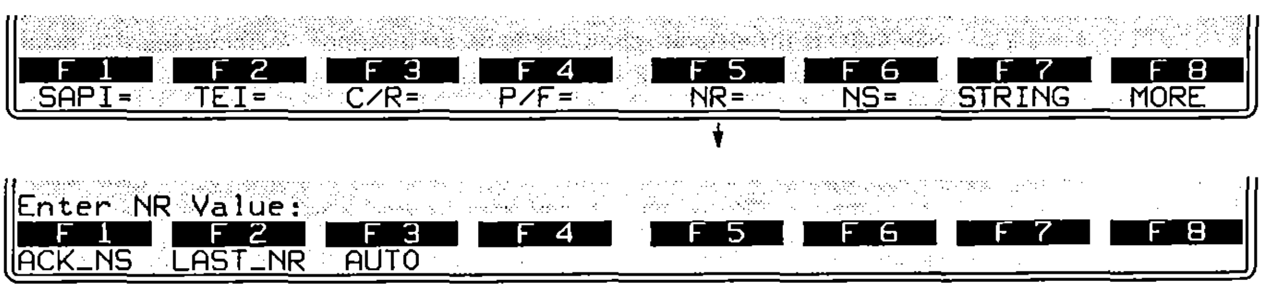


Figure 42-24 The N(R) field may be specified in INFO and supervisory frames to be sent.

LAST_NR means that you simply repeat the last N(R) you sent. Normally this is the correct N(R) following a bad N(S). The NR= LAST_NR option allows you to force the other side to initiate recovery.

AUTO means that you will behave as a normal LAPD station, acking valid N(S) values and repeating your last N(R) whenever an invalid N(S) is received.

11. *N(S)*. N(S) fields are transmitted in INFO frames only. (See the frame-field diagrams in Figure 42-4.) Entries for N(S) in SEND INFO actions are optional. The softkeys that open below NS= are illustrated in Figure 42-25.

    To specify an N(S) value, press the softkey for NS=, then enter a hexadecimal in the form of one or two alphanumerics. Valid hex entries are the same as for N(R). A SEND INFO action that *specifies* an N(S) value—NS= 0, for example—will clear the window so that the INFO frame is buffered immediately.

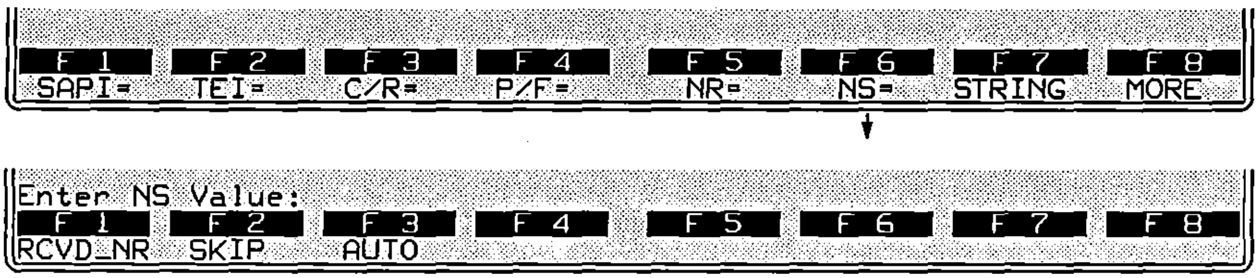


Figure 42-25 The N(S) field may be specified in a *SEND INFO* action.

Other N(S) options are RCVD_NR, SKIP, and AUTO. RCVD_NR means that you send the N(S) value that the other side says it is expecting. This is the valid N(S) in most cases, but not when you send two or more I-frames in a row without waiting for acknowledgment.

SKIP means that you *add one* to your correct N(S). This will look to the other side as though the line has taken a "hit" and a frame has been lost. This selection causes the window to be cleared.

NS= AUTO is the default setting for SEND INFO actions. AUTO means that every *new* INFO frame sent will have an N(S) value of one higher than the previous.

12. *String*. Strings are sent in LAPD only as adjuncts to frame-types when they are named in SEND actions. If you want to send a string of raw data without a protocol "envelope," you must go to Layer 1 and send the raw string from there.

    Press the SEND softkey followed by the softkey for a frame type. Add any necessary or desired SEND options for the particular frame type. Then press the STRING softkey (labeled F7 in Figure 42-25).

    There is no spreadsheet keyword that identifies send-strings at any layer. *The spreadsheet compiler identifies strings by the quotation marks surrounding them.* Always enclose strings in quotation marks. (To send an actual " -character in your string, type \" .) See Section 32 for more information on strings.

Here is a simple SEND action that includes no options besides a string:

ACTIONS: SEND FRMR " $^{1}_{1}$$^{6}_{6}$$^{0}_{8}$ "

And here is a SEND action that includes a full complement of optional fields, including a string:

ACTIONS: SEND INFO SAPI= 04 TEI= 1A C/R= 0 P/F= 0 NR= AUTO NS= AUTO
" $^{7}_{B}$$^{2}_{C}$$^{0}_{A}$7036449000" GDBCC

Most ASCII-keyboard, control, and hexadecimal characters are legal in a send-string. Special keys ([FLAG], [CONT EXT], [BIT MASK]) are not legal. Refer to Table 32-2.

To insert a canned fox message into a transmit string, type FOX inside of double parens, as follows: ((FOX)). Remember that the double parens are special characters produced by the [CTRL]-[9] and [CTRL]-[0] combinations. Constants, counters, and flags can also be embedded in a string. See Section 32, Strings.

13. *BCC.* There are three BCC options for every SEND action in LAPD. One of the options, GDBCC, is the default. Any frame that does not request a bad BCC or an abort will have a good frame-check sequence calculated for it and appended to it. BCC also is an option for SEND actions at Layer 1; but it does not occur at Layer 3 or higher.

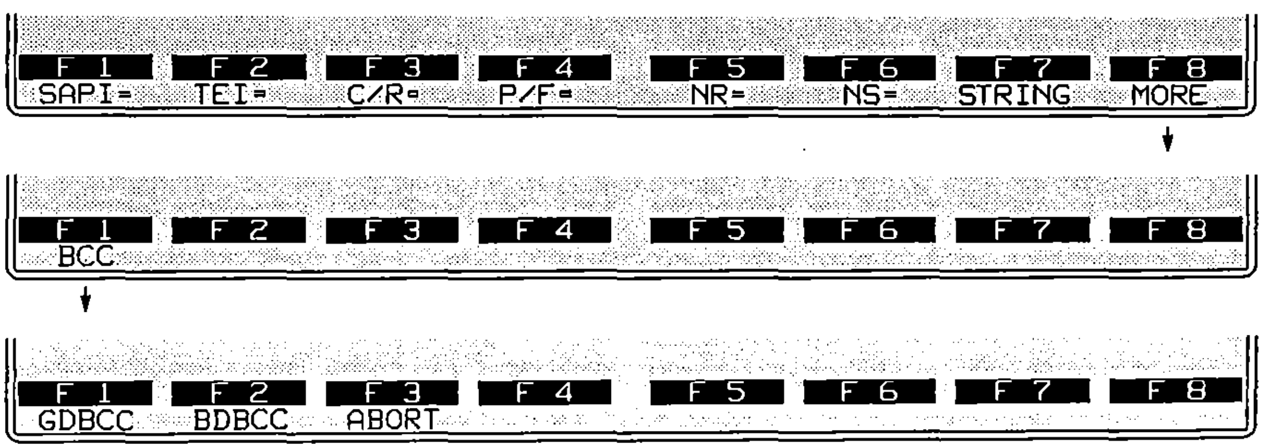


Figure 42-26 Type of BCC is a *SEND* option for frames at Layer 2.

The three softkey selections for BCC are shown in Figure 42-26. A sixteen-bit CCITT frame check is selected automatically for BOP protocols and cannot be changed or disabled. A bad BCC will be CRC-16 instead of CCITT.

When ABORT is the BCC selection, instead of appending a proper frame check the transmitter will hold the lead at mark for eight bits (or longer if the transmitter is idling $^{F}_{F}$). Inside of a frame, seven 1-bits in a row are sufficient to signal an abort.

(B) Give Data

GIVE_DATA is the F2 action on the first rack of action softkeys (refer to Figure 42-18). This action takes the I-field from a received INFO frame and passes it up to Layer 3 along with a DL_DATA IND primitive. (See Figure 33-5 in the section, OSI Primitives on the Protocol Spreadsheet.) In an emulate mode, data is delivered up to Layer 3 only by one of two actions at Layer 2: GIVE_DATA, or else a DL_DATA IND primitive followed by the data string.

(C) Resend

The RESEND function is mapped to F1 on the second layer of action softkeys. See Figure 42-27. The first RESEND action will resend the first frame in the window. The window is a queue that buffers INFO frames for retransmission in case one or more transmissions are lost or in error.

The first frame in the window always is the *earliest outstanding* (unacknowledged) frame. Every time an acknowledgment is received, the window is cleared to the extent of the acknowledgment and a new "first-frame" position is established. The first RESEND after an acknowledgment always sends the first window frame.

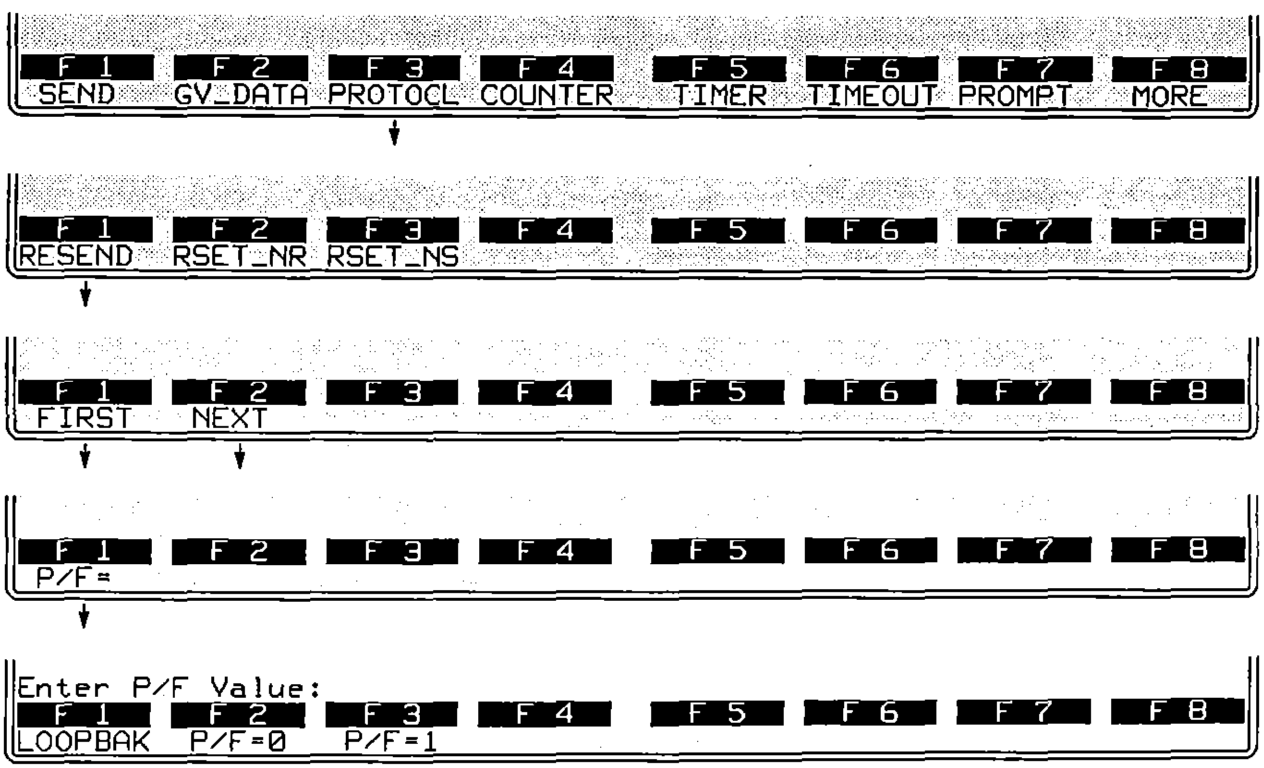


Figure 42-27 The *RESEND* action allows you to recover from sequence errors.

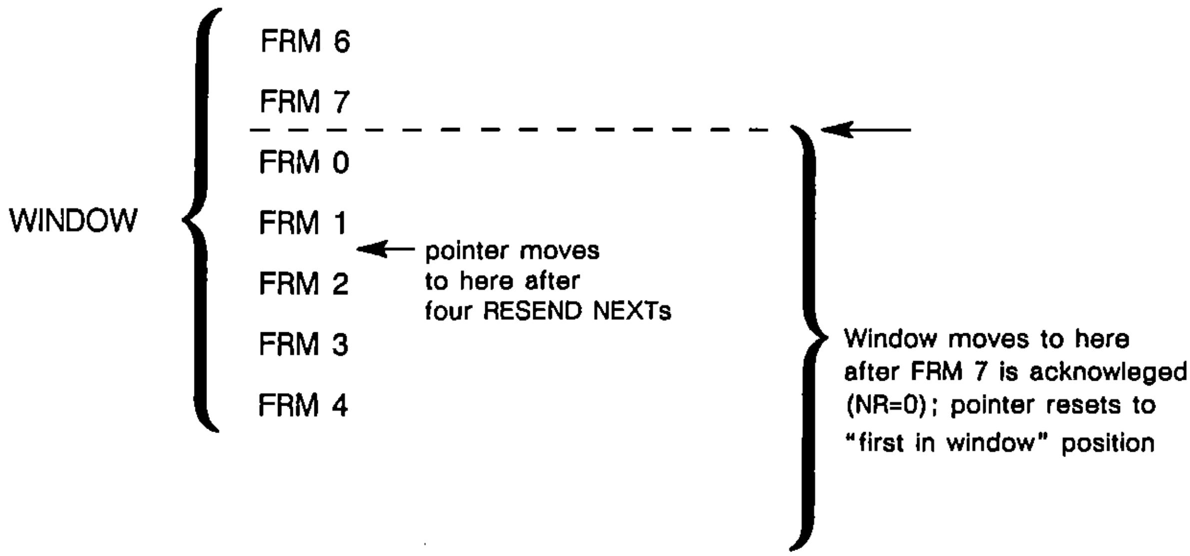


Figure 42-28 Resends cause the pointer to move, while acknowledgments move the pointer *and the entire window.*

The *second and subsequent* RESENDs following an acknowledgment also will send the first window frame, provided that the keyword FIRST is appended directly to the RESEND entry. Otherwise, they send the NEXT (second) and subsequent window frames. Figure 42-28 shows the position of the the resend "pointer" after four consecutive RESEND NEXT actions. RESEND NEXT is the default resend when neither FIRST nor NEXT is specified.

The resend-pointer is reset to the beginning of the window automatically by any acknowledgment, or by a RESEND FIRST action in the spreadsheet program.

1. *Resend first/next.* RESEND FIRST means that the resend-pointer is reset to the beginning of the window, the first frame in the window is resent, and the pointer is advanced to the second position in the window. The effect of a RESEND FIRST action is illustrated in Figure 42-29.

   The RESEND FIRST action makes it possible for you to resend all the frames in the window one by one, and then *resend them again* if necessary.

2. *P/F=loopback/0/1.* The P/F bit in the resend-frame can be set to 0 or 1 by this optional action. If PF= LOOPBACK, the bit will echo the last P/F bit received. (Default is 1 in a RESEND action.)

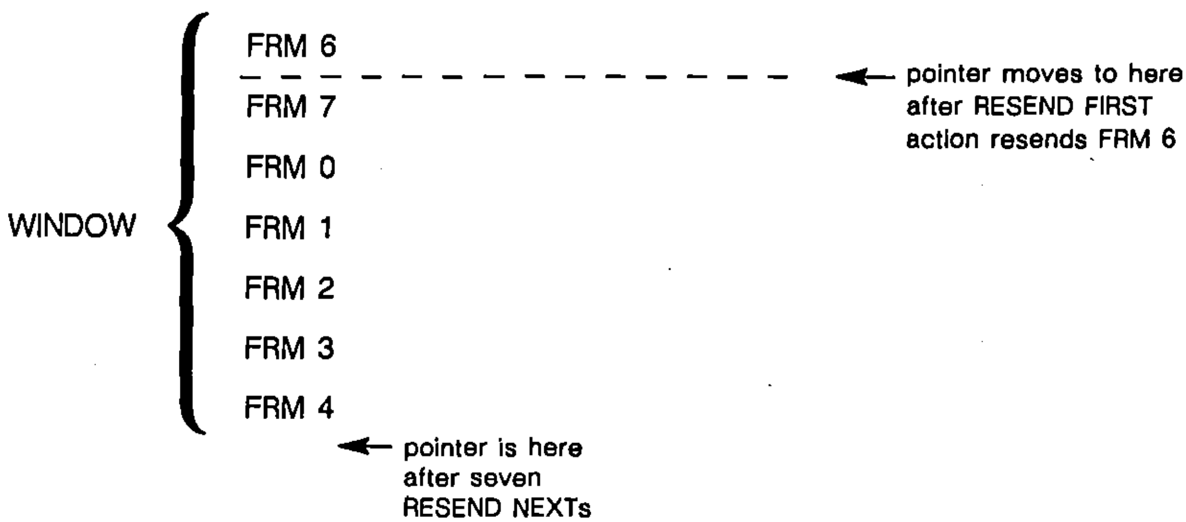


Figure 42-29 ***RESEND FIRST*** **resets the pointer, allowing you to resend the entire window** ***repeatedly*****.**

(D) Reset N(R) and Reset N(S)

RESET_NR and RESET_NS are the [F2] and [F3] actions on the second rack of action softkeys in the LAPD personality package. (Refer again to Figure 42-18.) The sequence-number fields in I-frames and supervisory frames can be reset by these two Protocol Spreadsheet actions. Sequence numbers are not reset *automatically* during a test by any frame that is sent or received.

RESET_NS also clears the transmit window.

42.6 Display Actions

ENHANCE and SUPPRESS pertain to lines of data on the Layer 2 protocol trace (see Section 42.2). They do not suppress and enhance data on the raw-data display. Raw data is enhanced and suppressed at Layer 1.

DTE, DCE, and RCV conditions can trigger an ENHANCE or SUPPRESS action.

(A) Enhance

Whenever a DTE, DCE, or RCV condition comes true at Layer 2, the frame that satisfied the condition can be enhanced on the LAPD protocol-trace display, or it can be deleted from the trace completely. In an actions block on the Protocol Spreadsheet, press the ENHANCE softkey—F2 on the third rack of action softkeys. Figure 42-30 shows the three softkey subselections beneath ENHANCE. They are REVERSE, BLINK, and LOW.

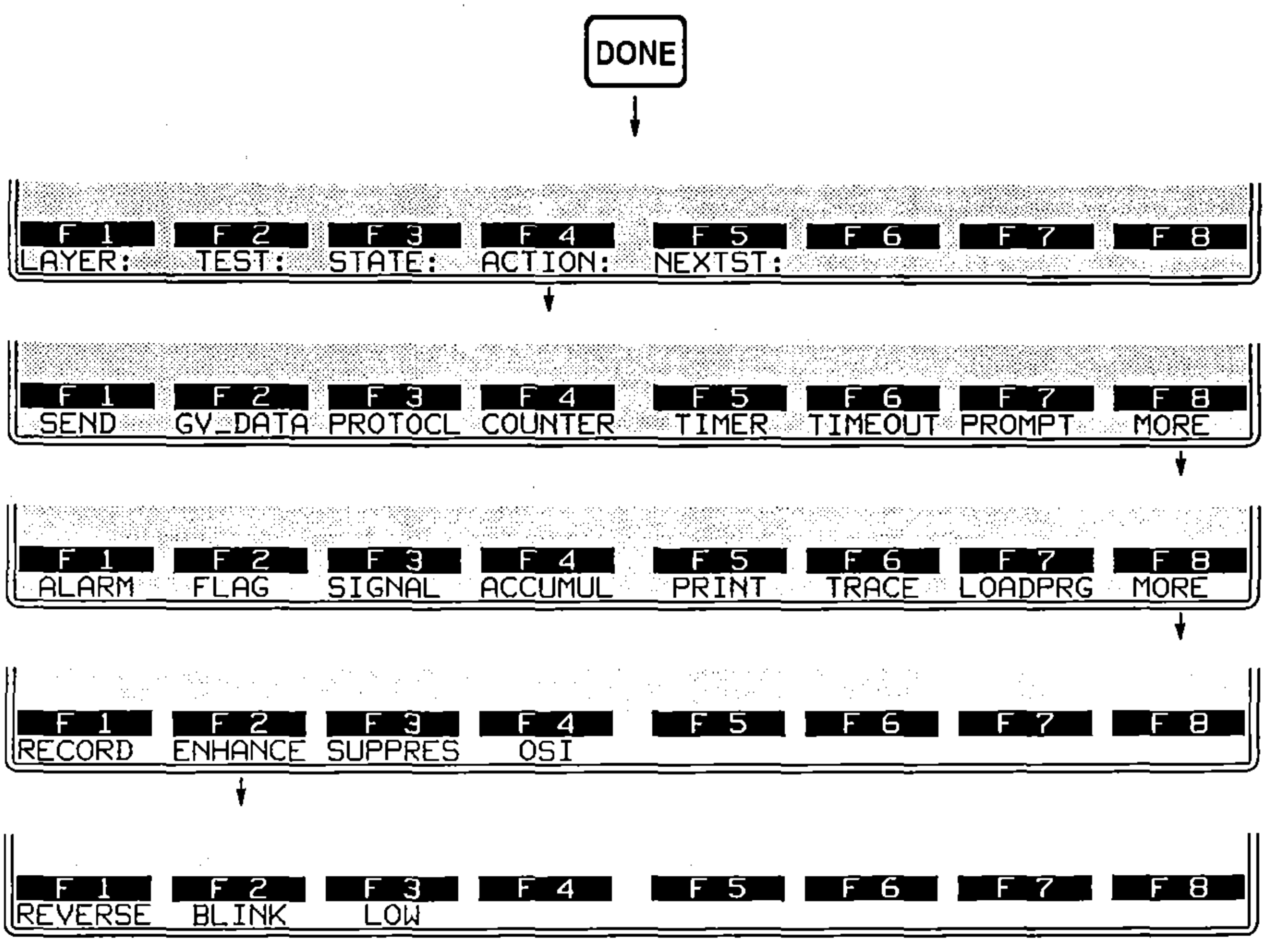


Figure 42-30 Selected frames on the protocol trace may be enhanced or suppressed.

Reverse-image and blink enhancements affect the plasma-display screen. In addition, a low-intensity enhancement can be applied to screens that are transmitted to a black-and-white monitor connected at the RS-170 port at the rear of the INTERVIEW.

Reverse, blink, and low enhancements can be mapped to colors on a color monitor attached at the INTERVIEW's RGB port (Figure 1-6). See Section 17.2 for an explanation of how reverse, blink, and low enhancements relate to character and background colors in the RGB output.

MON/DISK/FD1 BLK=00019 P 06/23/89 11:14
ASCII/8/NONE/BOP

SRC	SAPI	TEI	C/R	TYPE	Nr	Ns	P/F	SIZE	TIME	BCC
DCE	04	1A	1	DISC			0	0003	0915:08.021	G
DTE	04	1A	1	UA			0	0003	0915:08.172	G
DTE	04	1A	0	SABM			1	0003	0915:08.212	G
DCE	04	1A	0	UA			1	0003	0915:08.440	G
DTE	04	1A	0	INFO	0	0	0	0007	0915:08.482	G
DCE	04	1A	1	INFO	0	0	0	0008	0915:08.723	G
DTE	04	1A	1	RR	1		0	0003	0915:08.842	G
DCE	04	1A	0	RR	1		0	0003	0915:08.915	G
DTE	04	1A	0	INFO	1	1	0	0019	0915:08.916	G
DCE	04	1A	0	RR	2		0	0003	0915:08.959	G
DCE	04	1A	1	INFO	2	1	0	0006	0915:09.033	G
DTE	04	1A	1	RR	2		0	0003	0915:09.362	G
DCE	04	1A	1	INFO	2	2	0	0018	0915:09.505	G
DTE	04	1A	1	RR	3		0	0003	0915:09.667	G
DTE	04	1A	0	INFO	3	2	0	0006	0915:09.747	G

F 1 F 2 F 3 F 4 F 5 F 6 F 7 F 8
L2TRACE L3TRACE

Figure 42-31 A DTE SABM has been enhanced.

Figure 42-31 shows one screen of a Layer 2 protocol trace in which DTE SABM frames have been enhanced in reverse video. The trigger that caused this enhancement was as follows:

CONDITIONS: DTE SABM
ACTIONS: ENHANCE REVERSE

(B) Suppress

Individual frames that are suppressed in Layer 2 actions are deleted from the trace display. Figure 42-30 showed the softkey path to SUPPRES.

43 Q.931

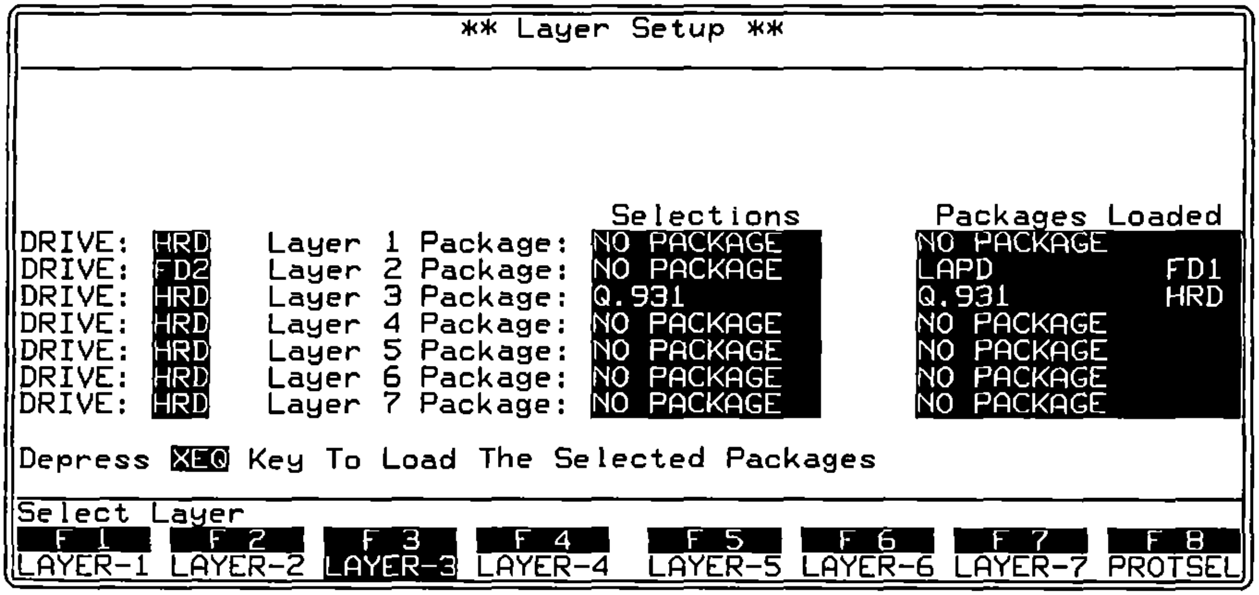


Figure 43-1 The Q.931 personality package is loaded from the Layer Setup screen at Layer 3.

43 Q.931

Q.931 is a "layer personality package" of functions that are loaded into memory from disk via the Layer Setup screen. Figure 43-1 shows the Layer Setup screen configured to load in the Q.931 package from the hard disk. Refer to Section 8 for details on operating the Layer Setup screen.

The Q.931 package consists of the following:

- A protocol trace (illustrated in Figure 43-2) that distills from Q.931 data the Level 3 events that have protocol significance. This trace is accessible by softkey in Run mode at all times.

- A group of conditions and actions at Layer 3 on the Protocol Spreadsheet that facilitate ISDN programming. Figure 43-4 shows the softkey path to the first rack of condition softkeys when the Q.931 package is loaded in at Layer 3 and a LAYER: 3 programming block has been opened on the spreadsheet.

43.1 Protocol Trace

The Q.931 package includes an automatic message–trace display that summarizes Layer 3 activity. This trace mode is enabled whenever the unit is in Run mode, both real–time and frozen.

While the unit is in Run mode, press the softkey for PROTOCL (F2 on the primary rack of display–mode softkeys) and then the softkey for L3TRACE (F2) to bring the protocol trace for Q.931 to the screen. Figure 43-2 is an example of this trace display. Each horizontal row in the trace represents a "message" as defined in CCITT Recommendation Q.931.

MON/LINE BLK=00000 S 06/29/89 17:30
ASCII/8/NONE/BOP

SRC	FLG	CALL-REF-VAL	MSG-TYPE	INFO-ELEMENT	TIME	BCC
DTE	0	01	SETUP	04 02 88 90 18 01 83 24 01 02	1645:19.237	G
DCE	0	01	SETUPACK	34 01 00 18 01 89	1645:19.314	G
DTE	0	01	INFO	2C 0A 37 30 33 36 34 34 39 30 30 30	1645:36.176	G
DCE	0	01	INFO	30 0A 37 30 33 36 34 34 39 30 30 30	1645:36.288	G
DCE	0	01	CALLPRO		1645:38.123	G
DCE	0	01	ALERT		1645:40.628	G
DCE	0	01	CONN		1645:42.689	G
DTE	0	01	SUSP	10 03 41 52 43	1713:16.271	G
DCE	0	01	SUSPACK		1713:16.281	G
DTE	0	01	SETUP	04 02 88 90 18 01 83 24 01 02	1713:18.142	G
DCE	0	01	RELCOM		1713:18.315	G
DTE	0	01	RES	10 03 41 52 43	1713:45.565	G
DCE	0	01	RESACK		1713:45.715	G
DCE	1	81	SETUP	04 02 88 90 18 01 8A	1730:44.427	G
DTE	1	81	CONN	24 01 02	1730:44.883	G

F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8
L2TRACE	L3TRACE						

Figure 43-2 Each horizontal row on the trace display represents a message.

(A) The Protocol Trace in Freeze Mode

Press [FREEZE] to prevent the addition of new data to *all* the display buffers, including the trace buffers. The frozen trace display may be scrolled through or paged through. The top line always is the cursor line (though there is no actual cursor on the trace display). Pressing [ROLL FWD] or [↓] moves the viewing "window" down relative to the data to add one line of fresher data to the bottom of the screen. Pressing [ROLL BACK] or [↑] moves the viewing window up to add a line of older data to the top of the screen.

Depression of the [NEXT PAGE] key adds fifteen lines—one full page—of newer frames to the frozen trace screen. Depression of [PREV PAGE] adds fifteen lines of older frames.

The frame displayed on the top line of frozen trace-data will appear as the first frame in the raw-data or data-plus-leads display. To view the raw data that generated a particular line in the trace display, use [ROLL FWD] or [ROLL BACK] (or [↑] or [↓]) to move the line in question to the top of the screen. Then press one of the data softkeys.

(B) Trace Columns

The columns in the protocol trace for Q.931 are explained below.

1. *Source*. The SRC column identifies the lead on which the message was monitored, TD (DTE) or RD (DCE). This column identifies the *physical* source of the message, not the *logical* source. The physical DTE uses the TD lead to transmit. The physical DCE uses RD to transmit.

   Just as on the data display, RD data is underlined.

2. *Flag*. The FLG column refers to the call-reference flag and is used to identify where the call originated. Calls originating on the user side of the link will show a flag value of 0 in every message from both the DTE and the DCE. (This is a *call*-origination flag, not a *message*-origination flag.)

   If a call originates from a remote user, every message that references that call will have a flag value of 1.

3. *Call reference value*. The number used by a message to reference a particular call is given in the CALL-REF-VAL column. This is a fifteen-column field that displays the variable-length call-reference value in from one to fifteen hexadecimal characters. This field is blank when the call-reference *length* value (see Figure 43-3) is zero.

   The flag bit (see "Flag," above) is not included in the display of the first byte of the call-reference value.

4. *Message type*. The thirty message types that are named in the MSG-TYPE column are shown in Figure 43-3. If a message type does not fit any of the patterns in the figure, it is listed in the MSG-TYPE column as UNKWN followed by the hexadecimal value of the message-type byte: UNKWN=7C.

   If the number of bytes in the message is below the required minimum, the message is posted as INVALID.

5. *Information element*. The INFO-ELEMENT field presents up to sixteen bytes of character data (decoded into hex) for all messages that contain information elements beyond the message-type field. Info elements are mandatory in some messages and optional in others.

   In the INFO-ELEMENT fields with data shown in Figure 43-2, the first byte always is an "identifier" byte, with a value that you can decode using the "Info Element 1" field diagrams on the right half of Figure 43-3. The second byte is a length byte, with a value that indicates the number of "contents" bytes that intervene before the next element-identifier.

The first info-element data in Figure 43-2, for example, begins with the hex character 04. This translates on the field diagrams in Figure 43-3 as a "Bearer Capability" info element. The next byte, 02, indicates that the remaining contents are two bytes long, followed by the end of the data or by another information element. This means that 18, "Channel ID," is the next info-element identifier in the string; and so forth.

Note in the field diagrams in Figure 43-3 that there are four types of single-byte information element.

6. *Time*. The time of the arrival of the *end of the frame containing the message* at the DTE or DCE monitor is provided by a 24-hour clock and posted to the trace display. The clock is accurate to the millisecond.

   When **Time Ticks:** ON is selected on the Front-End Buffer Setup screen (see Section 9), time values are incorporated into the data itself. As a result, times posted to the trace display will not be affected when recorded data is played back, even at varying speeds.

   If **Time Ticks:** OFF was selected instead during live recording, times on the trace during playback will be influenced by "local conditions" such as playback speed, idle suppression, etc.

7. *Frame Checking.* A BOP frame ends as soon as a 7E flag or seven 1-bits in a row are detected. If a flag ends the frame, a frame check is performed and the result is posted both to the data display and to the **BCC** column of the trace display. The symbol G denotes a good frame check, while B symbolizes a bad frame.

   A for abort is posted to the displays when a frame is ended by seven 1-bits.

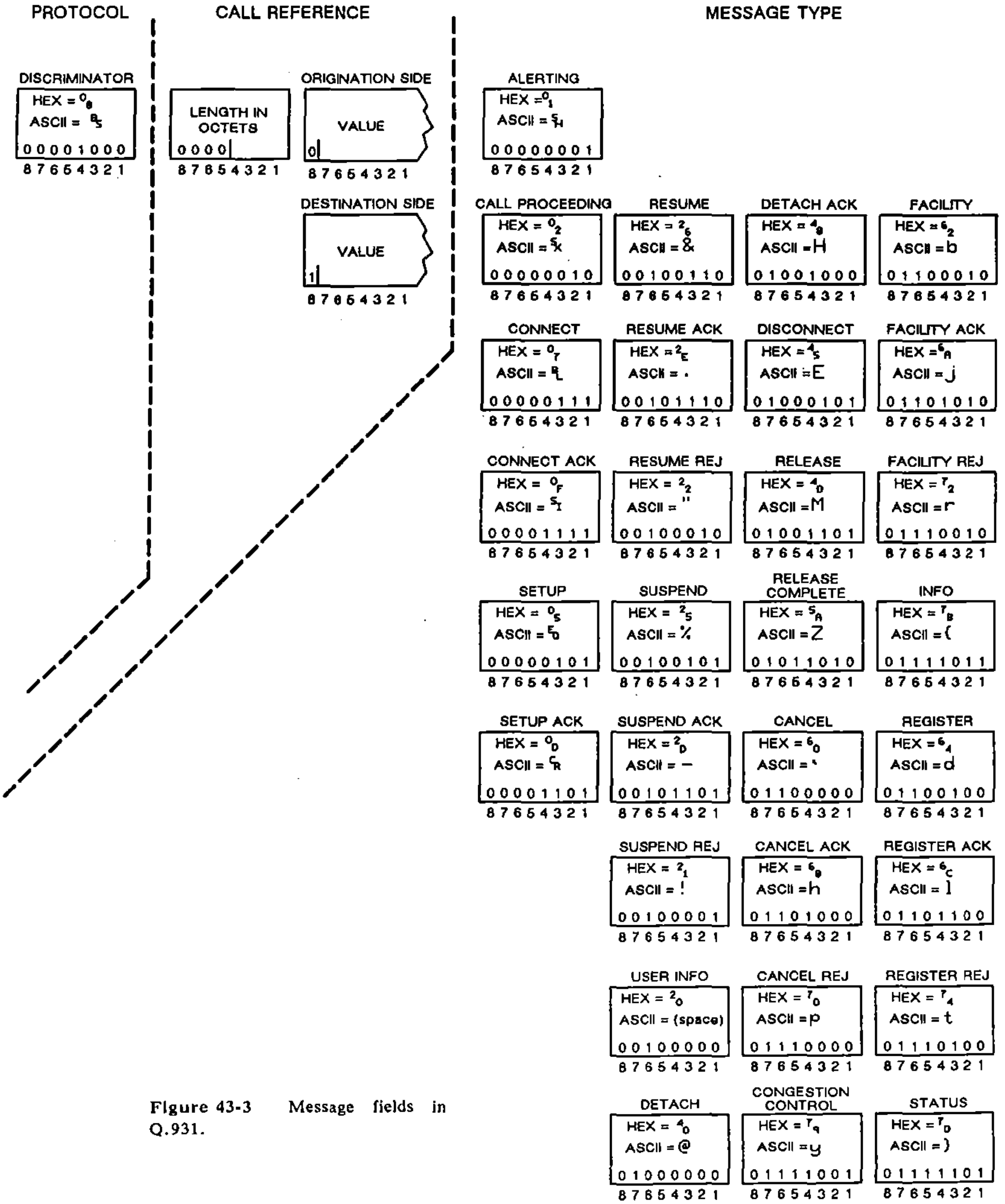


Figure 43-3 Message fields in Q.931.

INFORMATION ELEMENT 1 — INFO ELEMENT 2, etc.

Information element	Octet 0: HEX =	ASCII =	Octet 0 bits (8 7 6 5 4 3 2 1)	Octet 1 (8 7 6 5 4 3 2 1)
BEARER CAPABILITY	04	E_T	0 0 0 0 0 1 0 0	LENGTH IN OCTETS
CAUSE	08	B_S	0 0 0 0 1 0 0 0	LENGTH IN OCTETS
CONNECTED ADDRESS	0C	F_F	0 0 0 0 1 1 0 0	LENGTH IN OCTETS
CALL IDENTITY	10	D_L	0 0 0 1 0 0 0 0	LENGTH IN OCTETS
CALL STATE	14	D_4	0 0 0 1 0 1 0 0	LENGTH IN OCTETS
CHANNEL ID	18	C_N	0 0 0 1 1 0 0 0	LENGTH IN OCTETS
CCITT-STANDARDIZED FACILITIES	1C	F_S	0 0 0 1 1 1 0 0	LENGTH IN OCTETS
NETWORK-SPECIFIC FACILITIES	20	(space)	0 0 1 0 0 0 0 0	LENGTH IN OCTETS
TERMINAL CAPABILITIES	24	$	0 0 1 0 0 1 0 0	LENGTH IN OCTETS
DISPLAY	28	(	0 0 1 0 1 0 0 0	LENGTH IN OCTETS
KEYPAD	2C	,	0 0 1 0 1 1 0 0	LENGTH IN OCTETS
KEYPAD ECHO	30	Ø	0 0 1 1 0 0 0 0	LENGTH IN OCTETS
SIGNAL	34	4	0 0 1 1 0 1 0 0	LENGTH IN OCTETS
SWITCHHOOK	36	6	0 0 1 1 0 1 1 0	LENGTH IN OCTETS
ORIGINATION ADDRESS	6C	l	0 1 1 0 1 1 0 0	LENGTH IN OCTETS
DESTINATION ADDRESS	70	p	0 1 1 1 0 0 0 0	LENGTH IN OCTETS
REDIRECTING ADDRESS	74	t	0 1 1 1 1 0 0 0	LENGTH IN OCTETS
TRANSIT NETWORK SELECTION	7[illegible]	x	0 1 1 1 1 0 0 0	LENGTH IN OCTETS
LOW LAYER COMPATIBILITY	7C	¦	0 1 1 1 1 1 0 0	LENGTH IN OCTETS
HIGH LAYER COMPATIBILITY	7D	}	0 1 1 1 1 1 0 1	LENGTH IN OCTETS
USER-USER INFO	7E	~	0 1 1 1 1 1 1 0	LENGTH IN OCTETS
RESERVED (ESCAPE)	7F	▨	0 1 1 1 1 1 1 1	LENGTH IN OCTETS

Single-octet element	HEX =	ASCII =	Bits (8 7 6 5 4 3 2 1)
RESERVED			1 0 0 0
SHIFT			1 0 0 1
MORE DATA	A0	(space)	1 0 1 0 0 0 0 0
CONGESTION LEVEL			1 0 1 1

43.2 Monitor Conditions

When the Q.931 personality package is loaded in (via the Layer Setup screen), a set of conditions checks DTE and DCE leads both in monitor and emulate modes. This set of conditions is accessed by the DTE and DCE selections on the first rack of condition softkeys at Layer 3. See Figure 43-4.

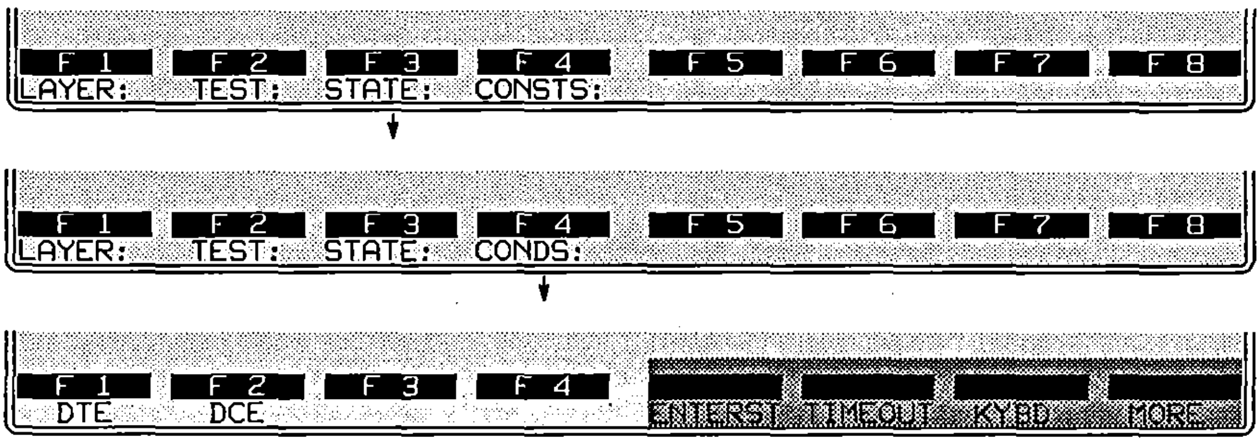


Figure 43-4 **The softkeys for *DTE* and *DCE* are used to monitor ISDN protocol events once *Layer: 3* has been entered on the Protocol Spreadsheet.**

After the keyword DTE (or DCE) is written to the spreadsheet, a rack of softkeys appears that represent *types* of message: ALERT, CONN, STATUS, and so forth.

(A) Message Types

The softkeys for the thirty standard as well as "other" message types are illustrated in Figure 43-5. Press a softkey to write one of these message types to the Layer 3 spreadsheet. DTE or DCE followed by a message-type mnemonic—DTE SUSP, for example, or DCE REL—is a complete condition and will come true if a matching message-type is monitored. Call-reference, origination-link, and destination-link conditions may be added to the simple message-type mnemonic, but they are optional.

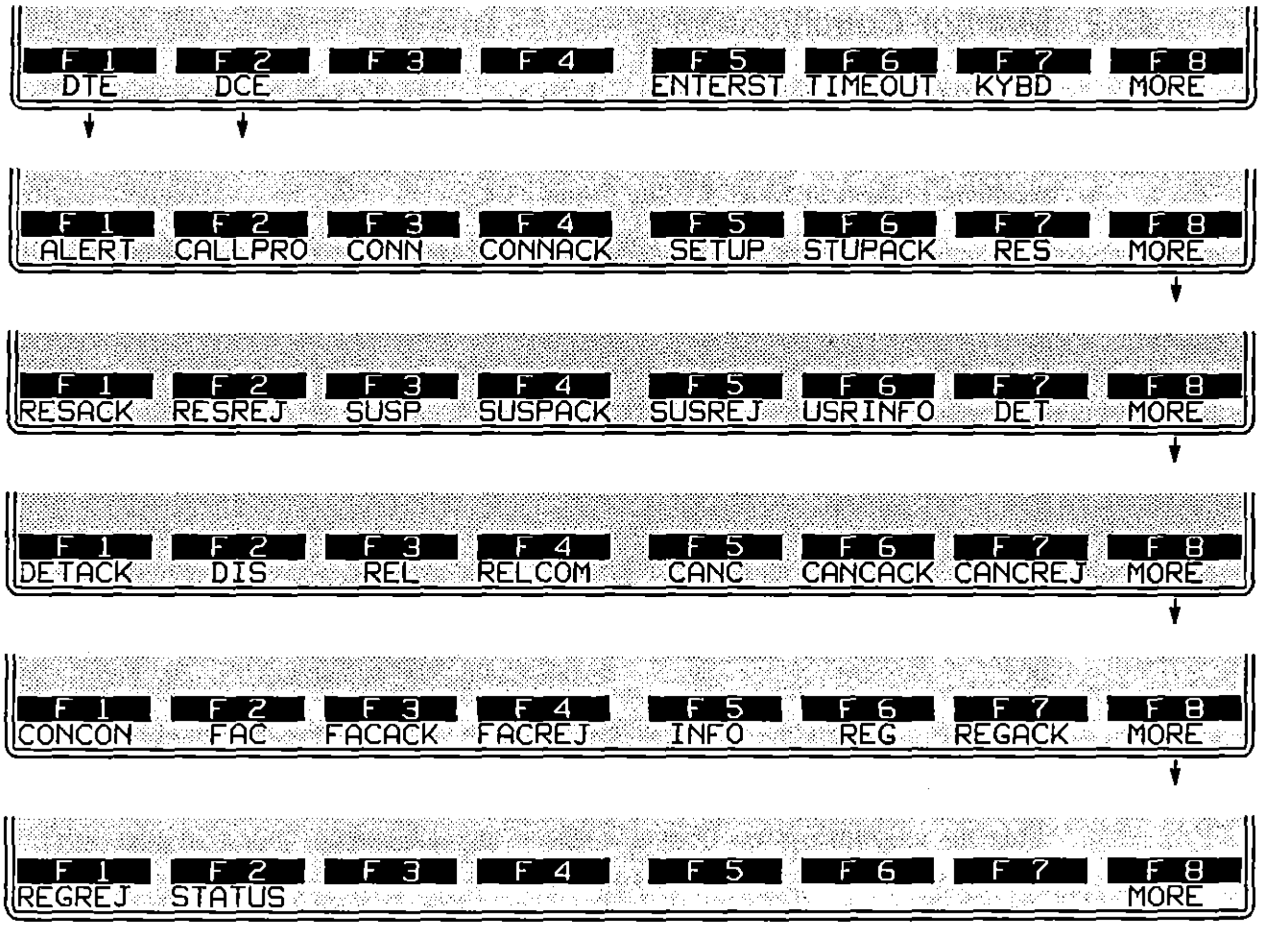


Figure 43-5 Message types.

(B) Call Reference Value

A specific call-reference value may be added as a condition to any of the message type conditions. Once you have pressed the softkey for a particular message type (or once you have touch-typed the message type followed by a space), the rack of softkeys shown in Figure 43-6 will appear.

Press the softkey for C_REF=, shown in Figure 43-6. Then enter the call-reference value as a sequence of hex digits inside of quotation marks. The sequence may be from one to twelve semi-octets long. Type each digit as an alphanumeric in the range *0–9* and *A–F* (or *a–f*), *without using the* HEX *key.* The call reference 7F with flag-bit 0, for example, appears as follows:

CONDITIONS: DTE SETUP C_REF= "7F"

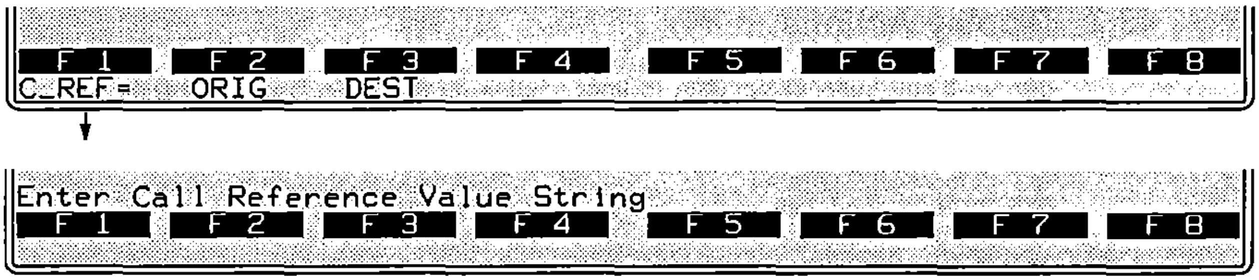


Figure 43-6 Call-reference, origination-link, and destination-link conditions may be added to a message-type condition.

Include the origination/destination-*flag* bit in your string. If the DCE, for example, gives call reference #4 to a call that originated at a remote link, the entry C_REF= "84" (with flag = 1) will detect this call reference, while the string "04" (flag = 0) will not detect it.

(C) Origination/Destination Link

A message-type condition may be set to come true only with respect to calls that originated *locally* (or *remotely*).

To make a message-type condition specific to calls that originated with a user on the link that is being monitored by the INTERVIEW, press the softkey for ORIG (F2 on the rack of softkeys in Figure 43-6). Only messages that have zero as the call-reference flag bit will satisfy this condition.

This condition, for example, looks for a Facility-type message that references a call that originated locally:

CONDITIONS: DTE FAC ORIG

Or a message-type condition may require remote origination of a call. In that case, the link being monitored is the "destination" of the call, and you will press the softkey for DEST, F3 on the rack of softkeys in Figure 43-6. Only messages that have 1 as the call-reference flag bit will satisfy this condition.

43.3 Display Actions

ENHANCE and SUPPRESS pertain to lines of data on the Layer 3 protocol trace (see Section 43.1). They do not suppress and enhance data on the raw-data display. Raw data is enhanced and suppressed at Layer 1.

DTE and DCE conditions can trigger an ENHANCE or SUPPRESS action.

(A) Enhance

Whenever a DTE or DCE condition comes true at Layer 3, the message that satisfied the condition can be enhanced on the Q.931 protocol-trace display, or it can be deleted from the trace completely. In an actions block on the Protocol Spreadsheet, press the ENHANCE softkey—F1 on the first rack of action softkeys. Figure 43-7 shows the three softkey subselections beneath ENHANCE. They are REVERSE, BLINK, and LOW.

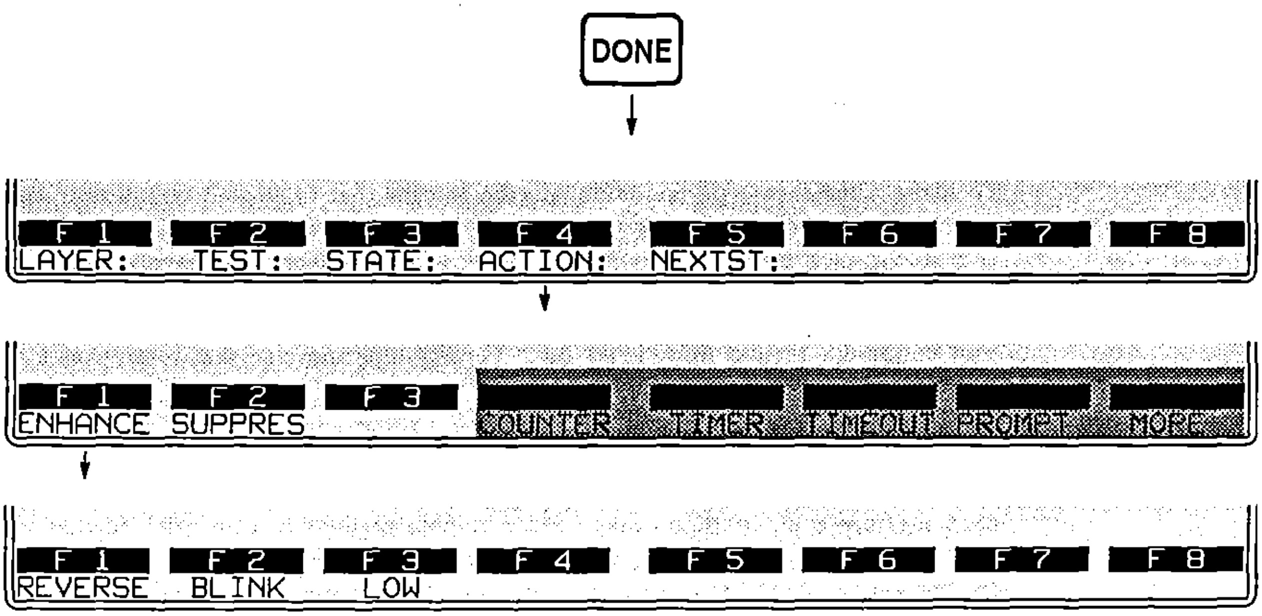


Figure 43-7 Selected messages on the protocol trace may be enhanced or suppressed.

Reverse-image and blink enhancements affect the plasma-display screen. In addition, a low-intensity enhancement can be applied to screens that are transmitted to a black-and-white monitor connected at the RS-170 port at the rear of the INTERVIEW.

Reverse, blink, and low enhancements can be mapped to colors on a color monitor attached at the INTERVIEW's RGB port (Figure 1-6). See Section 17.2 for an explanation of how reverse, blink, and low enhancements relate to character and background colors in the RGB output.

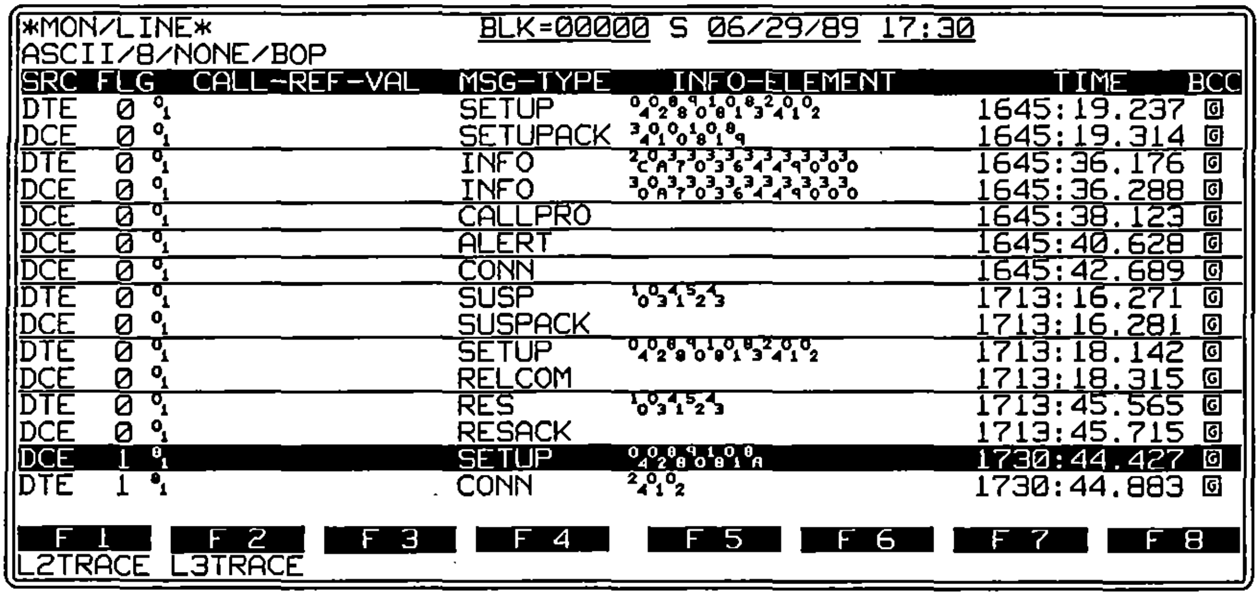


Figure 43-8 A DCE SETUP has been enhanced.

Figure 43-8 shows one screen of a Layer 3 protocol trace in which DCE SETUP messages have been enhanced in reverse video. The trigger that caused this enhancement was as follows:

```
CONDITIONS: DCE SETUP
ACTIONS: ENHANCE REVERSE
```

(B) Suppress

Individual message-types that are suppressed in Layer 3 actions are deleted from the trace display. Here is an example of an action that suppresses all DTE Information messages:

```
CONDITIONS: DTE INFO
ACTIONS: SUPPRESS
```

44 SS#7 Layer 1

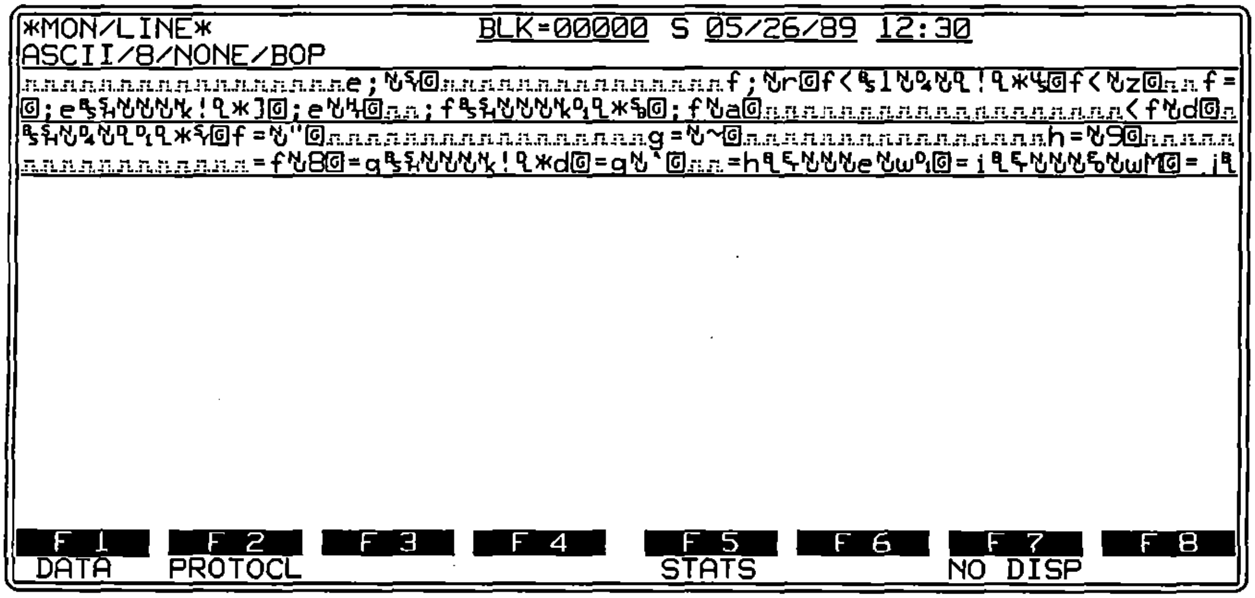


Figure 44-1 SS#7 Dual-line data display, with 7E flags suppressed and redundant LSU's and Fill-In's compressed.

44 SS#7 Layer 1

SS#7 (CCSS#7) is an abbreviation for the CCITT-defined Common Channel Signalling System #7. The INTERVIEW 7000 Series provides modifiable data display at Layer 1, a special display for Layer 2 (link) protocol and Layer 3 (network management) protocol. Automatic selections for SS#7 protocol appear at Layers 2 and 3 of the Protocol Spreadsheet when the correct protocol packages are loaded.

44.1 SS#7 Run-Time Displays

(A) Data Display

Figure 44-1 shows SS#7 data being monitored as dual-line data. 7E flags have been suppressed on the Line Setup screen and Fill-In's and LSU's have been compressed. As with all dual-line displays, TD and RD data appear on alternate lines, and RD data is always underlined. Time fill characters maintain the timing relationships between RD and TD characters, accurate to within one character on the display.

(B) SS#7 Layer Traces

An SS#7 Layer 2 trace is available when SS#7 protocol is loaded at Layer 2. A Layer 3 trace is available when SS#7 is loaded at Layer 3. If you select PROTOCOL and **Layer:** 2 or 3 as the display, this trace will be active when you press RUN. Refer to Sections 45 and 46 for more information on and examples of these traces.

44.2 Setup for SS#7

Three steps are involved in setting up for SS#7 protocol. First, load the protocol from the Layer Setup screen as described in Section 8. Then select the correct **Mode** and data **Format** on the Line Setup menu, and, finally, select the options you prefer on the Display Setup menu.

(A) Layer Setup

SS#7 packages are available at Layers 1, 2, and 3. The Layer 1 package provides data compression and is described at the end of this section. Options available with the Layer 2 and the Layer 3 packages are discussed in Sections 45 and 46, respectively.

(B) Line Setup

The **Format** selection on the Line Setup menu should be BOP (Bit-Oriented Protocol) when SS#7 is analyzed. This and other Line Setup selections are described in Section 5.

(C) Display Setup

Select initial display options on the Display Setup menu. All available display modes are applicable to SS#7 data. Protocol displays specific to SS#7, which appear only when an SS#7 Personality Package has been loaded, are described in Sections 45 and 46. Data, Display Window, and Program Trace displays are described in Section 6.

You have the option of suppressing 7E flags on the Display Setup menu. See Section 6.3(C).

Data suppressed from the display is available for triggering in real-time. However, it is not available for triggering when character-oriented data from the screen buffer is played back.

It is also possible to suppress all occurrences of a particular type of frame from the display. Refer to the description of the SUPPRESS action in Section 45.

44.3 SS#7 Compression at Layer 1

When the Layer 1 package SS7_CMPRESN is loaded, redundant Fill-In and Link Status Signal Units are suppressed from the character display and also the Layer 2 trace display in Run mode. That is, only the first in a series of identical Link Status or Fill-In Signal Units is displayed and presented to the trigger program. Subsequent identical units are compressed, until a different type of signal unit is transmitted on the same side of the line. Compare Figure 44-2 to Figure 44-3 (in which Fill-In's and LSU's have been compressed).

> NOTE: The number of suppressed signal units and flags can be monitored via four C variables. Refer to Table 82-1.

Bit-image recording of data is not affected by Layer 1 suppression. Simply select and load NO_PACKAGE at Layer 1 and play the same bit-image data back again, to cancel the effects of suppression. All the original Link Status and Fill-In Signal Units will be presented to the screen display and the triggers.

MON/LINE BLK=00000 S 05/26/89 12:04
ASCII/8/NONE/BOP

SRC	TYPE	LI	BIB	BSN	FIB	FSN	TIME	BCC
DTE	FILL-IN	00	1	4D	1	3F	1204:31.257	G
DCE	FILL-IN	00	1	3F	1	4D	1204:31.280	G
DTE	FILL-IN	00	1	4D	1	3F	1204:31.303	G
DCE	FILL-IN	00	1	3F	1	4D	1204:31.327	G
DTE	FILL-IN	00	1	4D	1	3F	1204:31.346	G
DCE	FILL-IN	00	1	3F	1	4D	1204:31.375	G
DTE	FILL-IN	00	1	4D	1	3F	1204:31.395	G
DCE	FILL-IN	00	1	3F	1	4D	1204:31.423	G
DTE	FILL-IN	00	1	4D	1	3F	1204:31.441	G
DCE	FILL-IN	00	1	3F	1	4D	1204:31.461	G
DTE	FILL-IN	00	1	4D	1	3F	1204:31.515	G
DCE	FILL-IN	00	1	3F	1	4D	1204:31.546	G
DTE	FILL-IN	00	1	4D	1	3F	1204:31.577	G
DCE	MESSAGE	08	1	3F	1	4E	1204:31.598	G
DTE	FILL-IN	00	1	4D	1	3F	1204:32.019	G

F 1 F 2 F 3 F 4 F 5 F 6 F 7 F 8
L2TRACE L3TRACE

Figure 44-2 All LSU's and Fill-In's detected are displayed on this screen.

MON/LINE BLK=00000 S 05/26/89 12:04
ASCII/8/NONE/BOP

SRC	TYPE	LI	BIB	BSN	FIB	FSN	TIME	BCC
DTE	FILL-IN	00	1	4D	1	3F	1204:31.222	G
DCE	FILL-IN	00	1	3F	1	4D	1204:31.576	G
DCE	MESSAGE	08	1	3F	1	4E	1204:31.593	G
DCE	FILL-IN	00	1	3F	1	4E	1204:32.021	G
DTE	FILL-IN	00	1	4E	1	3F	1204:32.048	G
DTE	MESSAGE	08	1	4E	1	40	1204:32.069	G
DCE	FILL-IN	00	1	40	1	4E	1204:32.080	G
DTE	FILL-IN	00	1	4E	1	40	1204:32.115	G
DTE	MESSAGE	08	1	4E	1	41	1204:32.130	G
DCE	FILL-IN	00	1	41	1	4E	1204:32.154	G
DTE	FILL-IN	00	1	4E	1	41	1204:32.177	G
DCE	MESSAGE	08	1	41	1	4F	1204:32.195	G
DCE	FILL-IN	00	1	41	1	4F	1204:32.208	G
DTE	FILL-IN	00	1	4F	1	41	1204:32.237	G
DCE	MESSAGE	08	1	41	1	50	1204:32.271	G

F 1 F 2 F 3 F 4 F 5 F 6 F 7 F 8
L2TRACE L3TRACE

Figure 44-3 Redundant LSU's and Fill-In's have been compressed in this data.

45 SS#7 Layer 2

```
                         ** Layer Setup **


                                        Selections          Packages Loaded
DRIVE: HRD    Layer 1 Package: SS7_CMPRESN         SS7_CMPRESN    HRD
DRIVE: HRD    Layer 2 Package: SS7                 SS7            HRD
DRIVE: HRD    Layer 3 Package: SS7                 SS7            HRD
DRIVE: HRD    Layer 4 Package: NO PACKAGE          NO PACKAGE
DRIVE: HRD    Layer 5 Package: NO PACKAGE          NO PACKAGE
DRIVE: HRD    Layer 6 Package: NO PACKAGE          NO PACKAGE
DRIVE: HRD    Layer 7 Package: NO PACKAGE          NO PACKAGE
Depress XEQ Key To Load The Selected Packages
Select Layer
  F 1      F 2      F 3      F 4      F 5      F 6      F 7      F 8
LAYER-1  LAYER-2  LAYER-3  LAYER-4  LAYER-5  LAYER-6  LAYER-7  PROTSEL
```

Figure 45-1 The SS#7 personality package for Layer 2 is loaded from the Layer Setup screen.

45 SS#7 Layer 2

SS#7 (CCSS#7) is an abbreviation for the CCITT-defined Common Channel Signalling System #7. At Layer 2, SS#7 is a "layer personality package" of functions that are loaded into memory from disk via the Layer Setup screen. Figure 45-1 shows the Layer Setup screen configured to load in the Layer 2 SS#7 package from the hard disk. Refer to Section 8 for details on operating the Layer Setup screen.

45.1 Set Up for SS#7

(A) Layer Setup

The SS#7 package at Layer 1 allows you to compress redundant frames, as explained in Section 44.

The Layer 2 SS#7 package consists of the following:

- A protocol trace (illustrated in Figure 45-2) that distills from SS#7 data the Level 2 events that have protocol significance. This trace is accessible by softkey in Run mode at all times.
- A group of conditions and actions at Layer 2 on the Protocol Spreadsheet that facilitate SS#7 programming. Figure 45-4 shows the softkey path to the first rack of condition softkeys when the SS#7 package is loaded in at Layer 2.

(B) Line and Display Setup

Be sure that the **Format** selection is BOP (for Bit-Oriented Protocol) when you are testing SS#7. Select display options on the Display Setup menu. These options are discussed in Section 44.2.

45.2 Protocol Trace

The Layer 2 SS#7 package includes an automatic frame-trace display that summarizes link-level activity. This trace mode is enabled whenever the unit is in Run mode, both real-time and frozen.

While the unit is in Run mode, press the softkey for L2TRACE to bring the protocol trace for SS#7 Layer 2 to the screen. (If the SS#7 package for Layer 3 is also loaded in, the L2TRACE softkey will appear after you have pressed PROTOCL, F2 on the primary rack of display-mode softkeys.)

Figure 45-2 is an example of the Layer 2 trace display. Each horizontal row in the trace represents a frame.

MON/LINE BLK=00000 S 05/26/89 12:30
ASCII/8/NONE/BOP

SRC	TYPE	LI	BIB	BSN	FIB	FSN	TIME	BCC
DCE	MESSAGE	08	1	3B	1	66	1229:59.160	G
DCE	FILL-IN	00	1	3B	1	66	1229:59.203	G
DTE	FILL-IN	00	1	66	1	3B	1229:59.242	G
DTE	MESSAGE	08	1	66	1	3C	1229:59.278	G
DTE	FILL-IN	00	1	66	1	3C	1229:59.306	G
DCE	FILL-IN	00	1	3C	1	66	1229:59.352	G
DTE	MESSAGE	08	1	66	1	3D	1229:59.371	G
DTE	FILL-IN	00	1	66	1	3D	1229:59.421	G
DCE	FILL-IN	00	1	3D	1	66	1229:59.441	G
DCE	MESSAGE	08	1	3D	1	67	1229:59.470	G
DCE	FILL-IN	00	1	3D	1	67	1229:59.506	G
DTE	FILL-IN	00	1	67	1	3D	1229:59.521	G
DCE	MESSAGE	07	1	3D	1	68	1229:59.559	G
DTE	FILL-IN	00	1	68	1	3D	1229:59.588	G
DCE	MESSAGE	07	1	3D	1	69	1230:50.007	G

F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8
L2TRACE	L3TRACE						

Figure 45-2 SS#7 Layer 2 Protocol Trace.

(A) The Protocol Trace in Freeze Mode

Press [FREEZE] to prevent the addition of new data to *all* the display buffers, including the trace buffers. The frozen trace display may be scrolled through or paged through. The top line always is the cursor line (though there is no actual cursor on the trace display). Pressing [ROLL FWD] or [↓] moves the viewing "window" down relative to the data to add one line of fresher data to the bottom of the screen. Pressing [ROLL BACK] or [↑] moves the viewing window up to add a line of older data to the top of the screen.

Depression of the [NEXT PAGE] key adds fifteen lines—one full page—of newer frames to the frozen trace screen. Depression of [PREV PAGE] adds fifteen lines of older frames.

The frame displayed on the top line of frozen trace-data will appear as the first frame in the raw-data or data-plus-leads display. Compare Figure 45-2 with Figure 45-3. To view the raw data that generated a particular line in the trace display, use [ROLL FWD] or [ROLL BACK] (or [↑] or [↓]) to move the line in question to the top of the screen. Then press one of the data softkeys. Figure 45-3 shows part of a dual-line data screen in Freeze mode. The first frame in the display is the same one that is traced at the top of Figure 45-2.

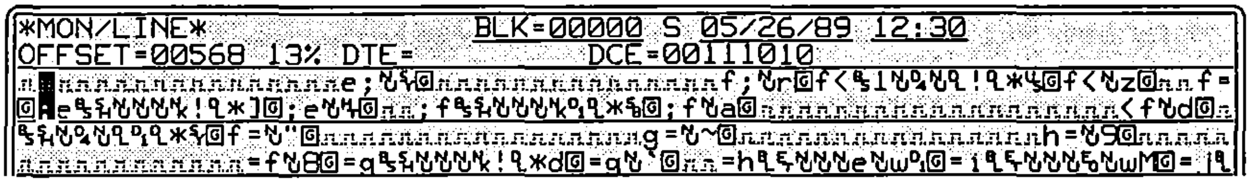


Figure 45-3 Data-display of Protocol Trace shown in Figure 45-2.

(B) Trace Columns

The columns in the protocol trace for Layer 2 *SS#7* are explained below.

1. *Source.* The SRC column identifies the lead on which the signal unit was monitored, TD (DTE) or RD (DCE). Just as on the data-display, RD data is underlined.

2. *Type.* The second column, TYPE, lists the signal-unit type (STATUS= for a Link Status Signal Unit, FILL_IN for a Fill-In Signal Unit, or MESSAGE for a Message Signal Unit). For a Link Status Signal Unit, the status type is also given as an abbreviation.

   The format for Fill-In and Link Status Signal Units are shown at the end of this section, in Figure 45-10 and Figure 45-11. Abbreviations and values for Link Status Signal Units (LSU) types are defined in Table 45-1.

Table 45-1
LSU Status Field
(Bits 2-0 of first Status Field Octet)

Acronym	Definition	Binary Value
O	Out of Align	000
N	Normal	001
E	Emergency	010
OS	Out of Service	011
PO	Processor Outage	100
B	Busy	101

Note: Bits 7-3 of the First Status Field Octet (SFO) are spare.

A second Status Field Octet may be present.

3. *Length indicator.* The value of the Length Indicator byte (LI) is given in the third column of the display. A value of 00 here indicates a Fill-In Signal Unit, a value of 01 or 02 indicates a Link Status Signal Unit, and a hex value of 03-3F indicates a Message Signal Unit (MSU).

4. *Backward indicator bit.* The fourth column, labeled BIB, provides the value of the Backward Indicator Bit.

5. *Backward sequence number.* The hex value of the Backward Sequence Number (BSN) is listed in the next column.

6. *Forward indicator bit.* The FIB column provides the Forward Indicator Bit.

7. *Forward sequence number.* The Forward Sequence Number (FSN) is displayed in hex in the next column.

8. *Time.* The time of the arrival of the *end of the frame* at the DTE or DCE monitor is provided by a 24-hour clock and posted to the trace display. The clock is accurate to the millisecond.

   When Time Ticks: ON is selected on the Front-End Buffer Setup screen (see Section 9), time values are incorporated into the data itself. As a result, times posted to the trace display will not be affected when recorded data is played back, even at varying speeds.

   If Time Ticks: OFF was selected instead during live recording, times on the trace during playback will be influenced by "local conditions" such as playback speed, idle suppression, etc.

9. *Frame checking.* An SS#7 frame ends as soon as a ^F_E flag or seven 1-bits in a row are detected. If a flag ends the frame, a frame check is performed and the result is posted both to the data display and to the BCC column of the trace display. The symbol G denotes a good frame check, while B symbolizes a bad frame.

   A for abort is posted to the displays when a frame is ended by seven 1-bits.

45.3 Monitor Conditions

When the Layer 2 SS#7 personality package is loaded in (via the Layer Setup screen), a set of conditions checks DTE and DCE leads both in monitor and emulate modes. This set of conditions is accessed by the DTE and DCE selections on the first rack of condition softkeys at Layer 2. See Figure 45-4.

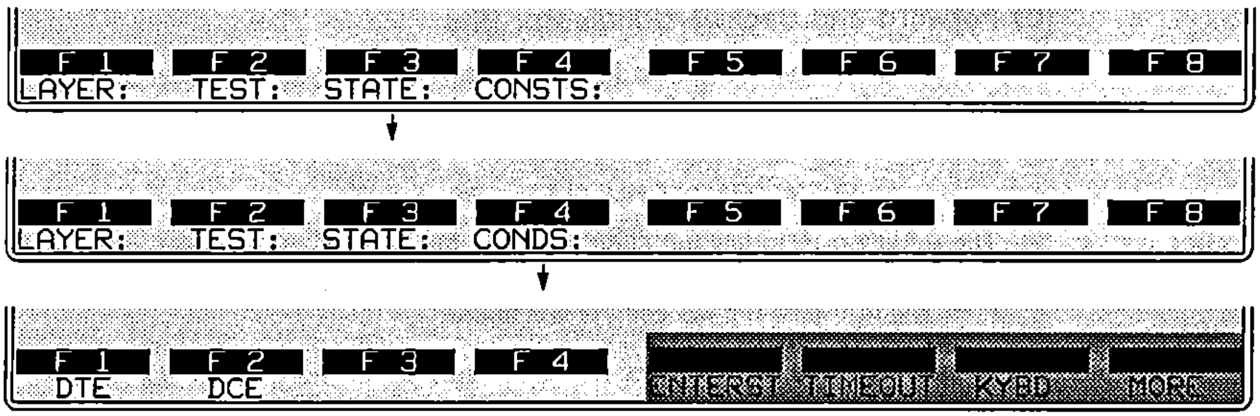


Figure 45-4 To monitor line conditions, first select *DTE* or *DCE*.

(A) Signal-Unit Types

After the keyword DTE (or DCE) is written to the spreadsheet, a rack of softkeys appears that represents *types* of Signal Units.

1. *Fill-In and Message*. The softkeys for FILL_IN (Fill-In Status Unit), MESSAGE (Message Signal Unit), and STATUS= (Link Status Signal Unit) are illustrated in Figure 45-5. Press a softkey to write one of these signal-unit types to the Layer 2 spreadsheet.

   DTE (or DCE) FILL_IN and DCE (or DTE) MESSAGE are complete conditions and will come true if a matching frame is monitored. BIB, FIB, and BCC conditions may be added to the simple frame mnemonic, but they are optional.

2. *Link Status*. DTE (or DCE) STATUS= is not a complete condition. Select an LSU type from the third softkey rack shown in Figure 45-5. The full set of abbreviations and their meanings is given in Table 45-1.

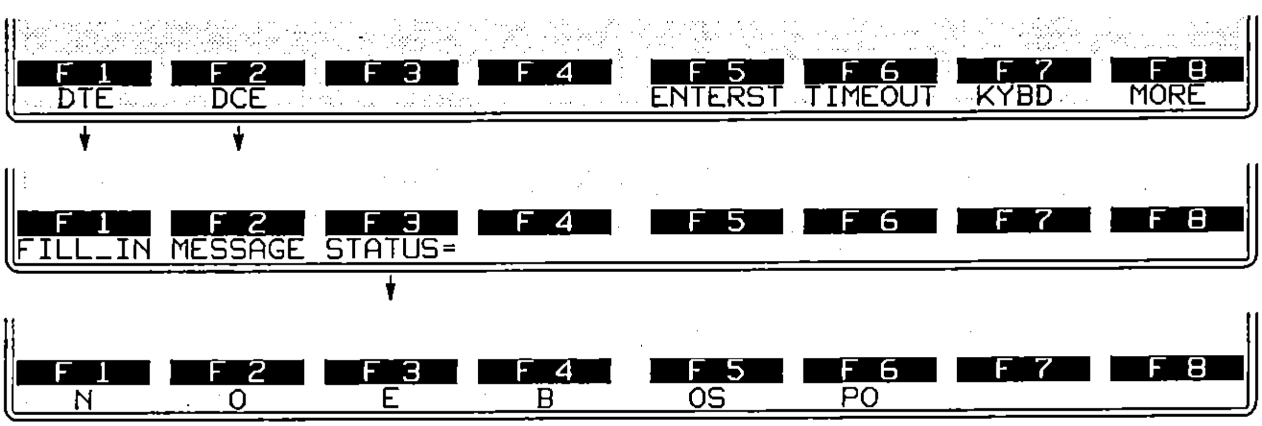


Figure 45-5 Frame types.

(B) Forward and Backward Indicator Bits

For any SS#7 frame type, you have the option of specifying the value of the Backward Indicator Bit (BIB= 0, BIB= 1) and the value of the Forward Indicator Bit (FIB= 0, FIB= 1):

CONDITIONS: DTE FILL_IN BIB= 1 FIB= 1

The softkey path to BIB and FIB is shown in Figure 45-6. If you omit either the FIB or the BIB field, the omitted FIB or BIB is not checked in the received frame. Press DONE to bypass the BIB and FIB conditions.

To make BIB and FIB selections for Link Status Signal Units, follow the softkey path shown in Figure 45-7.

(C) BCC Conditions

For any SS#7 frame type, you also have the option of specifying a BCC or abort condition:

CONDITIONS: DTE MESSAGE BD_BCC

The softkey path to BCC selections for Fill-In and Message Signal Units is shown in Figure 45-6. Press DONE to bypass the BCC condition.

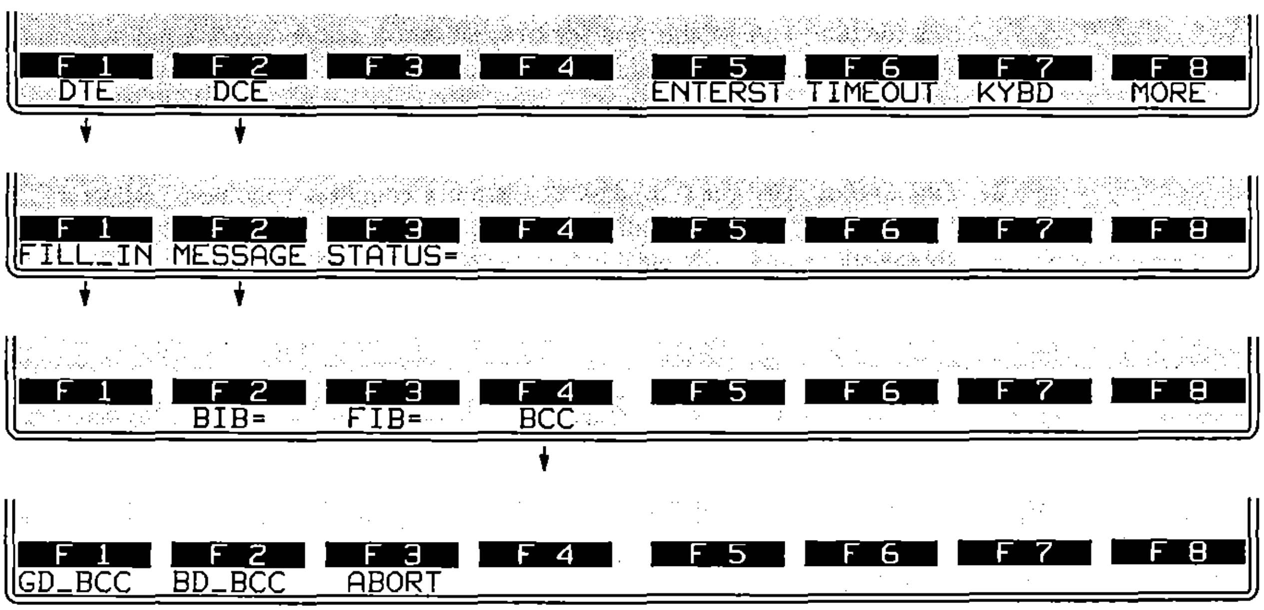


Figure 45-6 You may specify *BIB*, *FIB*, or *BCC* conditions immediately following *FILL_IN* or *MESSAGE* selections.

To make BCC selections for Link Status Signal Units, follow the softkey path shown in Figure 45-7.

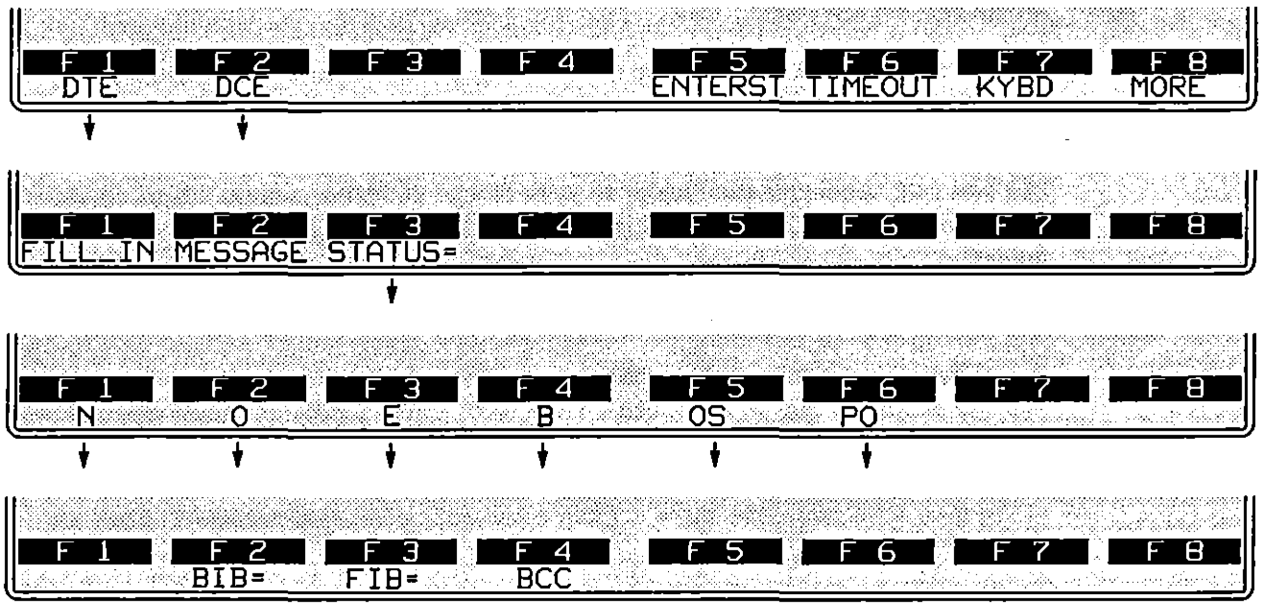


Figure 45-7 You must specify the type of Link Status Unit for a *STATUS=* spreadsheet condition. *BIB*, *FIB*, and *BCC* conditions may then be selected.

45.4 Display Actions

ENHANCE and SUPPRESS pertain to lines of data on the Layer 2 protocol trace (see Section 45.2). They do not suppress and enhance data on the raw-data display. Raw data is enhanced and suppressed at Layer 1.

DTE and DCE conditions can trigger an ENHANCE or SUPPRESS action. These conditions are active when the INTERVIEW is in monitor mode or in either of the emulate modes.

(A) Enhance

Whenever a DTE or DCE condition comes true at Layer 2, the frame that satisfied the condition can be enhanced on the SS#7 Layer 2 protocol-trace display, or it can be deleted from the trace completely. In an actions block on the Protocol Spreadsheet, press the ENHANCE softkey—F1 on the first rack of action softkeys. Figure 45-8 shows the three softkey subselections beneath ENHANCE. They are REVERSE, BLINK, and LOW.

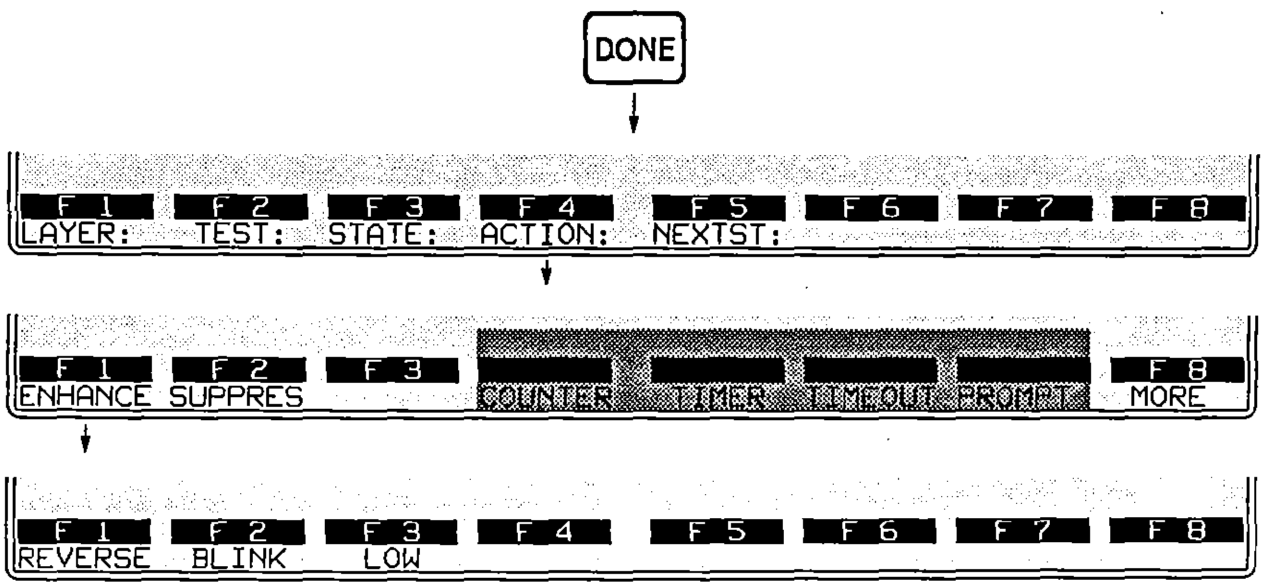


Figure 45-8 Selected frames on the protocol trace may be enhanced or suppressed.

Reverse-image and blink enhancements affect the plasma-display screen. In addition, a low-intensity enhancement can be applied to screens that are transmitted to a black-and-white monitor connected at the RS-170 port at the rear of the INTERVIEW.

Reverse, blink, and low enhancements can be mapped to colors on a color monitor attached at the INTERVIEW's RGB port (Figure 1-6). See Section 17.2 for an explanation of how reverse, blink, and low enhancements relate to character and background colors in the RGB output.

MON/LINE BLK=00000 S 05/26/89 12:30
ASCII/8/NONE/BOP

SRC	TYPE	LI	BIB	BSN	FIB	FSN	TIME	BCC
DCE	MESSAGE	08	1	3B	1	66	1229:59.160	G
DCE	FILL-IN	00	1	3B	1	66	1229:59.203	G
DTE	FILL-IN	00	1	66	1	3B	1229:59.242	G
DTE	MESSAGE	08	1	66	1	3C	1229:59.278	G
DTE	FILL-IN	00	1	66	1	3C	1229:59.306	G
DCE	FILL-IN	00	1	3C	1	66	1229:59.352	G
DTE	MESSAGE	08	1	66	1	3D	1229:59.371	G
DTE	FILL-IN	00	1	66	1	3D	1229:59.421	G
DCE	FILL-IN	00	1	3D	1	66	1229:59.441	G
DCE	MESSAGE	08	1	3D	1	67	1229:59.470	G
DCE	FILL-IN	00	1	3D	1	67	1229:59.506	G
DTE	FILL-IN	00	1	67	1	3D	1229:59.521	G
DCE	MESSAGE	07	1	3D	1	68	1229:59.559	G
DTE	FILL-IN	00	1	68	1	3D	1229:59.588	G
DCE	MESSAGE	07	1	3D	1	69	1230:50.007	G

F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8
L2TRACE	L3TRACE						

Figure 45-9 DTE Message Signal Units have been enhanced.

Figure 45-9 shows one screen of a Layer 2 protocol trace in which DTE MSUs have been enhanced in reverse video. The trigger that caused this enhancement was as follows:

CONDITIONS: DTE MESSAGE
ACTIONS: ENHANCE REVERSE

(B) Suppress

Individual frames that are suppressed in Layer 2 actions are deleted from the trace display. Figure 45-8 shows the softkey path to SUPPRES.

45.5 SS#7 Emulation

You may use SS#7 protocol for interactive testing of a DTE or a DCE. However, transmitted strings must be entered manually, since no automatic selections are currently available for emulation, either at Layer 2 or Layer 3.

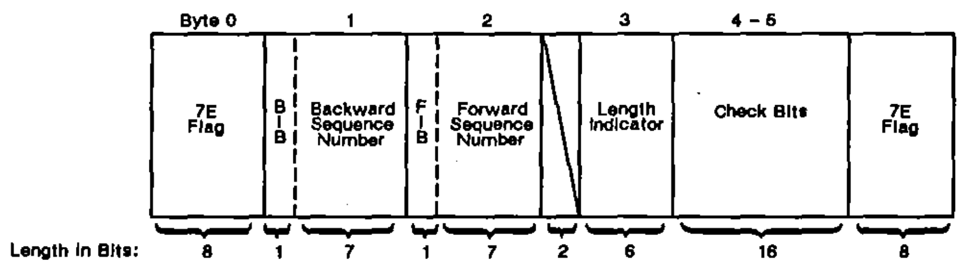
45.6 SS#7 Frame Structures and Values

The format for Fill-In Signal Units is given in Figure 45-10.

The format for Link Status Signal Units is given in Figure 45-11. Table 45-1 lists possible LSU status values.

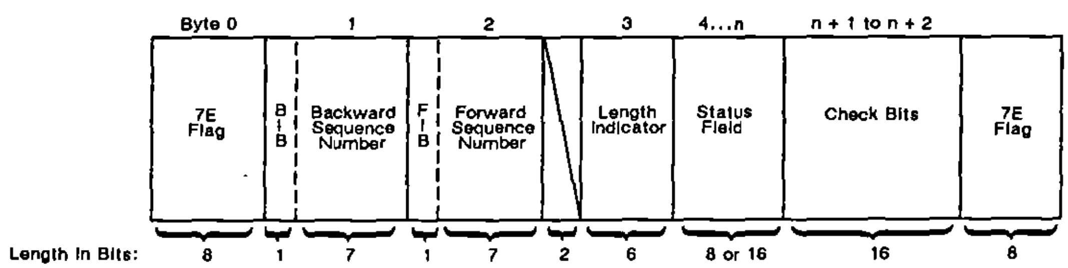
Refer to Section 46 for the structure of a Message Signal Unit and for the differences in CCITT and ANSI (US Standard) frame format. Also consult Section 46 for any information pertinent to SS#7 Level 3.

NOTE: Frame format, unless otherwise stated, reflects the frame as displayed on the screen, not the actual transmission order.



BIB: Backward Indicator Bit
FIB: Forward Indicator Bit
Length Indicator = 0 for Fill-in's
(LSB to right of each byte)

Figure 45-10 Format of Fill-in Signal Unit (FI).



BIB: Backward Indicator Bit
FIB: Forward Indicator Bit
Length Indicator for LSU's = 1 or 2
(LSB to right of each byte)

Figure 45-11 Format of Link Status Signal Unit (LSU).

46 SS#7 Layer 3

```
                              ** Layer Setup **

                                          Selections          Packages Loaded
DRIVE: HRD    Layer 1 Package: NO PACKAGE          NO PACKAGE
DRIVE: HRD    Layer 2 Package: SS7                 SS7                   HRD
DRIVE: HRD    Layer 3 Package: SS7                 SS7                   HRD
DRIVE: HRD    Layer 4 Package: NO PACKAGE          NO PACKAGE
DRIVE: HRD    Layer 5 Package: NO PACKAGE          NO PACKAGE
DRIVE: HRD    Layer 6 Package: NO PACKAGE          NO PACKAGE
DRIVE: HRD    Layer 7 Package: NO PACKAGE          NO PACKAGE
Depress XEQ Key To Load The Selected Packages
Select Layer
   F 1       F 2       F 3       F 4       F 5       F 6       F 7       F 8
LAYER-1   LAYER-2   LAYER-3   LAYER-4   LAYER-5   LAYER-6   LAYER-7   PROTSEL
```

Figure 46-1 The SS#7 personality package for Layer 3 is loaded from the Layer Setup screen.

46 SS#7 Layer 3

SS#7 (CCSS#7) is an abbreviation for the CCITT-defined Common Channel Signalling System #7. At Layer 3, SS#7 is a "layer personality package" of functions that are loaded into memory from disk via the Layer Setup screen. Figure 46-1 shows the Layer Setup screen configured to load in the Layer 3 SS#7 package from the hard disk. Refer to Section 8 for details on operating the Layer Setup screen.

The Layer 3 SS#7 package consists of the following:

- A special SS#7 Packet Level Setup screen that controls certain parameters when the unit is tracing SS#7.
- A protocol trace (illustrated in Figure 46-2) that distills from SS#7 data the Layer 3 events that have protocol significance. This trace is accessible by softkey in Run mode at all times.
- A group of conditions and actions at Layer 3 on the Protocol Spreadsheet that facilitate SS#7 programming. Figure 46-3 shows the softkey path to the first rack of condition softkeys when the SS#7 package is loaded in at Layer 3.

46.1 Packet-Level Setup

The SS#7 Packet Level Setup screen must be configured correctly for an accurate trace display.

To bring up this screen, first go to the Layer Setup screen (press PROGRAM, F5). Execute the SS#7 selection at Layer 3: SS7 should appear in the **Packages Loaded** column. Press F8 (labeled PROTSEL) to bring up the prompt to **Select Protocol Configuration Screen**. Then press F3 (LAYER-3) to call up the SS#7 Packet Level Setup screen.

The only parameter field on this screen is **National Format**. This field allows you to specify the format of the point codes in the label portion of a frame with a National Network Indicator (binary 10 or 11). Select CCITT or ANSI (US Standard). It is important that you select the correct format prior to testing, since the format which the INTERVIEW anticipates for national frames differs depending on your choice. Compare the two frame structures in Figure 46-9.

(A) CCITT Format

When you select CCITT, national frames are structured like international frames. These frames contain 14-bit point codes within a 32-bit routing label.

NOTE: The INTERVIEW represents a 14-bit CCITT point code as two hexadecimal bytes, and it pads the two most significant bit positions of the left-most byte with zeros.

(B) ANSI Format

The default selection is ANSI, which is US standard format, in which national frames contain 24-bit point codes within a 56-bit routing label.

46.2 Protocol Trace

While the unit is in Run mode, press the softkey for PROTOCL (F2 on the primary rack of display-mode softkeys) and then the softkey for L3TRACE (F2)to bring the protocol trace for SS#7 Layer 3 to the screen. Figure 46-2 is an example of this trace display. Each horizontal row in the trace represents an MSU.

(A) The Protocol Trace in Freeze Mode

Press FREEZE to prevent the addition of new data to *all* the display buffers, including the trace buffers. The frozen trace display may be scrolled through or paged through. The top line always is the cursor line (though there is no actual cursor on the trace display). Pressing ROLL FWD or ↓ moves the viewing "window" down relative to the data to add one line of fresher data to the bottom of the screen. Pressing ROLL BACK or ↑ moves the viewing window up to add a line of older data to the top of the screen.

Depression of the NEXT PAGE key adds fifteen lines—one full page—of newer frames to the frozen trace screen. Depression of PREV PAGE adds fifteen lines of older frames.

The MSU displayed on the top line of frozen trace-data will appear as the first frame in the raw-data or data-plus-leads display. To view the raw data that generated a particular line in the trace display, use ROLL FWD or ROLL BACK (or ↑ or ↓) to move the line in question to the top of the screen. Then press one of the data softkeys.

(B) Trace Columns

There are eleven columns in the Layer 3 display.

1. *Source.* The first column (SRC) identifies the MSU source as DTE (TD) or DCE (RD). Just as on the data-display, RD data is underlined.

```
*MON/LINE*                    BLK=00000 S 09/13/89 11:00
ASCII/8/NONE/BOP
```

SRC	NI	P	DPC	OPC	TYPE	DATA	SLS	CIC	TIME	BCC
DCE	I1	3	1AF3	1CA5	NETM= E0	20 40 18 10 1C 00 1C 00	04		1059:17.000	G
DCE	I0	3	2211	10CC	SPARE	66 77 1F 99 AA	04		1059:17.000	G
DCE	I0	3	2211	10CC	SPARE	66 77 1F 99 AA	04		1059:17.000	G
DCE	I1	3	1AF3	1CA5	SCCP= E6	20 40 20 10 1C 00 1C 00	04		1059:18.000	G
DCE	I1	3	1AF3	1CA5	TUP= 20	40 22 10 1C 00 1C 00 82		0E 84	1059:18.000	G
DCE	I1	3	1AF3	1CA5	ISDN= 40	25 10 1C 00 1C 00 FC 41	04	00 EA	1059:18.000	G
DCE	I1	3	1AF3	1CA5	DUP0	40 27 10 1C 00 1C 00 74		44 55	1059:18.000	G
DCE	I1	3	1AF3	1CA5	DUP1	40 2A 10 1C 00 1C 00 B6		44 55	1059:18.000	G
DCE	N0	0	295AF3	200047	NETM= 40	10 1C 00 1C 00 2E 47 00	00		1059:20.000	G
DCE	N0	0	295AF3	200247	RESERVED	99 AB	17		1059:20.000	G
DCE	N0	0	295AF3	200447	RESERVED	99 AA	17		1059:21.000	G
DCE	N0	0	295AF3	200647	SCCP= 48	10 1C 00 1C 00 9C 48 00	00		1059:21.000	G
DCE	N0	0	295AF3	200847	TUP= 50	10 1C 00 1C 00 14 49 00	00		1059:21.000	G
DCE	N0	0	295AF3	200A47	ISDN=CMR		00	00 4B	1059:21.000	G
DCE	N0	0	295AF3	200C47	DUP0		00	00 55	1059:21.000	G

```
F 1       F 2       F 3   F 4   F 5   F 6   F 7   F 8
L2TRACE   L3TRACE
```

Figure 46-2 SS#7 Layer 3 Protocol Trace.

2. *Network indicator.* The second column (labeled NI) interprets the Network Indicator in a two-character field. The first bit in the two-bit network Indicator is always set to 0 in international signal units; the first bit is set to 1 in all national signal units. On the SS#7 trace, the bit value is represented as an "I" to indicate CCITT international format or "N" to represent national format, whether ANSI or CCITT. The value of the second bit in the Network Indicator is also displayed on the trace screen.

3. *Priority.* The third column (P) displays the value of the Priority code, regardless of format. The Priority code has a value of 0-3 for US Format. These bits are spare in CCITT International or National Format.

4. *Destination point code.* The next column (DPC) provides the Destination Point Code. When the NI field indicates ANSI format (N), three hex bytes are used in the DPC column. CCITT format (I) allocates only 14 bit positions. The 14 bits are displayed as two bytes, with the two left-most bit positions padded with zeros.

5. *Originating point code.* The next column (**OPC**) provides the Originating Point Code. When the **NI** field indicates ANSI format (**N**), three hex bytes are used in the **OPC** column. CCITT format (**I**) allocates only 14 bit positions. The 14 bits are displayed as two bytes, with the two left-most bit positions padded with zeros.

6. *Type.* The **TYPE** column defines the message type (that is, the Service Indicator) for MSUs. The values of the different Service Indicators are given in Table 46-1. For Integrated Services Data Network (**ISDN**), Network Management (**NETM**), Telephone User Part (**TUP**), or Signaling Connection Control Part (**SCCP**) messages, the header type is given either as an abbreviation or as a hex value. Abbreviations are defined in Table 46-2 through Table 46-5. A hex value appears when the header has no defined abbreviation.

7. *Data.* The **DATA** column displays up to eight bytes of data in hexadecimal format. The amount of additional data displayed is defined for each message type as shown in Table 46-2 through Table 46-5.

8. *Signaling link selection.* The **SLS** column gives the hex value (one or two bytes) of the signaling link selection when an SLS is present. Depending on the MSU type, the SLS occupies four or five bits within the MSU. The 4- or 5-bit SLS is always shown as a hex byte in the Layer 3 trace. The 3 or 4 remaining bit positions of the byte are padded with zeros.

9. *Circuit identifier code.* When a Circuit Identifier Code is present, it is listed in the next column. The **CIC** is a 16-bit field within the MSU and is represented on the trace screen as two hex characters.

10. *Time.* The time of the arrival of the *end of the MSU* at the DTE or DCE monitor is provided by a 24-hour clock and posted to the trace display. The clock is accurate to the millisecond.

    When **Time Ticks:** ON is selected on the Front-End Buffer Setup screen (see Section 9), time values are incorporated into the data itself. As a result, times posted to the trace display will not be affected when recorded data is played back, even at varying speeds.

    If **Time Ticks:** OFF was selected instead during live recording, times on the trace during playback will be influenced by "local conditions" such as playback speed, idle suppression, etc.

11. *Frame checking.* An SS#7 frame ends as soon as a FE flag or seven 1-bits in a row are detected. If a flag ends the frame, a frame check is performed and the result is posted both to the data display and to the BCC column of the trace display. The symbol G denotes a good frame check, while B symbolizes a bad frame.

    A for abort is posted to the displays when a frame is ended by seven 1-bits.

    NOTE: In MSU's which are incomplete, the header is expanded if sufficient information is present. Additional unexpanded bytes displayed may include the first FCS byte followed by FF bytes which pad to the end of the frame display.

46.3 Monitor Conditions

When the Layer 3 SS#7 personality package is loaded in (via the Layer Setup screen), a set of conditions checks DTE and DCE leads both in monitor and emulate modes. This set of conditions is accessed by the DTE and DCE selections on the first rack of condition softkeys at Layer 3. See Figure 46-3.

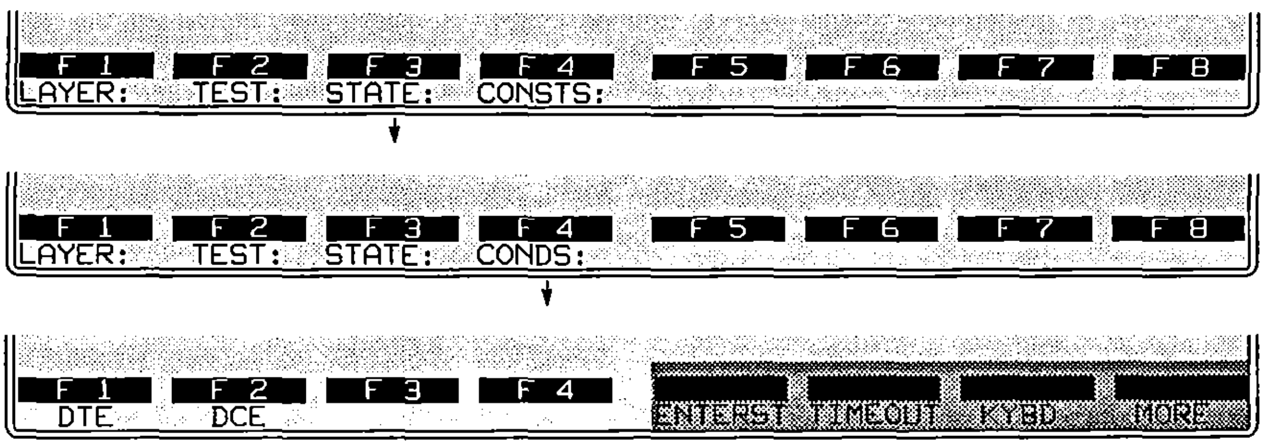


Figure 46-3 To monitor line conditions, first select *DTE* or *DCE*.

(A) Message Signal Unit Types

After the keyword DTE (or DCE) is written to the spreadsheet, a rack of softkeys appears that represents *types* of MSUs. See Figure 46-4.

The Message Signal Units which appear as automatic selections include NETM (Network Management), ISDN (Integrated Services Data Network User Part), SCCP (Signaling Connection Control Part), TUP (Telephone User Part), NTR (Network Test Regular), NTS (Network Test Special), DUP0 or DUP1 (Data User Part 0 and Data User Part 1), and OTHER (for user-specified MSU's). Values for the different MSU types are given in Table 46-1.

Press a softkey to write one of these MSU-types to the Layer 3 spreadsheet. DTE or DCE followed by an MSU-type mnemonic—DTE NETM, for example, or DCE ISDN—is a complete condition and will come true if a matching MSU is monitored.

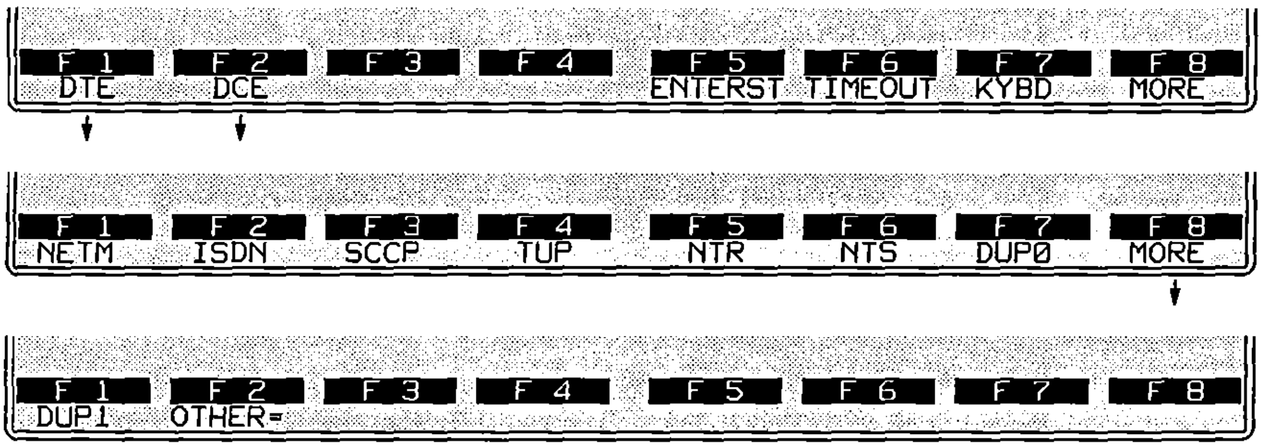


Figure 46-4 MSU types.

When you select OTHER as the MSU type, you must specify the value of the four low-order bits for the SIO (Service Indicator Octet). Enter the value of the four low-order bits as a single hexadecimal digit. (Do not use the [HEX] key.)

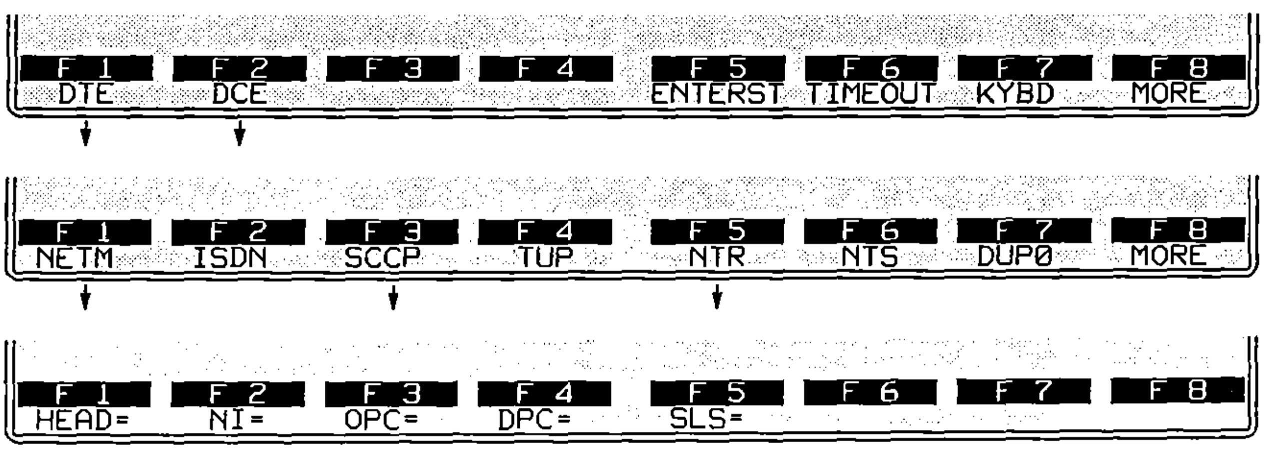


Figure 46-5 Selected MSU type determines subsequent softkey selections.

Certain secondary fields appear for the remaining MSU types. The fields for NETM, SCCP, and NTR selections are shown in Figure 46-5. These optional selections for MSUs permit you to specify Network Identifier, Originating Point Code, Destination Point Code, Signalling Link Selection (where applicable), Circuit Identification Code (where applicable), and Header (where applicable). See the spreadsheet example in Figure 46-6.

```
LAYER: 3
  TEST: l3check
    STATE: charge
      CONDITIONS: DTE SCCP HEAD= CC OPC= 1CA5 DPC= 1AF3
      ACTIONS: ENHANCE BLINK
```

Figure 46-6 Three optional conditions (*HEAD=* , *OPC=* , and *DPC=*) have been selected for SCCP Message Signal Units on the DTE side.

(B) MSU Header

When certain MSUs are selected, you may also specify the header in the MSU. Selectable headers are available when the MSU selection is NETM, NTR, SCCP, TUP, or ISDN. Header selections for NETM, SCCP, TUP, or ISDN MSUs, their meanings, and their values are given in Table 46-2 through Table 46-5. Header selections for NTR MSUs are given in Note 8.

(C) Network Indicator

Once you have specified an MSU type, you may specify the Network type. Select NI= N to signify a National network; select NI= I to indicate an International network.

> NOTE: National in this case refers to the value of the first two bits in the Service Indicator Octet. It does NOT distinguish between CCITT National and US Standard Format. To designate the appropriate frame structure, you MUST select CCITT or US Standard Format as a Layer Setup parameter as described in Section 46.1. Legal values in the OPC and DPC fields and the actual data strings anticipated as CONDITIONS on the Protocol Spreadsheet are determined by your Layer Setup selection for Network type.

(D) Originating Point Code

Type in the OPC as hexadecimal digits. (Do not use the [HEX] key.) The size of this field differs for a CCITT MSU or a US Standard MSU.

In CCITT format, the OPC is a 14-bit field. Type in a two-byte entry (four hex digits), and assume that the two high-order bits of the left-most byte are zeros. (Legal values are 0000 to 3FFF.)

In US standard format, the OPC is a three-byte field. (Legal values are 000000 to FFFFFF.)

(E) Destination Point Code

Type in the DPC as hexadecimal digits. (Do not use the [HEX] key.) As with the OPC, the size of this field varies, depending on the frame structure (CCITT or US Standard) selected as a Layer Setup parameter. Legal entries are the same as for Originating Point Codes.

(F) Signaling Link Selection

MSU's which contain an SLS are listed in Table 46-1.

The SLS occupies four bits in CCITT format. The four high-order bits of the same byte are always zero. Valid entries for CCITT format are 00 to 0F.

In US Standard format, the SLS occupies five low-order bits of a byte, and the three high-order bits of the same byte are set to zero. Valid entries for US format are 00 to 1F.

Enter two hexadecimal digits as the SLS. (Do not press [HEX].)

(G) Circuit Identifier Code

MSUs which contain a CIC are listed in Table 46-1. For ISDN MSUs, the CIC is a two-byte field. Enter the CIC as hexadecimal digits in the range 0 to FFFF. Do not use the [HEX] key. For TUP MSUs, enter up to three hexadecimal digits in the range 0 to FFF.

46.4 Display Actions

ENHANCE and SUPPRESS pertain to lines of data on the Layer 3 protocol trace (see Section 46.2). They do not suppress and enhance data on the raw-data display. Raw data is enhanced and suppressed at Layer 1.

DTE and DCE conditions can trigger an ENHANCE or SUPPRESS action. These conditions are active when the INTERVIEW is in monitor mode or in either of the emulate modes.

(A) Enhance

Whenever a DTE or DCE condition comes true at Layer 3, the MSU that satisfied the condition can be enhanced on the SS#7 Layer 3 protocol-trace display, or it can be deleted from the trace completely. In an actions block on the Protocol Spreadsheet, press the ENHANCE softkey—[F1] on the first rack of action softkeys. Figure 46-7 shows the three softkey subselections beneath ENHANCE. They are REVERSE, BLINK, and LOW.

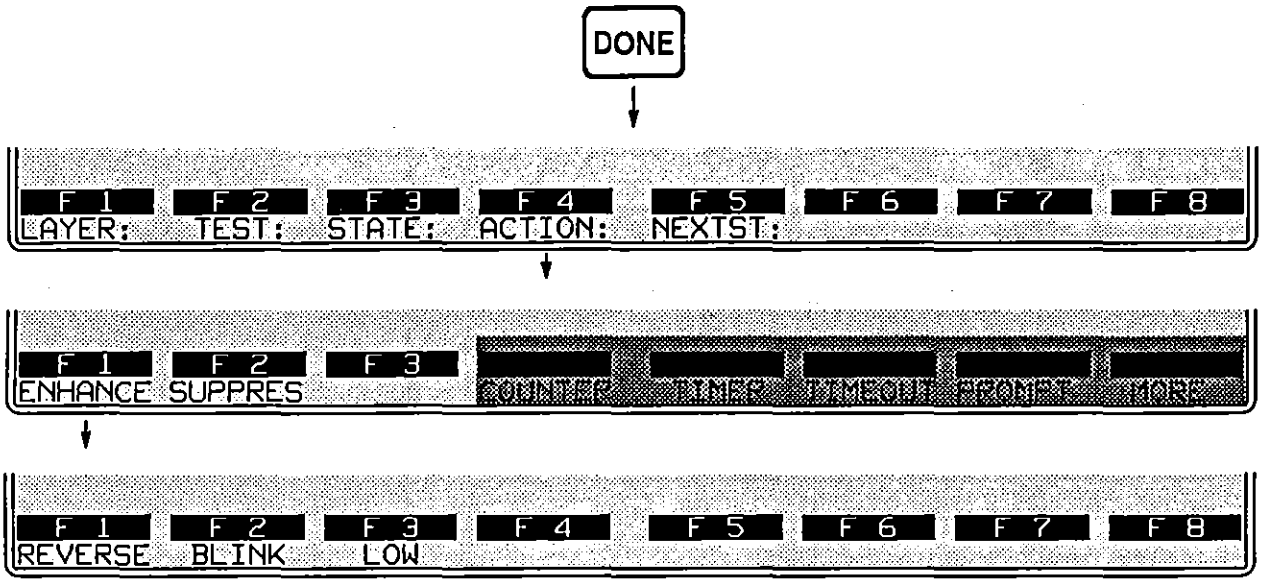


Figure 46-7 Selected MSUs on the protocol trace may be enhanced or suppressed.

Reverse-image and blink enhancements affect the plasma-display screen. In addition, a low-intensity enhancement can be applied to screens that are transmitted to a black-and-white monitor connected at the RS-170 port at the rear of the INTERVIEW.

Reverse, blink, and low enhancements can be mapped to colors on a color monitor attached at the INTERVIEW's RGB port (Figure 1-6). See Section 17.2 for an explanation of how reverse, blink, and low enhancements relate to character and background colors in the RGB output.

Figure 46-8 shows one screen of a Layer 3 protocol trace in which NETM MSUs have been enhanced in reverse video. The trigger that caused this enhancement was as follows:

```
CONDITIONS: DCE NETM
ACTIONS: ENHANCE REVERSE
```

(B) Suppress

Individual MSUs that are suppressed in Layer 3 actions are deleted from the trace display. Figure 46-7 shows the softkey path to SUPPRES.

MON/LINE BLK=00000 S 07/13/89 11:00
ASCII/8/NONE/BOP

SRC	NI	P	DPC	OPC	TYPE	DATA	SLS	CIC	TIME	BCC
DCE	I1	3	1AF3	1CA5	NETM= E0	40 18 10 1C 00 1C 00			1059:17.000	G
DCE	I0	3	2211	10CC	SPARE	66 77 1F 99 AA	04		1059:17.000	G
DCE	I0	3	2211	10CC	SPARE	66 77 1F 99 AA	04		1059:17.000	G
DCE	I1	3	1AF3	1CA5	SCCP= E6	20 40 20 10 1C 00 1C 00	04		1059:18.000	G
DCE	I1	3	1AF3	1CA5	TUP= 20	40 22 10 1C 00 1C 00 82		0E 84	1059:18.000	G
DCE	I1	3	1AF3	1CA5	ISDN= 40	25 10 1C 00 1C 00 FC 41	04	00 EA	1059:18.000	G
DCE	I1	3	1AF3	1CA5	DUP0	40 27 10 1C 00 1C 00 74		44 55	1059:18.000	G
DCE	I1	3	1AF3	1CA5	DUP1	40 2A 10 1C 00 1C 00 86		44 55	1059:18.000	G
DCE	N	0	295AF3	200047	NETM= 40	10 1C 00 1C 00 47 00	00		1059:20.000	G
DCE	N0	0	295AF3	200247	RESERVED	99 AA	17		1059:20.000	G
DCE	N0	0	295AF3	200447	RESERVED	99 AA	17		1059:21.000	G
DCE	N0	0	295AF3	200647	SCCP= 48	10 1C 00 1C 00 9C 48 00	00		1059:21.000	G
DCE	N0	0	295AF3	200847	TUP= 50	10 1C 00 1C 00 14 49 00	00		1059:21.000	G
DCE	N0	0	295AF3	200A47	ISDN=CMR		00	00 4D	1059:21.000	G
DCE	N0	0	295AF3	200C47	DUP0		00	00 55	1059:21.000	G

F 1 F 2 F 3 F 4 F 5 F 6 F 7 F 8
L2TRACE L3TRACE

Figure 46-8 NETM Message Signal Units have been enhanced.

46.5 Structure of SS#7 Message Signal Units

Figure 46-9 shows the general structure of a Message Signal Unit. Figure 46-10 illustrates how CCITT International or National labels are entered and transmitted. MSU types are defined in Table 46-1. Table 46-2 through Table 46-5 define possible MSU headers for Network Management, SCCP, ISDN, and TUP MSU's.

> NOTE: Structure, unless otherwise stated, reflects the MSU as displayed on the screen, not the actual transmission order of data.

Consult Figure 45-10 and Figure 45-11 for the format of Fill-In and Link Status Signal Units. Any information pertinent to SS#7 Layer 2 is included in Section 45.

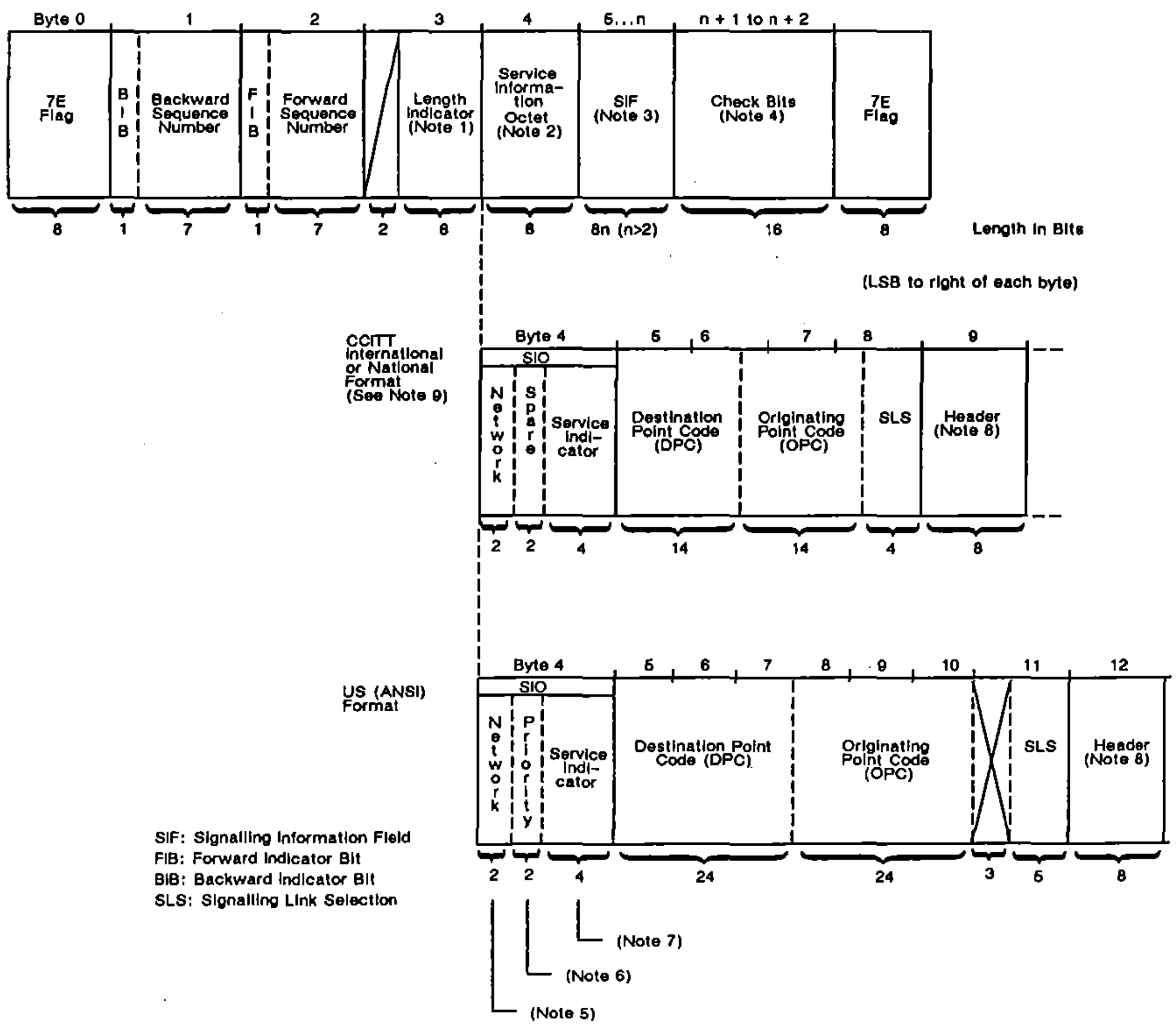


Figure 46-9 Format of a Message Signal Unit (MSU).

NOTES:

1. Length Indicator for an MSU has a value of 3 to 63 (3 to 3F, hex).

2. The Service Information Octet contains a Service Indicator (Table 46-1), Bits 3-0 and a Network Indicator, Bits 7-6. In US Format only, a Priority Code is present in Bits 5-4. Bits 5-4 are spare in CCITT International or National Format.

3. The Signaling Information field contains a Label and a Header. There are two label formats: US, a 56 bit format, and CCITT, a 32 bit format. The CCITT National label follows the same format as a CCITT International label (see expansions, this figure). The header is located at Octet 9 in CCITT International or National Format and at Octet 12 in US Format.

4. The two octets preceding the closing flag are block check results. Only the first octet will appear in SS#7 line data. The second is replaced by a block check symbol (G, B, H). See Section 10 for an explanation of block checking in Bit-Oriented Protocols.

5. Network Indicators
   00-01 = CCITT International Format
   10-11 = US Standard (ANSI) or CCITT National Format

6. The Priority Code has a value of 0-3 for US Format. These bits are undefined for International Format. They are also undefined in CCITT National Format.

7. A Service Indicator with Bits 3-2 = 01 (in either US or CCITT International or National Format) indicates a User Part. The subsequent structure of the signal unit is dependent on the User Part Type and is not reflected by this figure. Values for TUP and ISDN headers are given in Table 46-4 and Table 46-5.

8. The header gives the Network Management Header (Table 46-2), SCCP Message Header (Table 46-3), or Test Header.

   In Test Messages (SIO = 0001), the four low-order bits determine the type. A value of

   0001 = LTM (Link Test Message)

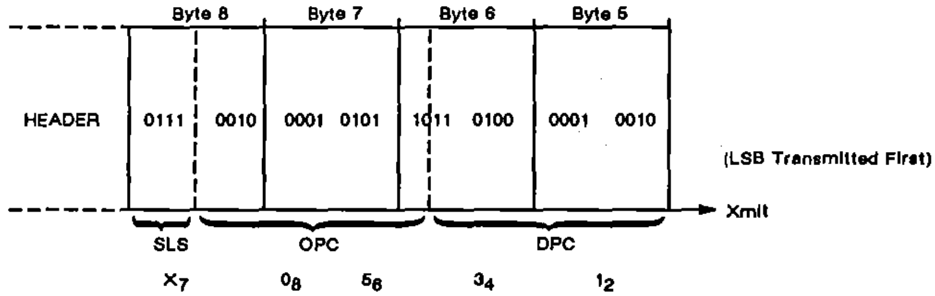
   0010 = LTA (Link Test Acknowledge).

   The four high-order bits are not defined.

9. Since the label in CCITT International or National Format is not byte-aligned, the values displayed in hexadecimal on the INTERVIEW screen are skewed. As a result, CCITT labels must be interpreted as shown in Figure 46-10.

Label values entered in spreadsheet conditions: DPC= 3412
OPC= 0856

Bit sequence that will satisfy the DPC= and OPC= Conditions:



Data as it appears (in hex) on INTERVIEW screen or in send string:

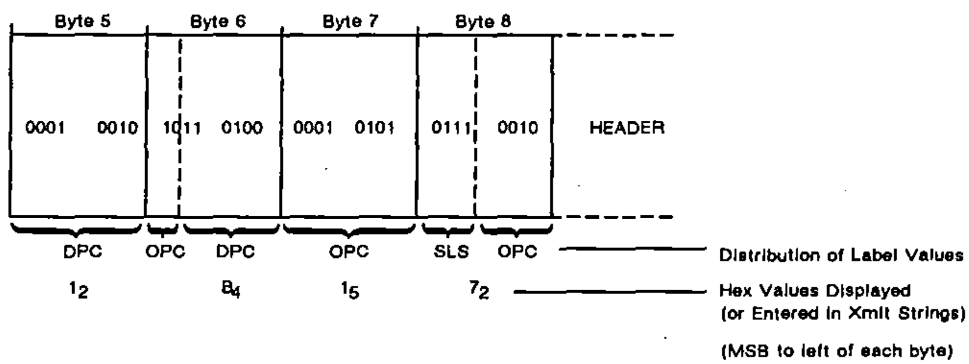


Figure 46-10 CCITT labels are entered and transmitted as shown.

Table 46-1
MSU Service Indicators
(Bits 3-0 of the SIO)

Mnemonic	Meaning	Binary Value
NETM (2)	Network Management	0000
NTR (2)	Regular Testing	0001
NTS (2)	Special Testing	0010
SCCP (2)	Signalling Connection Control Part	0011
TUP (1)	Telephone User	0100
ISDN (1) (2)	ISDN User	0101
DUP0	Data User (Call/Circuit)	0110
DUP1	Data User	0111
----	Spare	1000
----	Spare	1001
----	Spare	1010
----	Spare	1011
----	Spare	1100
----	Spare (3)	1101
----	Spare (4)	1110
----	Spare	1111

(1) Contains a CIC.
(2) Contains an SLS.
(3) ECIS6 for US Standard (ANSI) Format.
(4) Reserved, if US Standard (ANSI) Format.

Table 46-2
Network Management Headers
(Octet 9 for CCITT Format; Octet 12 for US-ANSI Format)

Mnemonic	Message	Hex	Added Bytes Shown	
			US	CCITT
COO	Changeover Order	11	2	1
COA	Changeover Acknowledge	21	2	1
CBD	Changeback Declaration	51	2	1
CBA	Changeback Acknowledge	61	2	1
ECO	Emergency Changeover Order	12	1	0
ECA	Emergency Changeover Acknowledge	22	1	0
RCT	Route-Set-Congestion-Test	13	0	0
TFC	Transfer Controlled	23	4	2
TFP	Transfer Prohibited	14	3	2
TCP (1)	Transfer Cluster Prohibited	24	3	-
TFR	Transfer Restricted	34	3	2
TCR (1)	Transfer Cluster Restricted	44	3	-
TFA	Transfer Allowed	54	3	2
TCA (1)	Transfer Cluster Allowed	64	3	-
RSP (1)	Route-Set-Test Destination Prohibited	15	3	-
RST (2)	Signaling-Route-Set-Test Signal	15	-	2
RSR (1)	Route-Set-Test Destination Restricted	25	3	-
RST (3)	Signaling-Route-Set-Test Signal	25	-	2
RCP (1)	Route-Set-Test Cluster Prohibited	35	3	-
RCR (1)	Route-Set-Test Cluster Restricted	45	3	-
LIN	Link Inhibited	16	1	0
LUN	Link Uninhibited	26	1	0
LIA	Link Inhibited Acknowledge	36	1	0
LUA	Link Uninhibited Acknowledge	46	1	0
LID	Link Inhibited Denied	56	1	0
LFU	Link Force Uninhibited	66	1	0
LLI (1)		76		-
LRI (1)		86		-
DLC	Data Link Connection Orders	18	2	2
CSS	Connection Successful	28	1	0
CNS	Connection Not Successful	38	1	0
CNP	Connection Not Possible	48	1	0

(1) US Format only.
(2) CCITT Format only.
(3) CCITT Format only, national option.

Table 46-3
SCCP Message Headers
(Octet 9 for CCITT International or National Format; Octet 12 for US-ANSI Format)

Mnemonic	Message	Hex	Added Bytes Shown US	Added Bytes Shown Int'l
CR	Connection Request	01	4+	4+
CC	Connection Confirm	02	7+	7+
CREF	Connection Refused	03	4+	4+
RLSD	Released	04	7+	7+
RLC	Release Complete	05	6	6
DT1	Data Form 1	06	6+	4+
DT2	Data Form 2	07	3+	5+
AK	Data Acknowledgment	08	4	5
UDT	Unitdata	09	1+	1+
UDTS	Unitdata Service	0A	1+	1+
ED	Expedited Data	0B	4+	3+
EA	Expedited Data Acknowledgment	0C	3	3
RSR	Reset Request	0D	7+	7+
RSC	Reset Confirmation	0E	6	6
ERR	Error	0F	4+	4+
IT	Inactivity Test	10	3	3

Table 46-4
Telephone User Part (TUP) Message Headers

Mnemonic	Message	Hex	Added Bytes Shown
IAM	Initial address message	11	3+
IAI	Initial address with information	21	3+
SAM	Subsequent address message	31	1+
SAO	Subsequent address with one signal	41	1
GSM	General forward setup information	12	2+
COT	Continuity signal	32	0
CCF	Continuity-failure signal	42	0
GRQ	General request message	13	1
ACM	Address complete message	14	1
CHG	Charging message	24	0+
SEC	Switching-equipment-congestion	15	0
CGC	Circuit-group-congestion	25	0
NNC	National-network-congestion	35	0
ADI	Address incomplete signal	45	0
CFL	Call-failure signal	55	0
SSB	Subscriber-busy signal	65	0
UNN	Unallocated-number signal	75	0
LOS	Line-out-of-service signal	85	0
SST	Send-special-information tone signal	95	0
ACB	Access barred signal	A5	0
DPN	Digital path not provided signal	B5	0
MPR	Misdialed trunk prefix	C5	0
EUM	Extended unsuccessful backward setup	F5	3
ANU	Answer signal, unqualified	06	0
ANC	Answer signal, charge	16	0
ANN	Answer signal, no charge	26	0
CBK	Clear-back signal	36	0
CLF	Clear-forward signal	46	0
RAN	Reanswer signal	56	0
FOT	Forward-transfer signal	66	0
CCL	Calling party clear signal	76	0
EAM	Extended answer message indication	F6	0
RLG	Release-guard signal	17	0
BLO	Blocking signal	27	0
BLA	Blocking-acknowledgment	37	0
UBL	Unblocking signal	47	0
UBA	Unblocking-acknowledgment	57	0
CCR	Continuity-check-request signal	67	0
RSC	Reset-circuit signal	77	0
MGB	Maintenance group blocking	18	1+
MBA	Maintenance group blocking acknowledge	28	1+
MGU	Maintenance group unblocking	38	1+
MUA	Maintenance group unblocking acknowledgment	48	1+

Table 46-4 (Continued)

Mnemonic	Message	Hex	Added Bytes Shown
HGB	Hardware failure group blocking	58	1+
HBA	Hardware failure group blocking acknowledgment	68	1+
HGU	Hardware failure group unblocking	78	1+
HUA	Hardware failure group unblocking acknowledge	88	1+
GRS	Circuit group reset	98	1+
GRA	Circuit group reset-acknowledge	A8	1+
SGB†	Software generated group blocking	B8	1+
SBA†	Software generated group blocking-acknowledge	C8	1+
SGU†	Software generated group unblocking	D8	1+
SUA†	Software generated group unblocking acknowledge	E8	1+
CFM	CCBS facility message	19	1+
CPM	Called party free message	29	0+
CPA	Called party answer	39	0+
CSV	Closed group selection/validation request	49	0+
CVM	Closed group validation check	59	3+
CRM	Closed group selection/validation response	69	5
CLI	Connection line identity	79	1+

† National option.

Table 46-5
ISDN Message Headers

Mnemonic	Message	Hex	Added Bytes Shown
IAM	Initial address	01	5+
SAM	Subsequent address	02	0+
INR	Information request	03	1+
INF	Information	04	1+
COT	Continuity	05	1
ACM	Address complete	06	2+
FOT	Forward transfer	08	0+
ANM	Answer	09	2+
UBM	Unsuccessful backward set-up information	0A	1+
REL	Release	0B	0+
PAU	Pause	0D	0+
RES	Resume	0E	0+
RLSD	Released	0F	0
RLC	Release complete	10	0
CCR	Continuity check request	11	0
RSC	Reset circuit	12	0
BLO	Blocking	13	0
UBL	Unblocking	14	0
BLA	Blocking acknowledgment	15	0
UBA	Unblocking acknowledge	16	0
GRS	Reset circuit group	17	0+
CGB	Circuit group blocking	18	1+
CGU	Circuit group unblocking	19	1+
CGBA	Circuit group blocking acknowledgment	1A	1+
CGUA	Circuit group unblocking acknowledgment	1B	1+
CMR	Call modification request	1C	1+
CMC	Call modification completed	1D	1+
RCM	Reject connect modify	1E	1+
FAR	Facility request	1F	1+
FAA	Facility accepted	20	1+
FRJ	Facility reject	21	2+
FAD	Facility deactivated	22	1+
FAI	Facility information	23	2+
CSVR	Closed group selection/validation request	25	0+
CSVS	Closed group selection/validation response	26	1+
DRS	Delayed release	27	0+
PAM	Pass along	28	0+
GRA	Reset circuit group acknowledgment	29	0+

47 V.35

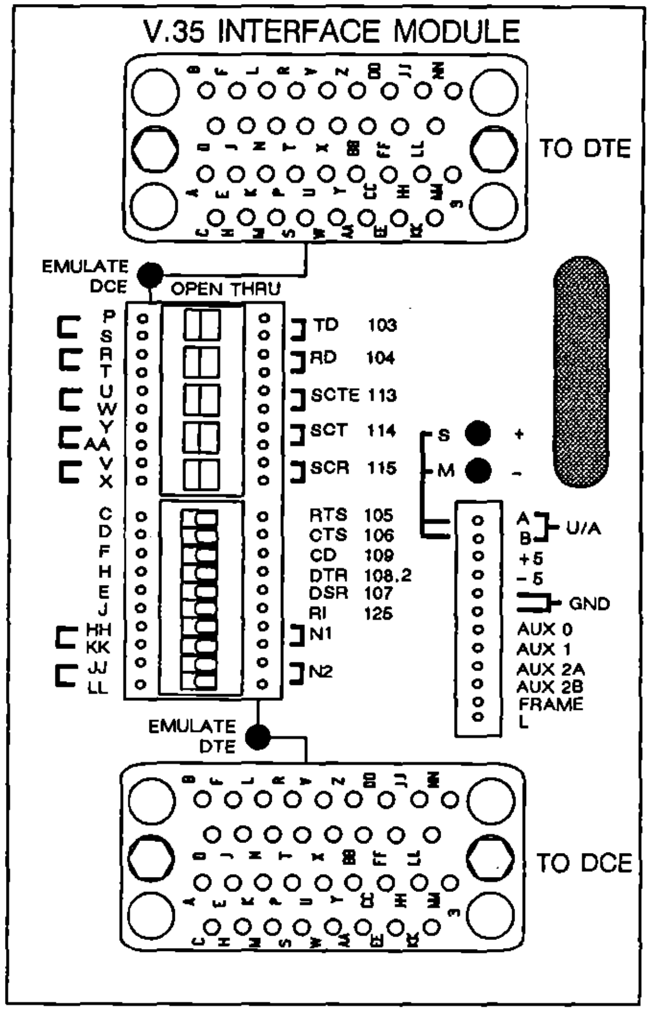


Figure 47-1 Breakout panel on V.35 Test Interface Module (TIM).

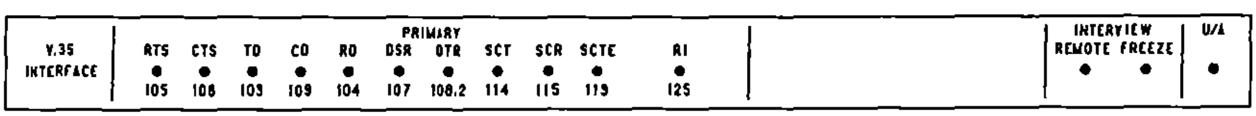


Figure 47-2 V.35 Green-Red LED Overlay.

47 V.35

Figure 47-1 and Figure 47-2 show the TIM and the LED overlay for the V.35 interface. Once the V.35 module is installed, the following EIA functions are enabled:

- Five balanced data and clock circuits and six single-wire, unbalanced control leads can be monitored on the front-panel green-red LEDs.
- Thirteen V.35 circuits can be switched, patched, and tested on the breakout box on the module.
- Up to five unbalanced control leads can be selected for real-time screen display.
- Seven unbalanced leads can be monitored by menu and spreadsheet triggers.
- Five single-wire, unbalanced V.35 leads, two single-wire, unbalanced auxiliary leads, and one two-wire, balanced auxiliary circuit come under spreadsheet *control* in emulate modes.
- Also in emulate modes, five single-wire, unbalanced V.35 leads, two single-wire, unbalanced auxiliary leads, one balanced, two-wire auxiliary circuit, six RTS-CTS handshake timers, and two transmit delays can be regulated via an Interface Control menu screen.

47.1 Connectors

When you break a data line for testing, you may connect one end of the line to the TO DTE connector on the TIM (see top of Figure 47-1). Connect the other end of the line to the TO DCE connector on the TIM. Even when the INTERVIEW is powered off, this provides a through connection for the data line.

When Mode: MONITOR or AUTOMONITOR is the program selection, the INTERVIEW monitors data passively through either (or both) TO connectors on the TIM.

When the INTERVIEW is operating in EMULATE DCE mode (selected on the Line Setup menu), the EMULATE DCE LED on the TIM is red. This indicates that the TO DTE connector is active. The INTERVIEW is transmitting and receiving data through the TO DTE connector.

When **Mode:** EMULATE DTE is the program selection, the unit transmits and receives data through the TO DCE connector. The EMULATE DTE LED is red, and the EMULATE DCE LED is off.

> *CAUTION: To connect the data line, you must interrupt the flow of data on the line. Be sure you have permission to break the line before doing so.*

47.2 Green-Red LEDs

The V.35 LED overlay (Figure 47-2) identifies fourteen LED indicators. Eleven of these represent V.35 circuits monitored at either of the line interfaces (TO DTE, TO DCE) on the test-interface module. An LED is dark when the unit is off, green when the unit is powered on but the lead is off or unterminated and red when the lead is at or above the *on* threshold.

For two-wire, balanced (data and clock) circuits, LEDs are red (*on*) for relative voltages of A over B of over +0.3 V. For single-wire, unbalanced leads, the indicators go red at signals more positive than +3 V with respect to signal ground.

Two of the LEDs switch to red when the unit is in a special mode, Remote mode or Freeze mode. Remote means that the unit is *under* remote control via the REMOTE port. The remote-control feature is not implemented.

The final LED label on the right end of the overlay is UA (user assigned). This LED monitors any lead or twisted pair of leads patched to the UA-input jack(s) on the module. See Figure 47-3. Any of the V.35 circuits that are not accounted for on the front overlay can be assigned to this LED by the user.

It is important to note that the front-panel LED indicators always reflect TIM activity. If the LEDs are active while data is being played back from disk, the activity is on the line, not in the data stored on the disk. Playback data may activate triggers that monitor interface leads, and it may generate a data-plus-leads display; but playback data never drives the green-red LEDs.

47.3 Breakout Box

The INTERVIEW is tied to the digital communications line by two cable-connections on the interface module, one cable going to the DTE and one to the DCE. Refer to Section 47.1. In between the two cables are the INTERVIEW's drivers and receivers and, on the face of the module, a breakout area. The breakout area has a column of switches that allows any V.35 circuit to be opened, and two columns of patch jacks that allow circuits to be rerouted by patch cords.

Figure 12-3 in a previous section illustrated the position of the INTERVIEW's receivers and high-impedance monitors relative to the breakout and patching area of any TIM (including V.35) when signals are moving across the interface module under two different emulate conditions (driving and receiving) and in Monitor mode. *Note that an opened switch will have a different effect on the screen display and LED display of signals depending on the test mode.*

The top five DIP switches on the breakout box (Figure 47-1) correspond to the V.35 balanced two-wire (data and clock) circuits. V.35 balanced circuits currently defined for international use are the following, with their pin designators in parentheses: TD (P,S), RD (R,T), SCTE (U, W), SCT (Y, AA), and SCR (V, X).

The next six DIP switches on the breakout box correspond to the V.35 unbalanced control leads. They are RTS (pin C), CTS (D), CD (F), DTR (H), DSR (E), and RI (J).

At the bottom of the breakout box are two additional balanced two-wire circuits, N1 (HH, KK) and N2 (JJ, LL). *N* stands for *National*: these circuits are reserved permanently for national use and may or may not be implemented in a network.

The DIP switches conduct signals straight through, or they open the circuits so that you can reroute them using one of the twisted-pair patch cords provided with the V.35 module. You may patch any of these pairs of leads to the leads on the opposite side of the DIP switches, or to the input or output jacks in the UA-input area on the TIM (Figure 47-3).

NOTE: Always keep the colors of the twisted pair oriented in the same direction to maintain correct balance. For example, if you patch one pair of V.35 leads with the yellow wire on top and the blue wire on the bottom, be sure to connect the other end with the yellow on top and the blue on the bottom.

NOTE ALSO: Patching or switching the leads on the front panel can affect not only the received data but also the actual data on the line, *even when the INTERVIEW is in Monitor mode.*

47.4 Special Input and Output Pins

Off to the right of the breakout area are two LEDs and another column of patch pins. The LEDs are a voltmeter for any unbalanced lead or balanced pair of leads patched to one or both top pins (A and B) on the pin column. These are the user-assigned inputs. The LEDs light when the input exceeds the input thresholds.

For balanced signals patched to the A and B jacks, the red + LED will go on for relative voltages of A over B of over + 0.3 V (*S*pace). The green – LED will light for relative voltages of A over B of -0.3 V (*M*ark).

For unbalanced leads, use only the A jack for patching. When a signal is patched to the A jack only, B is assumed to be signal ground. The *on* threshold for the red + LED in that case is +3 V, and -3 V for the green - LED.

CAUTION: For unbalanced signals, patch only into pin A on the user-assigned input: never use pin B.

The INTERVIEW's triggers can monitor the unassigned input, and actions can be initiated when the signal crosses the appropriate threshold (+3 V for unbalanced V.35 signals, or relative +0.3 V for balanced V.35 signals).

The user-assigned input can also catch glitches on any interface lead. Whenever the voltage crosses the +3 V threshold on an unbalanced lead or the +0.3 threshold (A over B) on a balanced circuit for at least one microsecond, the input latches until the trigger logic (the UA field on interface conditions) can check it.

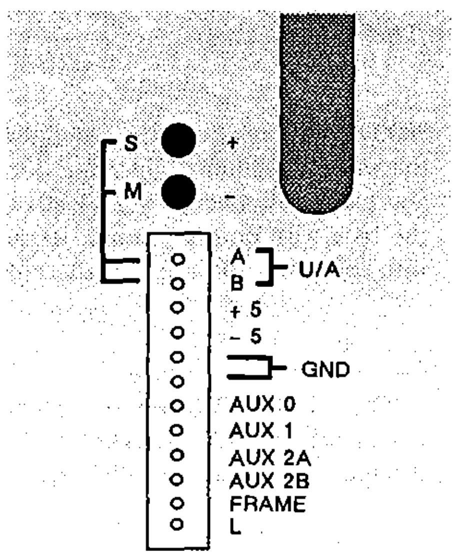


Figure 47-3 A separate column of patch jacks provides UA input and ten special output jacks.

Below the UA input are ten more patch jacks. See Figure 47-3. The first nine are output jacks. Two of the outputs supply +5 V and -5 V, respectively, through 1-kohm resistors.

The 5 V output pins may be used to patch steady spaces or marks out to the interface-access leads. For A-lead patching, +5 V is a space, and -5 V is a mark. For balanced patching, orienting both ends of the patch the same way (yellow on top, for instance) will output a space or *on* signal; while turning either end of the patch over will output a mark or *off* signal.

The third and fourth output pins are at signal ground. These are provided for balanced or unbalanced use.

The next four jacks allow you to patch the output of three auxiliary V.35 drivers that are controlled by trigger actions on the Protocol Spreadsheet and by selections on the Interface Control menu. Refer back to Sections 12.5 and 12.6 of the manual for a discussion of program control over AUX outputs.

Patch the AUX 0 and AUX 1 output jacks to *un*balanced leads that you wish to control via the program. Then use the AUX 0 and AUX 1 selections on the Protocol Spreadsheet and the Interface Control menu (refer to Figure 12-8 and Figure 12-14 in a previous section) to drive these leads on and off. AUX 2 on the spreadsheet and on the Interface Control menu controls the *balanced* output jacks AUX 2A and AUX 2B on the TIM.

> NOTE: The AUX pins on the test-interface module have nothing to do with the 25-pin TTL AUXILIARY connector on the rear of the unit.

The bottom pin in the input-output area of the TIM is a test point for pin L on the V.35 connectors. This is an unbalanced signal that is "reserved for future international use."

47.5 Screen Display of Lead Status

Five V.35 control leads can be selected for a data-plus-leads display, in which the control leads are represented by two-state timing lines drawn beneath TX and RX data. See Section 6.3(B).

47.6 Monitoring V.35 Control Leads

The status of seven V.35 leads can be tested by triggers. The leads are RTS, CTS, CD, DTR, DSR, RI, and a lead of the user's choosing patched to the UA-input jack (see 47.4 above). The status of the lead may be made a trigger-menu condition or a Spreadsheet condition.

47.7 Control of Lead Activity in Emulate Modes

Section 12 discussed the user's control over the standard (RS-232/V.24) interface in emulate modes. The mechanisms for this control were (1) actions on the Protocol Spreadsheet and (2) fields on the Interface Control menu. Refer to Sections 12.5 and 12.6. The same mechanisms apply in the same way to V.35.

48 RS–449

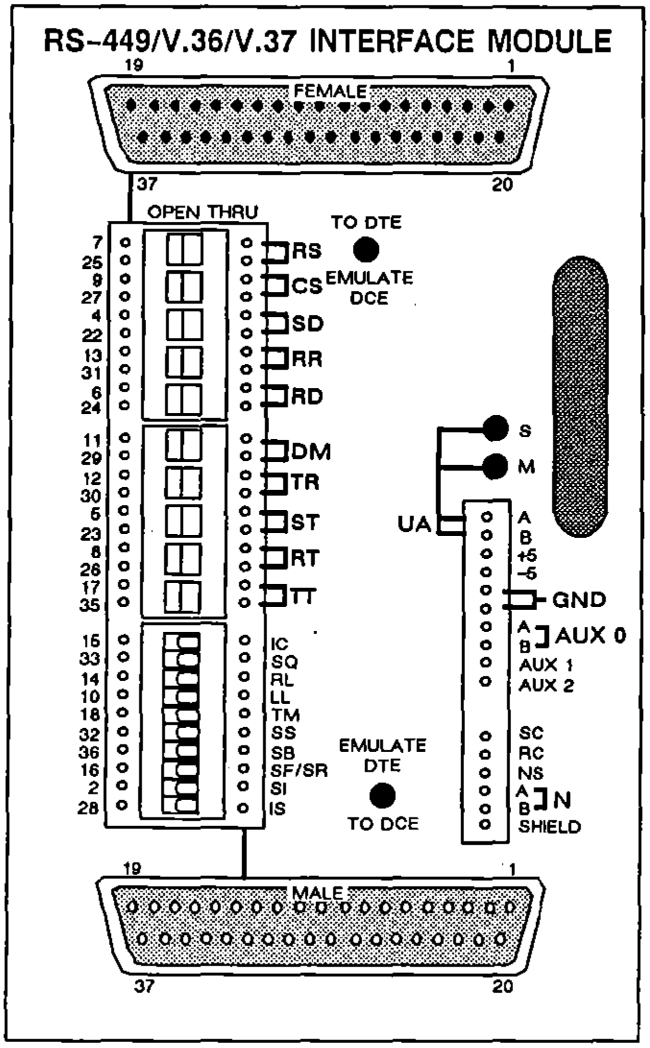


Figure 48-1 RS-449/V.36/V.37 Interface Module.

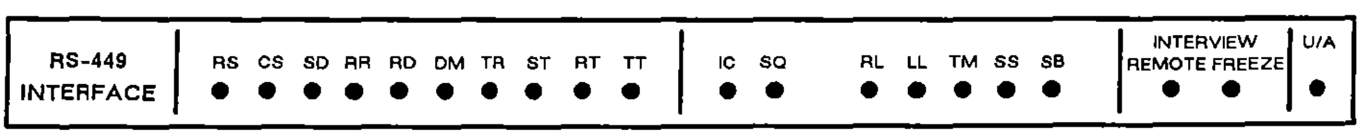


Figure 48-2 RS-449/V.36/V.37 LED Overlay.

48 RS-449

Figure 48-1 and Figure 48-2 show the TIM and the LED overlay for the RS-449/V.36/V.37 interface. Once the RS-449 module is installed, the following EIA functions are enabled:

- Ten balanced data, control, and clock circuits and seven single-wire, unbalanced control leads can be monitored on the front-panel green-red LEDs.
- Twenty RS-449 circuits can be switched, patched, and tested on the breakout box on the module.
- Up to five control circuits can be selected for real-time screen display.
- Seven control circuits can be monitored by menu and spreadsheet triggers.
- Five two-wire, balanced control circuits, one two-wire, balanced auxiliary circuit, and two single-wire, unbalanced auxiliary leads come under spreadsheet *control* in emulate modes.
- Also in emulate modes, five two-wire, balanced control circuits, one balanced, two-wire auxiliary circuit, two single-wire, unbalanced auxiliary leads, six RS-CS handshake timers, and two transmit delays can be regulated via an Interface Control menu screen.

48.1 Connectors

When you break a data line for testing, you may connect one end of the line to the TO DTE connector on the TIM (see top of Figure 48-1). Connect the other end of the line to the TO DCE connector on the TIM. Even when the INTERVIEW is powered off, this provides a through connection for the data line.

When **Mode:** MONITOR or AUTOMONITOR is the program selection, the INTERVIEW monitors data passively through either (or both) TO connectors on the TIM.

When the INTERVIEW is operating in EMULATE DCE mode (selected on the Line Setup menu), the EMULATE DCE LED on the TIM is red. This indicates that the TO DTE connector is active. The INTERVIEW is transmitting and receiving data through the TO DTE connector.

When **Mode:** EMULATE DTE is the program selection, the unit transmits and receives data through the TO DCE connector. The EMULATE DTE LED is red, and the EMULATE DCE LED is off.

CAUTION: To connect the data line, you must interrupt the flow of data on the line. Be sure you have permission to break the line before doing so.

48.2 Green-Red LEDs

The RS-449 LED overlay (Figure 48-2) identifies twenty LED indicators. Seventeen of these represent RS-449 circuits monitored at either of the line interfaces (TO DTE, TO DCE) on the test-interface module. An LED is dark when the unit is off, green when the unit is powered on but the lead is off or unterminated and red when the lead is at or above the *on* threshold.

For two-wire, balanced circuits, LEDs are red *(on)* for relative voltages of A over B of over +0.3 V. For single-wire, unbalanced leads, the indicators go red at signals more positive than +3 V with respect to signal ground.

Two of the LEDs switch to red when the unit is in a special mode, Remote mode or Freeze mode. Remote means that the unit is *under* remote control via the REMOTE port. The remote-control feature is a future enhancement.

The final LED label on the right end of the overlay is UA (user assigned). This LED monitors any lead or twisted pair of leads patched to the UA-input jack(s) on the module. See Figure 48-3. Any of the RS-449 circuits that are not accounted for on the front overlay can be assigned to this LED by the user.

It is important to note that the front-panel LED indicators always reflect TIM activity. If the LEDs are active while data is being played back from disk, the activity is on the line, not in the data stored on the disk. Playback data may activate triggers that monitor interface leads, and it may generate a data-plus-leads display; but playback data never drives the green-red LEDs.

48.3 Breakout Box

The INTERVIEW is tied to the digital communications line by two cable-connections on the interface module, one cable going to the DTE and one to the DCE. Refer to Section 48.1. In between the two cables are the INTERVIEW's drivers and receivers and, on the face of the module, a breakout area. The breakout area has a column of switches that allows any RS-449 circuit to be opened, and two columns of patch jacks that allow circuits to be rerouted by patch cords.

Figure 12-3 in a previous section illustrated the position of the INTERVIEW's receivers and high-impedance monitors relative to the breakout and patching area of any TIM (including RS-449) when signals are moving across the interface module under two different emulate conditions (driving and receiving) and in Monitor mode. *Note that an opened switch will have a different effect on the screen display and LED display of signals depending on the test mode.*

The top ten DIP switches on the breakout box (Figure 48-1) correspond to the RS-449 balanced two-wire circuits. RS-449 balanced circuits currently defined are the following, with their pin designators in parentheses: RS (7, 25), CS (9, 27), SD (4, 22), RR (13, 31), RD (6, 24), DM (11, 29), TR (12, 30), ST (5, 23), RT (8, 26), and TT (17, 35).

The next ten DIP switches on the breakout box correspond to RS-449 unbalanced leads. They are IC (15), SQ (33), RL (14), LL (10), TM (18), SS (32), SB (36), SF/SR (16), SI (2), and IS (28).

The DIP switches conduct signals straight through, or they open the circuits so that you can reroute them using one of the twisted-pair patch cords provided with the RS-449 module. You may patch any of these pairs of leads to the leads on the opposite side of the DIP switches, or to the input or output jacks in the UA-input area on the TIM (Figure 48-3).

> NOTE: Always keep the colors of the twisted pair oriented in the same direction to maintain correct balance. For example, if you patch one pair of RS-449 leads with the yellow wire on top and the blue wire on the bottom, be sure to connect the other end with the yellow on top and the blue on the bottom.

> NOTE ALSO: Patching or switching the leads on the front panel can affect not only the received data but also the actual data on the line, *even when the INTERVIEW is in Monitor mode*.

Off to the right of the breakout area is a single column of patch pins without DIP switches. Included in this column are three additional RS-449 unbalanced leads: SC (37), RC (20), and NS (34).

Also included among the patch pins at the lower right is one balanced two-wire circuit, N (3, 21). *N* stands for national. This circuit is reserved permanently for national use.

48.4 Special Input and Output Pins

Off to the right of the breakout area are two LEDs and another column of patch pins. The LEDs are a voltmeter for any unbalanced lead or balanced pair of leads patched to one or both top pins (A and B) on the pin column. These are the user-assigned inputs. The LEDs light when the input exceeds the input thresholds. For balanced signals patched to the A and B jacks, the red + LED will go on for relative voltages of A over B of over + 0.3 V (*S*pace). The green - LED will light for relative voltages of A over B of -0.3 V (*M*ark).

For unbalanced leads, use only the A jack for patching. When a signal is patched to the A jack only, B is assumed to be signal ground. The *on* threshold for the red + LED in that case is +3 V, and -3 V for the green - LED.

CAUTION: For unbalanced signals, patch only into pin A on the user-assigned input: never use pin B.

The INTERVIEW's triggers can monitor the unassigned input, and actions can be initiated when the signal crosses the appropriate threshold (+3 V for unbalanced RS-449 signals, or relative +0.3 V for balanced RS-449 signals).

The user-assigned input can also catch glitches on any interface lead. Whenever the voltage crosses the +3 V threshold on an unbalanced lead or the +0.3 threshold (A over B) on a balanced circuit for at least one microsecond, the input latches until the trigger logic (the UA field on interface conditions) can check it.

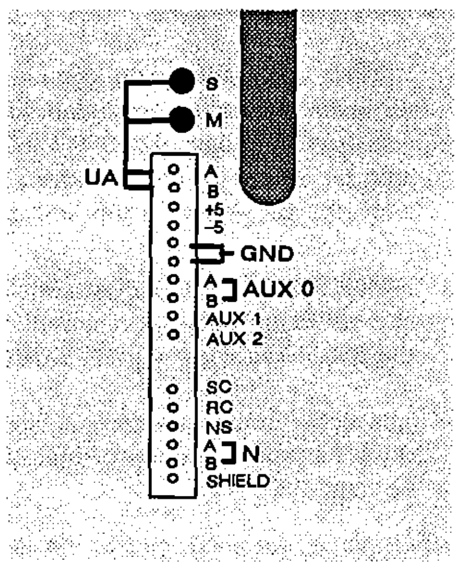


Figure 48-3 A separate column of patch jacks provides UA input and fourteen special jacks.

Below the UA input are fourteen more patch jacks. See Figure 48-3. The first eight are output jacks. Two of the outputs supply +5 V and –5 V, respectively, through 1-kohm resistors.

The 5 V output pins may be used to patch steady spaces or marks out to the interface-access leads. For A-lead patching, +5 V is a space, and –5 V is a mark. For balanced patching, orienting both ends of the patch the same way (yellow on top, for instance) will output a space or *on* signal; while turning either end of the patch over will output a mark or *off* signal.

The third and fourth output pins are at signal ground. These are provided for balanced or unbalanced use.

The next four jacks allow you to patch the output of three auxiliary RS-449 drivers that are controlled by trigger actions on the Protocol Spreadsheet and by selections on the Interface Control menu. Refer back to Sections 12.5 and 12.6 of the manual for a discussion of program control over AUX outputs.

Patch the AUX 0A and AUX 0B output jacks to *balanced* leads that you wish to control via the program. Then use the AUX 0 selection on the Protocol Spreadsheet and the Interface Control menu (refer to Figure 12-8 and Figure 12-14 in a previous section) to drive this circuit on and off. AUX 1 and AUX 2 on the spreadsheet and on the Interface Control menu controls the *unbalanced* output jacks AUX 1 and AUX 2 on the TIM.

> **NOTE:** The AUX pins on the test-interface module have nothing to do with the 25-pin TTL AUXILIARY connector on the rear of the unit.

Below the output area of the pin column are test points for five additional RS-449 unbalanced leads: SC (37), RC (20), NS (34), and N (3, 21). Frame ground is provided by the bottom pin in the column.

48.5 Screen Display of Lead Status

Five RS-449 control leads can be selected for a data-plus-leads display, in which the control leads are represented by two-state timing lines drawn beneath TX and RX data. See Section 6.3(B). The Display Setup menu and the data-plus-leads screen use the RS-232 names for leads. Consult Table 48-1 for the appropriate lead-name conversions.

Table 48-1
RS-449/RS-232 Conversion for Display and Triggering

To test or display this RS-449 lead . . .	. . . select this RS-232 lead on menu or spreadsheet
RS	RTS
CS	CTS
RR	CD
DM	DSR
TR	DTR
(SD	TD)
(RD	RD)

48.6 Monitoring RS-449 Control Leads

The status of seven RS-449 leads can be tested by triggers. The leads are RS, CS, RR, TR, DM, IC, and a lead of the user's choosing patched to the UA-input jack (see Section 48.4 above). The status of the lead may be made a trigger-menu condition or a Spreadsheet condition. The trigger menus and the spreadsheet "tokens" use RS-232 circuit names: refer to Table 48-1 for the circuit-name conversions.

48.7 Control of Lead Activity in Emulate Modes

Section 12 discussed the user's control over the standard (RS-232/V.24) interface in emulate modes. The mechanisms for this control were (1) actions on the Protocol Spreadsheet and (2) fields on the Interface Control menu. Refer to Sections 12.5 and 12.6. The same mechanisms apply in the same way to RS-449.

49 X.21

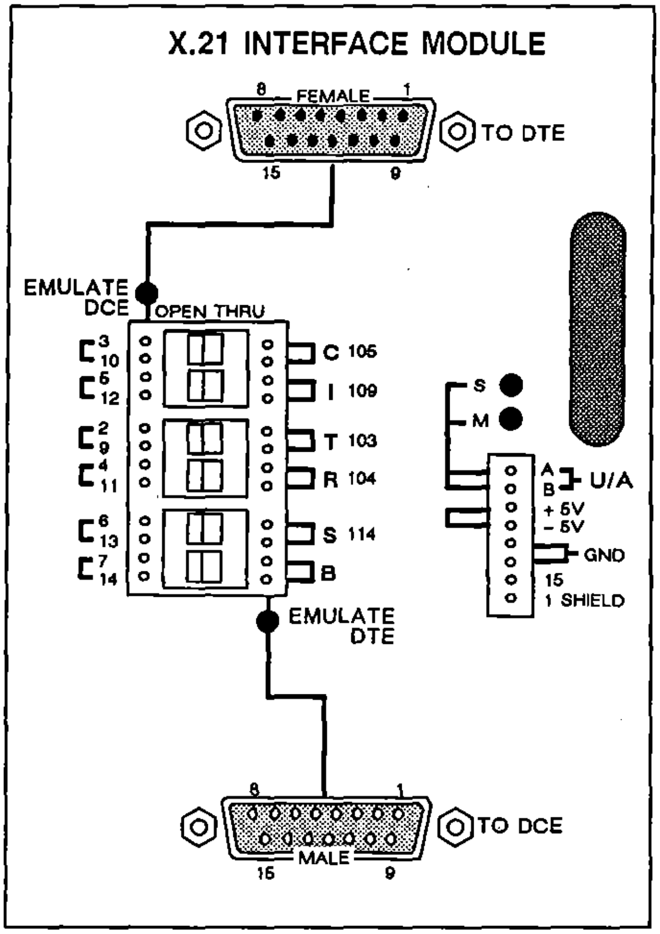


Figure 49-1 X.21 Interface Module.

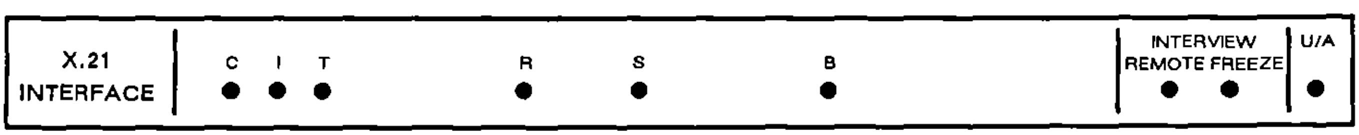


Figure 49-2 X.21 LED Overlay.

49 X.21

Figure 49-1 and Figure 49-2 show the TIM and LED overlay for the X.21 interface. Once the X.21 module is installed, the following functions are enabled:

- The six balanced data, control, and clock circuits can be monitored on the front-panel, green–red LEDs.
- Six X.21 circuits can be switched, patched, and tested on the breakout box on the module.
- C and I control leads can be selected for real–time screen display.
- When the X.21 layer-personality package has been loaded in from the Layer Setup screen or from a previously stored program, four data and control leads and a fifth, user–assigned lead can be monitored by spreadsheet trigger.
- When the X.21 layer package has been loaded, T and C (or R and I) come under spreadsheet control in emulate modes.
- The initial line-setup phase—Call Setup phase or Data Transfer phase—can be controlled via an Interface Control menu screen.

49.1 Connectors

When you break a data line for testing, you may connect one end of the line to the TO DTE connector on the TIM (see top of Figure 49-1). Connect the other end of the line to the TO DCE connector on the TIM. Even when the INTERVIEW is powered off, this provides a through connection for the data line.

When **Mode:** MONITOR or AUTOMONITOR is the program selection, the INTERVIEW monitors data passively through either (or both) TO connectors on the TIM.

When the INTERVIEW is operating in EMULATE DCE mode (selected on the Line Setup menu), the EMULATE DCE LED on the TIM is red. This indicates that the TO DTE connector is active. The INTERVIEW is transmitting and receiving data through the TO DTE connector.

When Mode: EMULATE DTE is the program selection, the unit transmits and receives data through the TO DCE connector. The EMULATE DTE LED is red, and the EMULATE DCE LED is off.

> *CAUTION: To connect the data line, you must interrupt the flow of data on the line. Be sure you have permission to break the line before doing so.*

49.2 Green-Red LEDs

The X.21 LED overlay (Figure 49-2) identifies nine LED indicators. Six of these represent X.21 circuits monitored at either of the line interfaces (TO DTE, TO DCE) on the test-interface module. An LED is dark when the unit is off, green when the unit is powered on but the lead is off or unterminated and red when the lead is at or above the *on* threshold.

For two-wire, balanced X.21 circuits, LEDs are red (*on*) for relative voltages of A over B of over +0.3 V.

Two of the LEDs switch to red when the unit is in a special mode, Remote mode or Freeze mode. Remote means that the unit is *under* remote control via the REMOTE port. (The remote-control feature is not implemented.)

The final LED label on the right end of the overlay is UA (user assigned). This LED monitors any twisted pair of leads patched to the UA-input jacks on the module. See Figure 49-3. A circuit patched to the UA inputs can be tested by the program in Run mode via a LEADS UA ON/OFF condition on the Protocol Spreadsheet (see Section 35).

It is important to note that the front-panel LED indicators always reflect TIM activity. If the LEDs are active while data is being played back from disk, the activity is on the line, not in the data stored on the disk. Playback data may activate triggers that monitor interface leads, and it may generate a data-plus-leads display; but playback data never drives the green-red LEDs.

49.3 Breakout Box

The INTERVIEW is tied to the digital communications line by two cable-connections on the interface module, one cable going to the DTE and one to the DCE. Refer to Section 49.1. In between the two cables are the INTERVIEW's drivers and receivers and, on the face of the module, a breakout area. The breakout area has a column of switches that allows any X.21 circuit to be opened, and two columns of patch jacks that allow circuits to be rerouted by patch cords.

Figure 12-3 in a previous section illustrated the position of the INTERVIEW's receivers and high-impedance monitors relative to the breakout and patching area of any TIM (including X.21) when signals are moving across the interface module under two different emulate conditions (driving and receiving) and in Monitor mode. *Note that an opened switch will have a different effect on the screen display and LED display of signals depending on the test mode.*

The six DIP switches on the breakout box (Figure 49-1) correspond to the X.21 balanced two-wire (control, data, and clock) circuits. X.21 circuits are the following, with their pin designators in parentheses: C (3, 10), I (5, 12), T (2, 9), R (4, 11), S (6, 13), and B (7, 14). C and I are control circuits. T and R are data circuits. S and B are clock circuits.

The DIP switches conduct signals straight through, or they open the circuits so that you can reroute them using one of the twisted-pair patch cords provided with the X.21 module. You may patch any of these pairs of leads to the leads on the opposite side of the DIP switches, or to the input or output jacks in the UA-input area on the TIM (Figure 49-3).

> NOTE: Always keep the colors of the twisted pair oriented in the same direction to maintain correct balance. For example, if you patch one pair of X.21 leads with the yellow wire on top and the blue wire on the bottom, be sure to connect the other end with the yellow on top and the blue on the bottom.

> NOTE ALSO: Patching or switching the leads on the front panel can affect not only the received data but also the actual data on the line, *even when the INTERVIEW is in Monitor mode.*

49.4 Special Input and Output Pins

Off to the right of the breakout area are two LEDs and another column of patch pins. The LEDs are a voltmeter for any balanced pair of leads patched to both top pins (A and B) on the pin column. These are the user-assigned inputs. The LEDs light when the input exceeds the input thresholds. For balanced signals patched to the A and B jacks, the red + LED will go on for relative voltages of A over B of over + 0.3 V (*S*pace). The green - LED will light for relative voltages of A over B of -0.3 V (*M*ark).

The INTERVIEW's triggers can monitor the unassigned input, and actions can be initiated when the signal crosses the appropriate threshold (relative +0.3 V for balanced X.21 signals).

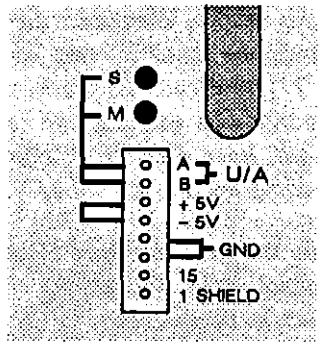


Figure 49-3 A special column of patch jacks provides UA input, positive and negative output jacks, two electrical grounds, a test point for pin 15, and case ground.

CAUTION: For unbalanced signals, patch only into pin A on the user-assigned input: never use pin B.

The user-assigned input can also catch glitches on any interface lead. Whenever the voltage crosses the +0.3 threshold (A over B) for at least one microsecond, the input latches until the trigger logic (the UA field on interface conditions) can check it.

Below the UA input are six more patch jacks. See Figure 49-3. The first two are output jacks that supply +5 V and -5 V, respectively, through 1-kohm resistors.

The 5 V output pins may be used to patch steady spaces or marks out to the interface-access leads. For balanced patching, orienting both ends of the patch the same way (yellow on top, for instance) will output a space or *on* signal; while turning either end of the patch over will output a mark or *off* signal.

The third and fourth pins are at signal ground.

The next to last pin on the special column is a test point for pin 15 on the X.21 connectors.

The bottom pin in the input-output area of the TIM is case ground.

49.5 Screen Display of Lead Status

C and I control leads can be selected for a data-plus-leads display, in which the control leads are represented by two-state timing lines drawn beneath T and R data.

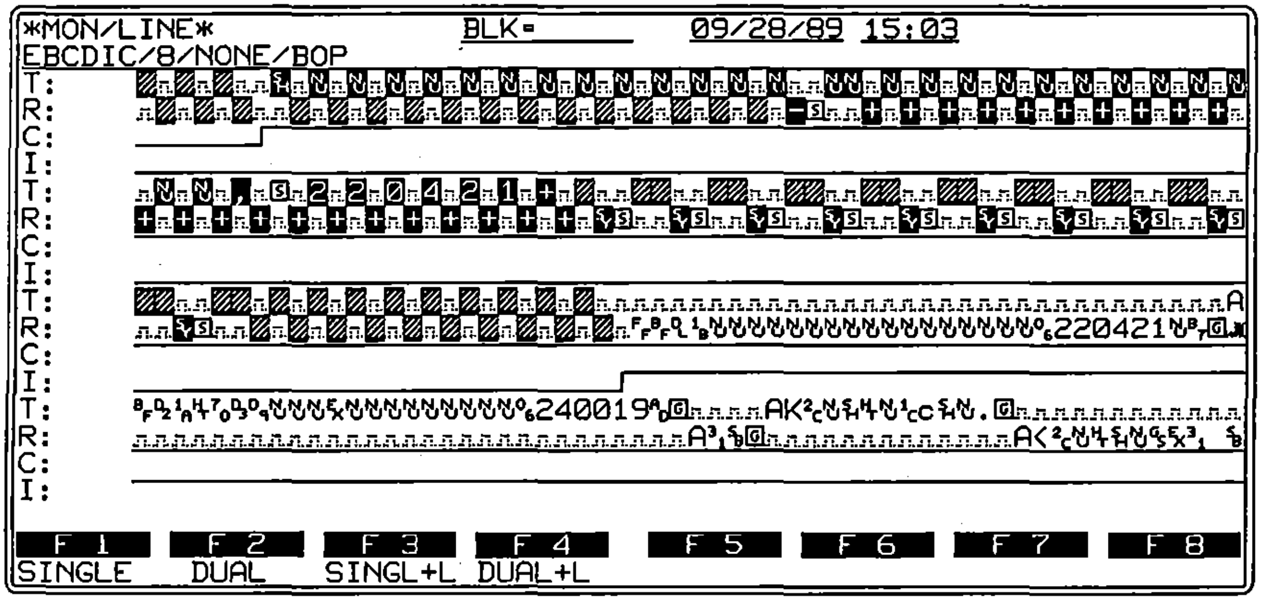


Figure 49-4 Control-lead transitions are displayable: in this example, C transitions high to indicate Call Request and I goes high to signal Ready for Data.

By pushing the Run-mode softkey labeled SINGL+L or DUAL+L (see Section 6), the user can monitor not only T and R display, but also a timing pattern for C and I control leads. A display of single-line data plus control leads is illustrated in Figure 49-4. The two states of the timing pattern can be defined in visual terms as low/high, in *CCITT Recommendation X.21* terms as off/on, and in electrical terms as minus/plus voltage.

Control leads are selected for display on the Display Setup menu. EIA leads available for screen monitoring are C and I (selectable as a pair). See Figure 49-5 for the single selection subfield under **Type:** DATA+LEADS.

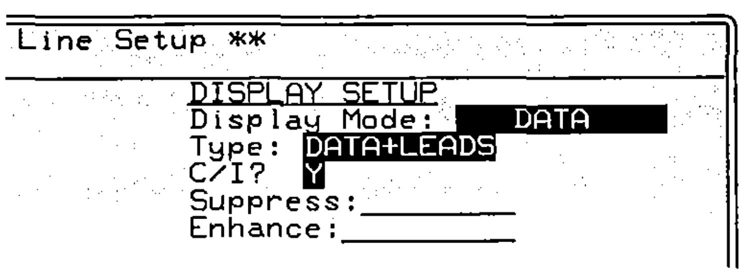


Figure 49-5 Two X.21 control leads are selectable under *Type: DATA+LEADS.*

If control leads are not set to be buffered on the Front-End Buffer Setup screen, control-lead status will not be available for data-plus-leads display and triggering. See Section 9.1(B) on buffering control leads.

A full set of leads is written to the bottom of the sixteen-line display area only if it fits completely. A full set is one or two lines of T/R data (with R underlined) and separate state-and-timing lines for C and I if specified previously on the Display Setup menu. For SINGL+L display, five full sets of data leads plus control leads will be accommodated on the display at one time. For DUAL+L display, four sets of leads will be displayed on one screen (as in Figure 49-4).

The purpose of the data-plus-leads display is to show the *sequence* of events. Two data bytes (or a data byte and a control-lead transition) are never displayed in the same vertical column. Otherwise, the order of their occurrence would be lost to the display. Even if the events were detected a millisecond or a microsecond apart, they are displayed in sequence.

Precise timing intervals, to a resolution of ten microseconds, between lead and data and between two leads can be attained both for live and recorded data with a simple trigger program that uses timers or via cursor timing in the data-plus-leads display. Timer increments are discussed in Section 9, FEB Setup, and Section 20, Tabular Statistics.

49.6 Monitoring X.21 Control Leads

The status of both X.21 data leads and both control leads can be tested by conditions on the Protocol Spreadsheet. These conditions are described in detail in Section 35.4. The leads are T, C, R, and I, plus a lead of the user's choosing patched to the UA-input jack (see Section 49.4 above).

49.7 Control of Lead Activity in Emulate Modes

After loading in the layer-personality package for X.21, the user may control one side of the X.21 interface in emulate modes. The mechanisms for this control are actions on the Protocol Spreadsheet. See Section 35 for an explanation of the X.21 protocol package.

49.8 Interface Control Menu Screen

Figure 49-6 shows the programming selections on the Interface Control menu screen for X.21.

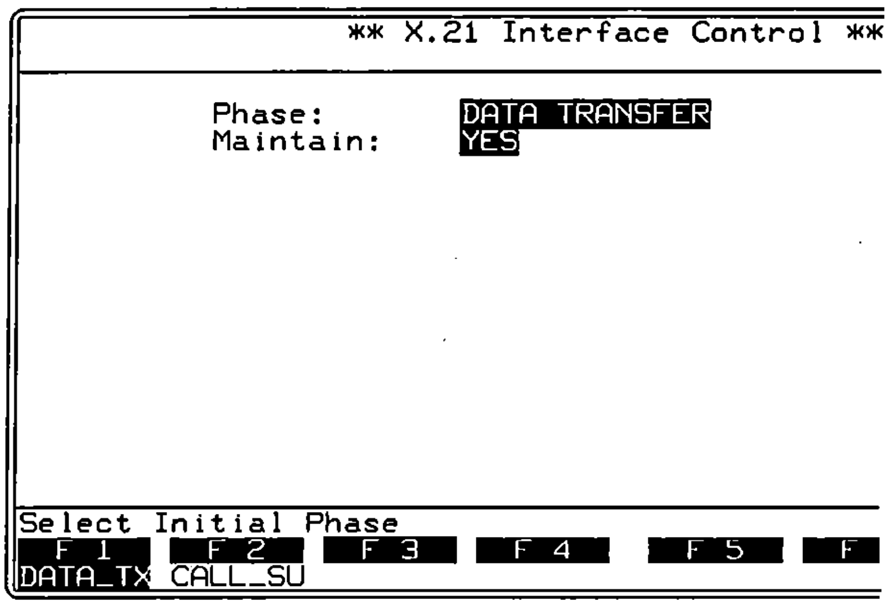


Figure 49-6 On the Interface Control menu, lead status can be maintained during Program mode and initial line-setup status can be specified.

(A) Initial Phase

In order to monitor and transmit X.21 data and higher-level data correctly without exiting Run mode and reconfiguring the line setup, the X.21 layer package provides two different "phases" of the transmitter and the receivers. These phases are called call setup and data transfer, and they may be programmed via softkey as spreadsheet actions. See Section 35.5(C).

The initial configuration phase that the program adopts upon entering Run mode is selectable on the X.21 Interface Control setup menu. See Figure 49-6. The default program-initiating phase is data transfer.

When the program is in call-setup phase, data is monitored and sent according to the following format and code: ASCII code, $^{S}_{Y}{}^{S}_{Y}$ sync pattern, 7 data bits, odd parity, no BCC. In data-transfer phase, the format and code are as defined by the user on the Line Setup menu.

(B) Maintain Lead Status

Maintain: YES allows you to preserve the current lead status even after exiting Run mode. Use this selection when, for example, you want to remain in data-transfer phase while you go into the Protocol Spreadsheet and revise the upper-layer program.

If you select **Maintain:** NO, all interface leads will be reset to the *off* voltage each time the unit leaves Run mode.

50 RS–485

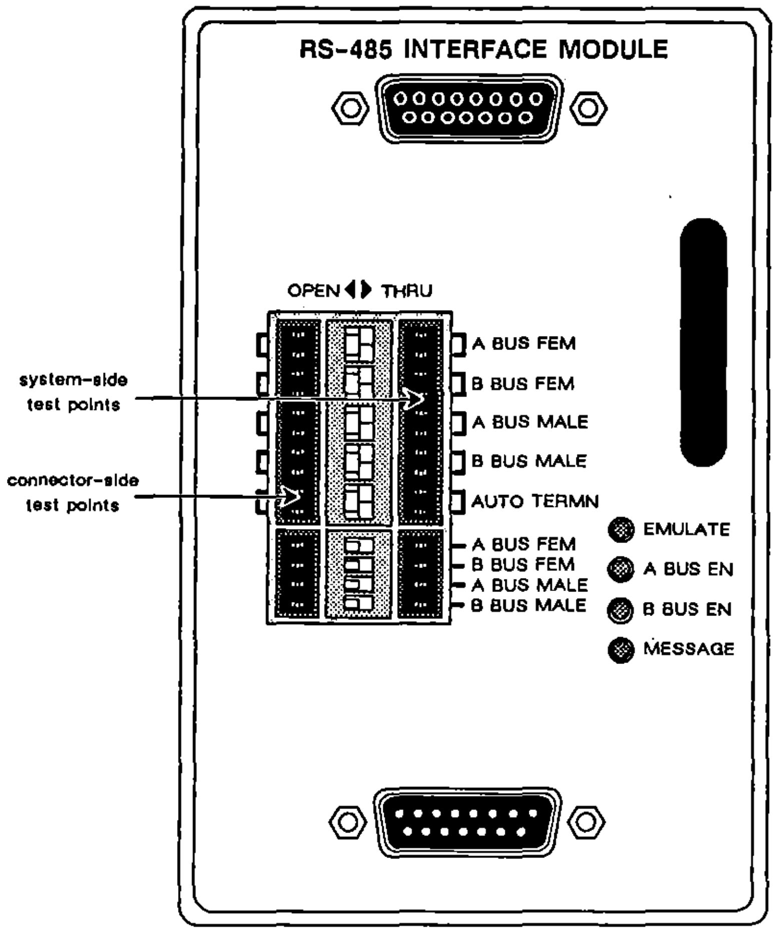


Figure 50-1 RS-485 Interface Module.

50 RS–485

RS–485 is a dual tri–state bus interface designed to operate to the British Telecom Specification RC–8245.

50.1 RS–485 Test Interface Module

Figure 50-1 shows the TIM for the RS–485 interface. **With the unit powered off**, insert the TIM into the module slot at the rear of the unit and press until it latches. After booting, the start–up screen will show RC–8245 as the installed TIM.

(A) Connectors

The connectors on the RS–485 TIM provide access to either (or both) bus(es). Use the connector(s) to monitor or emulate on either bus *without breaking the circuit*. If you do break a data line for testing, connect one end of the line to the female (top) connector on the TIM (Figure 50-1). Connect the other end of the line to the male (bottom) connector on the TIM. Even when the INTERVIEW is powered off, this provides a through connection for the data line. (For connector pin–designations, consult Table I–8.)

CAUTION: If you must interrupt the flow of data on the line, be sure you have permission to break the line before doing so.

When **Mode:** MONITOR or AUTOMONITOR is the program selection, the INTERVIEW only monitors data passively through the connector(s) on the TIM.

When **Mode:** EMULATE DTE is the program selection, the INTERVIEW can also transmit data through the connector(s). EMULATE DCE is not a valid selection since RS–485 does not have one–to–one DCE to DTE connections.

(B) Breakout Box

The INTERVIEW is tied to the digital communications line by the two cable connections on the interface module. Refer to Section (A) above. In between the cables are the INTERVIEW's drivers and receivers and, on the face of the module, a breakout area. The TIM in Figure 50-1 shows the normal settings for all DIP switches.

The top four DIP switches on the breakout box control the two RS-485 balanced, dual-lead data circuits. In the THRU position, the DIP switches conduct signals straight through to the connectors. When OPEN, as in Figure 50-2, either bus may be disconnected at the female or male (or both) connector(s). To access two (logically) separate devices, for example, OPEN the A BUS FEM and B BUS MALE (or the A BUS MALE and B BUS FEM) switches.

NOTE: The DIP switches do not control the A BUS EN and B BUS EN LEDs to the right of the breakout box. The buses are enabled/disabled via the RTS and DTR control leads.

When the INTERVIEW is in emulate mode and the AUTO TERMN switch is in the THRU position, 130-ohm resistors will automatically be placed across the buses when the INTERVIEW enters Run mode. The resistors remain in place until a monitor-mode program is run.

When the AUTO TERMN switch is THRU, the four single-pole switches at the bottom of the breakout box should be OPEN, as shown in Figure 50-2. To selectively terminate the bus(es) at a given connector, first OPEN the AUTO TERMN switch. Then set the appropriate connector-termination switch(es) to THRU.

Figure 50-2 also shows the logical location of the RS-485 TIM's test points. (Refer to Figure 50-1 for the physical location of the test points on the TIM.) Access these test points or reroute the circuits using one of the twisted-pair patch cords provided with the RS-485 module.

NOTE: Always keep the colors of the twisted pair oriented in the same direction to maintain correct balance. For example, if you patch one pair of RS-485 leads with the yellow wire on top and the blue wire on the bottom, be sure to connect the other end with the yellow on top and the blue on the bottom.

NOTE ALSO: Patching or switching the leads on the front panel can affect not only the received data but also the actual data on the line, *even when the INTERVIEW is in Monitor mode.*

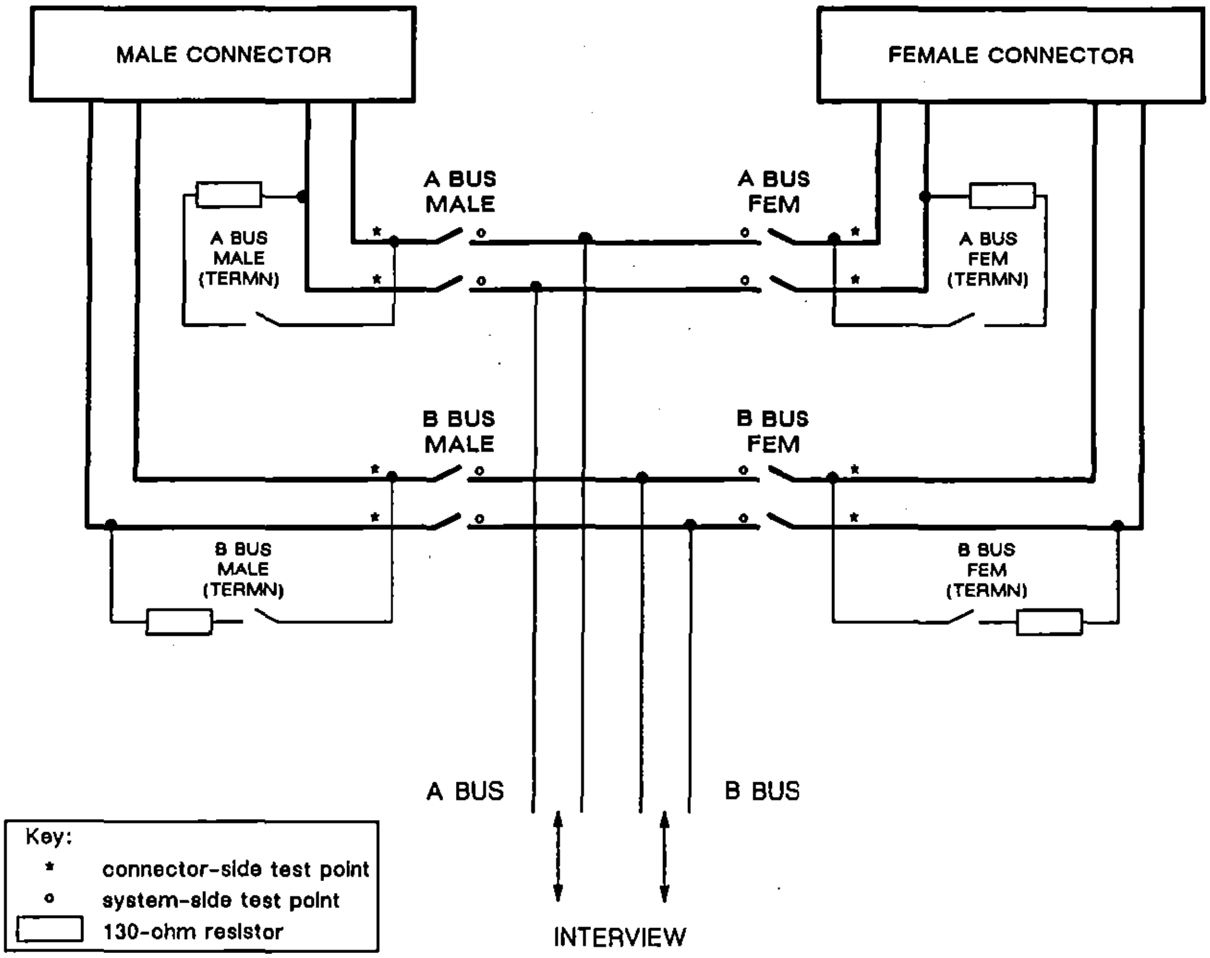


Figure 50-2 There is a pair of DIP switches for each bus. One switch controls the connection from the bus to the female connector; the other controls the connection to the male connector. When the *AUTO TERMN* switch is *OPEN*, use the four connector-termination switches (located below the *AUTO TERMN* switch on the TIM) to selectively place 130-ohm resistors across the balanced buses. To illustrate their positions, all switches in this figure are *OPEN*.

(C) LEDs

Off to the right of the breakout area are four LEDs. The top LED is on (red) when the Line Setup menu is configured to emulate DTE.

The next two LEDs, A BUS EN and B BUS EN, indicate which bus has been enabled/disabled via the Interface Control Screen, a spreadsheet EIA action, or the C *ctl_eia* routine. The default is both buses enabled. An "on" status for either of these LEDs means only that a bus is enabled, not that a driver has been activated. The status of the control leads, moreover, does not effect what is monitored.

Finally, the MESSAGE LED lights only when the line drivers are activated during an actual transmission. At higher speeds, rapid transition between on and off may cause the MESSAGE LED to appear constantly on. The MESSAGE LED, however, should not actually remain on between transmissions. If it does, return to monitor mode.

(D) TIM Operation

With an RS-485 TIM installed and the Line Setup menu configured appropriately for emulate mode (see Section 50.2(A) below), the INTERVIEW outputs a constant stream of flags. In accordance with RC-8245 protocol, however, the TIM limits the number of flags output to the line. In this HDLC protocol, three flags precede and one flag follows each message.

The RS-485 TIM detects the presence of data messages transmitted by the INTERVIEW (the result of spreadsheet SEND actions or C transmit routines). Only then does the TIM activate the drivers to allow transmission of three leading flags, the message, and one trailing flag. As soon as the transmission is complete, the TIM returns the drivers to their tri-state mode.

Excluding protocol flags, the minimum length of a message is four bytes. A message with fewer bytes causes the drivers to tri-state too early, resulting in an incomplete message.

50.2 Program Setup

(A) Line Setup

With the RS-485 TIM installed, make the following selections on the Line Setup menu:

Mode: MONITOR, AUTOMONITOR, or EMULATE DTE
Format: BOP
Clock Source: INTERNAL
Xmit Idle Char: $^{F}{}_{E}$ (in emulate mode)
Speed: 128000 (maximum speed)
NRZI: YES

(B) Screen Display

On any of the four data-screens, the A bus will be displayed as TD data and the B bus as (underlined) RD data. See Figure 50-3.

Notice in the dual-line display in Figure 50-3 that the INTERVIEW transmits first on both buses simultaneously. Subsequent transmissions alternate between the two buses. Also notice that the only flags in the display are those required for the RC-8245 protocol. All others are automatically suppressed by the TIM. Use the **Suppress** field on Display Setup menu to exclude protocol flags from Run-mode displays.

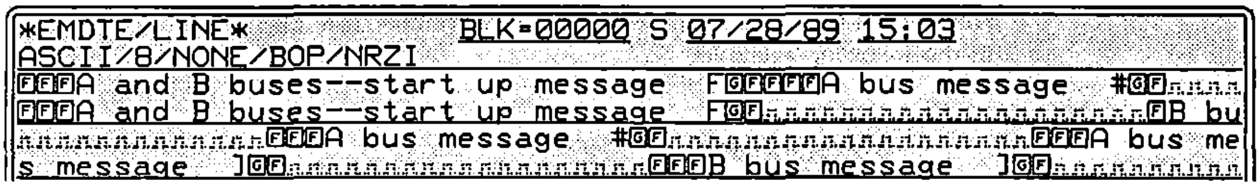


Figure 50-3 In emulate mode, INTERVIEW transmissions on the A bus are displayed as TD data and transmissions on the B bus as RD data. In this figure, the initial message is transmitted on both buses simultaneously. The remaining transmissions alternate between the A and B buses.

(C) Program Control of Buses

The RTS control lead enables/disables the A bus; DTR controls the B bus. The initial condition of RTS and DTR can be set via the Interface Control Screen. See Section 12.6. To programmatically enable/disable the buses, use the EIA action on the Protocol Spreadsheet (or Trigger menu). Consult Section 31.2(B) for more information on the EIA spreadsheet action.

You may transmit messages on an enabled bus via a SEND action (see Section 31.2) or one of the C transmit routines (Section 62.3).

The following program on the Protocol Spreadsheet uses the SEND action to generate the display in Figure 50-3:

```
LAYER: 1
    STATE: transmit
      CONDITIONS: KEYBOARD " "
      ACTIONS: EIA RTS ON DTR ON
        SEND "A and B buses--start up message  " GOOD_BCC
      CONDITIONS: DTE STRING "A and B" WAIT_EOF
      ACTIONS: EIA DTR OFF
        SEND "A bus message  " GOOD_BCC
      CONDITIONS: DTE STRING "A bus" WAIT_EOF
      ACTIONS: EIA RTS OFF DTR ON
        SEND "B bus message  " GOOD_BCC
      CONDITIONS: DCE STRING "B bus" WAIT_EOF
      ACTIONS: EIA RTS ON DTR OFF
        SEND "A bus message  " GOOD_BCC
```

NOTE: Remember that the minimum length of a message is four bytes. Also notice in the example above that the programmer's messages do not include protocol flags.

Accomplish the same result with the *ctl_eia* routine (see also Section 63.2), as in the following example:

```
LAYER: 1
    STATE: transmit
        CONDITIONS: KEYBOARD " "
        ACTIONS:
        {
         ctl_eia(0xfc, 0x00);
        }
          SEND "A and B buses--start up message  " GOOD_BCC
        CONDITIONS: DTE STRING "A and B" WAIT_EOF
        ACTIONS:
        {
         ctl_eia(0xfe, 0x02);
        }
          SEND "A bus message  " GOOD_BCC
        CONDITIONS: DTE STRING "A bus" WAIT_EOF
        ACTIONS:
        {
         ctl_eia(0xfd, 0x01);
        }
          SEND "B bus message  " GOOD_BCC
        CONDITIONS: DCE STRING "B bus" WAIT_EOF
        ACTIONS:
        {
         ctl_eia(0xfe, 0x02);
        }
          SEND "A bus message  " GOOD_BCC
```