Section 5

TRANSMISSION

RESISTANCE DESIGN

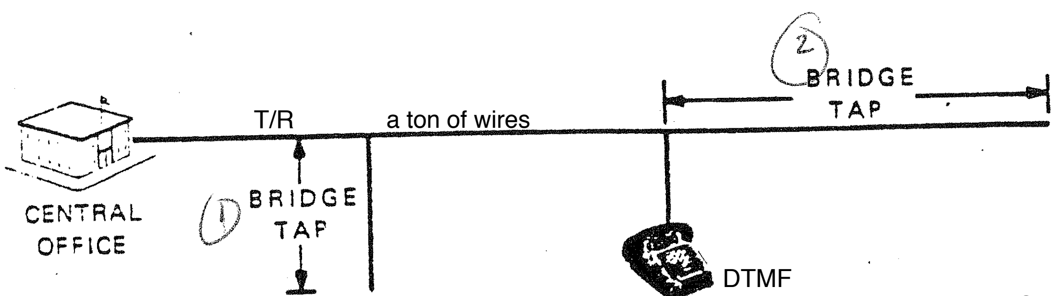
BSP 901-350-202, Par. 4.03
BSPs 902-115-100, -101

Design Rules

you can go over this

- Maximum loop resistance is 1300 ohms.
- Maximum bridge tap on nonloaded loops is 6 kft.
- All loops longer than 18 kft require loading (see loading rules on next page).

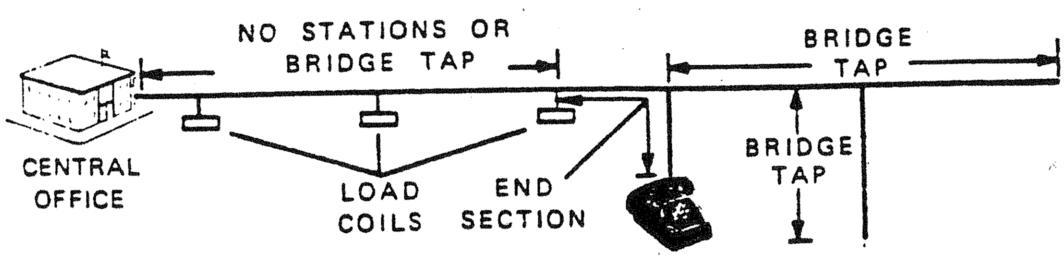
if the distance from the central office ot that persons phone is more than 18000 feet , it needs to be loaded, if not then it doesnt need to be loaded



extra wire that you technically dont need to provide serivce, but it does provide fplexability to connect lines to different parts of the T/R

SLC = subscriber line card

NON-LOADED LOOP



LOADED LOOP

Loading Rules

• Load-coil inductance	88 mH
• Load spacing	6 kft (nominal)
• Load-spacing deviation	±120 ft preferred, or ±500 ft permitted (under unusual circumstances)
• Central office end section (including office wiring)	equivalent in capacitance to 3000 ft of cable
• Sum of customer end section and bridge tap	3 to 12 kft preferred 3 to 15 kft permitted
• Loaded bridge tap	none permitted
• Bridge tap between load coils	none permitted

Cable Gauge

BSP 902-115-101

Cable gauge may be selected by use of the resistance design chart on the facing page. Its use is described in the BSP. Alternatively, the most economical 2-gauge design may be determined using the formulas below. (Loops up to 15.7 kft can be served by 26-gauge cable.)

Loop Length L (Kft)	Gauges Used	Length of Coarser Gauge (Kft)
15.7 to 18.0	24 and 26 nonloaded	2.66 (L – 15.7)
18.0 to 24.5	24 and 26 loaded	2.71 (L – 15.5)
24.5 to 37.1	22 and 24 loaded	2.79 (L – 24.5)
37.1 to 72.5	19 and 22 loaded	2.06 (L – 37.1)

Example: A 20-kft loop requires a 2-gauge design of 24- and 26-gauge loaded cable consisting of (from the second line in the table above):

$$2.71\,(20 - 15.5) = 2.71 \times 4.5 = 12.2 \text{ kft of 24 gauge cable.}$$

The remainder of the loop consists of:

$$20 - 12.2 = 7.8 \text{ kft of 26-gauge cable.}$$

In an actual design, constraints such as existing cable or the location of possible gauge-change points may require deviation from the above theoretical design. If so, any deviation must increase the amount of coarser gauge cable used.

LONG ROUTE DESIGN

BSPs 902-215-120, -121
GLs 76-05-192, 76-07-194

Long Route Design extends the loop resistance limit to 3600 ohms. This is accomplished with the following range extension and voice-frequency electronic devices:

- 2A Range Extender
- 5A Range Extender With Gain (REG) > 1600Ω
- 28A Ringer Isolator
- G-36 Handset.

Loading Rules

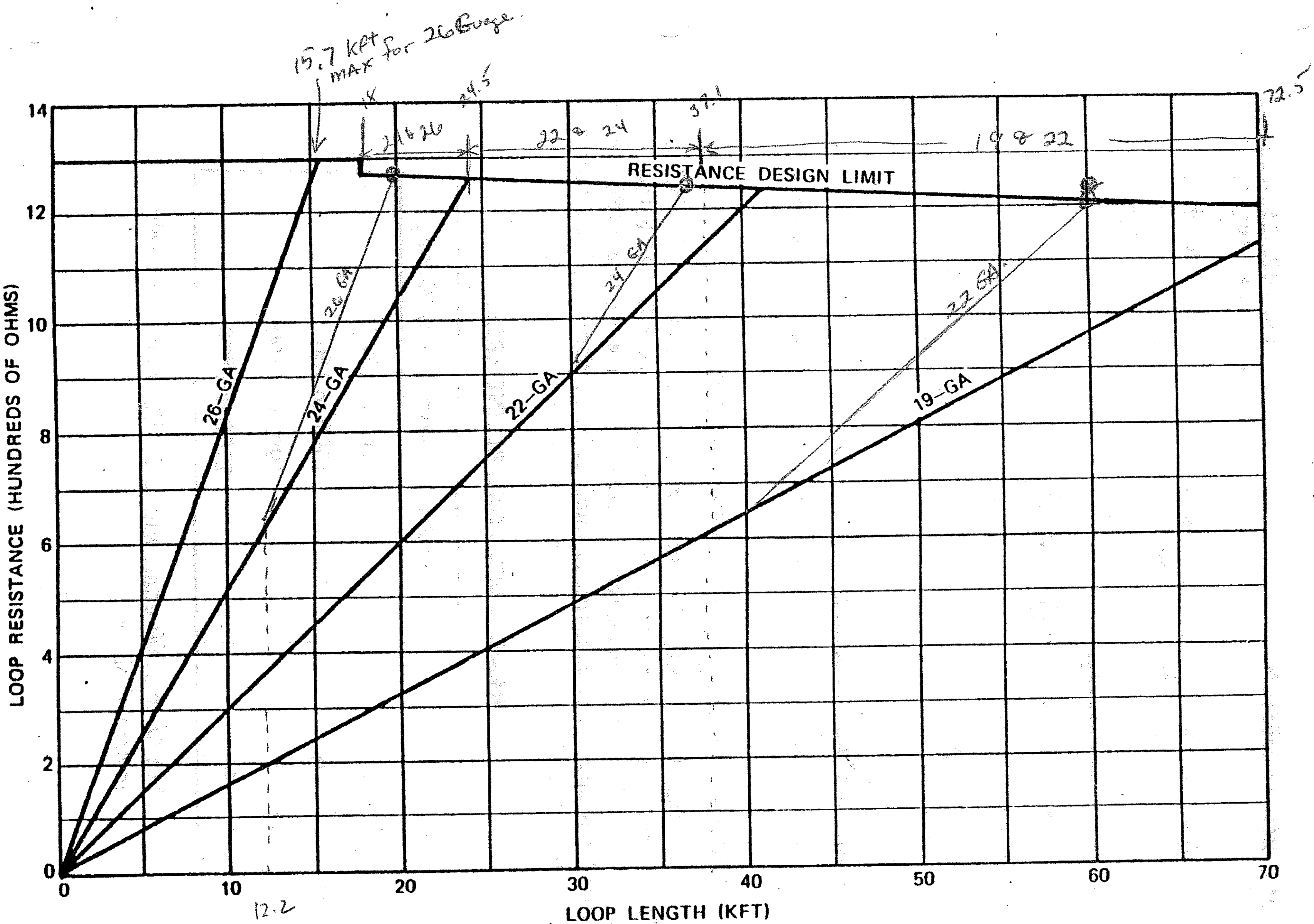
- All cable must be loaded.
- End section plus bridge tap must be 3 to 12 kft (3 to 18 kft with G-36 handset).
- All other resistance design loading rules apply.

Loop configurations using the above devices are shown on the facing page. Some flexibility is permitted in zone boundaries, as indicated below, so that the boundaries may coincide with (1) loads and preferred count (PC) sections where it is possible to establish 12-kilofoot PC sections, or (2) an interface so that the entire area served by an interface will be in one zone.

RESISTANCE ZONE BOUNDARIES

Zone	Outer Boundary Limits (Ohms)
13	1100 to 1300
16	1500 to 1600
18	1900 to 2100*
28	2700 to 2800

*1800 to 2200 ohms with 5A REG used exclusively in central office.


LOOP RESISTANCE (HUNDREDS OF OHMS)
LOOP LENGTH (KFT)
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
RESISTANCE DESIGN LIMIT
26–GA
24–GA
22–GA
19–GA
15.7 kft MAX for 26 Gauge
18
24.5
37.1
72.5
24 & 26
22 & 24
19 & 22
26 GA
24 GA
22 GA
12.2

;	19
;.5	7.5
I	25
!	14
;	7

ier slightly larger values if

pyright ITU. (Ref. 6).

ow from this diagram
oice signal. Likewise,
e local switch can be

al transmission plan,
enced to 800 Hz). For
For instance, many
* From this figure we
: subset in series with
ve disregard the feed
low, the figures 6 dB
t) are used.

ial line equipment, 2400 Ω.

Using Table 2.6, we can compute maximum loop lengths for 1000-Ω signaling resistance. As an example, for a 26-gauge loop, we have

$$\frac{1000}{83.5} = 11.97 \text{ or } 11{,}970 \text{ feet}$$

This, then, is the signaling limit, and not the loss (attenuation) limit, or what some call the "transmission limit," referred to in Section 2.4.3. As the reader has certainly inferred by now, resistance design is a method of designing subscriber loops using resistance limits as a basis or limiting parameter.

2.4.3 Calculating the Loss Limit. Attenuation or loop loss is the basis of transmission design of subscriber loops. The attenuation of a wire pair varies with frequency, resistance, inductance, capacitance, and leakage conductance. Also, resistance of the line will depend on temperature. For open-wire lines attenuation may vary by ±12% between winter and summer conditions. For

TABLE 2.6 Loss and Resistance per 1000 ft of Subscriber Cable[a]

Cable Gauge	Loss / 1000 ft (dB)	LOSS/1000FT (LOADED)	Ω/1000 ft of Loop
26	0.51	.34	83.5
24	0.41	.23	51.9
22	0.32	.15	32.4
19	0.21	—	16.1

[a]Cable is low-capacitance type (i.e., ≤ 0.075 nF / mi).

TABLE 2.7 Code for Load-Coil Spacing

Code Letter	Spacing (ft)	Spacing (m)
A	700	213.5
B	3000	915.0
C	929	283.3
D	4500	1372.5
E	5575	1700.4
F	2787	850.0
H	6000	1830.0
X	680	207.4
Y	2130	649.6

buried cable, which we are more concerned with in this context, variations due to temperature are much less.

Table 2.6 gives losses of some common subscriber cable per 1000 ft. If we are limited to 6-dB (loss) on a subscriber loop, then by simple division we can derive the maximum loop length permissible for transmission design considerations for the wire gauges shown.

$$26 \qquad \frac{6}{0.51} = 11.7 \text{ kft}$$

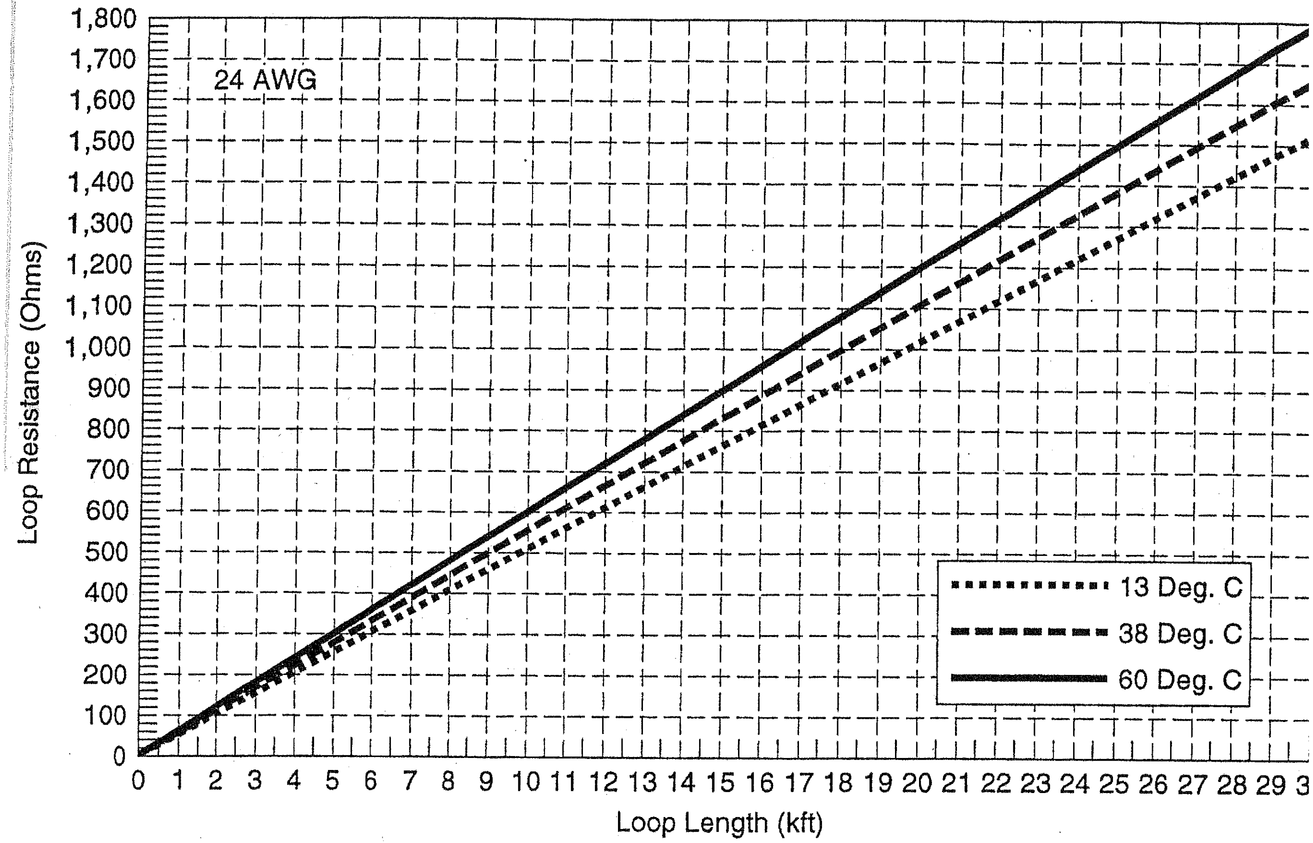
$$24 \qquad \frac{6}{0.41} = 14.6 \text{ kft}$$

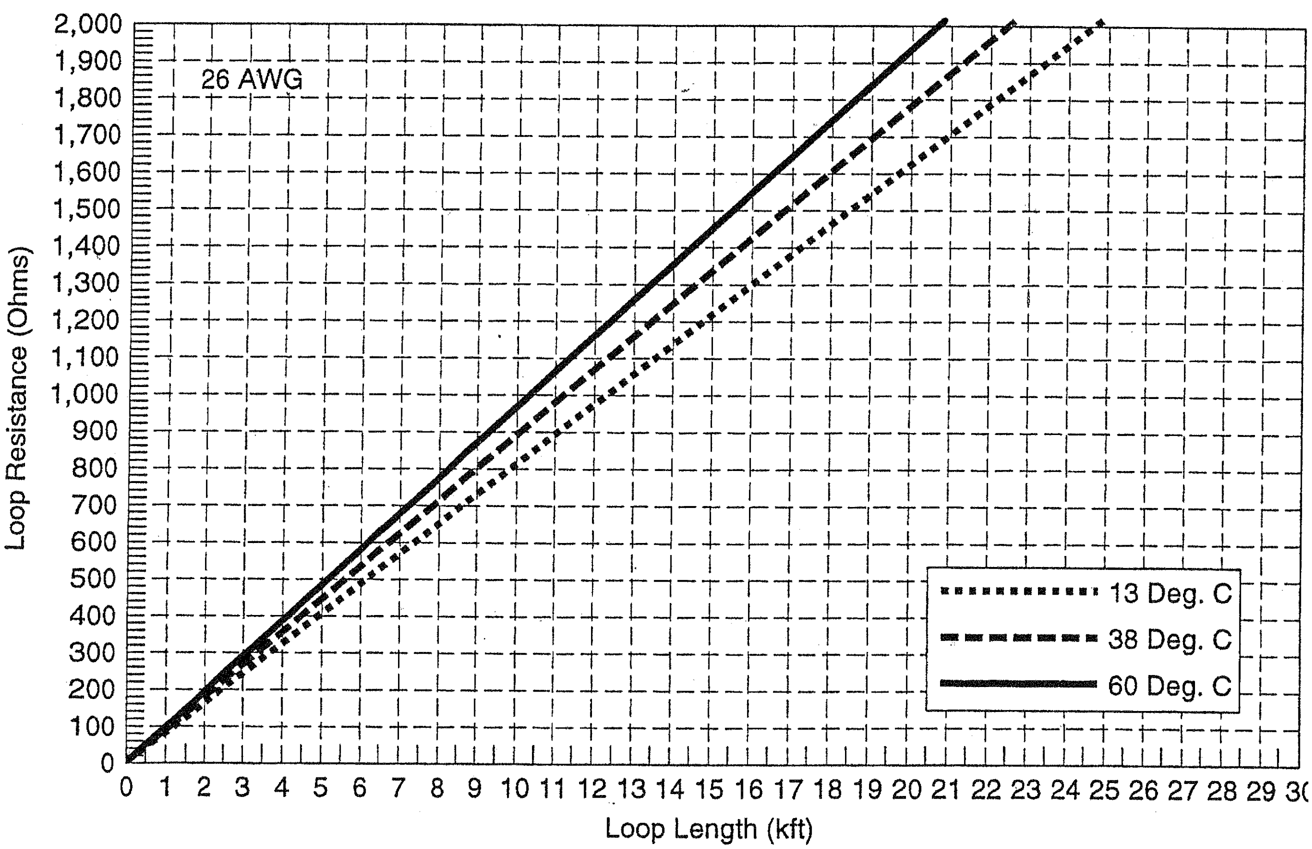
$$22 \qquad \frac{6}{0.32} = 19.0 \text{ kft}$$

$$19 \qquad \frac{6}{0.21} = 28.5 \text{ kft}$$

TABLE 2.8 Some Properties of Cable

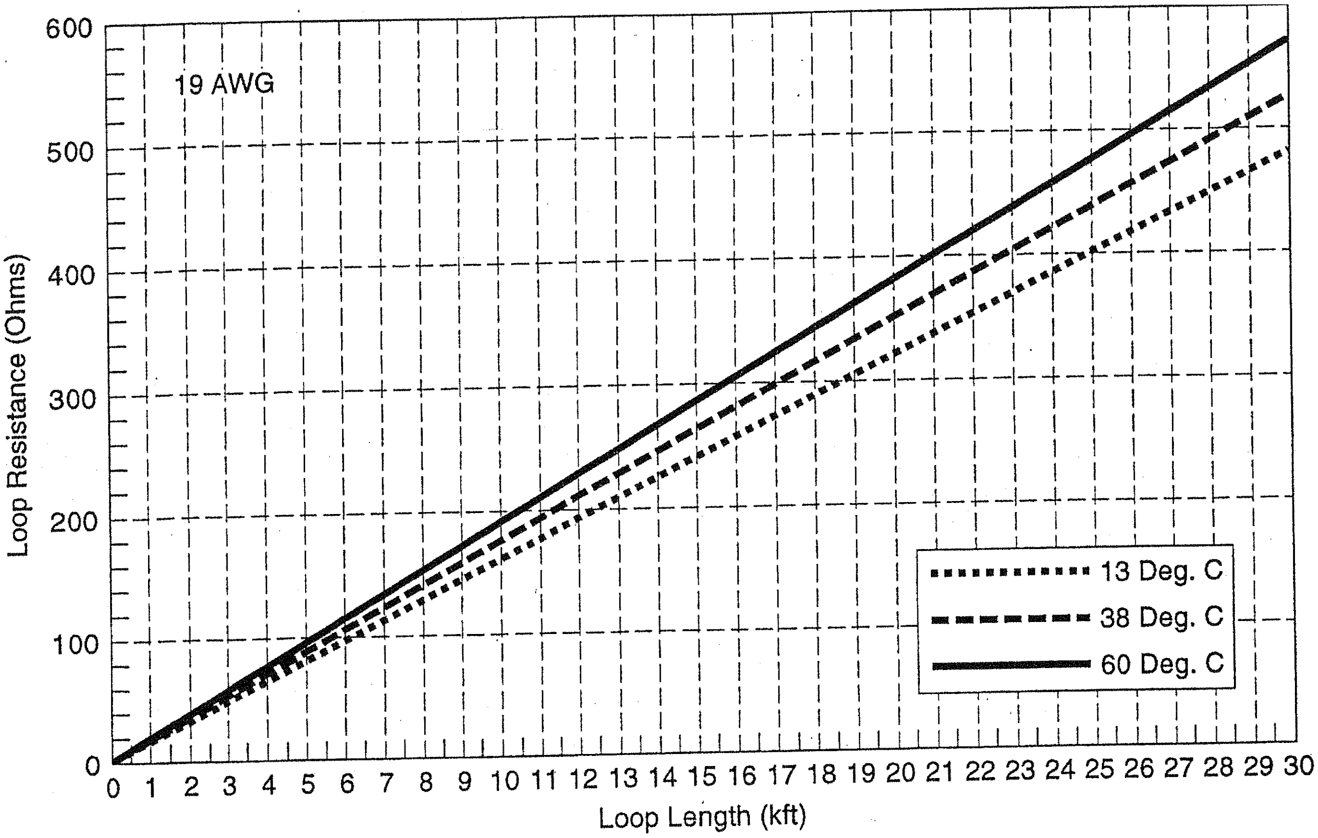
Diameter (mm)	AWG No.	Mutual Capacitance (nF / km)
0.32	28	40
		50
0.40		40
		50
		50
0.405	26	40
		50
		40
		50
		40
		50
0.50		40
		50
		50
0.511	24	40
		50
		40
		50
		40
		50
0.60		40
		50
		40
		50
0.644	22	40
		50
		40
		50
		40

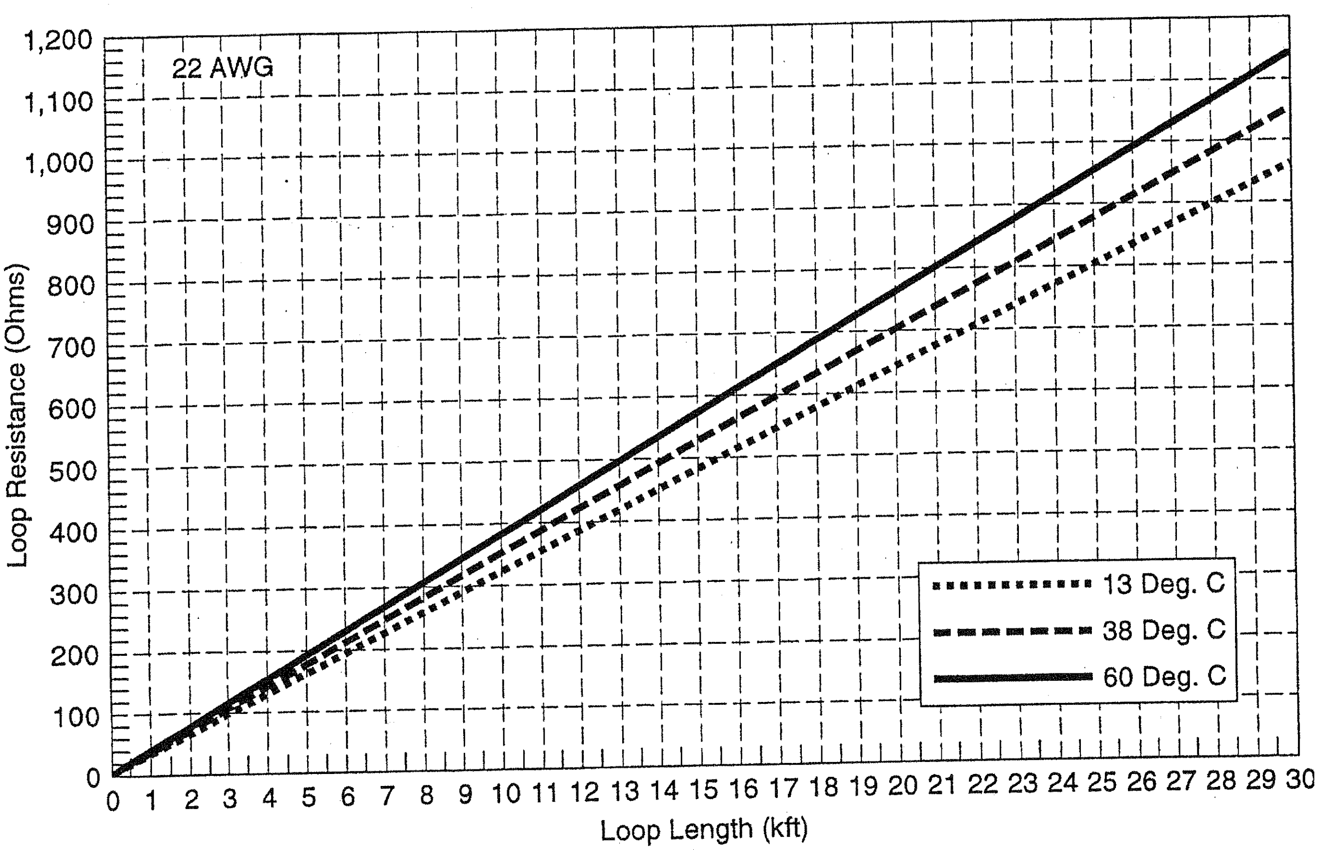




American Wire Gauge (AWG)	Diameter (inch)	Cross-Section (CM)[b]	Equivalen Diameter (m
19	0.03589	1,288	0.912
22	0.02535	642.4	0.643
24	0.02010	404.0	0.511
26	0.01594	254.1	0.404

[a]Source: [32]





Design Temperature	19 AWG	22 AWG	24 AWG	26 AWG
13 °C (55 °F)	15.9	31.7	50.3	81.1
38 °C (100 °F)	17.4	34.8	55.3	89.2
60 °C (140 °F)	18.9	37.7	59.8	96.5