Digital telephones line engineering

Contents

This section contains information on the following topics:

Engineering a telephone line

Use Procedure 45 "Engineering a telephone line" (page 227) to engineer a digital telephone line.

Procedure 45
Engineering a telephone line

Step	Action
1	Be sure that cable pair selections meet the following requirements: • AC signal loss is less than 12 dB at 256 kHz due to all sources. • DC loop resistance is less than 175 ohm. • Minimum loop length (mainframe bulkhead to telephone) is 30 m (100 ft).

- Near-end crosstalk coupling loss is >38 dB at Nyquist frequency of 256 kHz (not an issue for typical 22, 24, and 26 AWG twisted pair cable).
- No bridge taps are permitted.
- No loading coils are permitted.
- Protection devices of the carbon-block and gas-filled type are permitted if the off-state shunting impedance is better than 10 M$^{1}/_{2}$ resistive and less than 0.5 pF capacitive.

2 Be sure that the following criteria are met where under-carpet cabling is used:

- Characteristic impedance is at 256 kHz, 100 ± 10 ohm.
- Insertion loss is at 256 kHz, <4.6 dB/kft.
- The next pair-to-pair coupling loss is at 256 kHz, >40 dB.

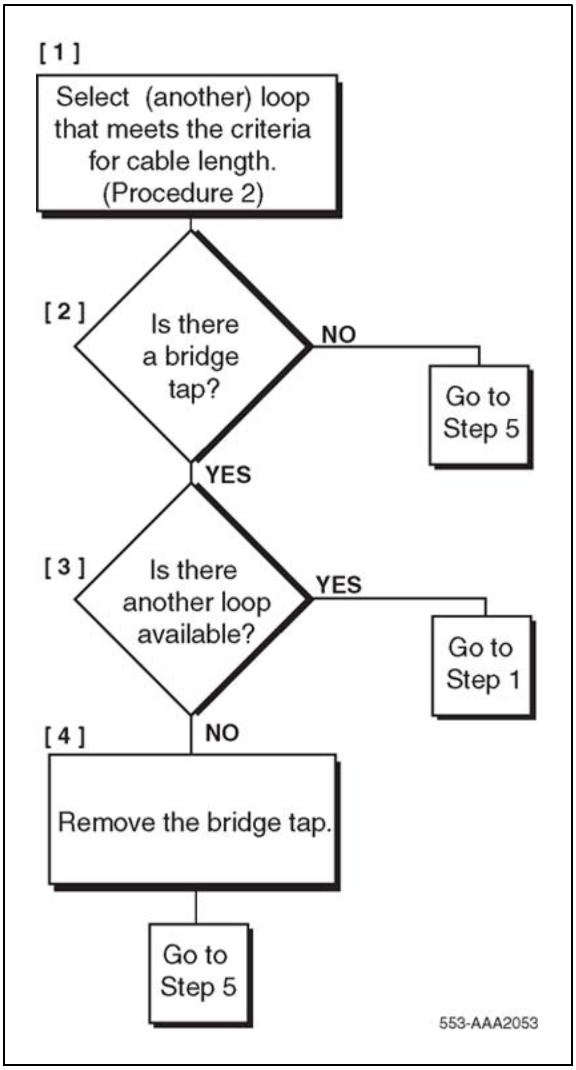
3 For a typical system with 22, 24, or 26 AWG standard twisted-pair cable, the requirements translate to the following allowable loops:

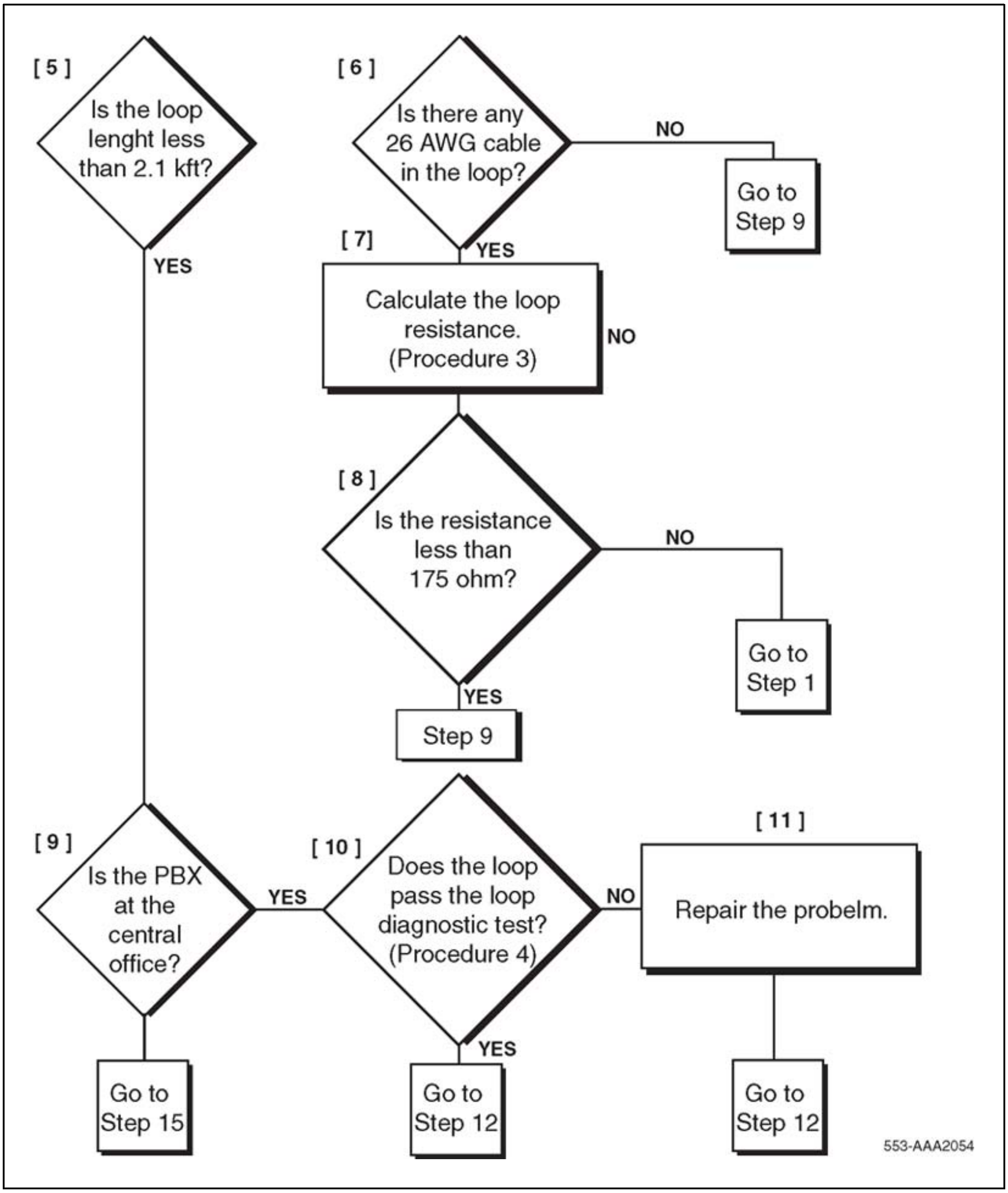
- up to 915 m (3000 ft) of 22 or 24 AWG cable
- up to 640 m (2100 ft) of 26 AWG cable

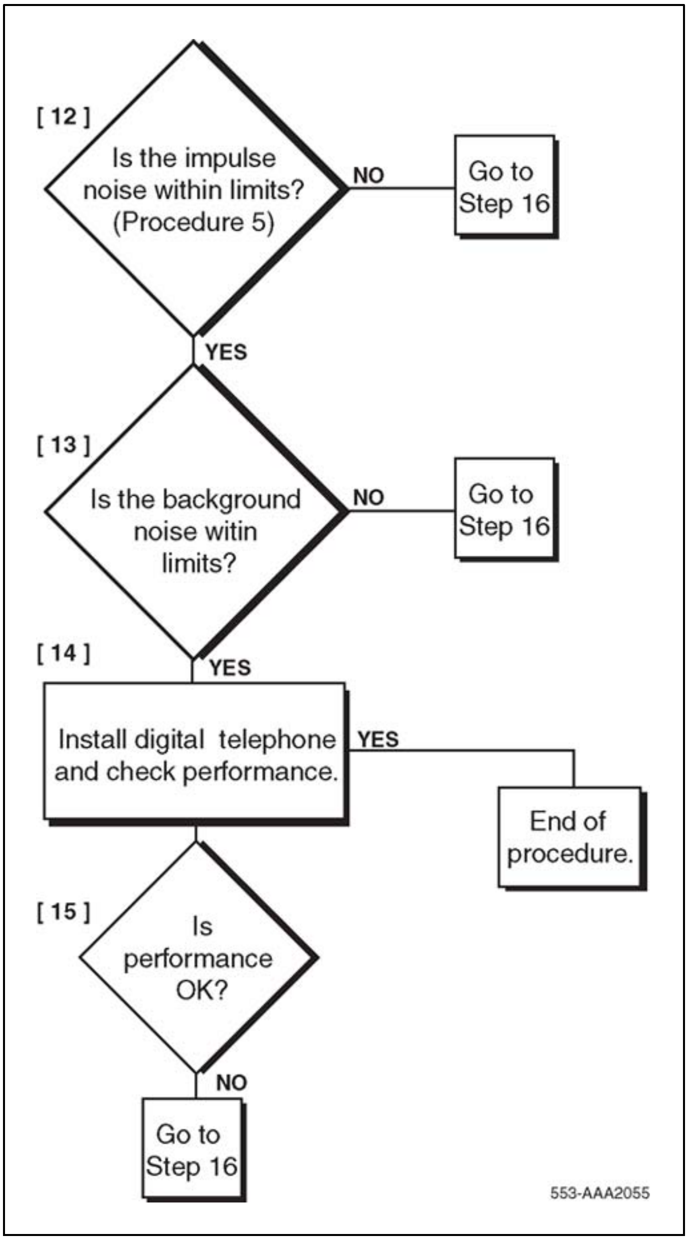
4 If the selected cable pair does not work satisfactorily, select another cable pair as shown in Figure 46 "Engineer a telephone line" (page 229).

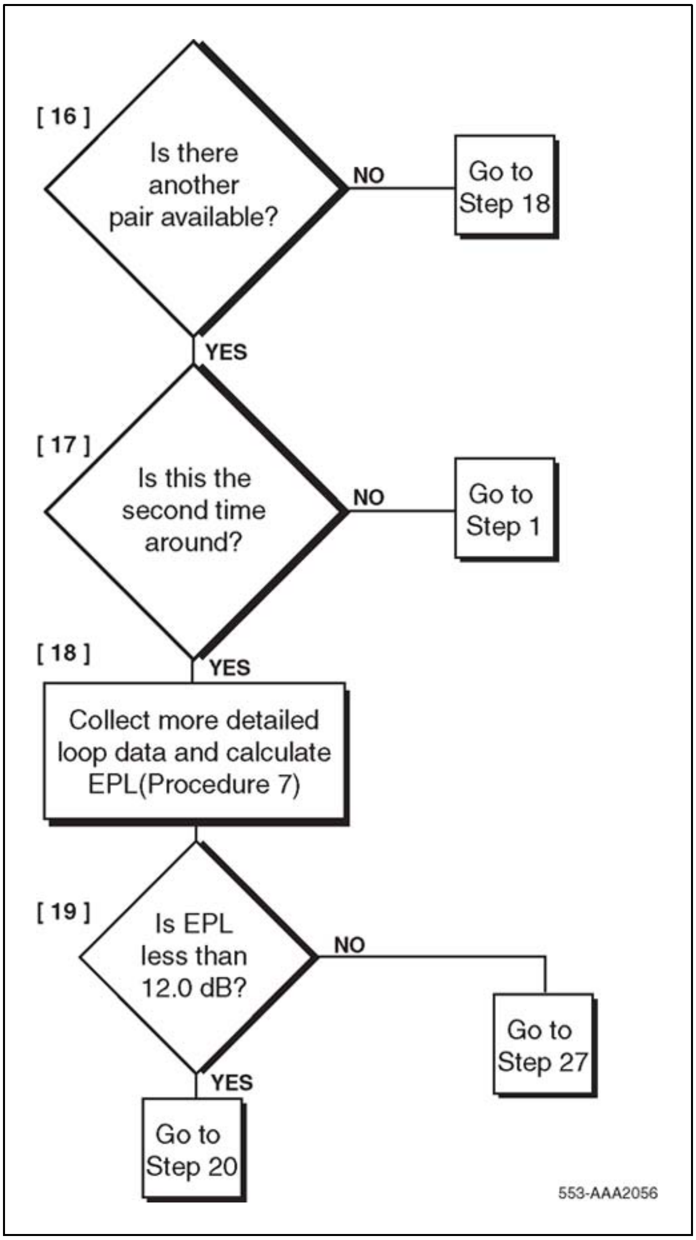
—End—

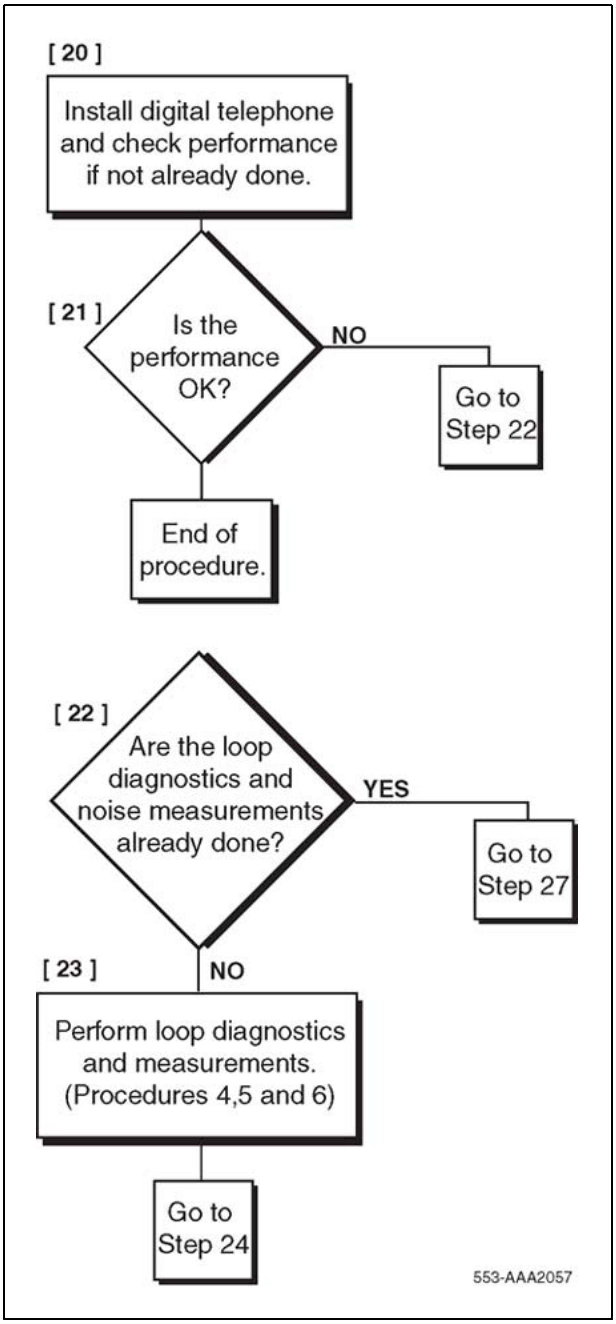
Figure 46
Engineer a telephone line

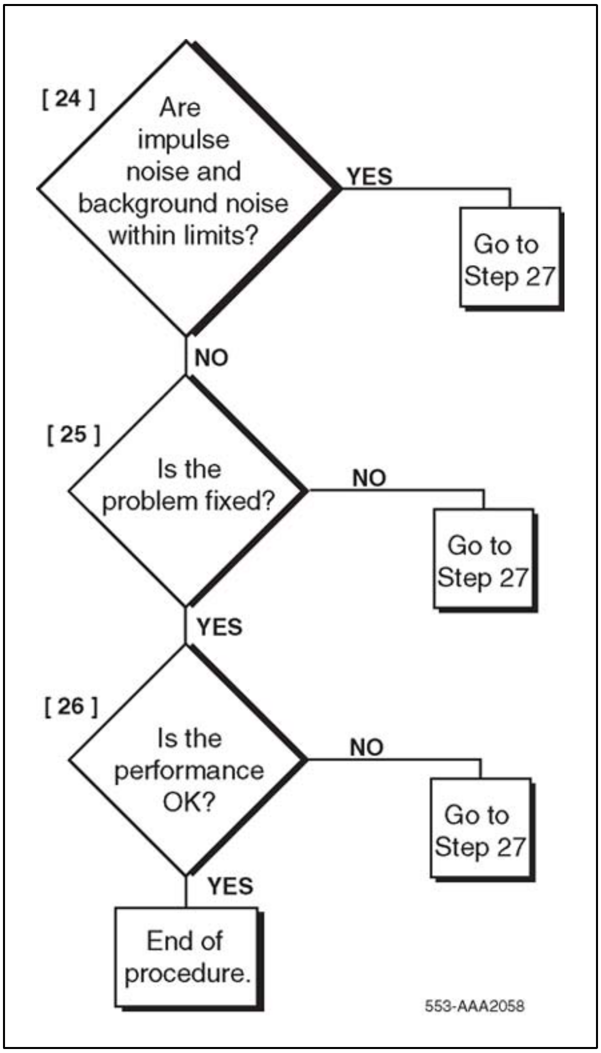


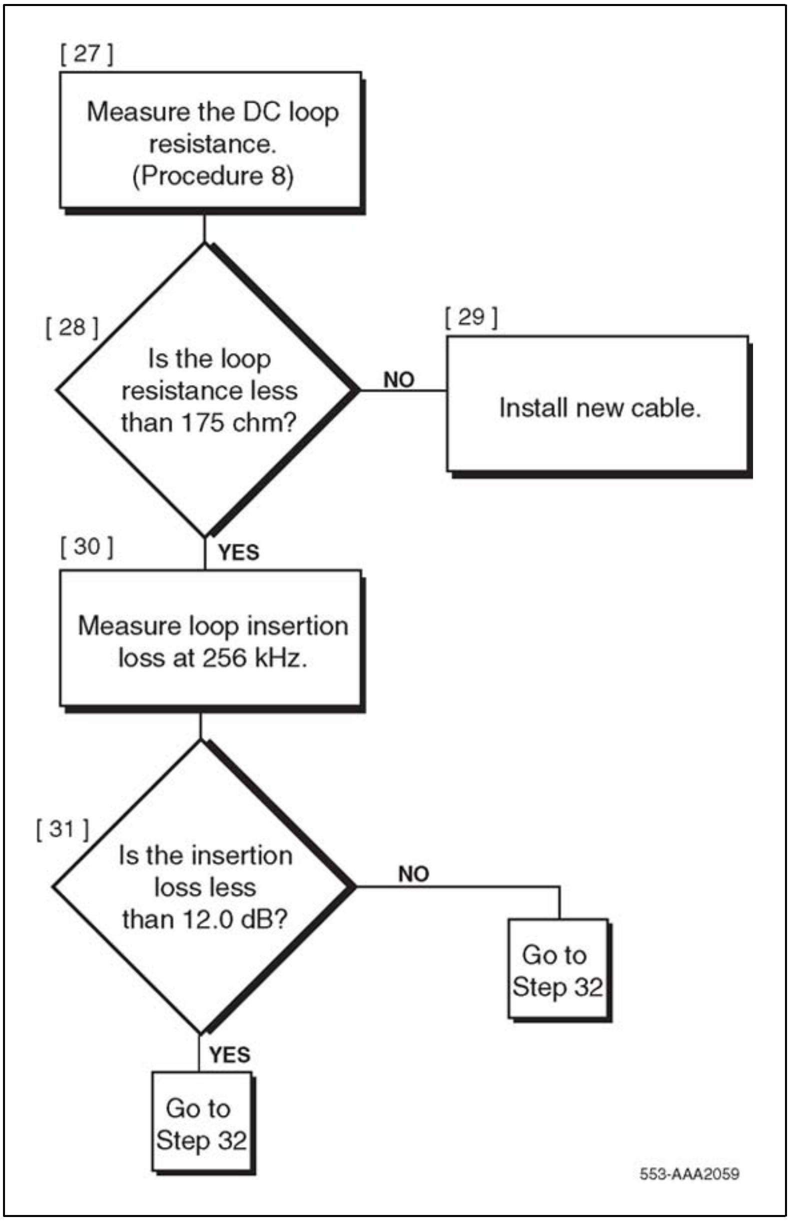

[5]
Is the loop lenght less than 2.1 kft?
YES
[6]
Is there any 26 AWG cable in the loop?
NO
Go to Step 9
YES
[7]
Calculate the loop resistance. (Procedure 3)
NO
[8]
Is the resistance less than 175 ohm?
NO
Go to Step 1
YES
Step 9
[9]
Is the PBX at the central office?
YES
[10]
Does the loop pass the loop diagnostic test? (Procedure 4)
NO
[11]
Repair the probelm.
Go to Step 15
YES
Go to Step 12
Go to Step 12
553-AAA2054

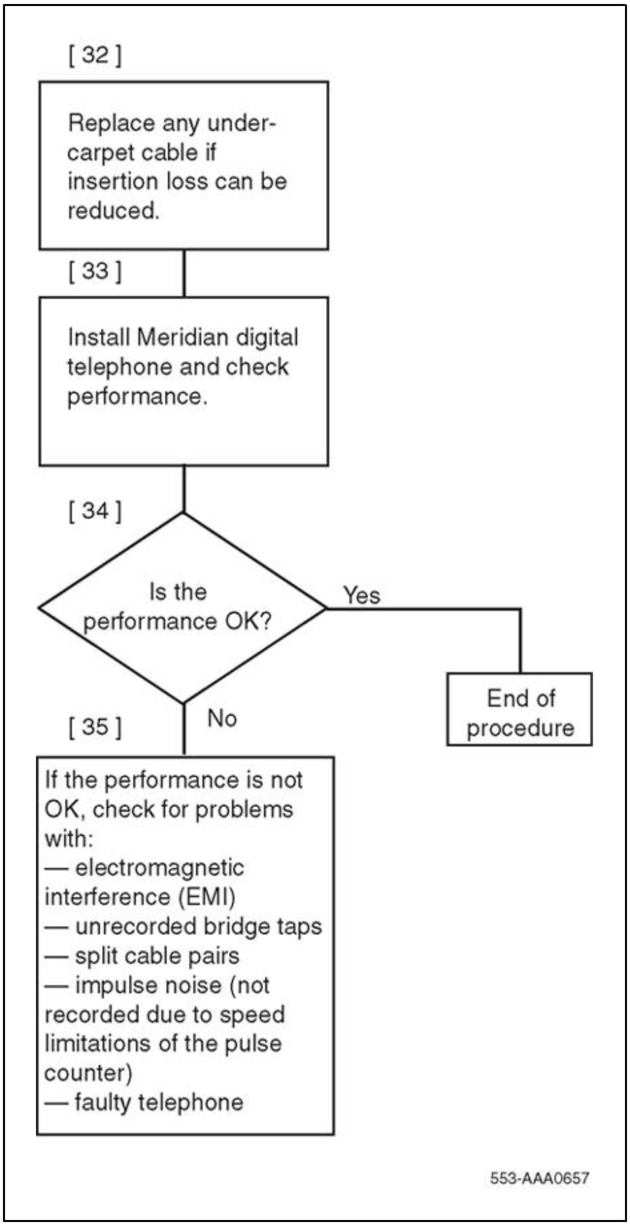

[12]
Is the impulse noise within limits? (Procedure 5)
NO
Go to Step 16
YES
[13]
Is the background noise witin limits?
NO
Go to Step 16
[14]
YES
Install digital telephone and check performance.
YES
End of procedure.
[15]
Is performance OK?
NO
Go to Step 16
553-AAA2055


[16]
Is there another pair available?
NO
Go to Step 18
YES
[17]
Is this the second time around?
NO
Go to Step 1
[18]
YES
Collect more detailed loop data and calculate EPL(Procedure 7)
[19]
Is EPL less than 12.0 dB?
NO
Go to Step 27
YES
Go to Step 20
553-AAA2056


[20]
Install digital telephone and check performance if not already done.
[21]
Is the performance OK?
NO
Go to Step 22
End of procedure.
[22]
Are the loop diagnostics and noise measurements already done?
YES
Go to Step 27
[23]
NO
Perform loop diagnostics and measurements. (Procedures 4,5 and 6)
Go to Step 24
553-AAA2057


[24]
Are impulse noise and background noise within limits?
YES
Go to Step 27
NO
[25]
Is the problem fixed?
NO
Go to Step 27
YES
[26]
Is the performance OK?
NO
Go to Step 27
YES
End of procedure.
553-AAA2058


[27]
Measure the DC loop resistance. (Procedure 8)
[28]
Is the loop resistance less than 175 chm?
NO
[29]
Install new cable.
YES
[30]
Measure loop insertion loss at 256 kHz.
[31]
Is the insertion loss less than 12.0 dB?
NO
Go to Step 32
YES
Go to Step 32
553-AAA2059



Selecting a Loop

For a Meridian digital telephone, the loop must be without bridge taps, less than 175 ohm DC resistance, and less than 12.0 dB loss at 256 kHz. For single-gauge 22 and 24 AWG cable, and D inside wiring, the length limit is 914.4 m (3000 ft). For single-gauge 26 AWG cable, the length limit is 640.08 m (2100 ft).

The allowable loop length assumes there is no under-carpet cable. If there is under-carpet cable that is a different type than Western Electric (WE) 4-pair cable, reduce the allowable loop length by using the following equation:

LM = [12 – (UC x UL)] /LL

where

LM	=	loop length limit in km (kft) (excluding the length of the under-carpet cable)
LL	=	loop loss in dB/km (dB/kft) at 256 kHz
UC	=	length of the under-carpet cable in km (kft)
UL	=	loss of the under-carpet cable in dB/km (dB/kft) at 256 kHz (see Table 45 "Attenuation at 256 kHz for U/C cable" (page 245) for dB values)

Calculating DC Loop Resistance

Use Procedure 46 "Calculating DC loop resistance" (page 237) to calculate the DC loop resistance.

Procedure 46
Calculating DC loop resistance

Step	Action

1 Calculate the DC loop resistance by adding the resistance of each cable section. Calculate the resistance of each cable section by using the following formula (cable resistances are given in Table 43 "Conductor resistance per unit" (page 238)):

LRi = CRi x SLi

where

LRi = DC resistance for cable section *i*

CRi = conductor resistance per unit length for the cable section *i*

SLi = length of cable section *i*

2 Add the total of all cable sections. If the total of all sections exceeds 175 ohm, select another loop.

Note: The loop resistance limit of 175 ohm must be reduced by 1 ohm for each percent of the loop that is aerial cable (see Table 43 "Conductor resistance per unit" (page 238)).

—End—

Table 43
Conductor resistance per unit

Gauge	Ohm per loop kft	Ohm per loop km
26	83	278
24	52	173
22	33	109
19	16	54

Performing Loop Diagnostic Tests

The following equipment is required for the loop diagnostic tests in Procedure 47 "Testing foreign voltage" (page 238):

- one volt-ohmmeter (VOM) for each test
- one 77 cable analyzer or equivalent for each test

Procedure 47
Testing foreign voltage

Step	Action
1	Set the VOM range switch to a scale 60 V DC/V AC or greater.
2	Connect the VOM test probes to the loop at the line card or distributing frame.
3	Measure the DC and AC voltage between the following points under no-load conditions: • tip (T) and ring (R) • T and ground (GND) • R and GND Requirement: Voltage readings should be less than 1 V DC/V AC.

—End—

Procedure 48
Testing insulation resistance

Step	Action
1	Set the VOM range switch to ohm x 10,000 and adjust the meter to zero.

2 Connect the VOM test probes to the loop at the line card or distribution frame.

3 Measure the resistance between the following points under no-load conditions:

- T and R
- T and GND
- R and GND

Requirement: Resistance readings must be greater than 10 M ohm.

—End—

Procedure 49
Testing DC continuity

Step	Action
1	Short circuit the T and R at the far end.
2	Using the VOM, measure the resistance between the T and R. Requirement: Resistance measurement should be approximately equal to the calculated loop resistance as described in Procedure 46 "Calculating DC loop resistance" (page 237).

—End—

Procedure 50
Testing capacitance unbalance

Step **Action**

1 Using the cable analyzer, measure the capacitance between the following points:

- T and GND
- R and GND

Requirement: The difference between the two readings must be <0.002 µF>.

—End—

Measuring Impulse Noise

Use Procedure 51 "Measuring impulse noise" (page 240) to measure impulse noise.

Procedure 51
Measuring impulse noise

Step	Action
1	Measure impulse noise on selected lines during busy hours. Use an NE–58B noise measurement set or the equivalent. ***Note:*** The termination and weighting filter required are 135 ohm and 100 kHz, respectively, and the blanking interval is 25 µs.
2	Using Figure 47 "Maximum allowable impulse noise counts versus loop loss" (page 242), determine that for a given loop loss and noise threshold the impulse noise counts for each 15-minute interval are below the corresponding curve. ***Note 1:*** The values in Figure 47 "Maximum allowable impulse noise counts versus loop loss" (page 242) were derived by assuming that the counter has a count rate or 512 pulses per second. ***Note 2:*** Because of the inaccuracy of the noise-measuring set, additional errors can occur during the blanking interval, and the reading consequently is lower than the actual measurement.

—End—

Measuring Background Noise

Use Procedure 52 "Measuring background noise" (page 240) to measure background noise.

Procedure 52
Measuring background noise

Step	Action
1	Measure background noise on the loop by using an NE-58B noise-measuring set.

Note: The weighting and termination to be used are 100 kHz flat and 135 ohm, respectively.

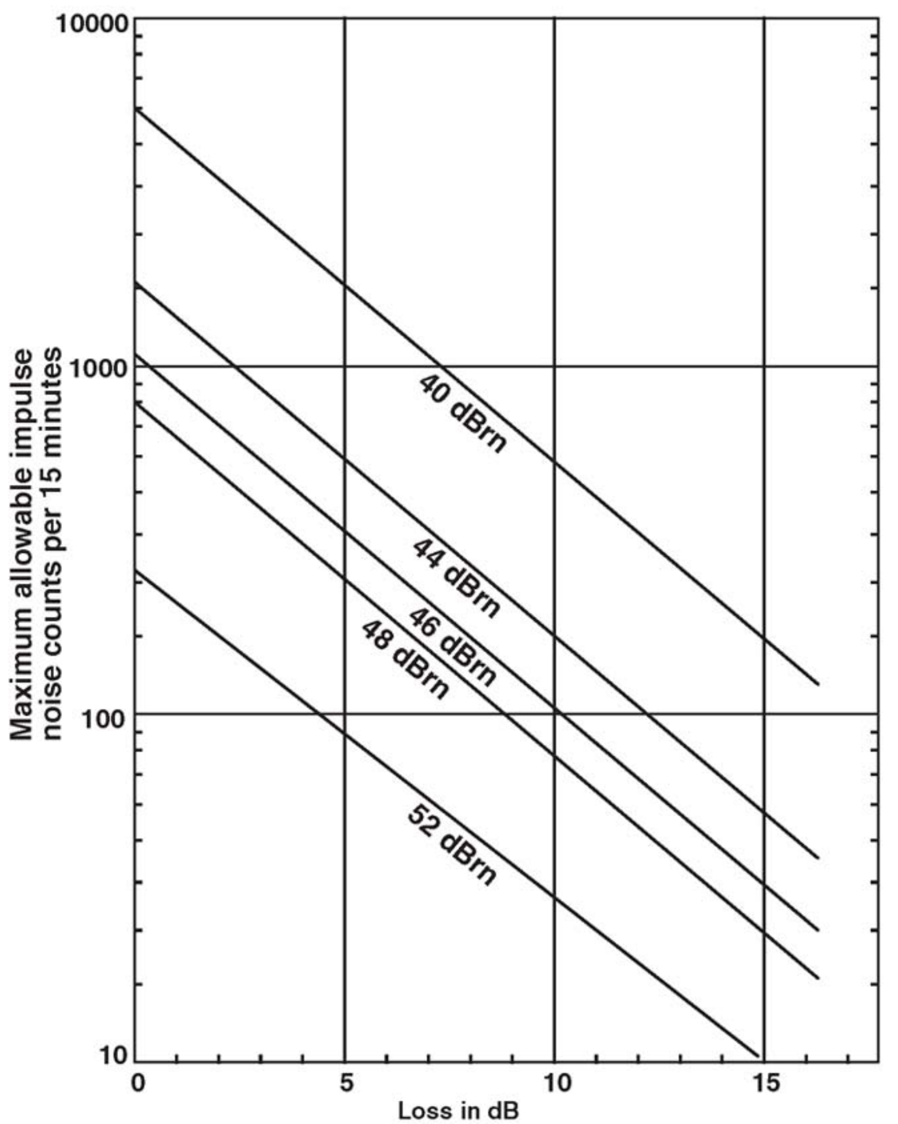
2 Reject the loop being tested if the measured background noise is not less than 51 dBrn.

—End—

Calculating Expected Pulse Loss

Use Procedure 53 "Calculating expected pulse loss" (page 242) to calculate expected pulse loss.

Figure 47
Maximum allowable impulse noise counts versus loop loss



Note: Impulse noise counter weighting is 100 kHz.
Termination is 135 ohms.

Procedure 53
Calculating expected pulse loss

Step	Action
1	Collect loop makeup data between the line card and the terminal. For each cable section, the data required is:

- cable type (PIC or pulp)
- gauge
- length
- type of plant construction (underground, aerial, or in-building)

2 Calculate individual cable section losses by using the figures in Table 44 "Cable attenuation at 256 kHz and 21.1 degrees C (70 degrees F)" (page 244) through Table 46 "Attenuation at 256 kHz for D inside wiring cable" (page 245), and the following equation:

CSLi = SLi x Li

- CSLi = cable section loss for section *i*
- SLi = section length of section *i*
- Li = loss per unit length for section *i*

3 Correct individual cable section losses for maximum cable temperature by using the following equation:

TCLi = CSLi x TCFi

- TCLi = temperature corrected loss for section *i*
- TCFi = temperature correction factor for section *i*

Correction factors:

- aerial cable TCF = 1.1
- underground cable TCF = 1.04
- in-building cable TCF = 1

4 Determine junction loss (see Figure 48 "Junction loss versus cable characteristicimpedance" (page 246)).

Note: Junction loss due to gauge discontinuity of outside plant cables and D inside wire varies between 0.03 dB and 0.07 dB and can be ignored. However, AMP 25-pair under-carpet wiring has a characteristic impedance of 40 ohm at 256 kHz, and its junction loss is approximately 2 dB. This must be included in the calculation.

5 Calculate the expected pulse loss (EPL) by finding the sum of the items.

6 Reject loops whose expected pulse loss is greater than 12 dB.

—End—

Example of applying calculation

Example of applying the calculation shown in Procedure 53 "Calculating expected pulse loss" (page 242)

Section 1:

Mainframe bulkhead to DF1 - 500m, 26 AWG PIC, underground

Section 2:

DF1 to DF2 - 200m, 26 AWG PIC, inside

Section 3:

DF2 to terminal - 24 AWG NT D-inside

Therefore:

SL1 = 1.5 km, SL2 = 0.2 km, SL3 = 0.1 km

From Table 44 "Cable attenuation at 256 kHz and 21.1 degrees C (70 degrees F)" (page 244) and Table 45 "Attenuation at 256 kHz for U/C cable" (page 245):

L1 = 13.7 dB/km, L2 = 13.7 dB/km, L3 = 13.3 dB/km.

Using the equation in Step 2, we arrive at the following:

CSL1 = 6.85 dB, CSL2 = 2.74 dB, and CSL3 = 1.33 dB

Temperature corrections:

Using correction factors of TCF1 = 1.04, and TCF2 and TCF3 = 1,

and using the equation in Step 3 results in TCL1 = 7.12 dB,

TLC2 = 2.74 dB, and TCL3 = 1.33 dB.

Expected pulse loss (EPL) value:

Neglecting any junction loss (see the note in Step 4), Step 5

results in an EPL value of TSL1 + TSL2 + TSL3 + 0 = 11.19 dB.

This is under the 12 dB limit and meets the criteria.

Table 44
Cable attenuation at 256 kHz and 21.1 degrees C (70 degrees F)

Cable type	26 AWG		24 AWG		22 AWG		19 AWG	
	dB/kft	dB/km	dB/kft	dB/km	dB/kft	dB/km	dB/kft	dB/km
PIC	4.2	13.7	3.1	10.2	2.5	8.1	1.7	5.6
Pulp	4.3	14.3	3.5	11.4	2.7	9.0	2.0	6.6

Table 45
Attenuation at 256 kHz for U/C cable

WE 4-pair		AMP 25-pair	
dB/kft	dB/km	dB/kft	dB/km
4.6	15.3	19.0	63.3

Table 46
Attenuation at 256 kHz for D inside wiring cable

NT		**WE**		**Superior**		**General**	
dB/kft	dB/km	dB/kft	dB/km	dB/kft	dB/km	dB/kft	dB/km
4.0	13.3	3.2	10.7	3.7	13.3	4.6	15.3

Measuring DC Loop Resistance

Measure DC loop resistance by using standard procedures.

Note: The DC loop resistance limit of 175 ohm should be reduced by 1 ohm for each one percent of the total loop that is aerial cable.

Figure 48
Junction loss versus cable characteristicimpedance