



## 115-TYPE NETWORKS FOR TOLL MESSAGE AND PROGRAM CIRCUITS

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**1. GENERAL**

**1.01** This section describes the various toll message and program circuit networks that are available in the 115-type design. Some of the older type networks have not been redesigned to the 115-type; information on these is given in Section 332-851-102.

**1.02** This issue replaces Issue 1, dated December, 1942; and Addendum, Issue 2, dated December,

1948. The section has been revised to include five new 115-type networks designed for balancing toll cable circuits and three new 115-type networks for balancing or test termination for program transmission circuits.

**1.03** The networks are listed on attached tables as follows:

Table A—Open-Wire Networks

Table B—Toll Cable Networks

Table C—Toll Entrance Cable Networks

Table D—Program Circuit Networks.

A figure is attached for each network giving complete information on the network, including a circuit diagram and network, impedance, and return-loss performance. In the case of certain of the open-wire networks, the strapping arrangement for different wire spacing is included.

**1.04** The 115P network is satisfactory as a balancing network for 16- or 19-gauge H-86-32 side circuits. The 115BG network has been designed for use on 16- or 19-gauge H-86-32 phantom circuits. Circuit information, impedance, and return-loss data for this network are given in Fig. 26. The loading for H-86-32 facilities is obtained by paralleling two H-172-63 loading units at each loading point.

**1.05** The 115AM network is designed to balance H-172-63 and H-174-106 side circuits. The 115AN is designed to balance H-172-63 phantom circuits and the 115AP is designed to balance H-174-106 phantom circuits.

**1.06** The five new toll cable circuit networks are designated 115BM, BN, BP, BR, and BS. The 115BM and BN networks are intended for balancing the impedance of 10-, 13-, and 16-gauge H-44 side and H-25 phantom circuits, respectively, and replace the 104E and 104F balancing networks. The 115BP and BR networks are intended for

balancing the impedance of 13-gauge H-31 side and H-18 phantom circuits, respectively; and they replace the 107A and 107D balancing networks.

**1.07** The 115BS network has been provided for balancing the impedance of 16-gauge B-22-N cable and replaces the D-87801 balancing network. The other three new networks for terminating or balancing 15-kHz program transmission circuits are designated 115BH, BJ, and BK. They have been provided for use with 16- or 19-gauge pairs having a capacitance of 0.062  $\mu$ F per mile and equipped with 3000-7.5, 1000-7.5, and 1500-11 loading systems. In the above loading systems the first figure represents the loading spacing in feet, and the second figure represents the inductance of the loading in millihenries. The principal use of these networks will be for the termination of the loading systems when making impedance runs to check the loading layout. However, they can also be used as balancing networks if it is desired to apply 2-wire repeaters to the program circuits for temporary use as message circuits.

**1.08** These three networks will also be suitable for test terminations in connection with impedance measurements on 15-kHz program transmission circuits in exchange cables that have their loading spacing reduced to an equivalent of 0.062  $\mu$ F per mile.

**1.09** The 115BK network should also be satisfactory for terminating or balancing 19-gauge B-22 program transmission circuits in the frequency range of about 100 to 5000 Hz. If this network is not available, a suitable network for a 19-B-22 pair may be obtained by modifying the 115T network (Fig. 1) as follows: remove strap between terminals 2 and 3, connect 150 ohms between terminals 2 and 3, and strap between terminals 5 and 6.

## **2. DESCRIPTION OF NETWORKS**

**2.01** The 115-type network consists of various capacitors, resistors, and (usually) retardation coils, all potted as one assembly and contained under a common can cover. The network is 6-15/16 inches high, 4-3/8 inches deep, 1-5/8 inches wide and is arranged for single-side relay-rack stud mounting on 7-inch vertical and 1-3/4 inch horizontal centers. The network terminals are in the rear. Each network contains a building-out capacitor, the terminals of which are in the front beneath

the can cover. The code of the network is stamped on the cover and also on the rear of the network.

### **A. Open-Wire Networks**

**2.02** Separate networks are not provided for different spacings of conductors as was done with the older types. Instead, different spacings are cared for by suitable strapping of the network terminals, as indicated on the individual network drawings. The open-wire networks of the 115-type are listed in Table A.

**2.03** The building-out capacitor is brought out to a separate terminal, No. 4, and a blank terminal, No. 2, is provided to facilitate the installation of building-out resistors, when necessary. Resistors of the 111-type are suitable for such use, since they can be supported on the network terminals by their leads. Since building-out resistors are seldom required, the networks come with terminals 2, 3, and 4 strapped.

### **B. Cable Networks**

**2.04** With the exception of the B-88-50 networks, which are designed to simulate half-coil circuit impedance, the cable networks are designed for basic end sections varying from 0.158 to 0.186 of full section. The design, however, includes resistance for half-section terminations so that optimum return loss is obtained when the circuits terminate at half-section and the building-out capacitance is made equal to the difference between half-section capacitance and the capacitance of the basic end section shown on the network drawings.

**2.05** With the exception of the 115S network for B135-BSA circuits, the cable networks are designed fundamentally for cable having a nominal side capacitance of 0.062  $\mu$ F per mile and a phantom capacitance of 0.10  $\mu$ F per mile. Where the cable capacitance runs higher or lower than this, the adverse effect on return loss can be avoided by an adjustment of the resistance component of the network impedance. Since this effect is of importance principally in toll cables, provision has been made in the toll cable networks for adjustments to compensate for it. The adjustments are indicated on the network drawings.

### 3. BALANCE CONSIDERATIONS

#### A. Return-Loss Performance—Design Values

**3.01** The drawing for each network shows the return loss between the network impedance, with allowance for manufacturing variations, and the characteristic impedance of the type of circuit concerned. With one or two exceptions mentioned below, this return loss is sufficiently high that its effect on the structural return loss of the circuit can be ignored.

**3.02** The exceptions referred to above occur in the case of the D-specification networks for open-wire circuits of unusual gauges and materials. As covered in other information, a structural return loss of 25 dB is generally assumed for these circuits. In computations, the network design value should be used as the structural return loss wherever the design value is less than 25 dB. A reference to the figures will show that this occurs only at low frequencies for the networks for 109 and 134 steel circuits.

#### B. Building-Out Capacitance and Resistance Adjustments

**3.03** The building-out element of the open-wire and toll entrance cable networks consists only of a building-out capacitor, and this is adjusted in the usual manner in specific cases. Resistance building-out is expected to be required only seldom, if ever. The terminal arrangements on the network, however, are such as to facilitate the addition of resistors (111-type), if required.

**3.04** As mentioned previously, the toll cable networks, in addition to the customary building-out capacitor, include resistors to adjust the network impedance in case the cable capacitance departs from nominal. If the average capacitance of the cable for the first few loading sections from the office is higher than nominal, the impedance will be lower than nominal and can be corrected for by removing resistance from the network. Resistance is added in case the capacitance is less than nominal. The strappings for various average cable capacitances are shown on the network drawings attached.

**3.05** Both the capacitance and resistance adjustments of the toll cable networks can be made on the basis of capacitance data for the cable in question where these are available. In absence of

such data, the adjustments can be made by means of return-loss measurements over the frequency range. In general, the optimum adjustment of the building-out resistance should be obtained at about 500 Hz or lower, and that of the capacitance above about 1500 Hz. The impedance of several circuits compared with the network impedances for the various strappings will also indicate the best adjustments. When these methods are not feasible, the best procedure will be to assume that the cable capacitance is nominal; strap the resistors for nominal capacitance, as shown by the figures; and adjust the capacitor on the basis of the length of the end section.

### 4. EQUIPMENT CONSIDERATIONS

#### A. New Installations

**4.01** The 115-type network is well adapted to new installations because of its compactness and terminal arrangements. A space of four 1-3/4 inch by 19-inch mounting plates will accommodate 10 networks, or 12 networks in case of 23-inch relay racks. The terminal arrangement is such that mounting bars can go across the center of the 7-inch mounting dimension to accommodate an assembly of miscellaneous apparatus where this is required.

**4.02** The mounting of the 115-type network horizontally on the 600-type mounting plate will probably be rare in the toll plant; but, when required, this type mounting plate can be obtained with suitable drilling.

#### B. Additions to Installations of 113-Type Networks

**4.03** The 115-type network is physically identical with the 113-type except that the network terminals are located near the top mounting stud instead of halfway between studs. As the wiring form customarily comes from the top of the bay, the new location of the terminals will cause no wiring difficulty.

#### C. Additions to Installations of the 102-, 103-, 104-, 107-, and 108-Type Networks

**4.04** Additions to installations of these types can be accomplished by the use of the 38A bracket. This bracket consists essentially of a base of the older type networks with a right angle bracket with terminals in the same position as that

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of the terminals of the older type. The 115-type network is mounted on this base and connected to the terminals of the bracket, which in turn are cabled in the same manner as the old type networks.

**4.05** The 38A bracket has the disadvantages that the network cannot be mounted until the terminal strappings have been made and that it requires considerably more space than the 115-type network. Where practicable, therefore, it would be preferable to avoid its use by placing the 115-type networks in a new space on the rack rather than in the space of existing networks of the older types.

### **D. Additions to D-Specification Networks for B-88-50**

**4.06** The D-specification networks described in Section 332-851-102 for B-88-50 circuits are of such nature that the replacing 115-type cannot be readily mounted in the same space. These D-specification networks will be continued for additions and maintenance in those cases where the 115-type cannot be mounted in new space.

### **E. Coil-Rack Mounting**

**4.07** Coil-rack mounting, if required, can be accomplished by attaching the network to the 38A bracket as described above and then fastening this assembly to a mounting detail per D-77985.

TABLE A

115-TYPE OPEN-WIRE NETWORKS

Network Code	Gauge	For Facility as Follows:			Network Fig.	Replaces
		Material	Circuit	Spacing		
115T *	104	Copper	Side or Phys	6, 8, 12, or 18-in.†	1	
115U *	128	Copper	Side or Phys	6, 8, 12, or 18-in.†	2	108A, 102A, 102B, 102C
115W *	165	Copper	Side or Phys	6, 8, 12, or 18-in.†	3	108B, 102H, 102J, 102K 108C, 102E, 102F, 102G
115Y	104	Copper	Phantom	12-in.	4	102D
115AA	128 or 165	Copper	Phantom	12-in.	5	102L, 103A
115AR *	080	Copper	Side or Phys	6, 8, or 12-in.	6	D-161328
115AS *	080	Copper	Phantom	8 or 12-in.	7	D-161329
115AW	109	High-Strength Steel	Side or Phys	12-in.	8	D-161386
115AY	109	High-Strength Steel	Phantom	12-in.	9	D-161387
115AT	134	Steel	Side or Phys	12-in.	10	D-161384
115AU	134	Steel	Phantom	12-in.	11	D-161385
115BA *	104	Copper-Steel ‡	Side or Phys	6, 8, or 12-in.	12	D-161804
115BD *	104	Copper-Steel ‡	Phantom	8 or 12-in.	13	D-161807
115BB *	128	Copper-Steel ‡	Side or Phys	6, 8, or 12-in.	14	D-161805
115BE *	128	Copper-Steel ‡	Phantom	8 or 12-in.	15	D-161808
115BC *	165	Copper-Steel ‡	Side or Phys	6, 8, or 12-in.	16	D-161806
115BF *	165	Copper-Steel ‡	Phantom	8 or 12-in.	17	D-161809

\* Adjustable for various wire spacings.  
(See individual network figures.)

† These are pole pairs or half pole pairs.

‡ 40-percent conductivity wire.

TABLE B

115-TYPE NETWORKS FOR TOLL GABLE CIRCUITS

Network Code	For Facility			Network Fig.	
	Gauge	Loading	Circuit		
115P	19	H-88-50	Side	18	113P
115R	19	H-88-50	Phantom	19	113R
115AF	19	B-88-50	Side	20	D-92945
115AG	19	B-88-50	Phantom	21	D-92946
115AH	19	H-44-25	Side	22	13P and 17H
115AJ	19	H-44-25	Phantom	23	13S and 17J
115EM	10, 13, or 16	H-44-25	Side	24	104E
115BN	10, 13, or 16	H-44-25	Phantom	25	104F
115P	16 or 19	H-86-32	Side	18	113P
115BG	16 or 19	H-86-32	Phantom	26	D-176421
115AM	16 or 19	H-172-63	Side	27	104A and 104B
115AN	16 or 19	H-172-63	Phantom	28	104C and 104D
115AM	16 or 19	H-174-106	Side	27	104A and 104B
115AP	16 or 19	H-174-106	Phantom	29	13T and 22A
115S	22BSA	B-135	Pair	30	113S

TABLE C

115-TYPE NETWORKS FOR TOLL ENTRANCE CABLE

Network Code	For Facility			Network Fig.	Replaces
	Gauge	Loading	Circuit		
115AB	19	H-31-18	Side	31	107C
115AD	19	H-31-18	Phantom	32	107F
115AC	16	H-31-18	Side	33	107B
115AE	16	H-31-18	Phantom	34	107E
115BP	13	H-31-18	Side	35	107A
115BR	13	H-31-18	Phantom	36	107D

TABLE D

PROGRAM CIRCUIT NETWORKS

Network Code	For Facility			Network Fig.	Replaces
	Gauge	Loading	Circuit		
115BH	16 or 19	3000-7.5	Pair	37	New
115BJ	16 or 19	1000-7.5	Pair	38	New
115BK	16 or 19	1500-11	Pair	39	New
115BS	16	B-22-N	Pair	40	D-87801
115T *	19	B-22	Pair	1	-

\* Requires modification as covered in 1.09.

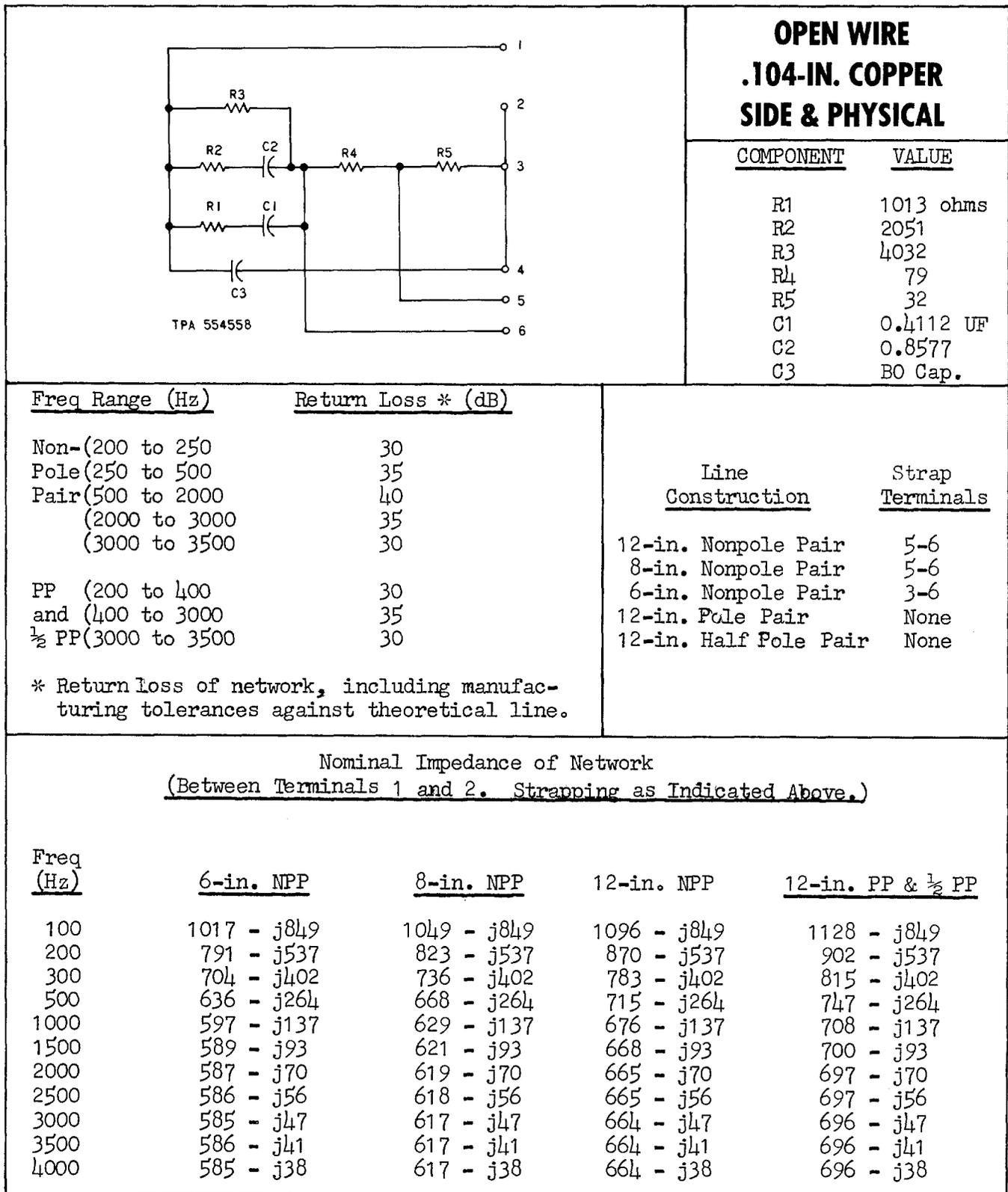


Fig. 1—115T Network—Engineering Information

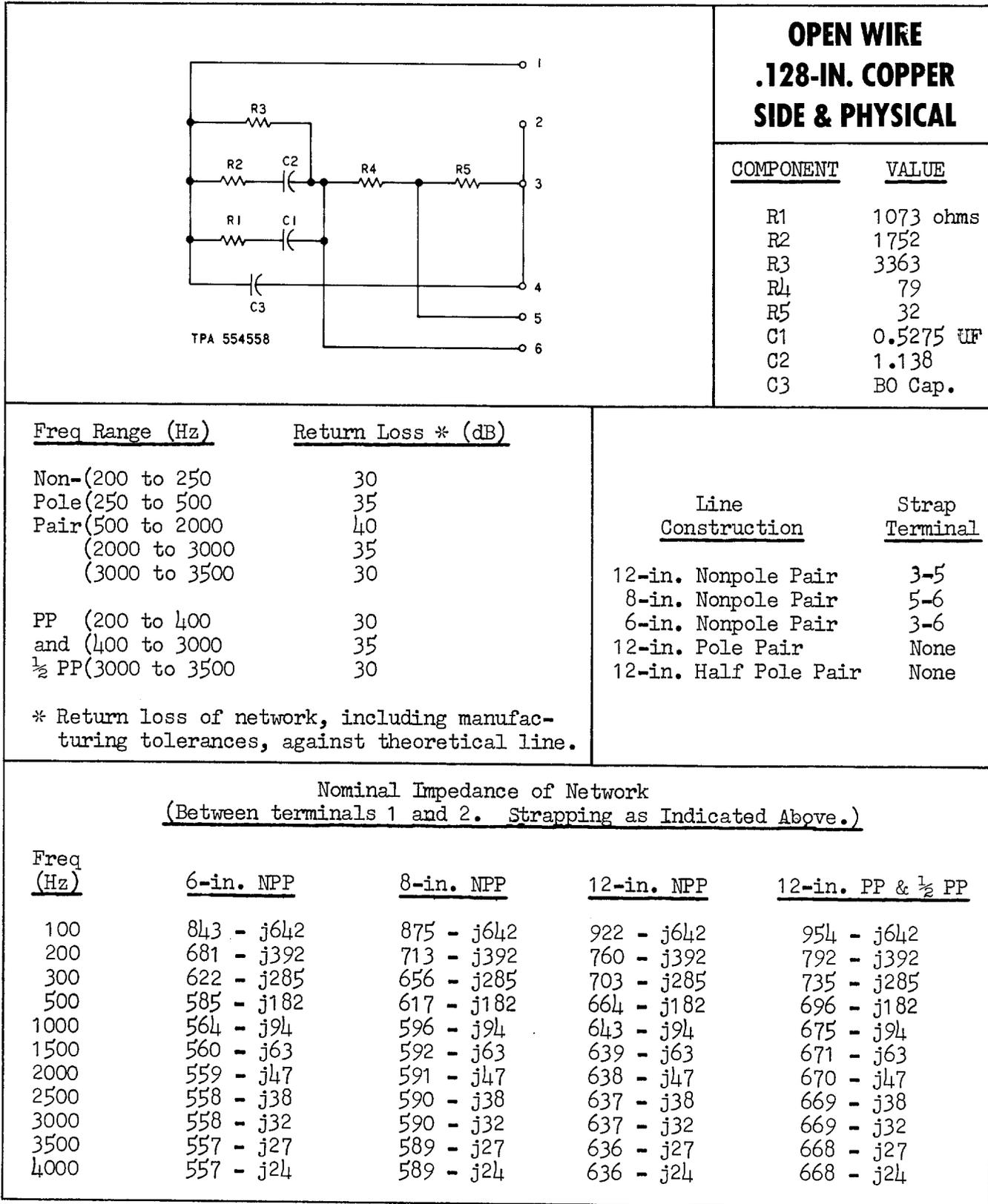
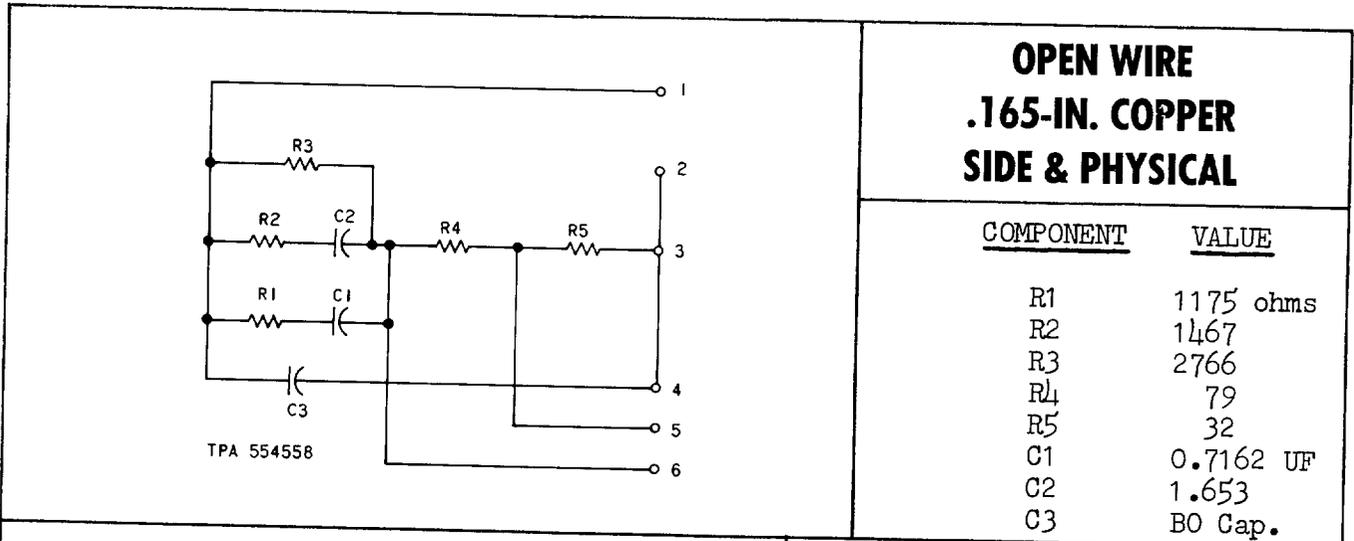


Fig. 2—115U Network—Engineering Information



**OPEN WIRE  
.165-IN. COPPER  
SIDE & PHYSICAL**

<u>COMPONENT</u>	<u>VALUE</u>
R1	1175 ohms
R2	1467
R3	2766
R4	79
R5	32
C1	0.7162 UF
C2	1.653
C3	BO Cap.

<u>Freq Range (Hz)</u>	<u>Return Loss * (dB)</u>
Non-(200 to 250	30
Pole(250 to 500	35
Pair(500 to 2000	40
(2000 to 3000	35
(3000 to 3500	30
PP (200 to 400	30
and (400 to 3000	35
½ PP(3000 to 3500	30

<u>Line Construction</u>	<u>Strap Terminals</u>
12-in. Nonpole Pair	3-5
8-in. Nonpole Pair	5-6
6-in. Nonpole Pair	3-6
12-in. Pole Pair	None
12-in. Half Pole Pair	None

\* Return loss of network, including manufacturing tolerances, against theoretical line.

Nominal Impedance of Network  
(Between Terminals 1 and 2. Strapping as Indicated Above.)

<u>Freq (Hz)</u>	<u>6-in. NPP</u>	<u>8-in. NPP</u>	<u>12-in. NPP</u>	<u>12-in. PP &amp; ½ PP</u>
100	687 - j446	719 - j446	766 - j446	798 - j446
200	588 - j258	620 - j258	667 - j258	699 - j258
300	558 - j181	590 - j181	637 - j181	669 - j181
500	540 - j112	572 - j112	619 - j112	651 - j112
1000	531 - j57	563 - j57	610 - j57	642 - j57
1500	529 - j38	561 - j38	608 - j38	640 - j38
2000	529 - j29	561 - j29	608 - j29	640 - j29
2500	528 - j23	560 - j23	607 - j23	639 - j23
3000	528 - j19	560 - j19	607 - j19	639 - j19
3500	528 - j16	560 - j16	607 - j16	639 - j16
4000	528 - j14	560 - j14	607 - j14	639 - j14

**Fig. 3—115W Network—Engineering Information**

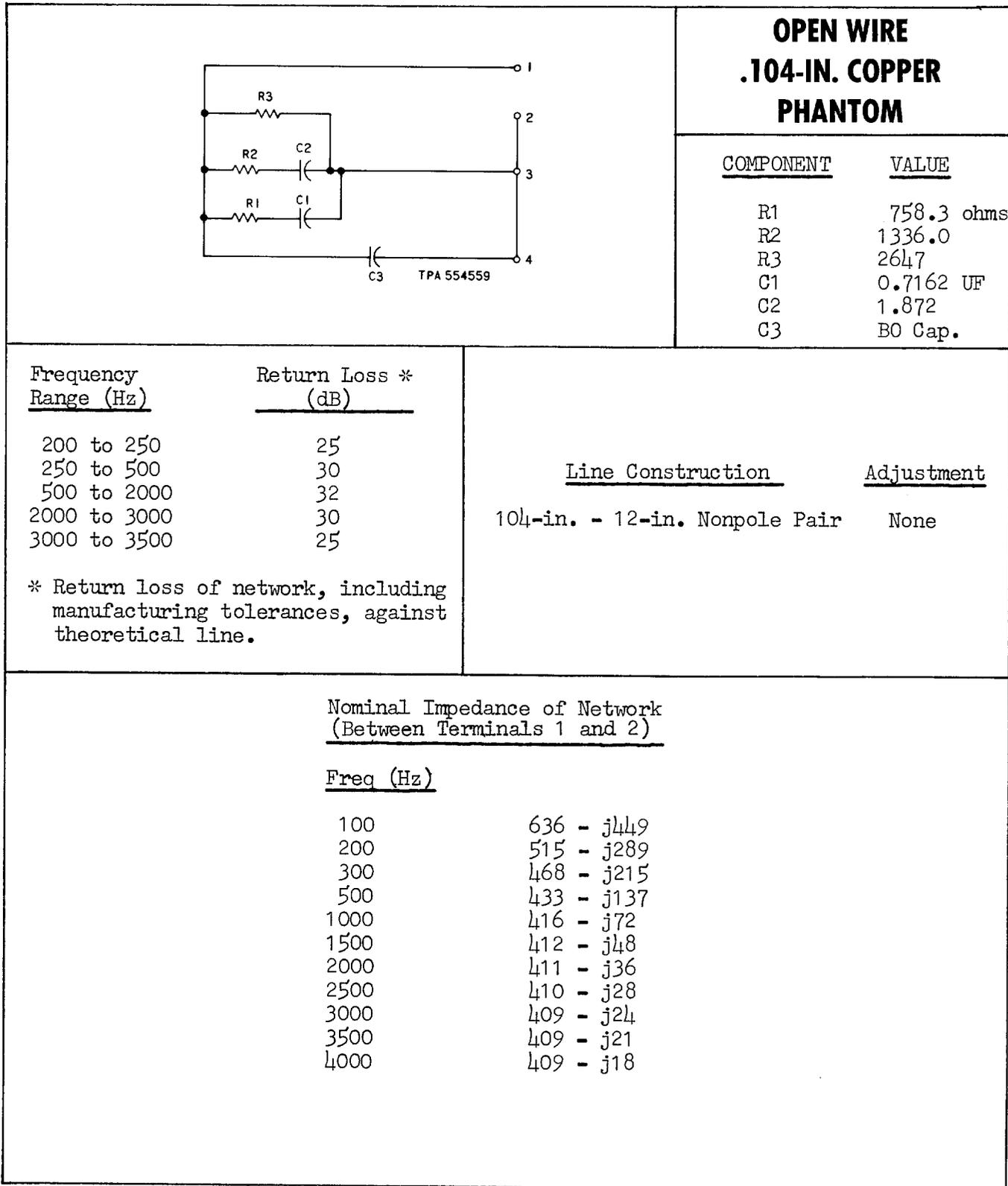
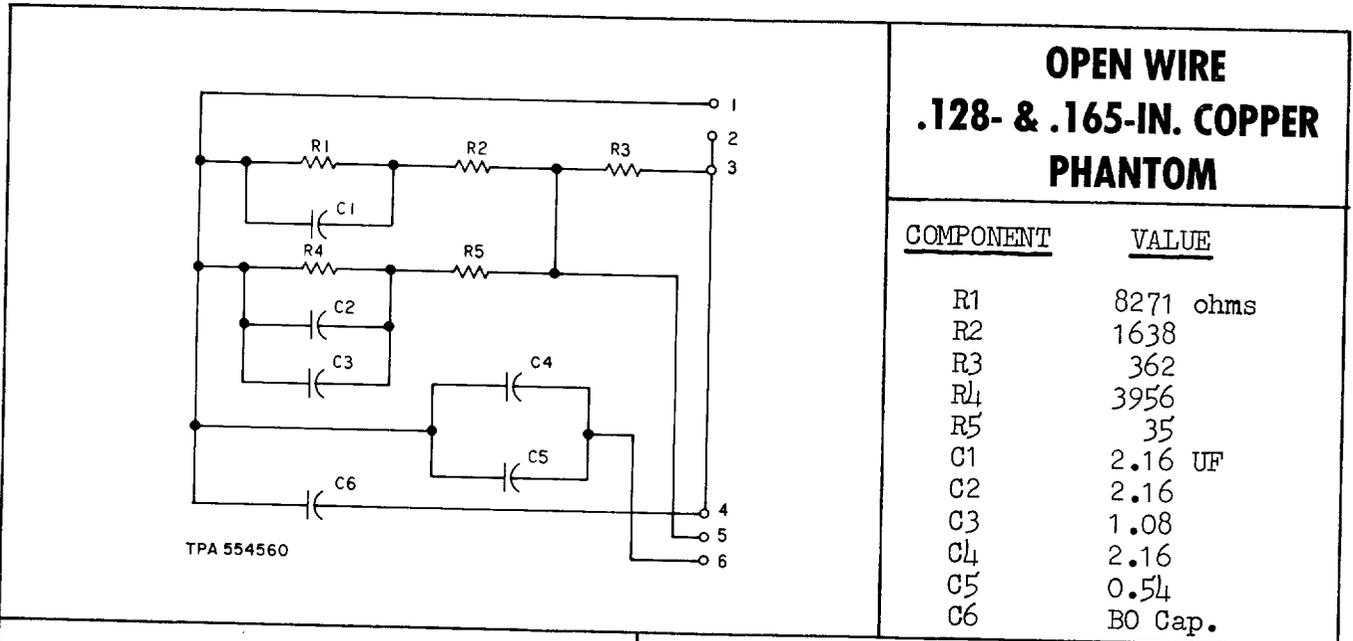


Fig. 4—115Y Network—Engineering Information



**OPEN WIRE  
.128- & .165-IN. COPPER  
PHANTOM**

<u>COMPONENT</u>	<u>VALUE</u>
R1	8271 ohms
R2	1638
R3	362
R4	3956
R5	35
C1	2.16 UF
C2	2.16
C3	1.08
C4	2.16
C5	0.54
C6	B0 Cap.

<u>Freq Range (Hz)</u>	<u>Return Loss * (dB)</u>
200 to 250	25
250 to 500	30
500 to 2000	32
2000 to 3000	30
3000 to 3500	25

\* Return loss of network, including manufacturing tolerances, against theoretical line.

<u>Line Construction</u>	<u>Strap Terminals</u>
.128-in. - 12-in. Nonpole Pair	None
.165-in. - 12-in. Nonpole Pair	5-6

Nominal Impedance of Network  
(Between Terminals 1 and 2. Strapping as Indicated Above.)

<u>Freq (Hz)</u>	<u>.128 in.</u>	<u>.165 in.</u>
100	521 - j393	418 - j245
200	438 - j223	386 - j130
300	416 - j153	379 - j88.7
500	404 - j93.8	374 - j54.6
1000	398 - j47.3	372 - j29.6
1500	397 - j31.6	371 - j21.8
2000	397 - j23.7	370 - j18.0
2500	396 - j19.0	368 - j15.7
3000	396 - j15.8	367 - j14.1
3500	396 - j13.5	367 - j12.8
4000	396 - j11.8	366 - j11.9

**Fig. 5—115AA Network—Engineering Information**

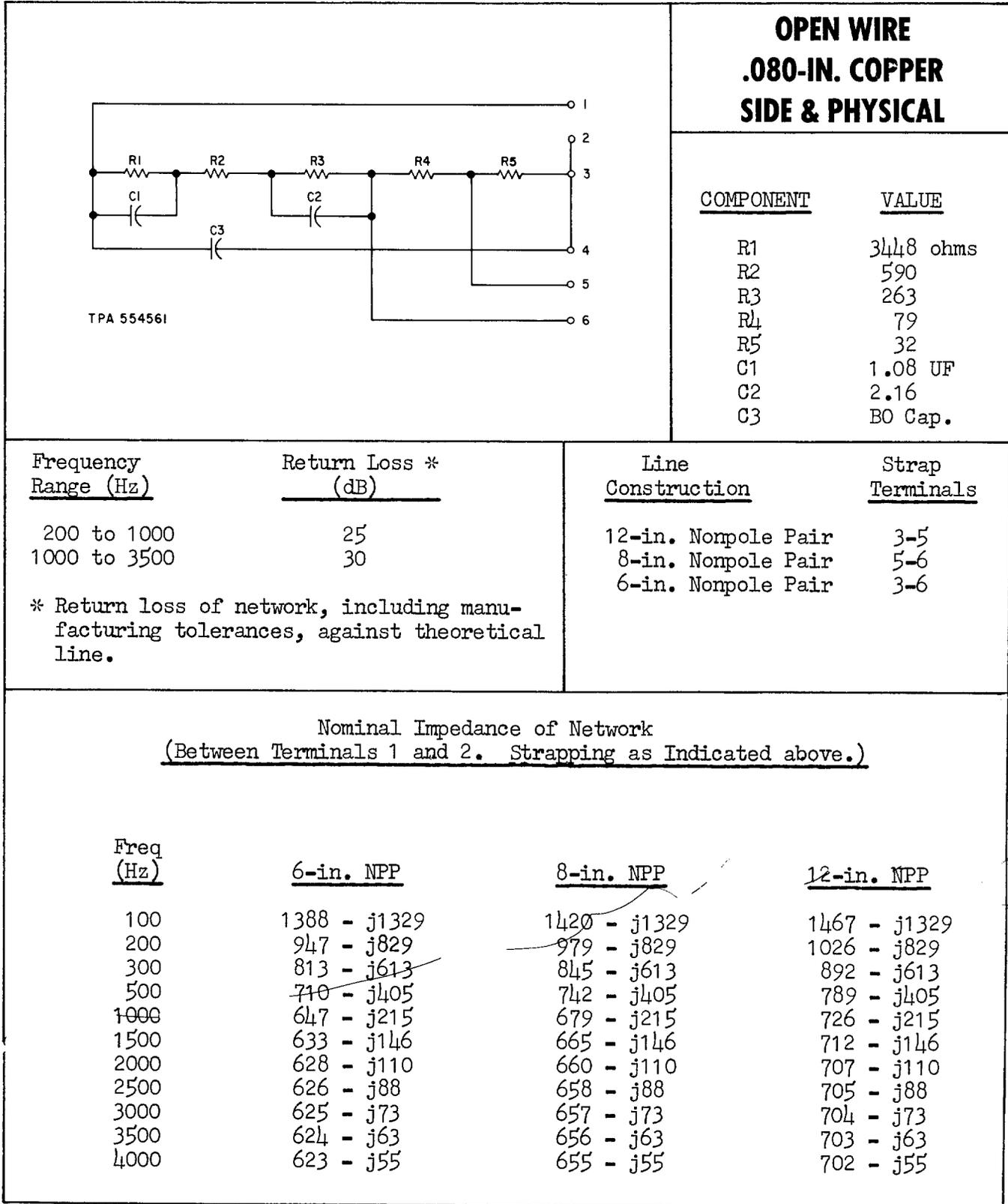
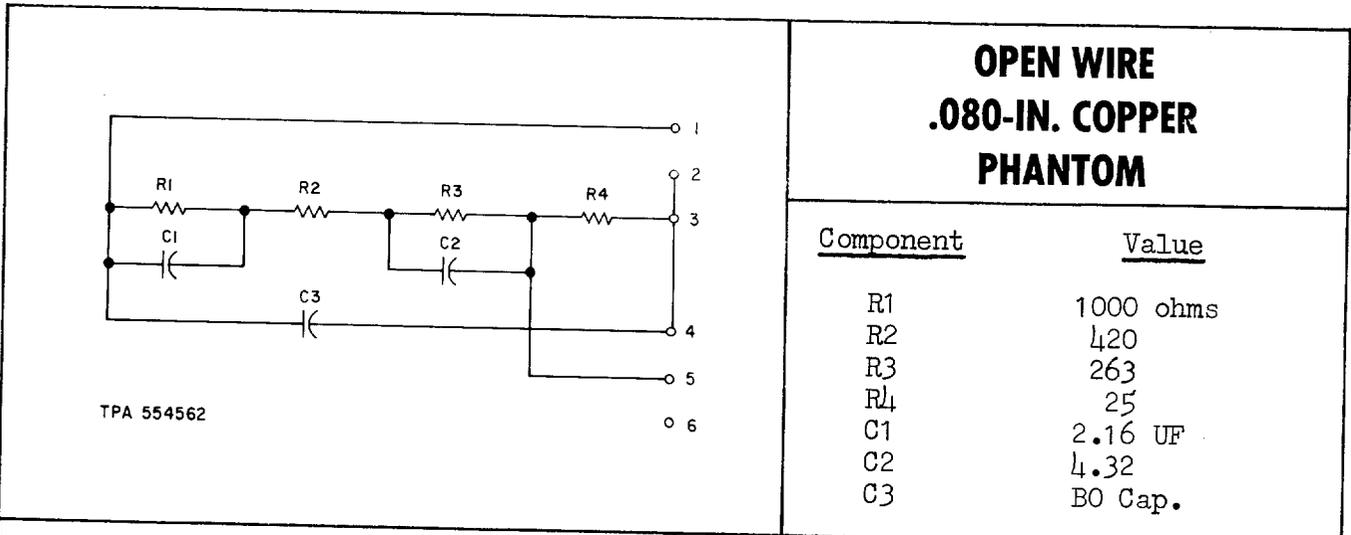


Fig. 6—115AR Network—Engineering Information



**OPEN WIRE  
.080-IN. COPPER  
PHANTOM**

<u>Component</u>	<u>Value</u>
R1	1000 ohms
R2	420
R3	263
R4	25
C1	2.16 UF
C2	4.32
C3	80 Cap.

<u>Frequency Range (Hz)</u>	<u>Return Loss * (dB)</u>
200 to 1000	25
1000 to 3500	30

\* Return loss of network, including manufacturing tolerances, against theoretical line.

<u>Line Construction</u>	<u>Strap Terminals</u>
12-in. Nonpole Pair	3-5
8-in. Nonpole Pair	None

Nominal Impedance of Network  
(Between Terminals 1 and 2. Strapping as Indicated Above.)

<u>Freq (Hz)</u>	<u>8-in. NPP</u>	<u>12-in. NPP</u>
100	971 - j602	946 - j602
200	651 - j448	626 - j448
300	524 - j332	524 - j332
500	482 - j213	457 - j213
700	441 - j155	441 - j155
1000	455 - j109	430 - j109
1500	450 - j73	425 - j73
2000	448 - j55	423 - j55
2500	447 - j44	422 - j44
3000	446 - j37	421 - j37
3500	446 - j32	421 - j32
4000	446 - j28	421 - j28

Fig. 7—115AS Network—Engineering Information

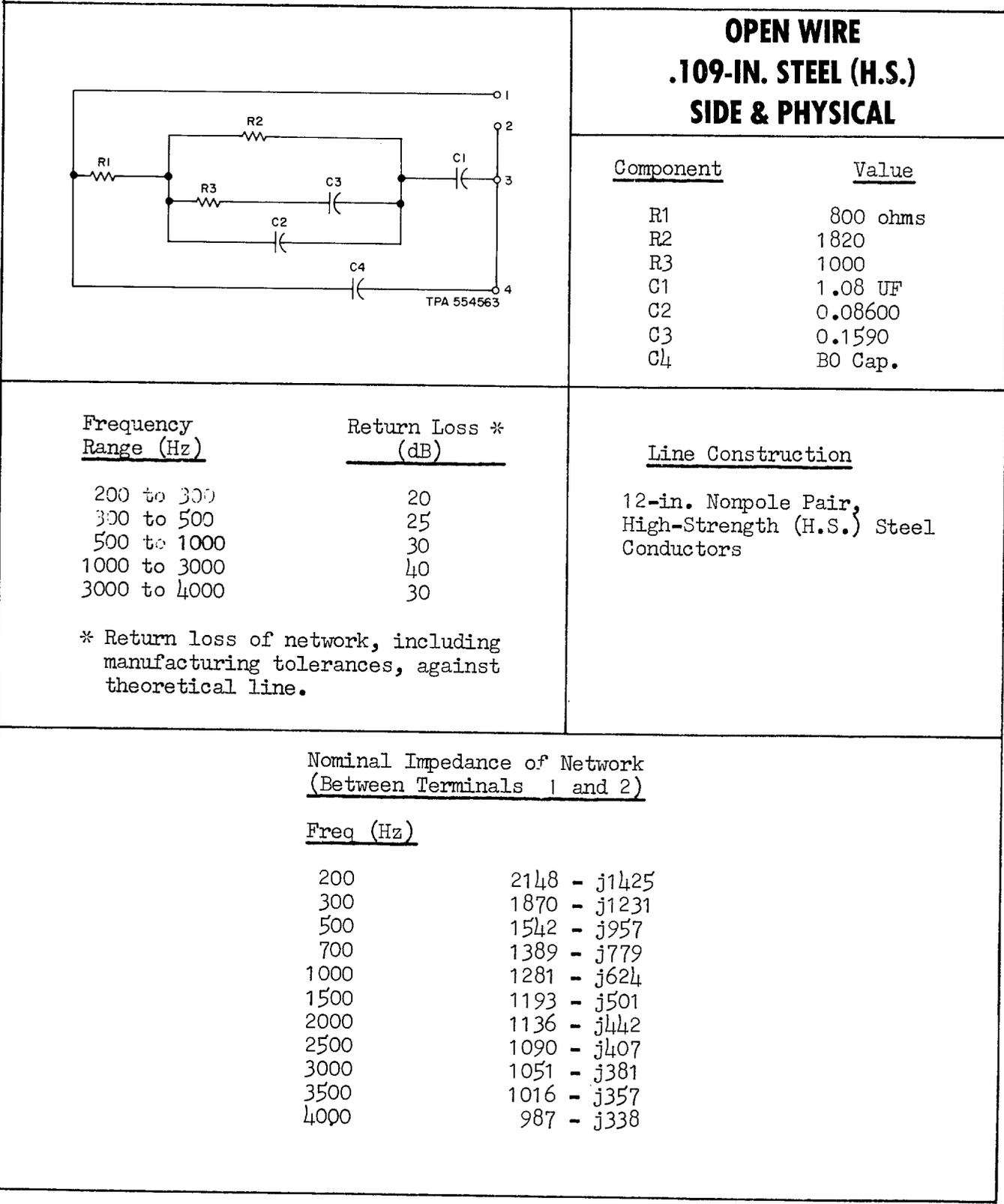
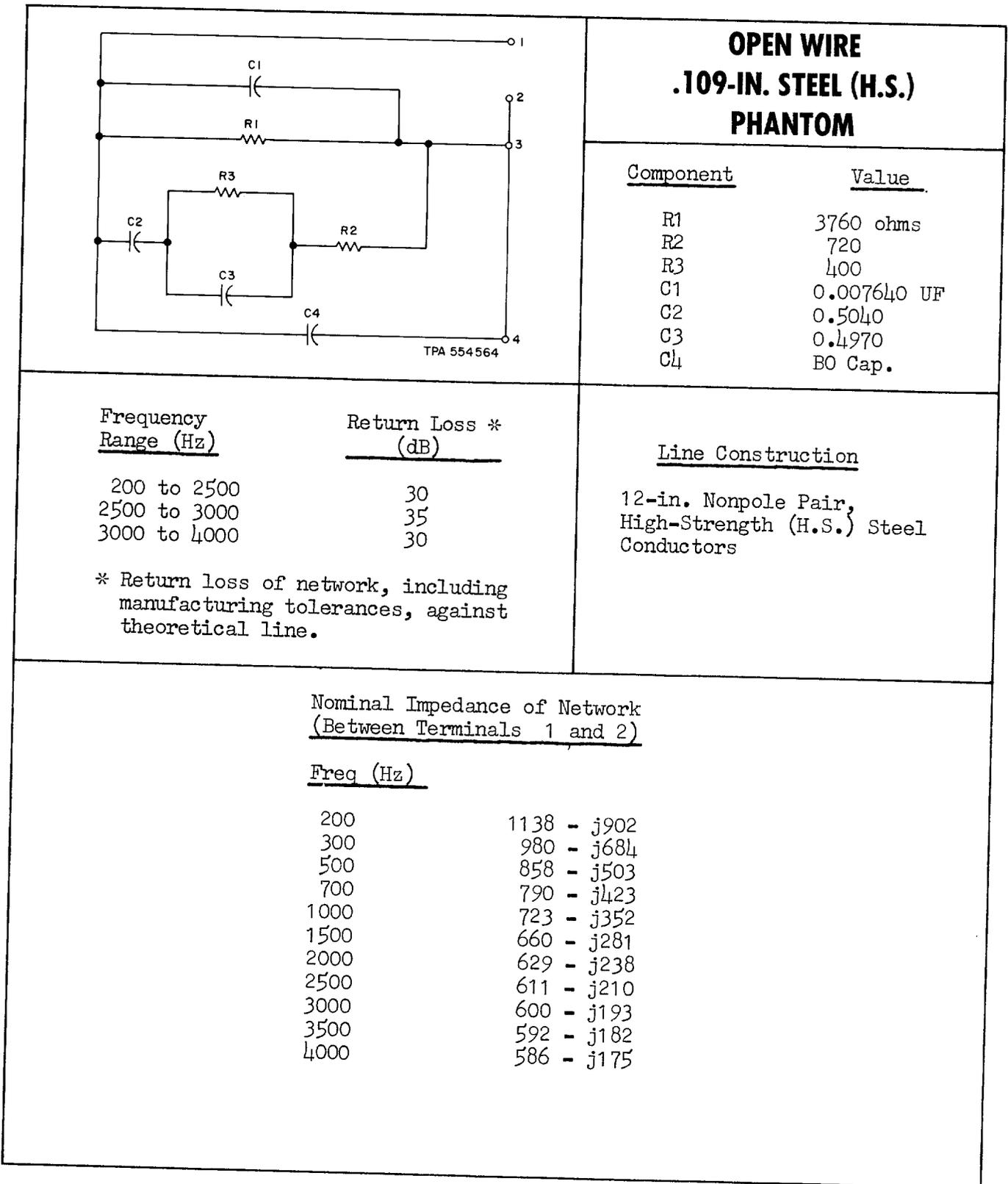


Fig. 8—115AW Network—Engineering Information



**OPEN WIRE  
.109-IN. STEEL (H.S.)  
PHANTOM**

<u>Component</u>	<u>Value</u>
R1	3760 ohms
R2	720
R3	400
C1	0.007640 UF
C2	0.5040
C3	0.4970
C4	BO Cap.

<u>Frequency Range (Hz)</u>	<u>Return Loss * (dB)</u>
200 to 2500	30
2500 to 3000	35
3000 to 4000	30

\* Return loss of network, including manufacturing tolerances, against theoretical line.

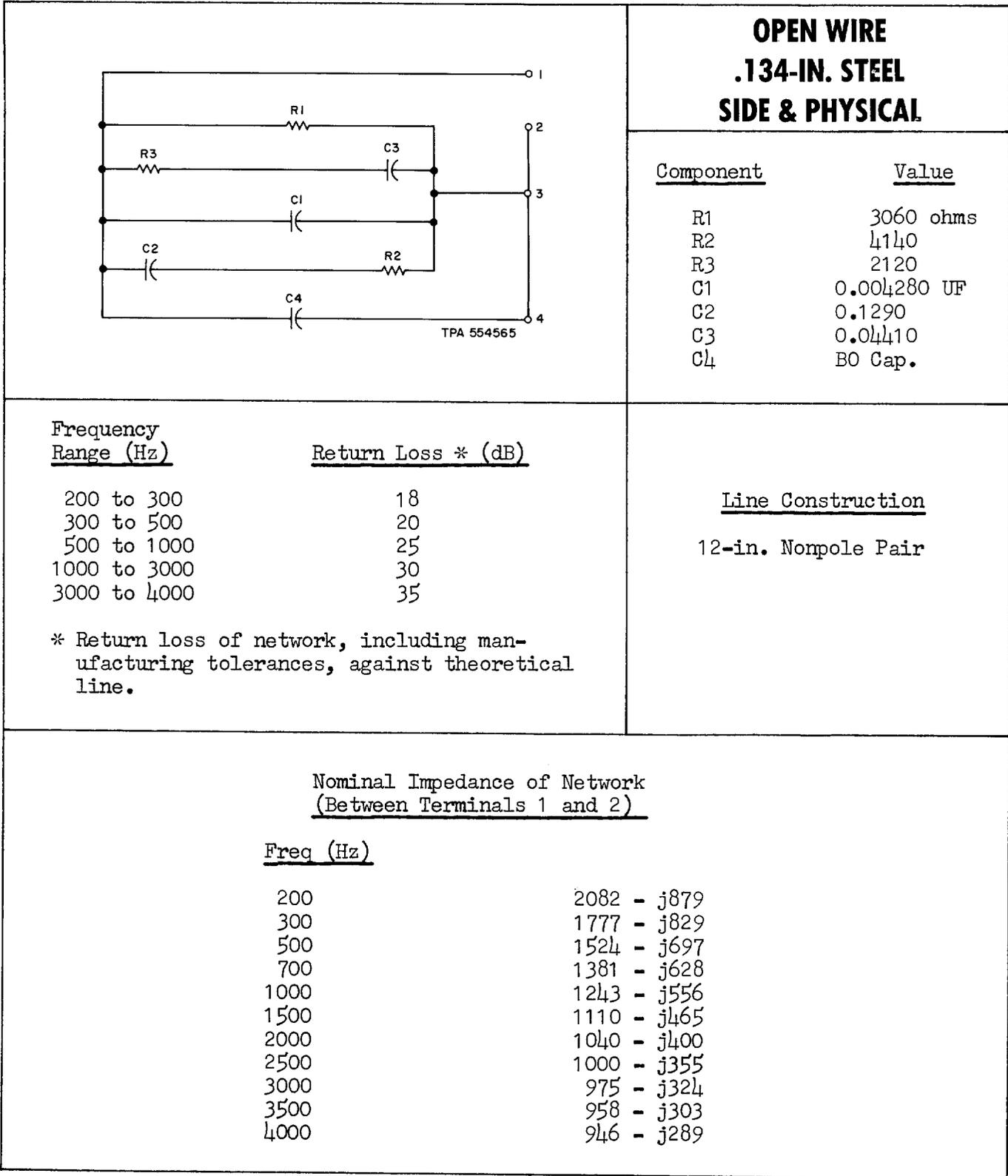
Line Construction

12-in. Nonpole Pair,  
High-Strength (H.S.) Steel  
Conductors

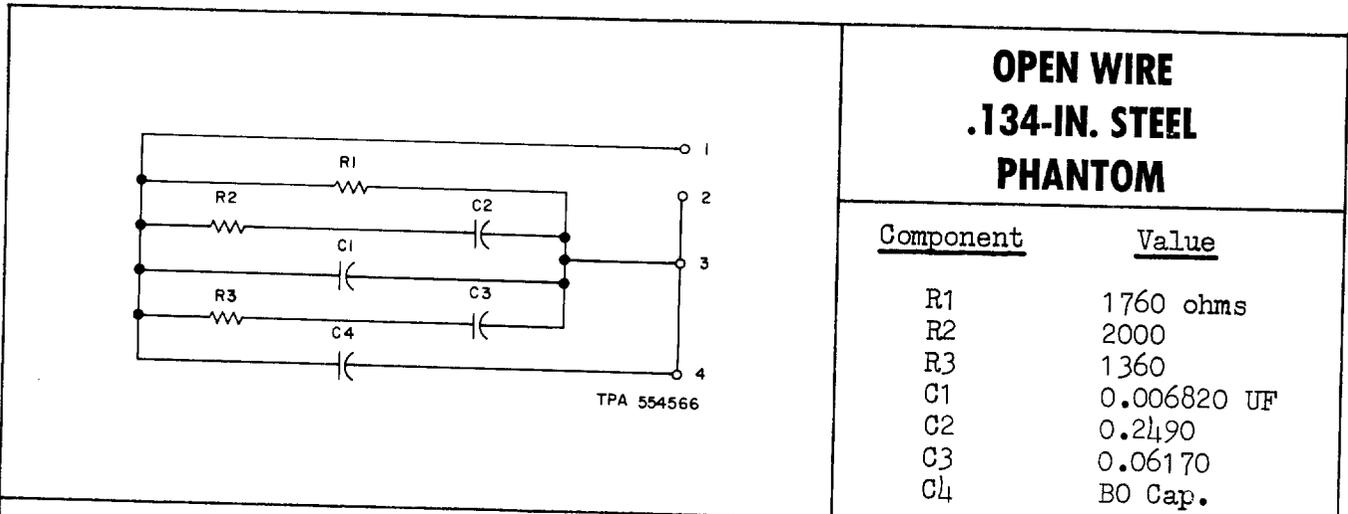
Nominal Impedance of Network  
(Between Terminals 1 and 2)

<u>Freq (Hz)</u>	
200	1138 - j902
300	980 - j684
500	858 - j503
700	790 - j423
1000	723 - j352
1500	660 - j281
2000	629 - j238
2500	611 - j210
3000	600 - j193
3500	592 - j182
4000	586 - j175

**Fig. 9—115AY Network—Engineering Information**



**Fig. 10—115AT Network—Engineering Information**



**OPEN WIRE  
.134-IN. STEEL  
PHANTOM**

<u>Component</u>	<u>Value</u>
R1	1760 ohms
R2	2000
R3	1360
C1	0.006820 UF
C2	0.2490
C3	0.06170
C4	BO Cap.

<u>Frequency Range (Hz)</u>	<u>Return Loss * (dB)</u>
200 to 300	18
300 to 500	20
500 to 1000	25
1000 to 2000	30
2000 to 4000	35

\* Return loss of network, including manufacturing tolerances, against theoretical line.

Line Construction  
12-in. Nonpole pair

Nominal Impedance of Network (Between Terminals 1 and 2)

<u>Freq (Hz)</u>	
200	1178 - j509
300	1010 - j462
500	864 - j381
700	792 - j338
1000	724 - j300
1500	654 - j257
2000	613 - j225
2500	588 - j202
3000	573 - j185
3500	562 - j173
4000	554 - j165

Fig. 11—115AU Network—Engineering Information

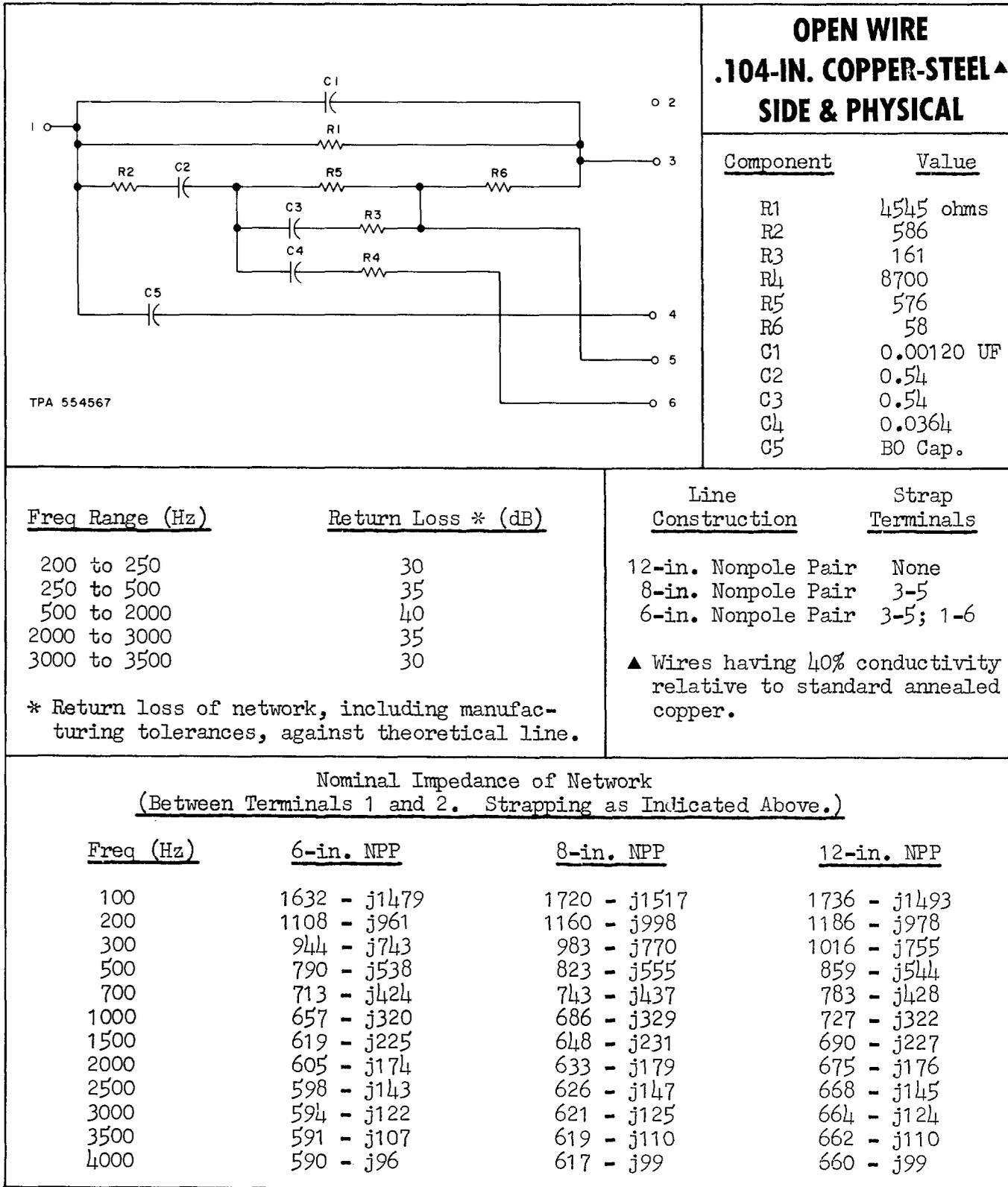
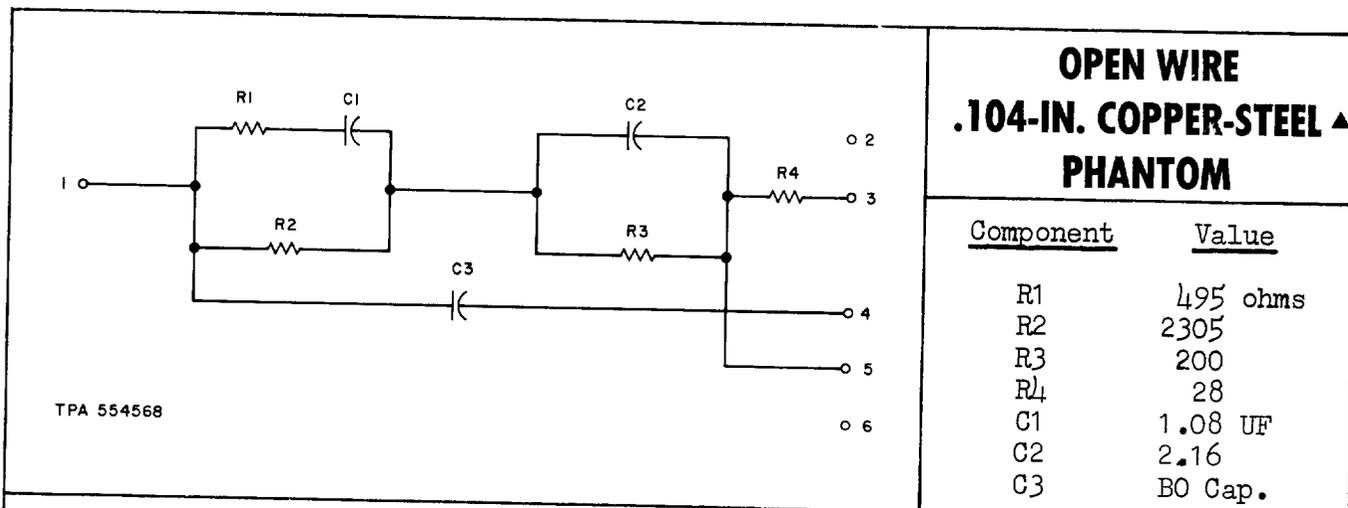


Fig. 12—115BA Network—Engineering Information



<u>Freq Range (Hz)</u>	<u>Return Loss * (dB)</u>
200 to 250	25
250 to 500	30
500 to 2000	32
2000 to 3000	30
3000 to 3500	25

\* Return loss of network, including manufacturing tolerances, against theoretical line.

<u>Line Construction</u>	<u>Strap Terminals</u>
12-in. Nonpole Pair	3-5
8-in. Nonpole Pair	None

▲ Wires having 40% conductivity relative to standard annealed copper.

Nominal Impedance of Network  
(Between Terminals 1 and 2. Strapping as Indicated Above)

<u>Freq (Hz)</u>	<u>8-in. NPP</u>	<u>12-in. NPP</u>
100	1033 - j833	1005 - j833
200	713 - j551	685 - j551
300	610 - j416	582 - j416
500	527 - j293	499 - j293
700	490 - j224	462 - j224
1000	465 - j164	437 - j164
1500	449 - j112	421 - j112
2000	443 - j84.7	415 - j84.7
2500	440 - j68.1	412 - j68.1
3000	439 - j57.5	411 - j57.5
3500	438 - j48.9	410 - j48.9
4000	438 - j43.2	410 - j43.2

Fig. 13—115BD Network—Engineering Information

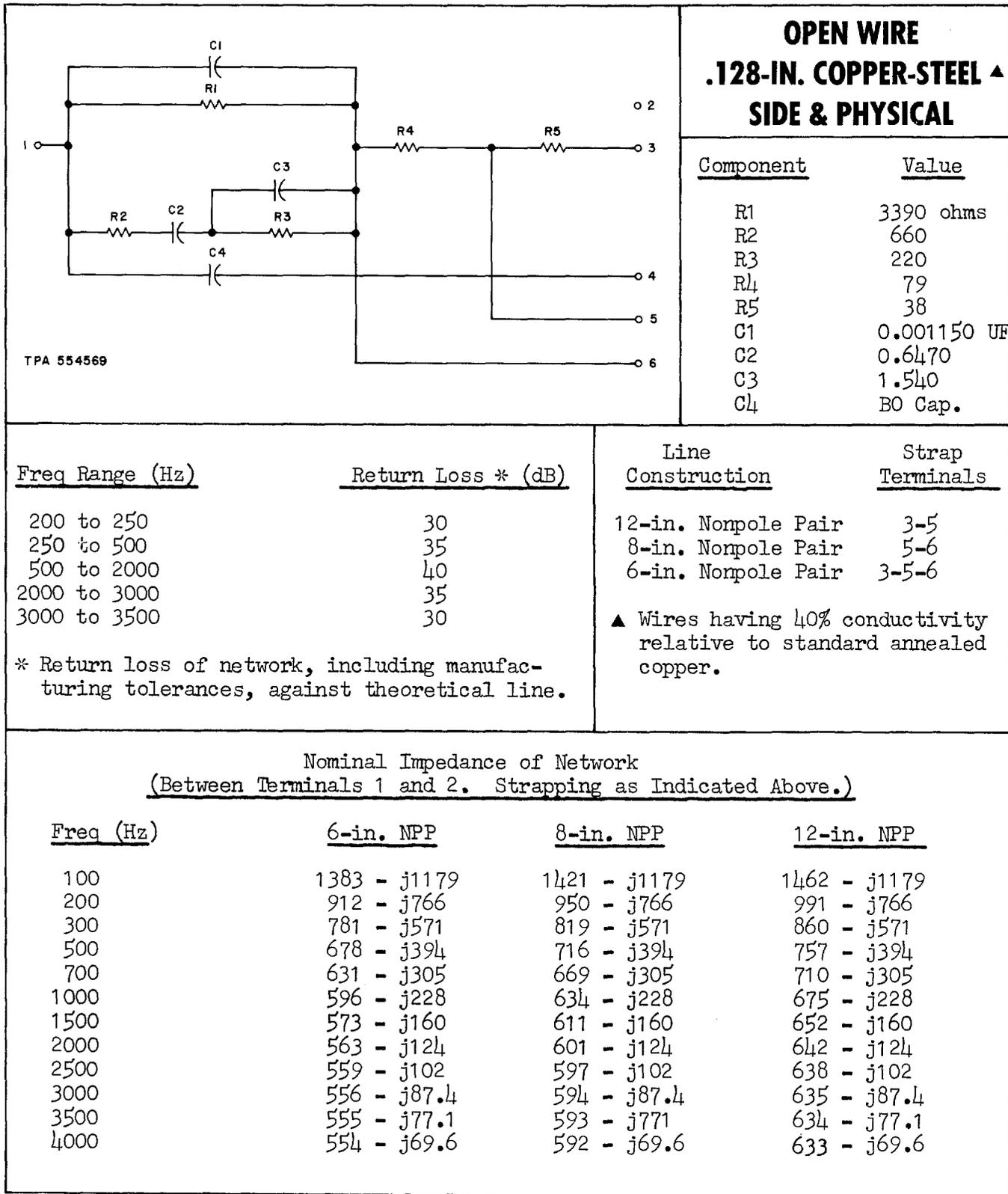
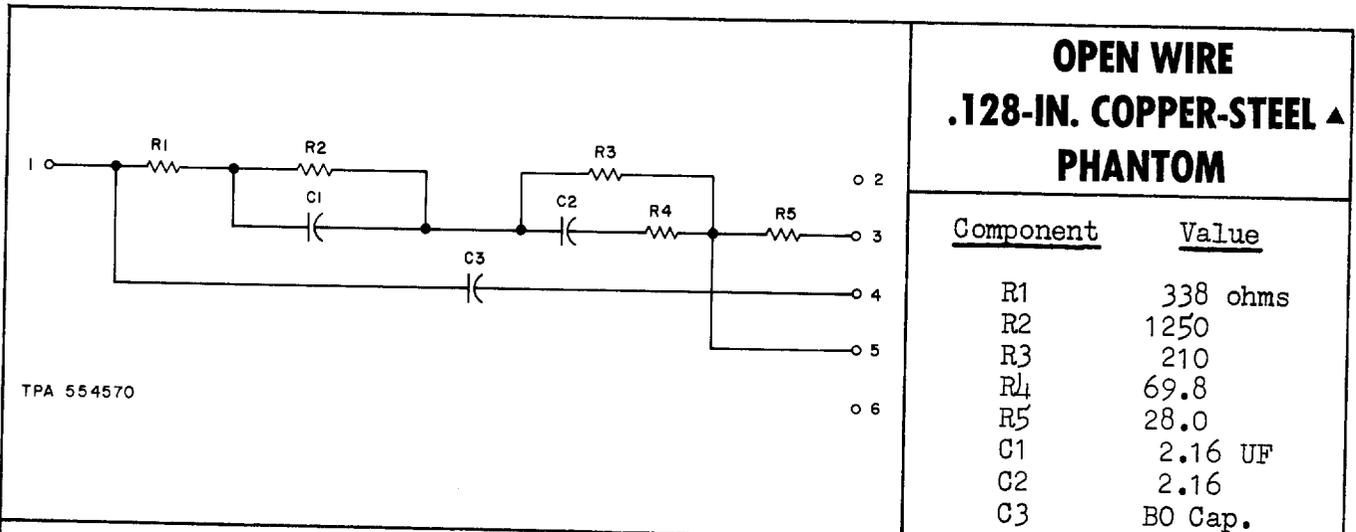


Fig. 14—115BB Network—Engineering Information



<u>Freq Range (Hz)</u>	<u>Return Loss * (dB)</u>
200 to 250	25
250 to 500	30
500 to 2000	32
2000 to 3000	30
3000 to 3500	25

\* Return loss of network, including manufacturing tolerances, against theoretical line.

<u>Line Construction</u>	<u>Strap Terminals</u>
12-in. Nonpole Pair	3-5
8-in. Nonpole Pair	None

▲ Wires having 40% conductivity relative to standard annealed copper.

Nominal Impedance of Network  
(Between Terminals 1 and 2. Strapping as Indicated Above.)

<u>Freq (Hz)</u>	<u>8-in. NPP</u>	<u>12-in. NPP</u>
100	878 - j599	850 - j599
200	618 - j415	590 - j415
300	533 - j315	505 - j315
500	469 - j210	441 - j210
700	447 - j157	419 - j157
1000	433 - j112	405 - j112
1500	425 - j75.8	397 - j75.8
2000	422 - j57.2	394 - j57.2
2500	420 - j45.9	392 - j45.9
3000	420 - j38.2	392 - j38.2
3500	419 - j32.8	391 - j32.8
4000	419 - j28.7	391 - j28.7

Fig. 15—115BE Network—Engineering Information

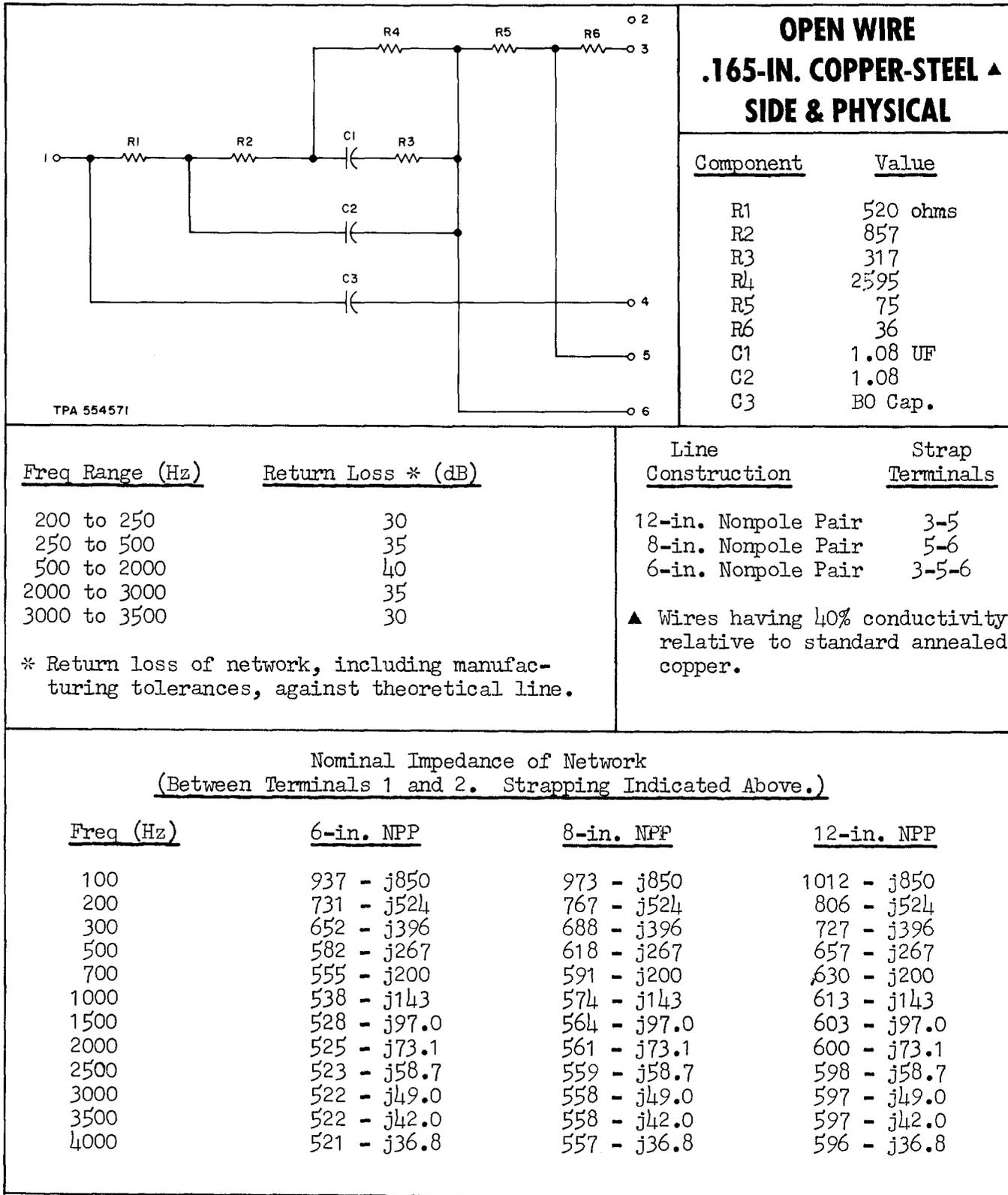
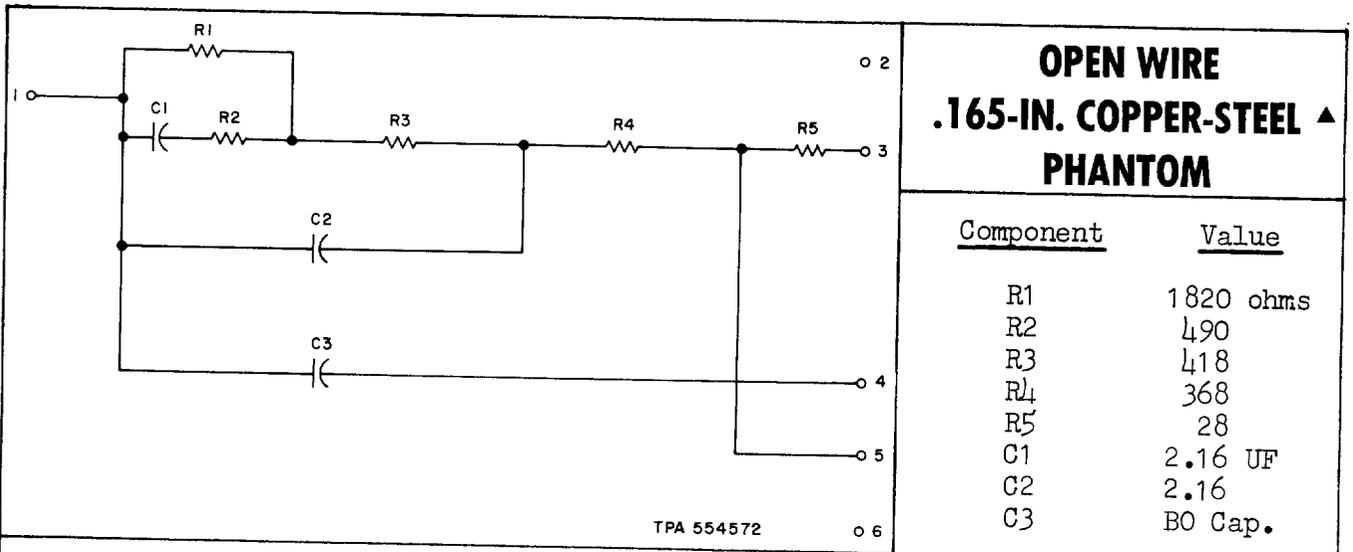


Fig. 16—115BC Network—Engineering Information



TPA 554572

Freq Range (Hz)	Return Loss * (dB)
200 to 250	25
250 to 500	30
500 to 2000	32
2000 to 3000	30
3000 to 3500	25

\* Return loss of network, including manufacturing tolerances, against theoretical line.

Line Construction	Strap Terminals
12-in. Nonpole Pair	3-5
8-in. Nonpole Pair	None

▲ Wires having 40% conductivity relative to standard annealed copper.

Nominal Impedance of Network  
(Between Terminals 1 and 2. Strapping as Indicated Above)

Freq (Hz)	8-in. NPP	12-in. NPP
100	627 - j453	599 - j453
200	504 - j292	476 - j292
300	456 - j217	428 - j217
500	421 - j140	393 - j140
700	409 - j103	381 - j103
1000	403 - j72.7	375 - j72.7
1500	399 - j48.8	371 - j48.8
2000	398 - j36.7	370 - j36.7
2500	397 - j29.4	369 - j29.4
3000	397 - j24.5	369 - j24.5
3500	397 - j21.0	369 - j21.0
4000	396 - j18.4	368 - j18.4

Fig. 17—115BF Network—Engineering Information

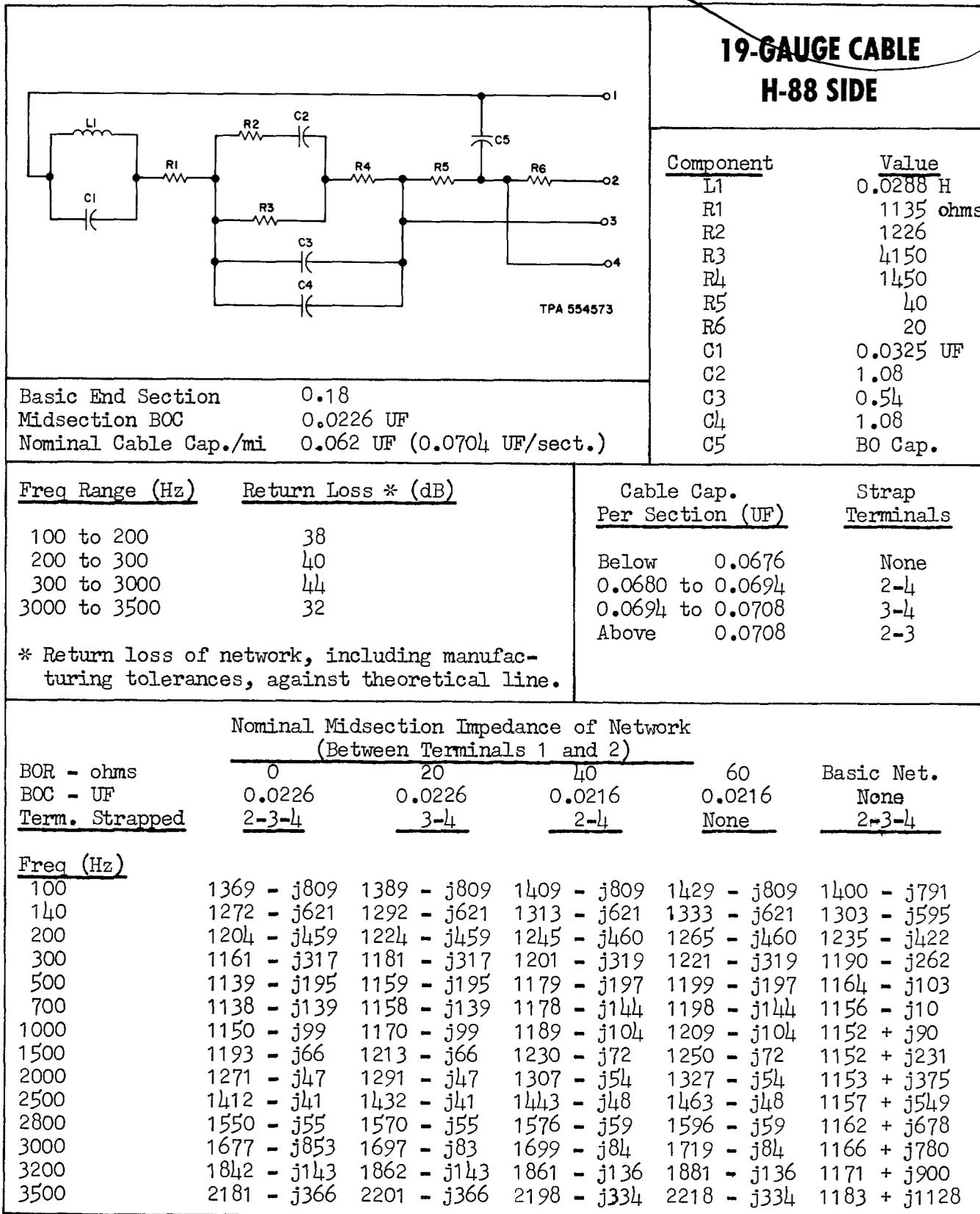


Fig. 18—115P Network—Engineering Information

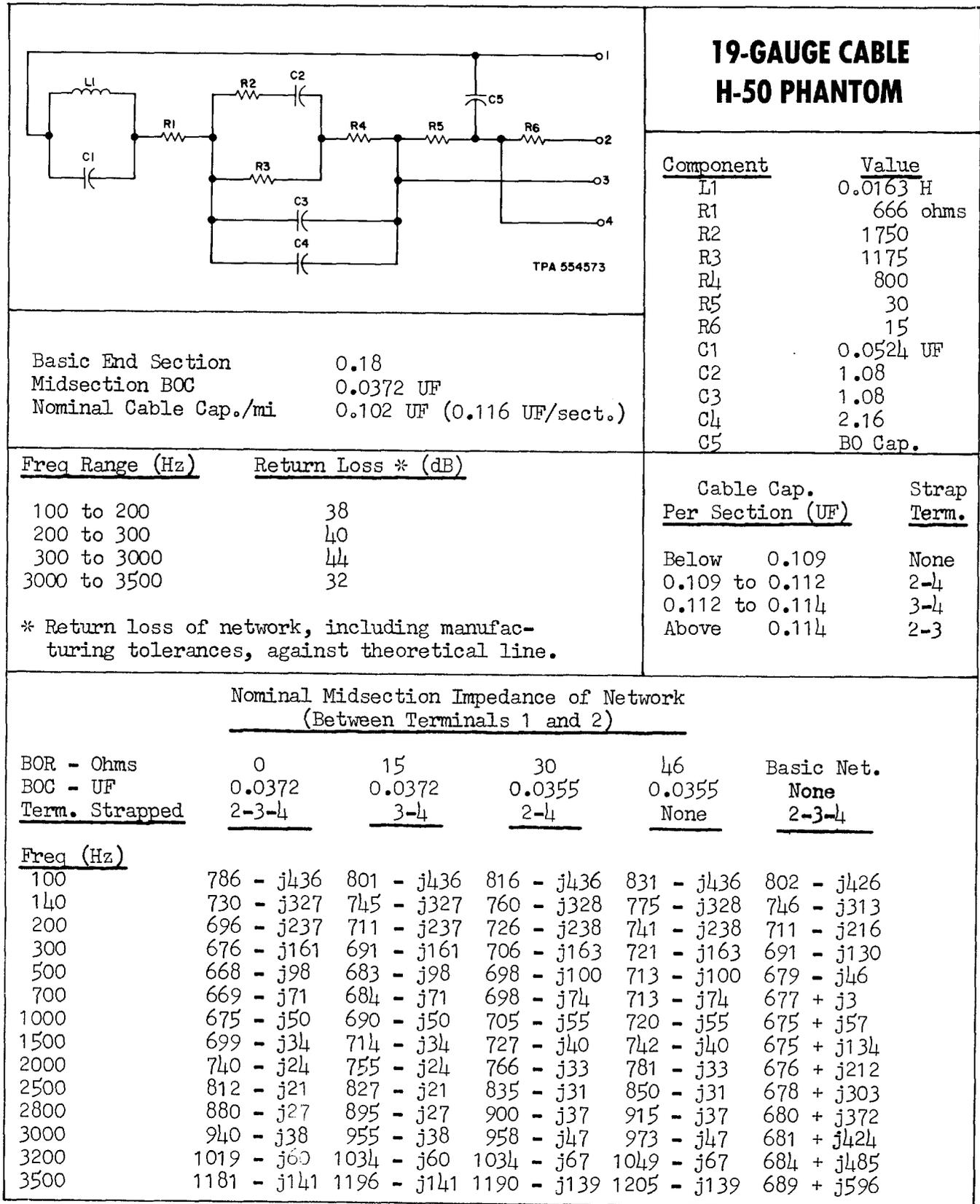


Fig. 19—115R Network—Engineering Information

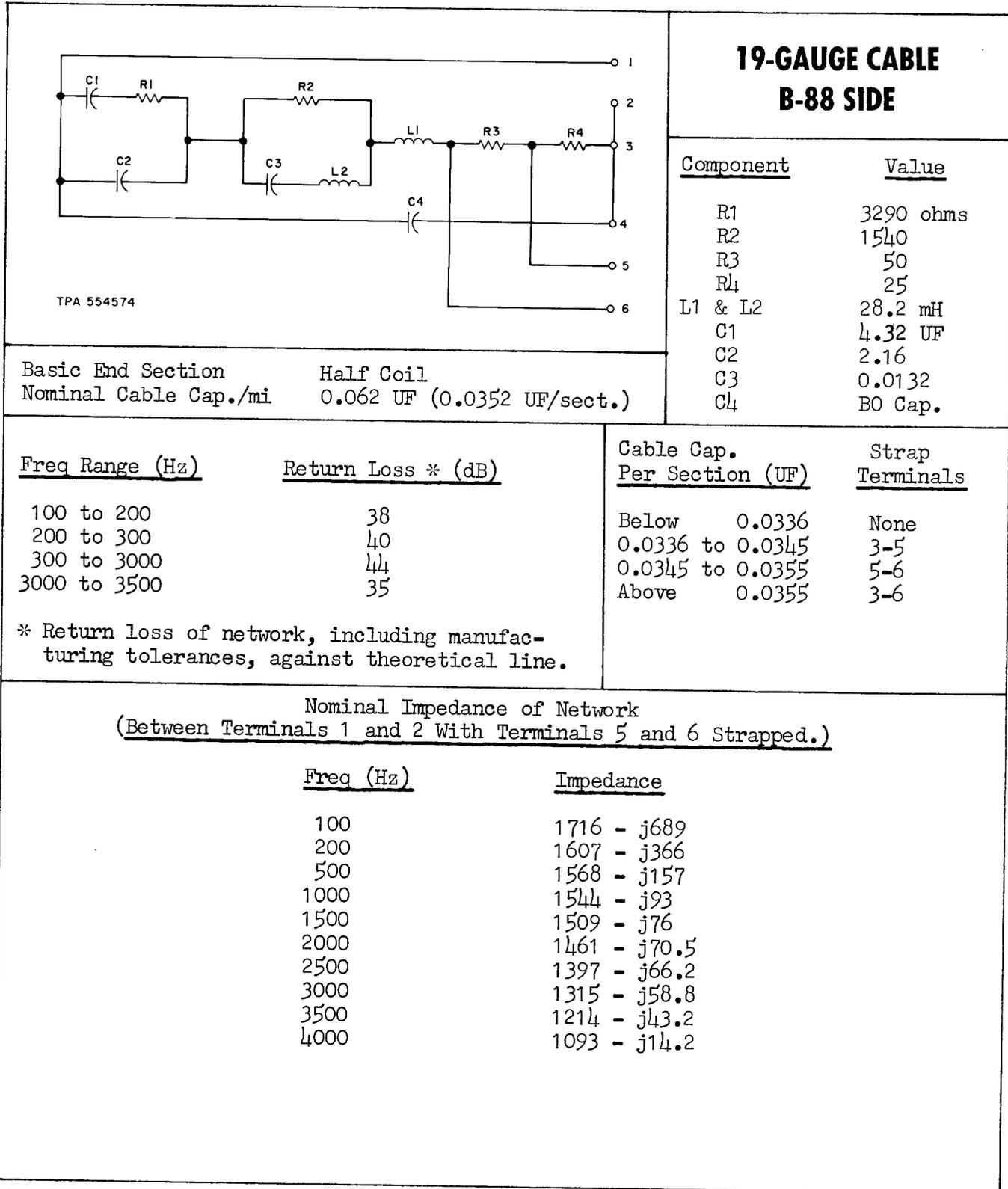


Fig. 20—115AF Network—Engineering Information

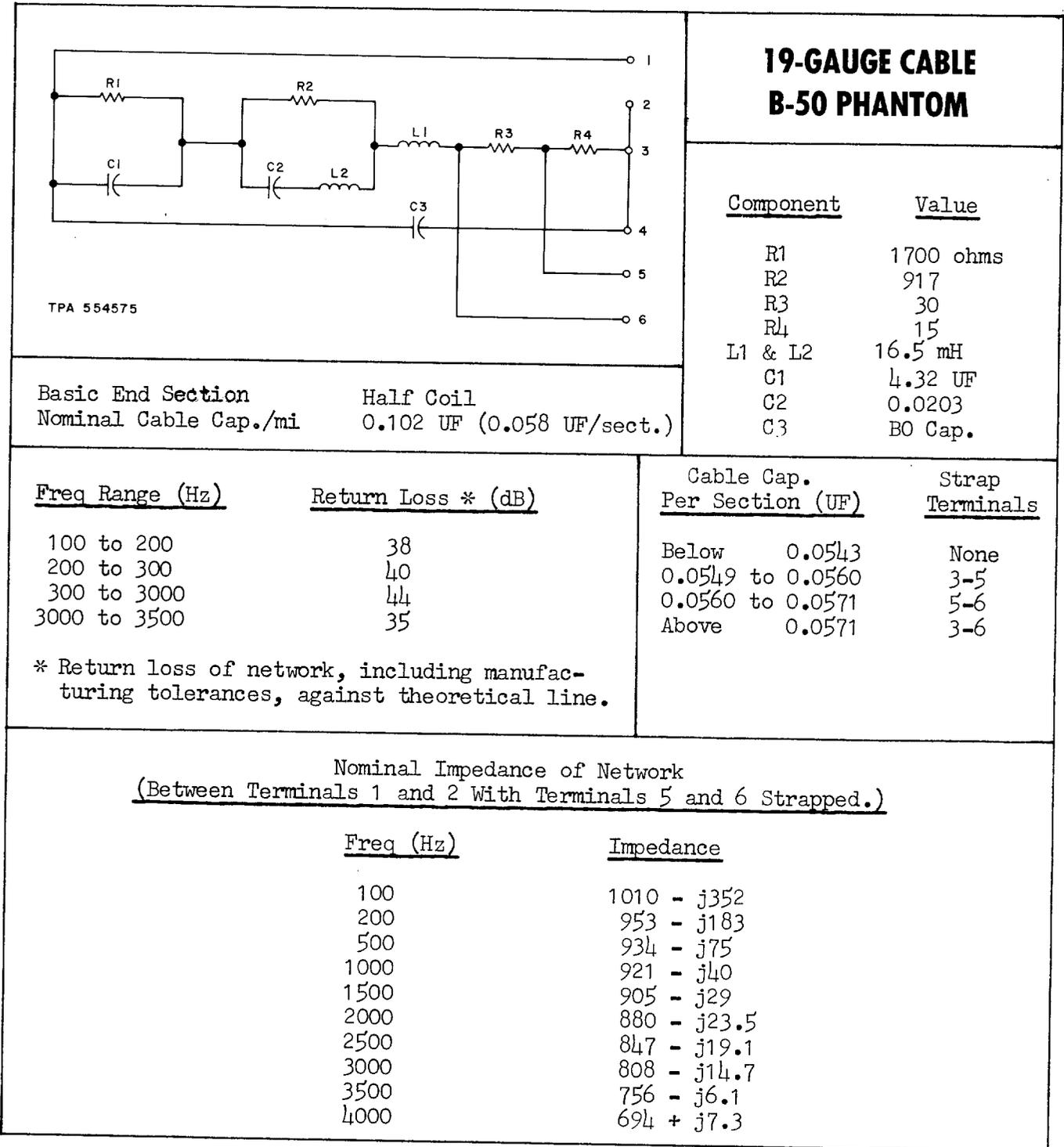


Fig. 21—115AG Network—Engineering Information

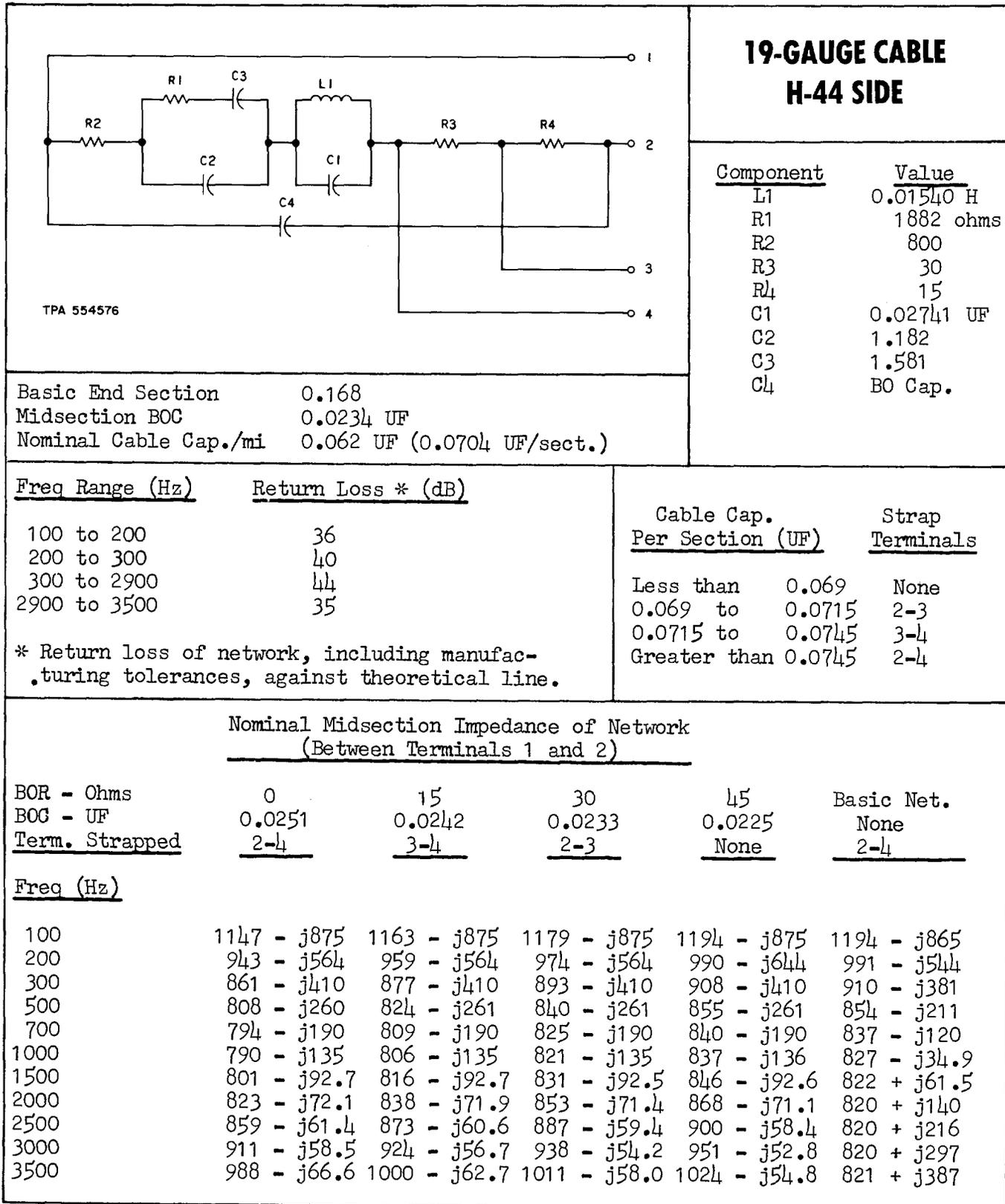


Fig. 22—115AH Network—Engineering Information

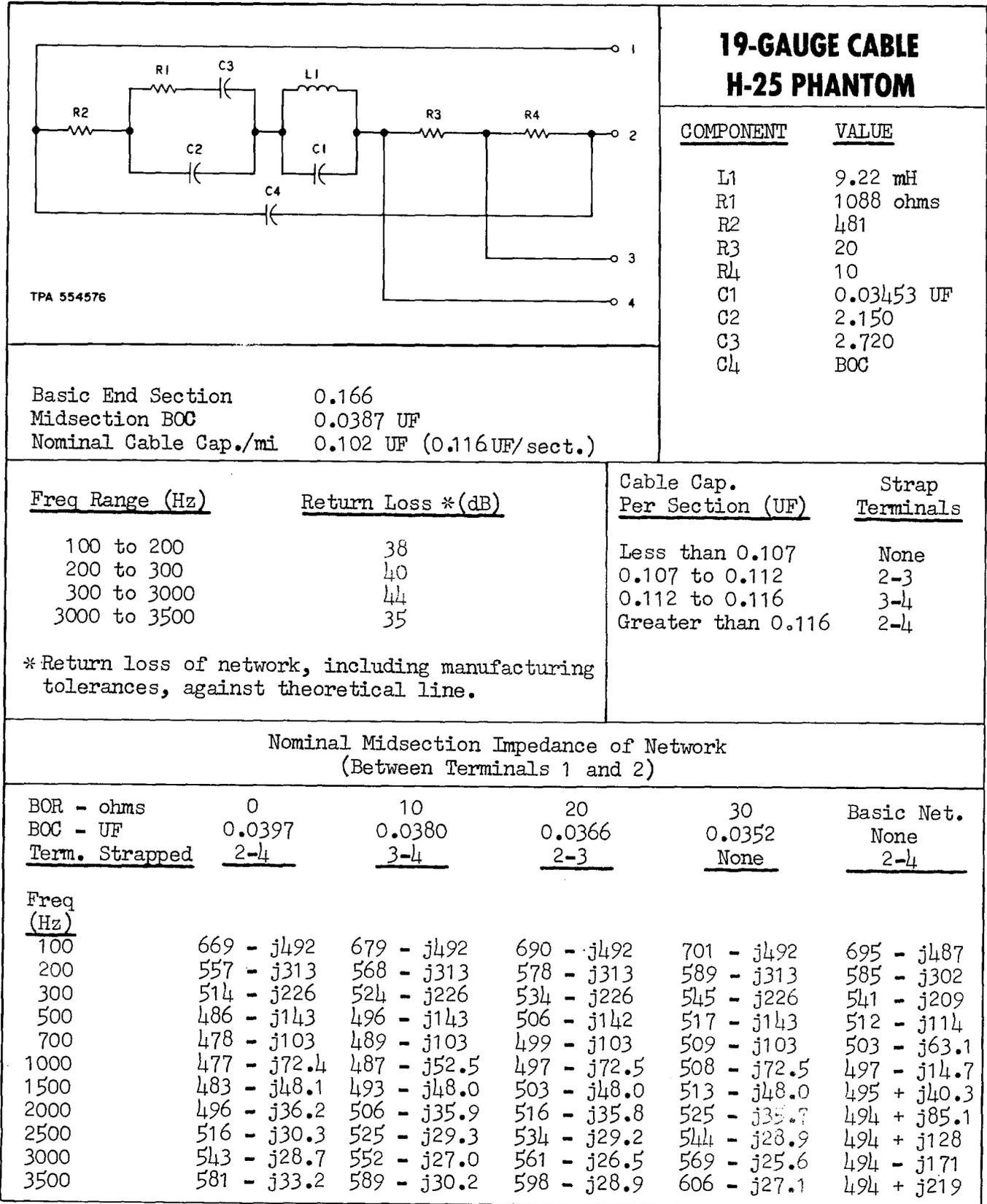
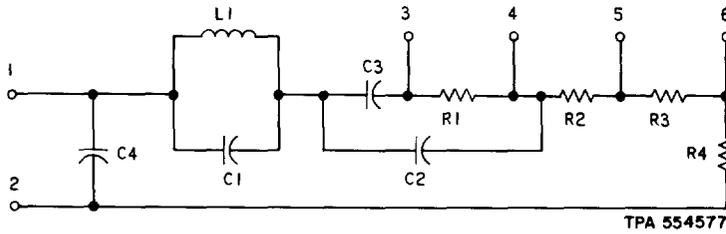


Fig. 23—115AJ Network—Engineering Information

**10-, 13-, AND 16-GAUGE CABLE  
H-44 SIDE**



<u>Component</u>	<u>Value</u>
L1	15.4 mH
C1	0.295 UF
C2, C3	2.16
R1	1595 ohms
R2	795
R3	15
R4	30
C4	80 Cond

Basic End Section	0.175
Midsection BOC	0.0229 UF
Nominal Cable Cap./mi	0.062 UF

<u>Frequency Range (Hz)</u>	<u>Return Loss * (dB)</u>		
	<u>10 GA</u>	<u>13 GA</u>	<u>16 GA</u>
200	25	35	40
300	28	40	40
500	32	40	40
1000 to 2000	40	40	40
2000 to 3000	35	35	37

<u>Cable Capacity (UF&gt;Loading Section)</u>	<u>Strap Term.</u>
Below 0.0663	None
0.0663 to 0.0691	5-6
0.0691 to 0.0719	2-6
Above 0.0719	2-5-6

\* Return loss of network, including manufacturing tolerances, against theoretical line.

Nominal Midsection Impedance of Network  
(Between Terminals 1 and 2)

	<u>10- and 13-Gauge</u>	<u>16-Gauge</u>
BOC - UF	0.0229	0.0229
<u>Terminals Strapped</u>	<u>(2-6)(3-4)</u>	<u>(2-6)</u>
<u>Freq (Hz)</u>		
200	805 - j183	867 - j335
300	805 - j121	832 - j234
500	807 - j72	812 - j143
1000	815 - j34	811 - j70
1500	832 - j19	825 - j43
2000	857 - j11	849 - j28
2500	895 - j4	886 - j18
3000	950 + j0.4	941 - j10
3500	1034 - j0.5	1024 - j9

Fig. 24—115BM Network—Engineering Information

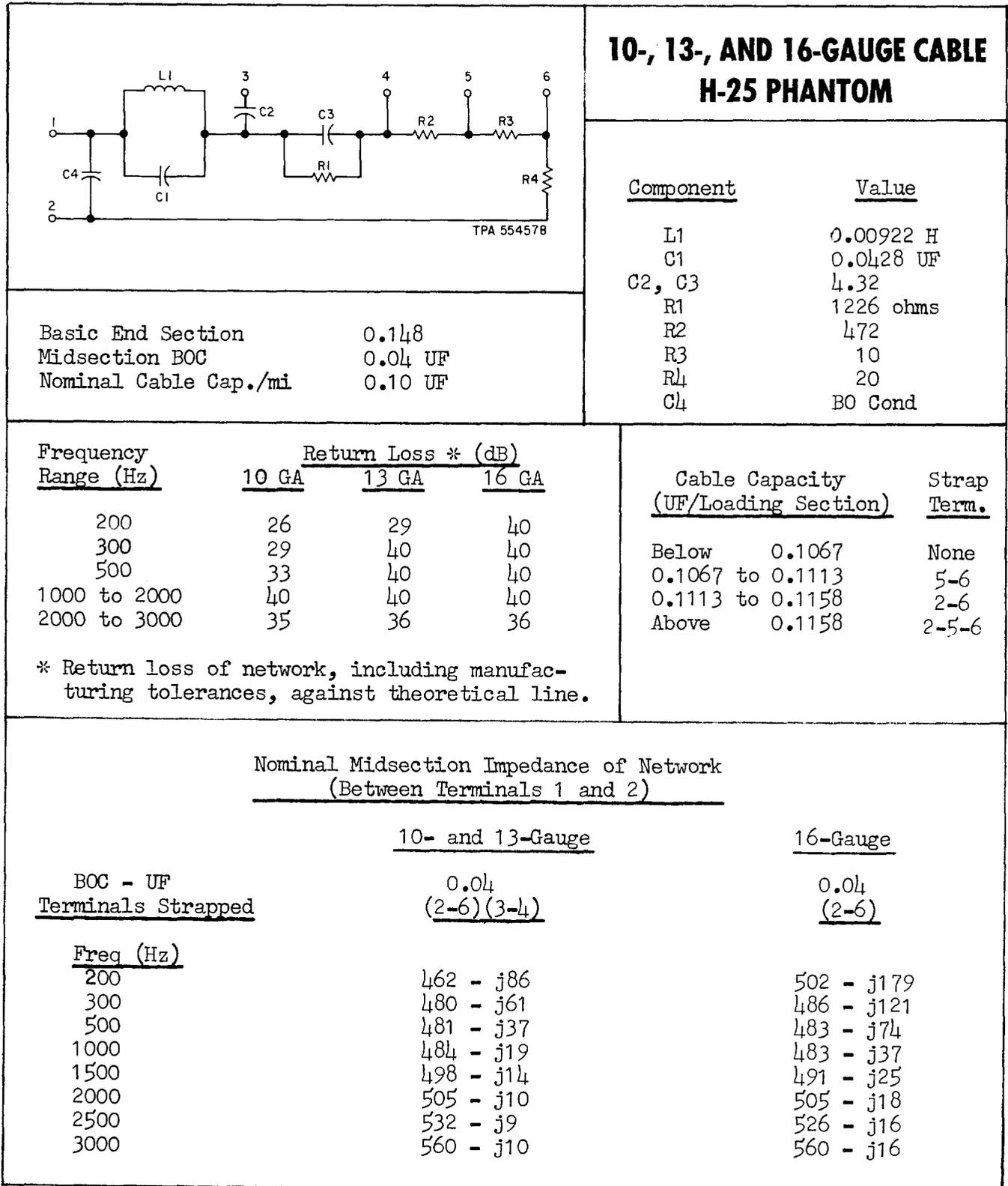
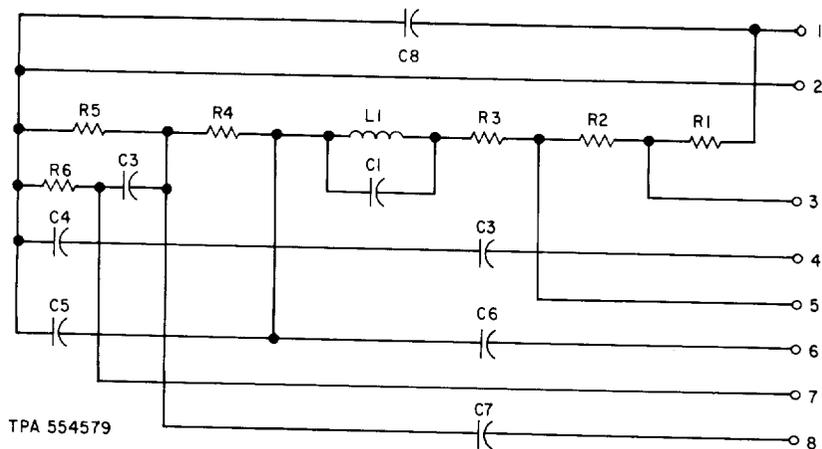


Fig. 25—115EN Network—Engineering Information

### 16- AND 19-GAUGE CABLE H-86-32 PHANTOM



Component	Value
R1	20
R2	10
R3	536
R4	743
R5	848
R6	1045
L1	10.55 mH
C1	0.0524 UF
C2, C7	1.08
C3, C5	0.45
C4, C6	2.16
C8	BOC

Basic End Section	0.1725
Midsection BOC	0.0372 UF
Nominal Cable Cap./mi	0.10 UF

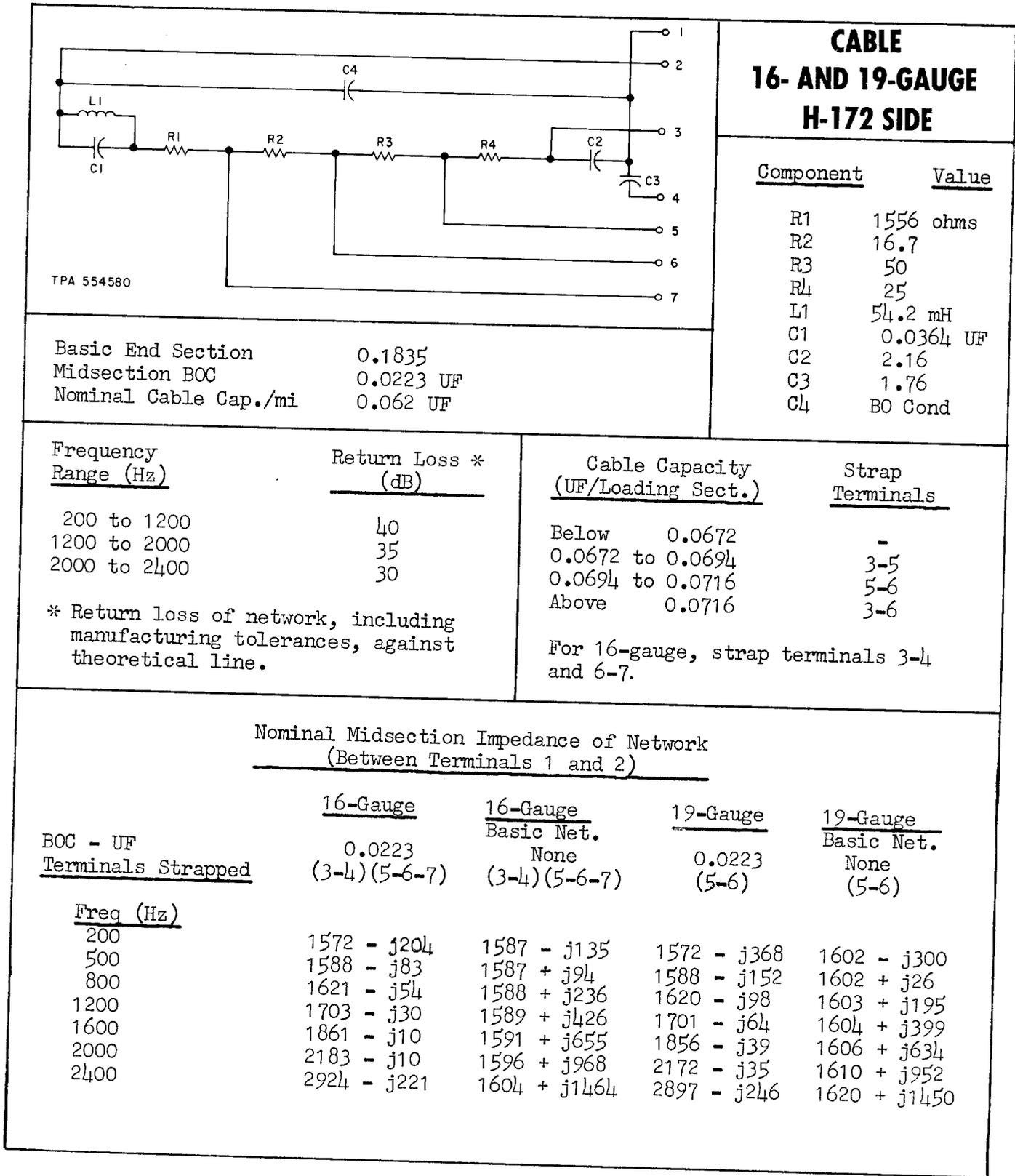
Frequency Range (Hz)	Return Loss * (dB)		Cable Capacity (UF>Loading Sect.)	Strapping	
	16-GA	19-GA		16-GA	19-GA
100	24	25			
200 to 300	35	38	Below 0.1075	(2-4-6) (7-8)	-
300 to 1500	35	40	0.1075 to 0.1115	(2-4-6) (7-8) (3-5)	(3-5)
1500 to 2500	39	40	0.1115 to 0.1157	(2-4-6) (7-8) (1-3)	(1-3)
2500 to 3000	39	35	Above 0.1157	(2-4-6) (7-8) (1-5)	(1-5)
3000 to 4000	30	35			

\* Return loss of network, including manufacturing tolerances, against theoretical line.

#### Nominal Midsection Impedance of Network (Between Terminals 1 and 2)

	19-Gauge	19-Gauge Basic Net.	16-Gauge	16-Gauge Basic Net.
BOR - Ohms	10	10	10	10
BOC - UF	0.0372	None	0.0372	None
Terminals Strapped	(1-3)	(1-3)	(1-3) (2-4-6) (7-8)	(1-3) (2-4-6) (7-8)
<u>Freq (Hz)</u>				
100	736 - j491	752 - j483	606 - j283	614 - j276
200	599 - j283	614 - j269	558 - j150	566 - j136
300	566 - j196	580 - j176	550 - j102	556 - j81
500	544 - j121	560 - j88	543 - j62	551 - j28
1000	546 - j64	551 + j7	549 - j33	549 + j37
1500	556 - j48	549 + j60	559 - j28	548 + j80
2000	574 - j34	549 + j115	579 - j20	548 + j130
2500	600 - j27	549 + j168	608 - j16	548 + j180
3000	644 - j24	548 + j228	651 - j16	548 + j238
3500	712 - j26	548 + j299	722 - j21	548 + j308
4000	829 - j55	548 + j393	840 - j47	548 + j400

Fig. 26—115BG Network—Engineering Information



**CABLE  
16- AND 19-GAUGE  
H-172 SIDE**

Component	Value
R1	1556 ohms
R2	16.7
R3	50
R4	25
L1	54.2 mH
C1	0.0364 UF
C2	2.16
C3	1.76
C4	BO Cond

Basic End Section	0.1835
Midsection BOC	0.0223 UF
Nominal Cable Cap./mi	0.062 UF

Frequency Range (Hz)	Return Loss * (dB)
200 to 1200	40
1200 to 2000	35
2000 to 2400	30

\* Return loss of network, including manufacturing tolerances, against theoretical line.

Cable Capacity (UF>Loading Sect.)	Strap Terminals
Below 0.0672	-
0.0672 to 0.0694	3-5
0.0694 to 0.0716	5-6
Above 0.0716	3-6

For 16-gauge, strap terminals 3-4 and 6-7.

Nominal Midsection Impedance of Network  
(Between Terminals 1 and 2)

	16-Gauge	16-Gauge Basic Net.	19-Gauge	19-Gauge Basic Net.
BOC - UF	0.0223	None	0.0223	None
<u>Terminals Strapped</u>	(3-4)(5-6-7)	(3-4)(5-6-7)	(5-6)	(5-6)
<u>Freq (Hz)</u>				
200	1572 - j204	1587 - j135	1572 - j368	1602 - j300
500	1588 - j83	1587 + j94	1588 - j152	1602 + j26
800	1621 - j54	1588 + j236	1620 - j98	1603 + j195
1200	1703 - j30	1589 + j426	1701 - j64	1604 + j399
1600	1861 - j10	1591 + j655	1856 - j39	1606 + j634
2000	2183 - j10	1596 + j968	2172 - j35	1610 + j952
2400	2924 - j221	1604 + j1464	2897 - j246	1620 + j1450

Fig. 27—115AM Network—Engineering Information

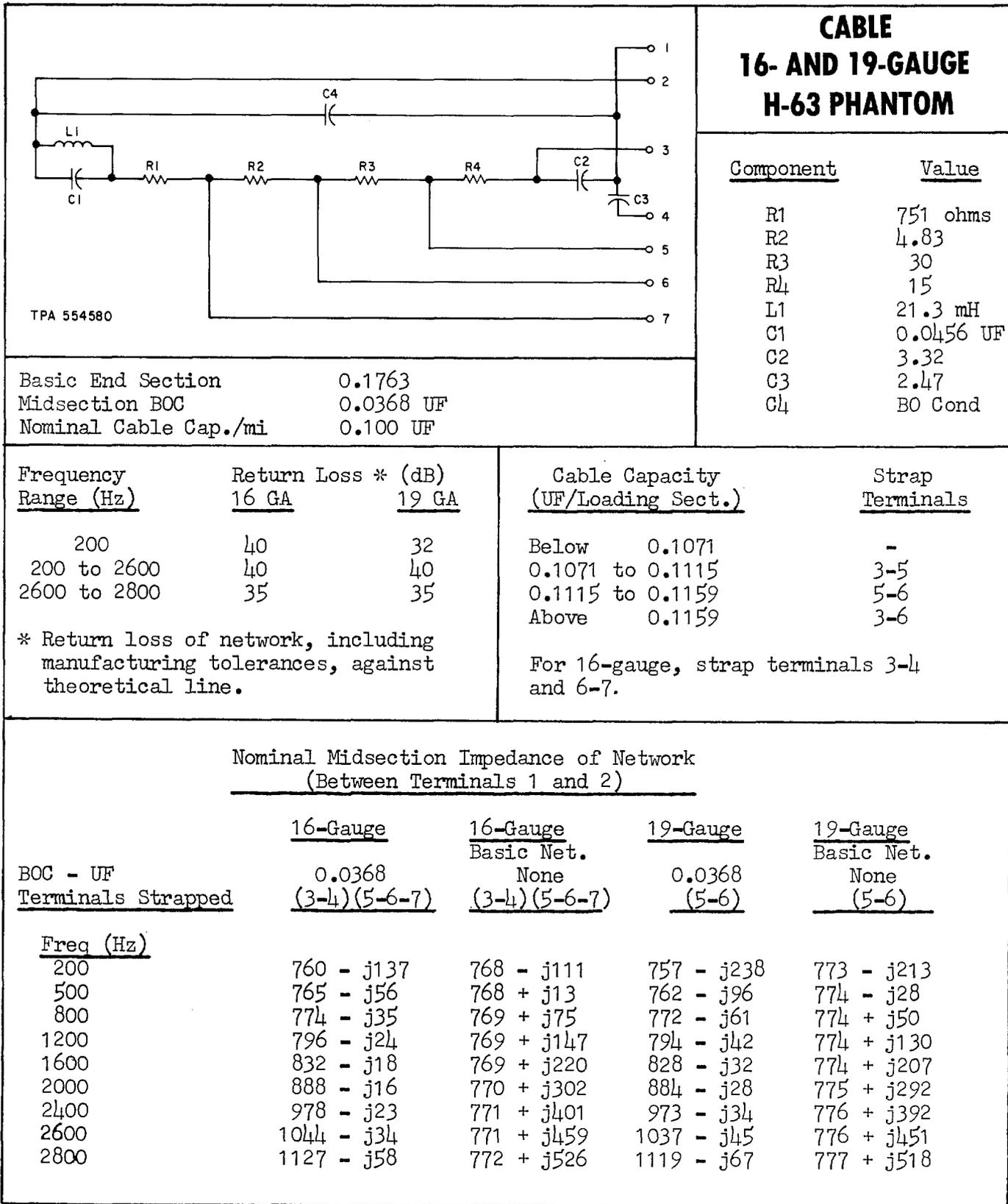


Fig. 28—115AN Network—Engineering Information

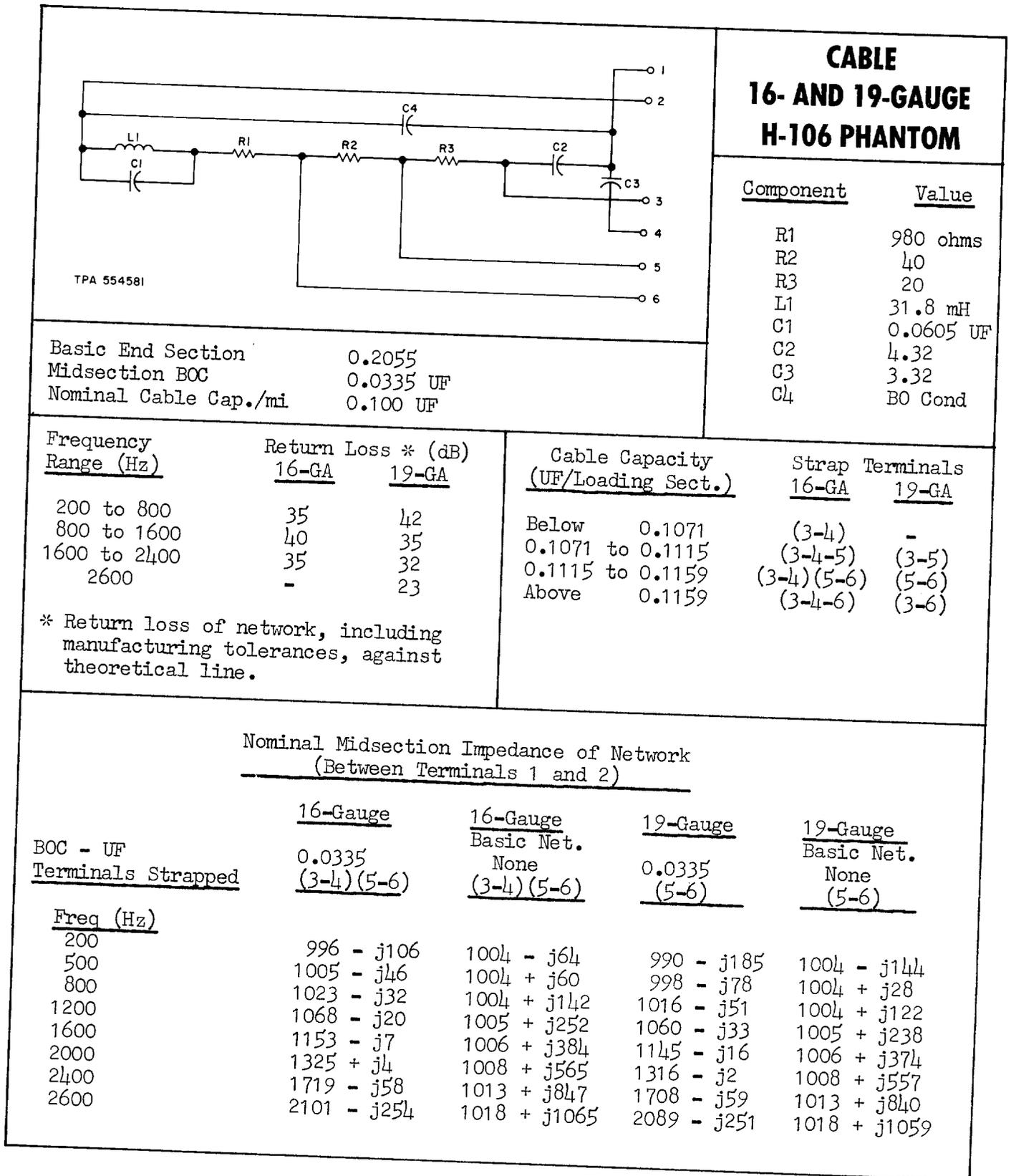


Fig. 29—115AP Network—Engineering Information

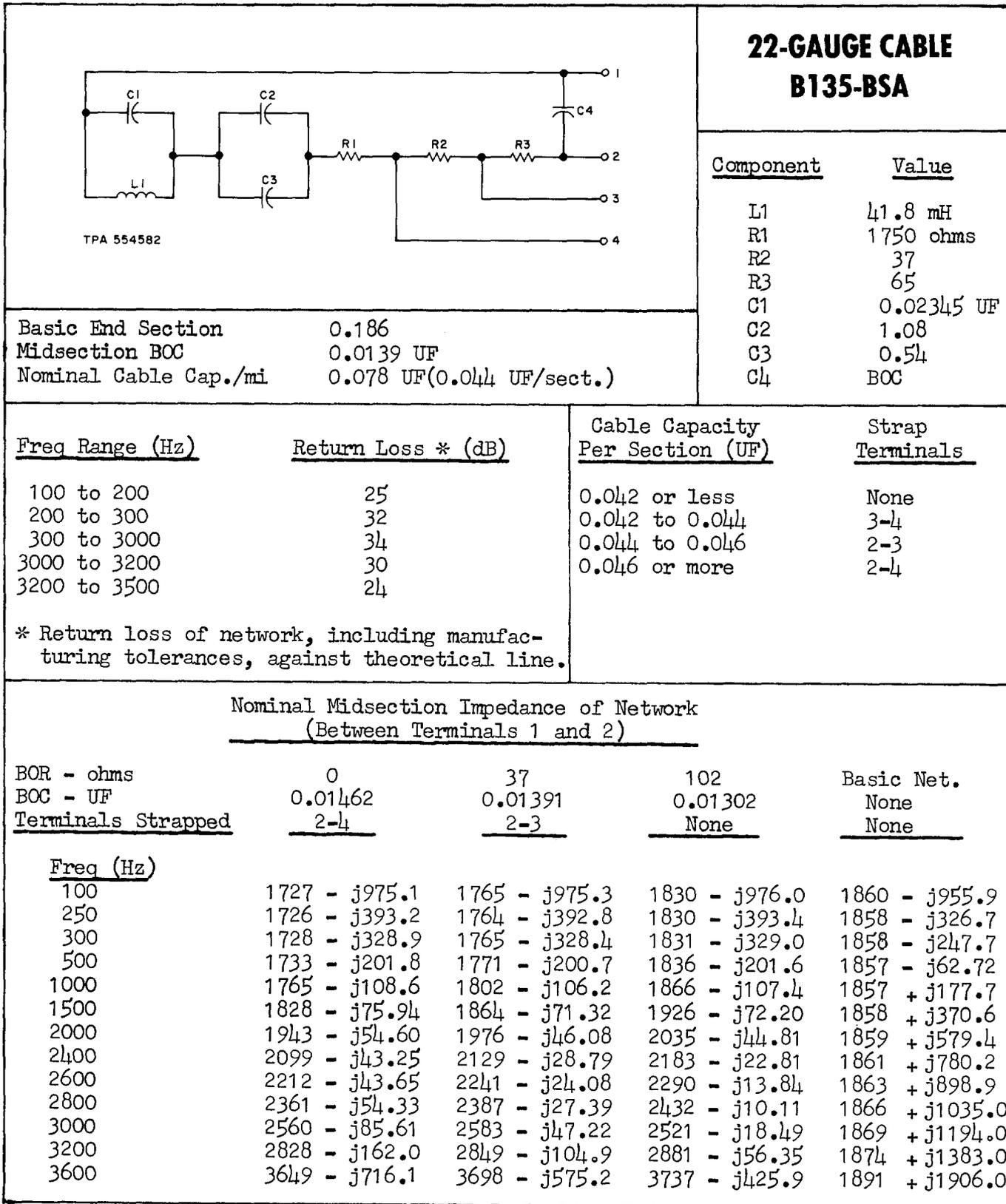
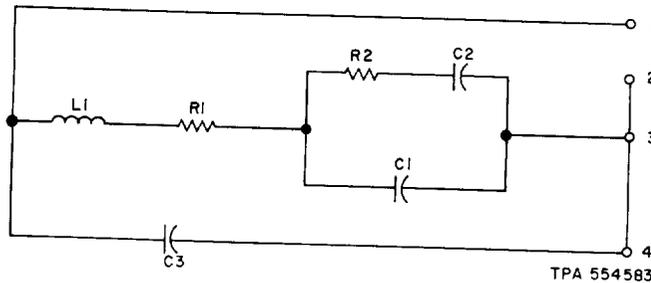


Fig. 30—115S Network—Engineering Information

**19-GAUGE CABLE  
H-31 SIDE**



TPA 554583

<u>Component</u>	<u>Value</u>
L1	11.95 mH
R1	702 ohms
R2	1430
C1	0.975 UF
C2	1.200
C3	BOC

Basic End Section	0.164
Midsection BOC	0.0237 UF
Nominal Cable Cap./mi	0.062 UF(0.0704 UF/sect.)

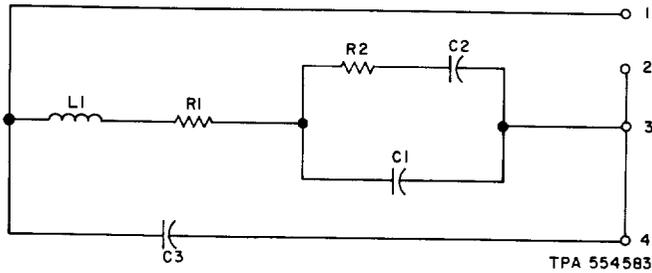
<u>Freq Range (Hz)</u>	<u>Return Loss * (dB)</u>
100 to 200	24
200 to 300	34
300 to 2800	40
2800 to 3500	34

\* Return loss of network, including manufacturing tolerances, against theoretical line.

Nominal Impedance of Network  
(Between Terminals 1 and 2)

<u>Freq (Hz)</u>	<u>Basic End Section Impedance</u>	<u>Midsection Impedance</u>
100	1055 - j892	1027 - j896
200	929 - j568	898 - j583
300	844 - j425	812 - j447
500	767 - j263	736 - j299
1000	721 - j84.5	695 - j157
1500	711 + j4.9	695 - j106
2000	708 + j69.0	705 - j81.4
2500	706 + j123	721 - j69.6
3000	706 + j171	741 - j68.0
3500	705 + j216	764 - j73.0

Fig. 31—115AB Network—Engineering Information



**19-GAUGE CABLE  
H-18 PHANTOM**

<u>Component</u>	<u>Value</u>
L1	6.80 mH
R1	420 ohms
R2	925
C1	1.940 UF
C2	2.340
C3	BOC

Basic End Section	0.166
Midsection BOC	0.0387 UF
Nominal Cable Cap./mi	0.102 UF (0.116 UF/Sect.)

<u>Freq Range (Hz)</u>	<u>Return Loss * (dB)</u>
100 to 200	24
200 to 300	34
300 to 2800	40
2800 to 3500	34

\* Return loss of network, including manufacturing tolerances, against theoretical line.

Nominal Impedance of Network  
(Between Terminals 1 and 2)

<u>Freq (Hz)</u>	<u>Basic End Section Impedance</u>	<u>Midsection Impedance</u>
100	621 - j491	607 - j494
200	532 - j308	516 - j316
300	484 - j227	468 - j239
500	447 - j134	432 - j155
1000	428 - j38.2	416 - j80.0
1500	424 + j9.8	417 - j53.8
2000	423 + j44.6	424 - j41.8
2500	422 + j74.1	432 - j36.3
3000	422 + j101	443 - j35.6
3500	422 + j126	456 - j39.0

**Fig. 32—115AD Network—Engineering Information**

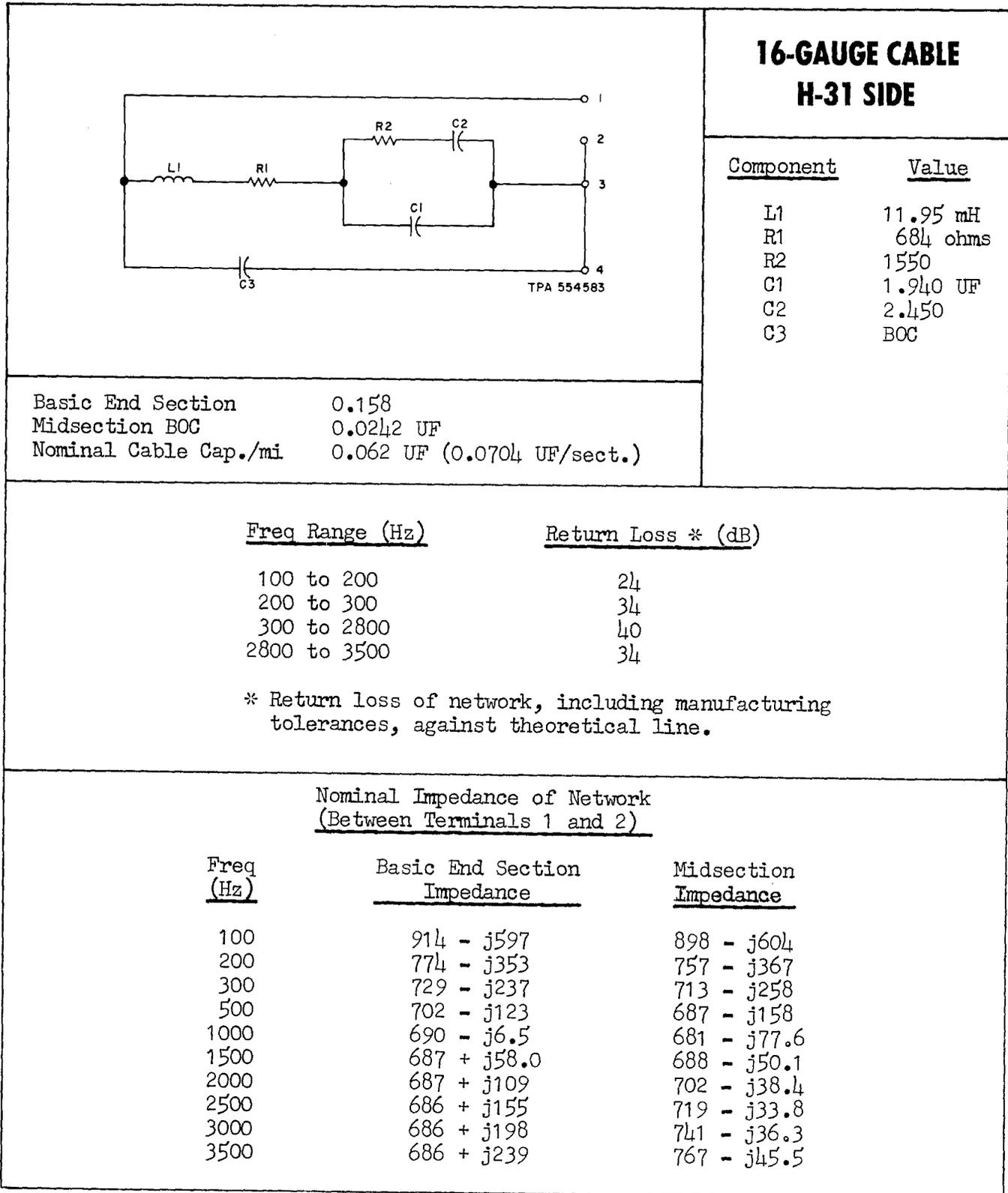
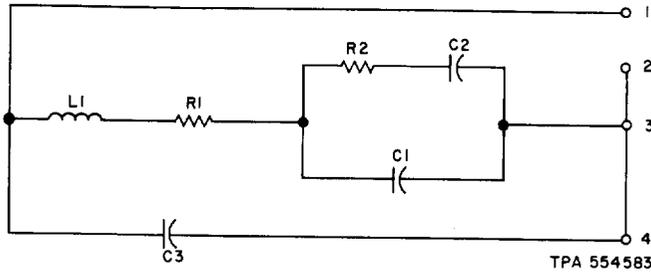


Fig. 33—115AC Network—Engineering Information

**16-GAUGE CABLE  
H-18 PHANTOM**



<u>Component</u>	<u>Value</u>
L1	6.80 mH
R1	411 ohms
R2	870
C1	3.70 UF
C2	4.50
C3	BOC

Basic End Section	0.166
Midsection BOC	0.0387 UF
Nominal Cable Cap./mi	0.102 UF (0.116 UF/sect.)

<u>Freq Range (Hz)</u>	<u>Return Loss * (dB)</u>
100 to 200	24
200 to 300	34
300 to 2800	40
2800 to 3500	34

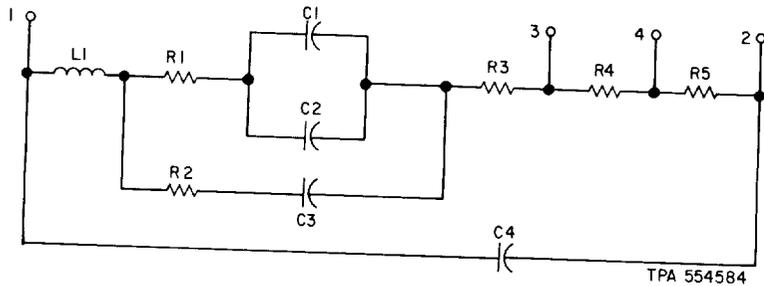
\* Return loss of network, including manufacturing tolerances, against theoretical line.

Nominal Impedance of Network  
(Between Terminals 1 and 2)

<u>Freq (Hz)</u>	<u>Basic End Section Impedance</u>	<u>Midsection Impedance</u>
100	529 - j320	521 - j324
200	458 - j180	450 - j188
300	434 - j124	426 - j136
500	420 - j63.2	413 - j83.3
1000	414 - j0.1	410 - j40.6
1500	413 + j35.5	414 - j26.2
2000	413 + j64.0	422 - j21.4
2500	412 + j89.6	431 - j18.7
3000	412 + j114	443 - j17.2
3500	412 + j137	457 - j16.1

Fig. 34—115AE Network—Engineering Information

**13-GAUGE CABLE  
H-31 SIDE**



<u>Component</u>	<u>Value</u>
R1	839 ohms
R2	1380
R3	586
R4	10
R5	20
C1	2.16 UF
C2	1.08
C3	4.32
L1	0.012 H
C4	80 Cond

Basic End Section	0.158
Midsection BOC	0.0242 UF
Nominal Cable Cap./mi	0.062 UF

<u>Freq Range (Hz)</u>	<u>Return Loss * (dB)</u>
100 to 3000	40
3000 to 3500	34

\* Return loss of network, including manufacturing tolerances against theoretical line.

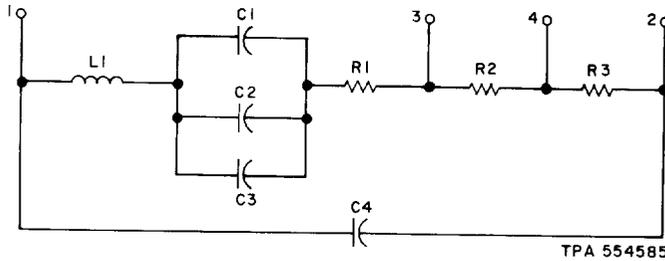
<u>Cable Capacity (UF&gt;Loading Section)</u>	<u>Strap Terminals</u>
Below 0.0663	None
0.0663 to 0.0691	3-4
0.0691 to 0.0719	2-4
Above 0.0719	2-3-4

Nominal Impedance of Network  
(Between Terminals 1 and 2) (2 and 4 Strapped)  
(BOC - 0.0242 UF)

<u>Freq (Hz)</u>	<u>Midsection Impedance</u>
100	769 - j378
200	700 - j208
300	683 - j141
500	675 - j84
1000	677 - j39
1500	687 - j23
2000	701 - j17
2500	720 - j16
3000	742 - j20
3500	768 - j31
4000	798 - j48

Fig. 35—115BP Network—Engineering Information

**13-GAUGE CABLE  
H-18 PHANTOM**



<u>Component</u>	<u>Value</u>
R1	400 ohms
R2	10
R3	20
C1	3.60 UF
C2	3.33
C3	0.026
L1	0.0068 H
C4	BO Cond

Basic End Section	0.165
Midsection BOC	0.379 UF
Nominal Cable Cap./mi	0.10 UF

<u>Freq Range (Hz)</u>	<u>Return Loss * (dB)</u>
100 to 200	24
200 to 300	34
300 to 3500	40

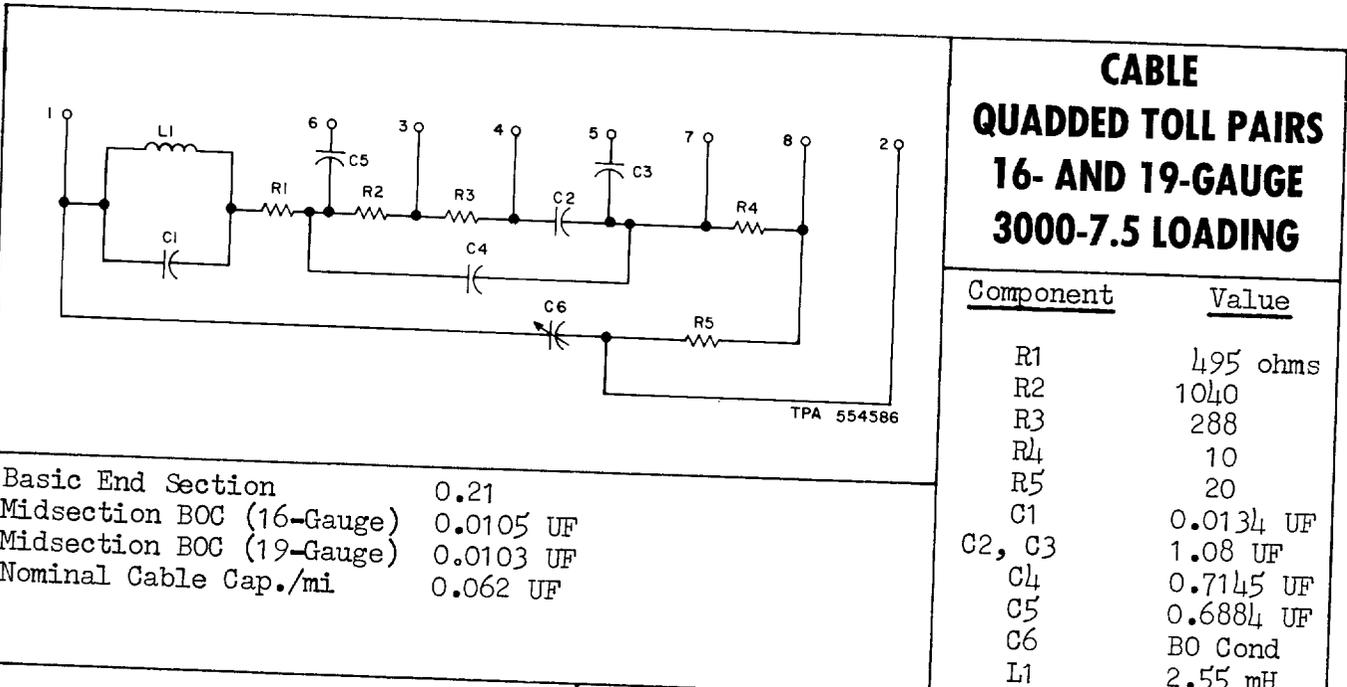
\* Return loss of network, including manufacturing tolerances against theoretical line.

<u>Cable Capacity (UF&gt;Loading Section)</u>	<u>Strap Terminals</u>
Below 0.1067	None
0.1067 to 0.1113	3-4
0.1113 to 0.1158	2-4
Above 0.1158	2-3-4

Nominal Impedance of Network  
(Between Terminals 1 and 2) (2 and 4 Strapped)  
(BOC - 0.0379 UF)

<u>Freq (Hz)</u>	<u>Midsection Impedance</u>
100	406 - j227
200	406 - j113
300	407 - j75
500	407 - j44
1000	410 - j20
1500	416 - j12
2000	424 - j9
2500	434 - j9
3000	446 - j11
3500	460 - j17
4000	476 - j25

Fig. 36—115BR Network—Engineering Information



**CABLE  
QUADDED TOLL PAIRS  
16- AND 19-GAUGE  
3000-7.5 LOADING**

Component	Value
R1	495 ohms
R2	1040
R3	288
R4	10
R5	20
C1	0.0134 UF
C2, C3	1.08 UF
C4	0.7145 UF
C5	0.6884 UF
C6	80 Cond
L1	2.55 mH

Basic End Section	0.21
Midsection BOC (16-Gauge)	0.0105 UF
Midsection BOC (19-Gauge)	0.0103 UF
Nominal Cable Cap./mi	0.062 UF

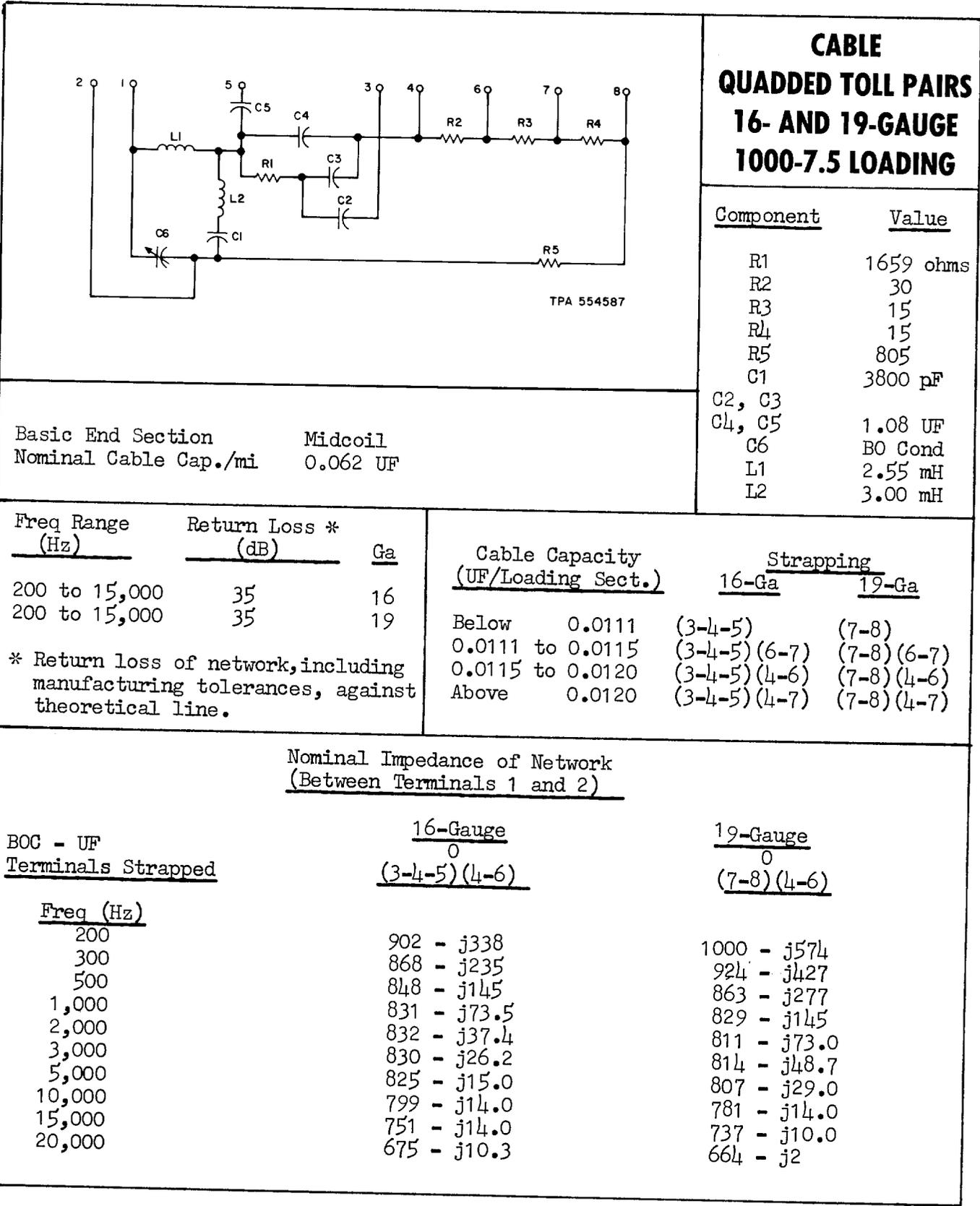
Freq Range (Hz)	Return Loss * (dB)	GA	Cable Capacity (UF/Section)	Strapping	
				16-GA	19-GA
200 - 15,000	35	16	Below 0.0331	(3-4-5) (6-7)	-
200 - 10,000	35	19	0.0331 to 0.0345	(3-4-5) (6-7) (7-8)	(7-8)
10,000 - 15,000	30	19	0.0345 to 0.0357	(3-4-5) (6-7) (2-8)	(2-8)
			Above 0.0357	(3-4-5) (6-7) (2-7)	(2-7)

\* Return loss of network, including manufacturing tolerances, against theoretical line.

Nominal Midsection Impedance of Network (Between Terminals 1 and 2)

BOC - UF Terminals Strapped	16-Gauge		19-Gauge
	0.0105 (3-4-5) (6-7) (2-8)		0.0103 (2-8)
<u>Freq (Hz)</u>			
200	671 - j413	812 - j670	
300	600 - j319	716 - j535	
500	543 - j211	607 - j381	
1,000	511 - j111	527 - j213	
2,000	503 - j57.9	503 - j110	
3,000	504 - j39.8	500 - j74.4	
5,000	512 - j25.8	506 - j45.3	
10,000	566 - j8.2	556 - j22.4	
15,000	730 - j26.0	714 - j36.0	
20,000	1122 - j577	1113 - j552	

Fig. 37—115BH Network—Engineering Information



**CABLE  
QUADDED TOLL PAIRS  
16- AND 19-GAUGE  
1000-7.5 LOADING**

Component	Value
R1	1659 ohms
R2	30
R3	15
R4	15
R5	805
C1	3800 pF
C2, C3	
C4, C5	1.08 UF
C6	BO Cond
L1	2.55 mH
L2	3.00 mH

Basic End Section                      Midcoil  
Nominal Cable Cap./mi                  0.062 UF

Freq Range (Hz)	Return Loss * (dB)	Ga	Cable Capacity (UF/Loading Sect.)		Strapping	
			16-Ga	19-Ga	16-Ga	19-Ga
200 to 15,000	35	16	Below 0.0111	(3-4-5)	(7-8)	
200 to 15,000	35	19	0.0111 to 0.0115	(3-4-5) (6-7)	(7-8) (6-7)	
			0.0115 to 0.0120	(3-4-5) (4-6)	(7-8) (4-6)	
			Above 0.0120	(3-4-5) (4-7)	(7-8) (4-7)	

Nominal Impedance of Network  
(Between Terminals 1 and 2)

BOG - UF Terminals Strapped	16-Gauge	19-Gauge
	0 (3-4-5) (4-6)	0 (7-8) (4-6)
<u>Freq (Hz)</u>		
200	902 - j338	1000 - j574
300	868 - j235	924 - j427
500	848 - j145	863 - j277
1,000	831 - j73.5	829 - j145
2,000	832 - j37.4	811 - j73.0
3,000	830 - j26.2	814 - j48.7
5,000	825 - j15.0	807 - j29.0
10,000	799 - j14.0	781 - j14.0
15,000	751 - j14.0	737 - j10.0
20,000	675 - j10.3	664 - j2

Fig. 38—115BJ Network—Engineering Information

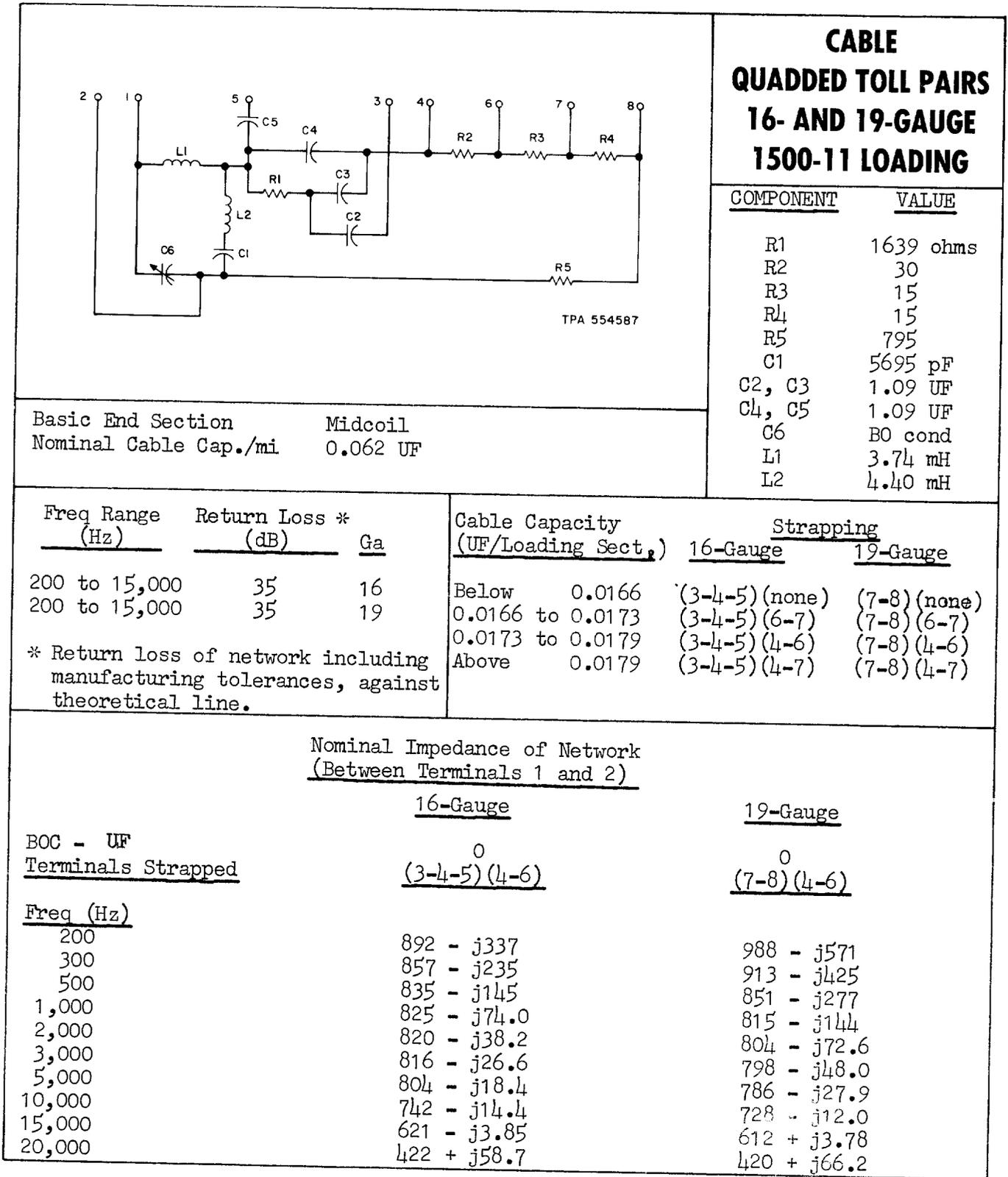
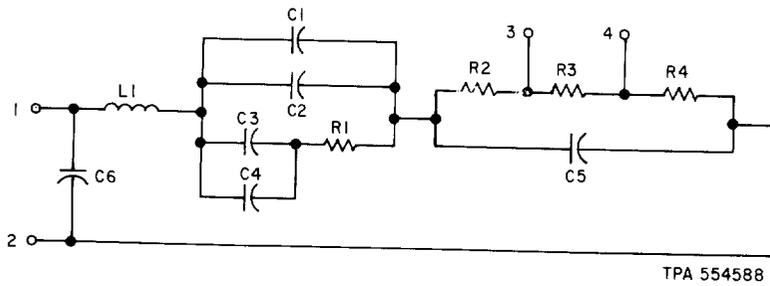


Fig. 39—115BK Network—Engineering Information

**16-GAUGE CABLE  
B-22-N**



<u>Component</u>	<u>Value</u>
R1	1662 ohms
R2	780
R3	15
R4	30
C1	0.718 UF
C2	1.66
C3	0.718
C4	1.88
C5	0.013
C6	B0 Cond
L1	0.0082 H

Basic End Section                      Midcoil  
Nominal Cable Cap./mi              0.062 UF

<u>Freq Range (Hz)</u>	<u>Return Loss * (dB)</u>
100 to 3500	40

<u>Cable Capacity (UF&gt;Loading Sect.)</u>	<u>Strap Terminal</u>
Below 0.0331	None
0.0331 to 0.0345	3-4
0.0345 to 0.0359	3-4
Above 0.0359	2-3-4

\* Return loss of network, including manufacturing tolerances, against theoretical line.

Nominal Impedance of Network (Between Terminals 1 and 2)

BOC - UF	0
<u>Terminals Strapped</u>	<u>2-4</u>

<u>Freq (Hz)</u>	
100	968 - j538
200	852 - j312
300	825 - j216
500	807 - j133
1000	796 - j67.4
1500	790 - j45.2
2000	784 - j33.5
2500	776 - j25.6
3000	767 - j19.1
3500	757 - j13.1
4000	745 - j6.8
5000	719 + j7.6
6000	690 + j25.7

**Fig. 40—115BS Network—Engineering Information**