

TRANSMISSION SPECIFICATIONS

1. GENERAL INFORMATION1
 Purpose1
 Effectivity1
 Conditions and Terms of Validity1
 Conditions of Measurement1
 References1
2. SPECIFICATIONS2
 VF Level Specifications2
 Noise and Distortion Specifications4
 Echo and Delay Specifications6
 Other Transmission Parameters7
 VB3 Voice Bank Specifications8

1. GENERAL INFORMATION

Purpose

1.01 This section provides the specifications relative to the transmission characteristics of the TRW Vidar Integrated Transmission and Switching (ITS) System.

Effectivity

1.02 The specifications herein are effective for all ITS equipment to be delivered beginning May 1, 1979.

Conditions and Terms of Validity

1.03 All specifications in this section are valid under the following conditions:

- (a) For an operating temperature range of 0° to 60°C (32° to 140°F)
- (b) For twenty (20) years, commencing at initial installation

1.04 The return loss specifications are valid for a maximum loop resistance of 25 ohms from the main distribution frame to any ITS analog input. This input may either be a subscriber terminal or a voice channel unit. The 25-ohm resistance above is for 24-gauge or 22-gauge switchboard cable which meets REA Specification PE-71.

1.05 The line interface specifications are valid for a line current range of 20 to 70 milliamperes.

Conditions of Measurement

1.06 The transmission characteristics of the ITS system relate to and are controlled by the time-division switching process inherent in the system.

1.07 The measurements that establish these specifications are made as follows:

- (a) In analog format at the analog main frame terminations, unless otherwise stated. The digital attenuators are set for 0 dB loss.
- (b) With a normal talk path between terminations, except that the digital attenuators are set for 0 dB loss.

References

1.08 For additional information, measurement methods, and definitions of specifications, refer to the following documents:

- (a) REA Form 522, General Specifications for Digital Stored Program Controlled Central Office Equipment.
- (b) AT&TCo, Notes on Distance Dialing, 1975 edition.
- (c) Record of meeting between USITA Equipment Compatibility Committee and AT&TCo, December 9, 1976. This document is generally referred to as the Digital Loss Plan Workshop record.

2. SPECIFICATIONS

2.01 Tables 1 through 4 list the transmission specifications for the ITS System. Table 5 provides the VB3 voice bank specifications, which are valid for an ambient operating temperature range of 0° to 50°C (32° to 122°F). The end-to-end specifications in Table 5 are based on a connection from one trunk to another of the same type through the ITS switch and apply under the following conditions:

- (a) Each trunk is in a different VB3 voice bank.
- (b) Both trunks are adjusted for -3 dBm input and output levels.
- (c) All signaling bits sent to each end are logic 1 binary bits.

Table 1. VF Level Specifications

1. INSERTION LOSS (TRUNK-TO-TRUNK AND TRUNK-TO-LINE)									
(a)	Trunk insertion loss is measured with a 1004 Hz, 0 dBm input signal at 900 ohms (2-wire trunk ports) or 600 ohms (4-wire trunk ports).								
(b)	Cross-office insertion loss (excluding cabling losses) is as follows:								
	<table border="0"> <thead> <tr> <th style="text-align: center;"><u>Connection</u></th> <th style="text-align: center;"><u>Loss</u></th> </tr> </thead> <tbody> <tr> <td>Digital trunk to digital trunk</td> <td style="text-align: center;">0 dB</td> </tr> <tr> <td>Analog trunk to analog trunk</td> <td style="text-align: center;">0 ±0.5 dB</td> </tr> <tr> <td>Trunk to line</td> <td style="text-align: center;">0 ±0.5 dB</td> </tr> </tbody> </table>	<u>Connection</u>	<u>Loss</u>	Digital trunk to digital trunk	0 dB	Analog trunk to analog trunk	0 ±0.5 dB	Trunk to line	0 ±0.5 dB
<u>Connection</u>	<u>Loss</u>								
Digital trunk to digital trunk	0 dB								
Analog trunk to analog trunk	0 ±0.5 dB								
Trunk to line	0 ±0.5 dB								
	Attenuation is added on receive side by software control.								
(c)	Software-controlled digital attenuators are provided for loss insertion in the receive side of a toll or inter-local connection to a subscriber line. Attenuator loss values are selected to be consistent with connection loss requirements of the Fixed Loss Plan for the Switched Digital Network and compatible with the present Via Net Loss (VNL) Plan. For trunk connections, receive side attenuation values of 0, 3, 5, and 6 dB are implemented in the ITS System.								

Table 1 VF Level Specifications (Cont)

2. INSERTION LOSS (LINE-TO-LINE)

- (a) Line insertion loss is measured with a 1004 Hz, 0 dBm input signal at 900 ohms, excluding cable losses.
- (b) Line cross-office loss (excluding cable losses and digital pad attenuation) is 0 ± 0.5 dB at $25^{\circ} \pm 5^{\circ}\text{C}$ ($77^{\circ} \pm 9^{\circ}\text{F}$).
- (c) Line-to-line attenuation is inserted in association with the use of compromise line hybrid balance circuitry in order to assure adequate singing margins, regardless of line impedance parameters (generally, a function of loading). Compromise networks permit operation with nonsegregated line facilities when 2 dB line-to-line attenuation is used.
 - (1) Line-to-line attenuation of $2 \text{ dB} \pm 0.5$ dB is provided in conjunction with SS20-01 or SS20-03 line circuits by insertion of a 2 dB loss value in the software-controlled digital attenuator [see 1. (c) above].
 - (2) Nominal 0 dB line-to-line loss is planned as a standard ITS System offering. Implementation will require the use of an SS20-02 line circuit, which will incorporate changeable hybrid balance networks to accommodate various line impedance parameters. TRW Vidar will provide availability and specifications upon completion of engineering evaluation and development.
- (d) The long-term variation of line-to-line loss for any one given connection shall not exceed ± 0.5 dB at $25^{\circ} \pm 5^{\circ}\text{C}$ ($77^{\circ} \pm 9^{\circ}\text{F}$).

3. CONTRAST

Between any two connections of the same type, connection loss (excluding cabling loss) shall not differ by more than 1 dB.

4. FREQUENCY RESPONSE

Frequency response is expressed in terms of loss relative to 1004 Hz. That is, (+) indicates more loss, and (-) indicates less loss.

- (a) The trunk-to-trunk response is as follows:

Frequency	Loss at 0 dBm0 Input	
	2-Wire to 2-Wire	4-Wire to 4-Wire
60 Hz	20 dB min. (transmit end)	Greater than 0 dB
180 Hz	0 to 5 dB	0 to 3 dB
300 to 3000 Hz	-0.5 to +1 dB	± 0.3 dB
3300 Hz	1.5 dB maximum	1.5 dB maximum
3400 Hz	0 to 3 dB	0 to 3 dB

Table 1. VF Level Specifications (Cont)

4. FREQUENCY RESPONSE (Cont)

(b) The line-to-line response is as follows:

<u>Frequency</u>	<u>Loss at 0 dBm0 Input</u>
60 Hz	Greater than 20 dB (transmit end)
300 Hz	-1 to +3 dB
600 to 2400 Hz	±1 dB
3200 Hz	-1 to +3 dB

(c) The trunk-to-line frequency response shall be a compromise between the values specified in 4. (a) and (b) above.

(d) **Upper Band Limits** -- The frequencies of 4000 Hz and 4600 Hz shall be attenuated by at least 14 dB and 32 dB, respectively, prior to sampling.

5. INTEROFFICE LEVEL PLANNING

In conformance with the Fixed Loss Plan for the Switched Digital Network, the ITS4 (Class 4) System operates at -3 TLP with TP3 testing. The ITS5 (Class 5) System operates at 0 TLP. Figure F0-1 illustrates various switching/trunking level interfaces. See 1.08 for references.

Table 2. Noise and Distortion Specifications

1. IDLE CHANNEL NOISE (STEADY NOISE)

Idle channel noise is measured on a terminated call (that is, across the ITS System to an off-hook analog termination). The idle channel noise shall be:

- (a) **Maximum** -- 23 dBrc0
- (b) **Average** -- 18 dBrc0
- (c) **3 kHz Flat** -- Less than 35 dBrc0

2. IMPULSE NOISE

The ITS System shall meet an impulse noise limit of not more than five (5) counts exceeding 54 dBrc0, voice bandweighted, in a 5-minute period on six such measurements made during the busy hour. This measurement is made over a line-to-line connection from the impulse noise counter through the ITS System to an analog 900-ohm termination.

Table 2. Noise and Distortion Specifications (Cont)

3. LONGITUDINAL BALANCE

For frequencies of 180, 300, 540, 1004, and 2000 Hz, the minimum balance shall be 60 dB. At 3400 Hz, the minimum shall be 50 dB. The method of measurement shall be as specified in IEEE Standard 455-1976, Standard Testing Procedure for Measuring Longitudinal Balance of Telephone Equipment Operating in the Voice Band.

4. LOW FREQUENCY INDUCTION

Under the configuration of Figure 1 of REA Form 522 (with a 60 Hz sine wave applied longitudinally at a potential of 30 vrms), the maximum system noise shall be 23 dBrc0.

5. LINE-TO-LINE LINEAR CROSSTALK COUPLING

Worst-case equal level linear crosstalk is to be 75 dB minimum in the range of 200 to 3400 Hz. This is to be measured between any two paths through the system connecting a 0 dBm0 level tone to the disturbing pair.

6. NONLINEAR DISTORTION (SINGLE FREQUENCY)

At 0 dBm0, the single frequency distortion is as follows:

<u>Input Frequency</u>	<u>Output Frequency</u>	<u>Signal at any Frequency in Range</u>
0 to 12 kHz	Any	-28 dBm0 maximum
1004 Hz	0 to 4 kHz	-40 dBm0 maximum

7. QUANTIZING DISTORTION

With 1004 Hz input and digital attenuator set at 0 dB, the signal-to-distortion ratio with C-message weighting shall be:

<u>Input Level</u>	<u>S/D Ratio</u>
0 to -30 dBm0	31 dB minimum
-30 to -40 dBm0	25 dB minimum
-40 to -45 dBm0	20 dB minimum

Table 2. Noise and Distortion Specifications (Cont)

8. GAIN TRACKING

With input of 1004 Hz, the maximum gain deviation (relative to 0 dBm0) shall be as follows:

<u>Input Level</u>	<u>Deviation</u>
+3 to -37 dBm0	±0.5 dB
-37 to -50 dBm0	±1 dB

9. OVERLOAD

The overload level at the appropriate impedance for the port being measured shall be +3 dBm0.

Table 3. Echo and Delay Specifications

1. RETURN LOSS

- (a) **Line-to-Line or Line-to-Trunk** -- Measured at 2-wire line port through ITS connection terminated on analog 2-wire port with 900 ohms in series with 2.16 microfarads. Test set hybrid balanced by 900 ohms in series with 2.16 microfarads.
- (1) Echo Return Loss (ERL): 18 dB minimum
 - (2) Singing Return Loss (SRL): 12 dB minimum
- (b) **Trunk-to-Trunk or Trunk-to-Line (2-Wire Trunk)** -- Measured at 2-wire trunk port through ITS connection terminated on analog 2-wire port with 900 ohms in series with 2.16 microfarads. Test set hybrid balanced by internal 900 ohms plus 2.16 microfarad network.
- (1) ERL: 24 dB minimum
 - (2) SRL: 17 dB minimum
- (c) **Trunk-to-Trunk or Trunk-to-Line (4-Wire Trunk)** -- Measured at 4-wire trunk port through ITS connection terminated on analog 2-wire port with 900 ohms in series with 2.16 microfarads.
- (1) ERL: 27 dB minimum
 - (2) SRL: 20 dB minimum

Table 3. Echo and Delay Specifications (Cont)

2. DELAY THROUGH THE ITS SWITCH

(a) The delay through the ITS switch (line-to-line analog at 1800 Hz) is:

- (1) One-Way Delay -- 700 μ sec nominal, 1095 μ sec worst-case
- (2) Round Trip Delay -- 1400 μ sec nominal, 1690 μ sec worst-case

(b) The probability that the one-way delay is greater than 1000 μ sec is less than 6 in one billion (6×10^{-9}).

(c) These delays exclude the delay associated with transmission to remote subscriber switches.

3. ENVELOPE DELAY

Within stated frequency range, the envelope delay distortion (difference in propagation delay across the ITS System between any two frequencies in the range) shall not exceed:

<u>Range</u>	<u>Delay Difference</u>
1000 to 2600 Hz	190 μ sec
800 to 2800 Hz	350 μ sec
600 to 3000 Hz	500 μ sec
400 to 3200 Hz	700 μ sec

Table 4. Other Transmission Parameters

1. CODING LAW

The ITS analog/digital conversion process is based on the $\mu = 255$ segmented (15-segment) coding law.

2. PORT IMPEDANCE

The ITS input impedance is 600 or 900 ohms for 2-wire ports and 600 ohms for 4-wire ports.

3. ERROR RATE

On a digital-to-digital connection, the ITS error rate through the switch (excluding the least significant bit) shall be less than one in 100 million (1×10^{-8}), averaged over a 5-minute period.

Table 5. VB3 Voice Bank Specifications

1. LONGITUDINAL BALANCE

The longitudinal balance specifications are based on testing in accordance with the AT&TCo D3 compatibility specification, Issue 2.

<u>Frequency</u>	<u>Longitudinal Balance</u>	
	<u>4-Wire</u>	<u>2-Wire</u>
200 Hz	86 dB	66 dB
1004 Hz or 1020 Hz	80 dB	60 dB
3000 Hz	78 dB	58 dB

2. FREQUENCY RESPONSE

(a) The 4-wire response specifications are as follows:

<u>Frequency</u>	<u>Gain Relative to Gain at 1 kHz</u>
180 Hz	-3 to 0 dB
300 to 3000 Hz	-0.25 to +0.25 dB
3300 Hz	-1.5 to 0 dB
3400 Hz	-3 to 0 dB

(b) The 2-wire response specifications are as follows:

<u>Frequency</u>	<u>Gain Relative to Gain at 1 kHz</u>
60 Hz	-20 dB maximum
180 Hz	-3 to 0 dB
300 to 3000 Hz	-1 to +0.5 dB

3. IDLE CHANNEL NOISE

25 dBrc0 maximum, with both ends terminated and all trunks idle in associated VB3 voice banks.

4. INTERCHANNEL CROSSTALK LOSS

65 dB minimum, measured with 1004 or 1020 Hz, at 0 dBm0.

5. INTRACHANNEL CROSSTALK LOSS (4-WIRE ONLY)

65 dB minimum, measured with 1004 or 1020 Hz, at 0 dBm0.

Table 5. VB3 Voice Bank Specifications (Cont)

6. SIGNAL-TO-DISTORTION RATIO

This ratio is measured with both ends terminated and all channels idle in associated VB3 voice banks. Also, the input signal is 1020 Hz; distortion is C-message-weighted.

<u>Input</u>	<u>Signal/Distortion Ratio</u>
0 to -30 dBm0	31 dB minimum
-40 dBm0	27 dB minimum
-45 dBm0	22 dB minimum

7. CODEC TRACKING

The codec tracking specification (measured at 1020 Hz) is:

- (a) ±0.5 dB from +3 to -37 dBm0.
- (b) ±1.0 dB from -37 to -50 dBm0.

8. ECHO RETURN LOSS (2-WIRE)

27 dB minimum, at 0 mA loop current.

9. SINGING RETURN LOSS (2- WIRE)

20 dB minimum, at 0 mA loop current.

10. RETURN LOSS (4-WIRE)

The 4-wire return loss is:

- (a) 28 dB minimum, at 1004 or 1020 Hz, at 0 dBm0.
- (b) 23 dB minimum, at 300 to 3000 Hz, at 0 dBm0.

11. IMPULSE NOISE

- (a) **With no signaling** (both ends terminated and all channels idle in associated voice banks), impulse noise is as follows:

<u>Threshold</u>	<u>Counts per 30 Minutes</u>
42 dBrn0 voice weighting	10 maximum
52-dBrn0 voice weighting	1 maximum
59 dBrn0 voice weighting	0.1 maximum

Table 5. VB3 Voice Bank Specifications (Cont)

11. IMPULSE NOISE (Cont)

- (b) With signaling (both ends terminated, any other through channel pulsing at 10 pps, and all other channels idle), impulse noise is as follows:

<u>Threshold</u>	<u>Counts per 5 Minutes</u>
49 dBrn0 voice weighting	5 maximum

12. DELAY DISTORTION

- (a) At -13 dBm0, peak-to-average ratio (par) is a minimum of 94 par units.
 (b) At 0 dBm0, the maximum envelope delay difference of any two frequencies within the following range is:

<u>Frequency Range</u>	<u>Maximum Envelope Delay Difference</u>
1150 to 2300 Hz	150 μ sec
1000 to 2500 Hz	190 μ sec
800 to 2700 Hz	375 μ sec

Note: Circuits meeting (b) above will also meet requirement (a).

13. SINGLE FREQUENCY DISTORTION (AT 0 dBm0)

The maximum signal at any frequency within the output frequency ranges below is:

<u>Input Frequency</u>	<u>Output Frequency</u>	<u>Signal at any Frequency in Range</u>
0 to 12 kHz	Any	-28 dBm0 maximum
1004 Hz	0 to 4 kHz	-40 dBm0 maximum

14. 1 kHz LEVEL STABILITY

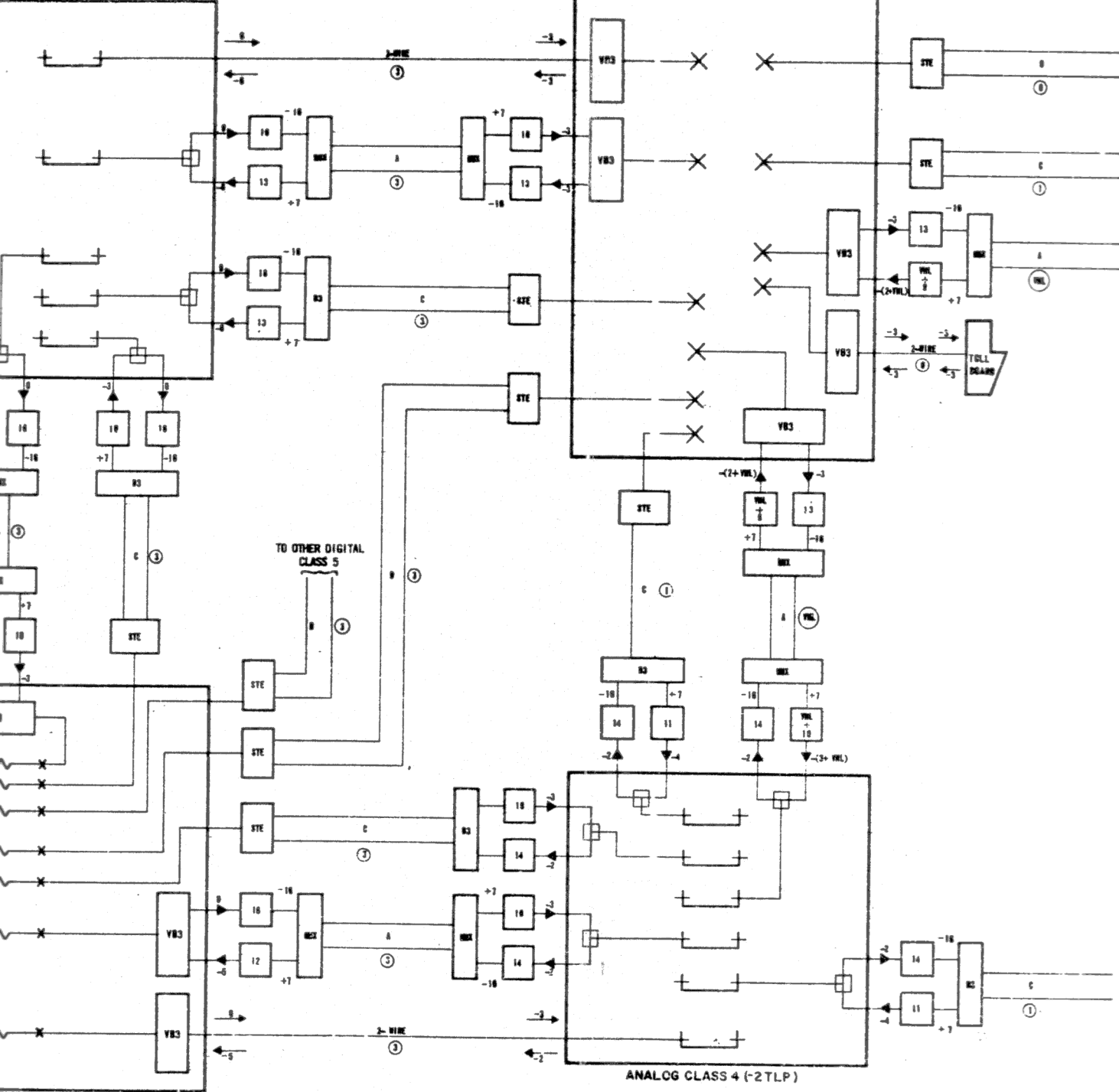
± 0.5 dB over operating temperature range of 0° to 50° C (32° to 122° F) and 3-month interval.

15. LOW-FREQUENCY INDUCTION (TESTED PER REA SPECIFICATION PE-60, APRIL 1975)

30 volts ac rms at 60 Hz applied longitudinally shall result in less than 26 dBrnc0 noise at either end of circuit.

ANALOG CLASS 5 (0 TLP)

DIGITAL CLASS 4 (-3 TLP)



TO ANALOG CSP (-2 TLP)

TO ANALOG CSP (-2 TLP)

NOTES:

8

3

D

C

A

STE

VNL

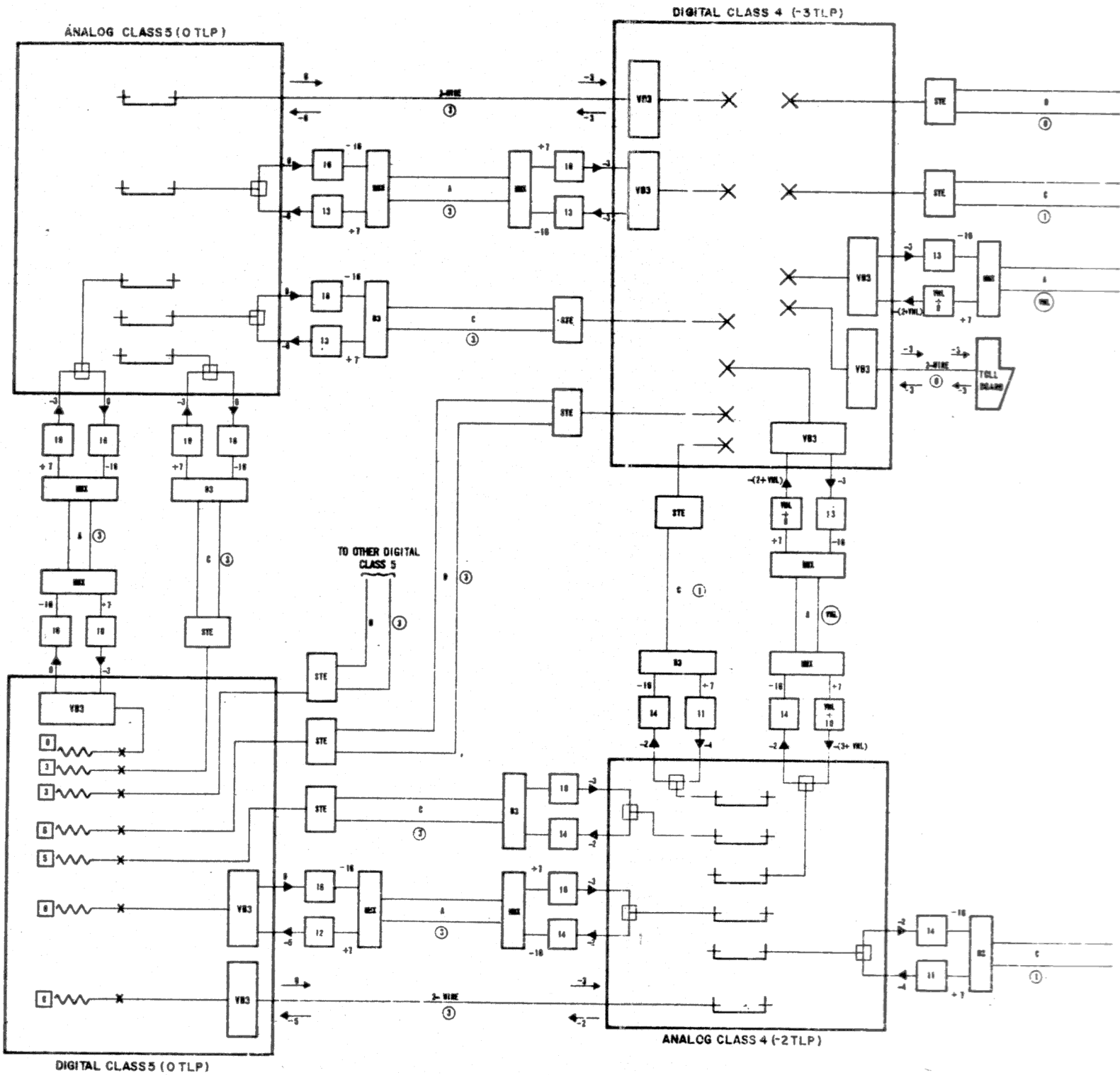
16

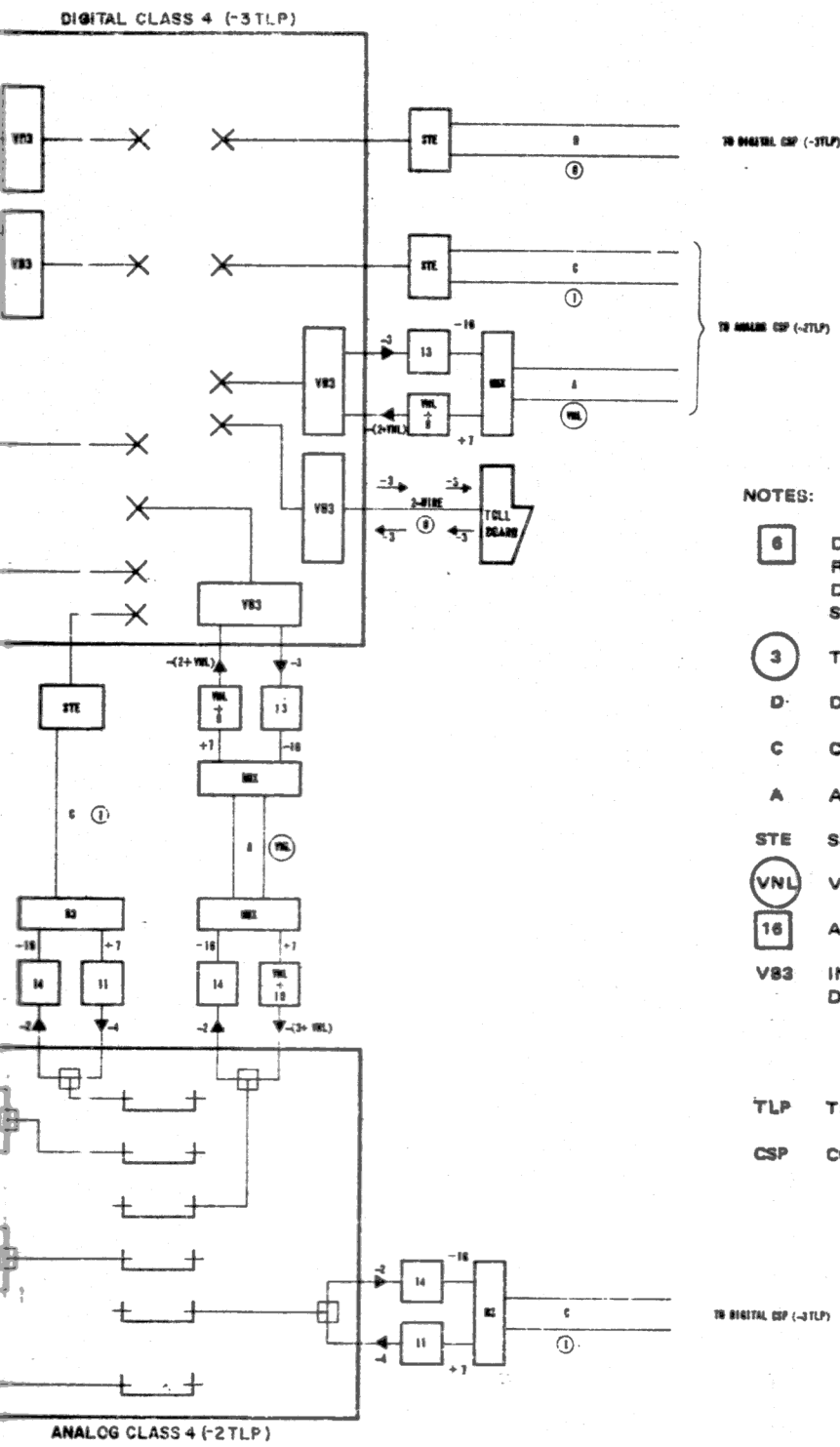
VBS

TLP

CSP

TO DIGITAL CSP (-3 TLP)





NOTES:

- 6 DIGITAL ATTENUATOR VALUE IN dB
RECEIVE SIDE OF CLASS 5 DIGITAL SWITCH.
DIGITAL ATTENUATORS REPRESENTED BY
SYMBOL
- 3 TRUNK ICL IN dB
- D DIGITAL TRUNK
- C COMBINATION TRUNK
- A ANALOG TRUNK
- STE SPAN TERMINATING EQUIPMENT
- VNL VIA NET LOSS
- 16 ANALOG LOSS PAD. VALUE INCLUDES HYBRID LOSS
- V83 INPUT/OUTPUT LEVELS IN dBm, RELATIVE TO
DIGITAL MILLIWATT

CLASS 4: -3/-3
CLASS 5: 0/0
- TLP TRANSMISSION LEVEL POINT
- CSP CONTROL SWITCH POINT
(CLASS 1, 2, OR 3)

Figure FO-1. Typical Digital/Analog Level Plan
Page 11
11 Pages