Ameritech

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Digital Service Interface Specification, Type I

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This Technical Reference is published by Ameritech Services Incorporated for the purpose of assisting customers in determining the type of equipment that is necessary for the termination of Type I digital service. Type I digital service provides subrate digital data rates of 2.4, 4.8, 9.6, or 56.0 kilobits per second between the Ameritech Operating Company central offices and the customer's location. This document also serves to inform the manufacturers and vendors of digital service terminating devices of the electrical requirements for connection to the Ameritech Operating Companies network.

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1.   GENERAL

This document describes the Ameritech Operating Companies (AOC) digital service interface between the AOC network and the customer's digital data terminal equipment in compliance with the Third Notice of Proposed Rulemaking issued June 14, 1983 in Docket FCC 81-216. This technical reference is intended to provide all necessary information to enable implementation of digital service circuits with the network interface defined at a point where the signal has not been reshaped into a standard digital signal. This document will involve all Ameritech Operating Companies, vendors, and customers gain experience with the provision of digital service. The interface specification is loop transmission system dependent and is, therefore, subject to change. The document is composed of several sections:

- Section 1 - GENERAL -

  Briefly describes the digital service interface and covers testing and maintenance considerations.

- Section 2 - DIGITAL LOOPS -

  Describes the makeup of and requirements for digital service loops.

- Section 3 - TRANSMITTED PULSE SHAPING REQUIREMENTS -

  Defines amplitude and pulse shaping requirements of the transmitted signal.

- Section 4 - RECEIVED SIGNAL CHARACTERISTIC -

  Defines and receives signal characteristics.

- Section 5 - CUSTOMER PROVIDED EQUIPMENT REQUIREMENTS -

  Defines customer provided equipment requirements.

- Section 6 - DIGITAL SERVICE CODING REQUIREMENTS -

  Defines customer equipment encoding and decoding requirements.

- Section 7 - TIMING AND JITTER -

  Defines timing accuracy and jitter - customer to network and network to customer.

- Section 8 - PHYSICAL NETWORK INTERFACE -

  Defines the physical network interface.

1.1. Network Interface

1.1.1. Customer's Side of Network Interface

The functions required on the customer side of the network interface to assure compatible operation include:

- Balanced loop terminations

- Arrangements for remote loopback testing by the AOC's.

- Coding and decoding of the signal

- Timing recovery

- Synchronous sampling

- Formatting

- The generation and recognization of control signals.

1.1.2. Office Channel Unit (OCU)

The customer provided equipment will communicate with the OCU in the serving central office. 4 OCU speeds are available to match the 4 customer speeds, 2.4, 4.8, 9.6, and 56.0 kilobits per second (kb/s). The OCU functions are to:

- Transmit outgoing loop signals to the station.

- Regenerate incoming loop signals.

- Assemble the data signals into a suitable format for network multiplexing and for loop transmission.

- Provide sealing current to the loop.

- Transmit and detect control signals.

- Transmit loopback control signals to the loop.

1.1.3.   Time-Division Multiplexers

Timer division multiplexing is used for the efficient transmission of data between central offices. Since this is a full duplex system (independent transmission paths in both directions), multiplexing and demultiplexing occur simultaneously.

1.1.4.   Network Synchronization

A synchronous timing signal, which is traceable to the Basic Synchronization Reference Frequency (BSRF), is applied to all digital service equipment at the A.O.C. central offices. This ensures that the data signals are synchronous, thus sampling takes place at the same frequency throughout the network.

The network synchronization is designed so that phase jitter and phase hits do not propagate through the network. The synchronization network is arranged so that the clocking devices have alternate supply sources and/or sufficient frequency accuracy to continue service without interruption.

1.2.   Testing and Maintenance

Testing and maintenance are an integral part of the digital network. The A.O.C. personnel can conduct remote tests which permits isolation and identify the required correction of trouble conditions. If customers suspect trouble on their digital service channel, they should call the provided telephone number for trouble reporting. A detailed customer explanation of a specific trouble on the digital service channel is a useful aid in expediting repairs. The reporting customer is expected to assist in the analysis of the problem. It is also expected that the customer will first check and determine that his terminal equipment is functioning properly before contacting the A.O.C.

In event of a customer trouble report, the A.O.C. will test the digital service channel. Such tests will cause the brief removal of customer data. These tests will be performed upon receiving a report of trouble from the customer, and it is essential to good service that customers will be willing to release their channel when testing by the A.O.C. personnel is required. The A.O.C. will not intentionally disturb the digital service channel without first receiving permission from the customer.

1.2.1.   Remote Testing

Most tests of a digital service channel will not require the A.O.C. personnel visit to the customer's premises, providing the customer has provisioned himself with station equipment as stated later in this document. Remove tests are then under control of the A.O.C. personnel who can remotely loopback the digital service channel at the customer's premises, permitting the

A.O.C. personnel to evaluate the circuit operation. Thus, customer equipment which provides loopback capability is essential at all times to permit the A.O.C. personnel to perform remote testing.

1.2.2.   Trouble Conditions

Where there is a failure in the inter-office digital facilities the network will detect the failure and a repetitive "Out-Of-Service" or "Out-Of-Frame" signal is sent to the customer's equipment. A failure in the local loop cannot be detected as such. When no signal condition is received on the loop side of the OCU a repetitive "Idle" or "Out-Of-Service" signal is sent towards the network. The type of signal sent is dependent upon the vintage of the OCU. Therefore, if a terminal receives an "Idle" or "Out-Of-Service" message when data is expected, the customer should check the far-end transmitting terminal. If the far-end is transmitting data, the customer should report the problem to the A.O.C. Also, a local loop failure may be recognized at the customer's equipment by the absence or distortion of the digital signals.

2.   Digital Loops

The following describes the makeup of, and design requirements for digital loops.

2.1.   Loop Design

Line receivers for loop operation require equalization of the frequency dependent attenuation in the cable. Principal design assumptions are:

  A.   Both line drivers and line receivers present a balanced configuration and an approximate 135 ohm resistive impedance to the line from 100 Hz to 4 times the Nyquist frequency as specified in Table 1.

  B.   Loop cable is non-loaded with a nominal .083 uf/mile shunt capacitance Cables of 19, 22, 24 and 26 gauge may be encountered, and may be mixed in a given loop. Actual capacitance may vary significantly with gauge and type of insulation, but grossly different characteristics, such as those of open wire, are not acceptable. Appendix A lists the primary and secondary transmission constants for a variety of cables. While the list is representative, it is not exhaustive.

2.2.   Loop Assignment and Loss

A loop is a candidate for digital assignment if its one way (2 wire) actual insertion loss between the Network Interface and OCU with 135 ohm terminations is equal to or less than 28 dB at the Nyquist (1/2 the bit rate) frequency. For the 4 digital service frequencies the Nyquist rates are given in Table 1.

Table 1.
Digital Service Frequencies

Digital Service Rate	Nyquist Frequencies
2.4 kb/s	1.2 kHz
4.8 kb/s	2.4 kHz
9.6 kb/s	4.8 kHz
19.2 kb/s	92 kHz
56.0 kb/s	28.0 kHz

2.3. Loop Conditioning

As noted above, digital loops will be non-loaded, bridged capacitors will be removed, and bridged taps will be limited as in Table 2:

Table 2.
Bridged Tap Limitations

Bit Rate	Total Bridged Tap	Longest Single Tap
2,4, 4.8 or 9.6 kb/s	6000 ft.	6000 ft.
19.2 and 56 kb/s	2500 ft.	2000 ft.

2.4. Digital Loop Requirements

Interference and Noise Detailed rules for pulse shaping, given in Section 3, are intended to minimize the risk of interference from digital service into other services as they exist in the loop plant.

Noise requirements are based on both ends of the cable being terminated in 135 ohms. Requirements are established for the AT&T Technologies Company 6F Noise Measuring Sets (or equivalent) equipped with a filter whose pass band is approximately 40 Hz to 30 kHz. This filter is used for all digital services signaling rates.

A steady background noise (e.g., thermal noise) requirement, based on a voltage magnitude averaging meter characteristic is given in Table 3.

Table 3.
Background Noise Requirements

Data Rate	40 Hz to 30 kHz Background Noise Level
2.4 kb/s	-42 dBm
4.8 kb/s	-45 dBm
9.6 kb/s	-53 dBm
19.2 kb/s	-56 dBm
56.0 kb/s	-56 dBm

Impulse noise levels may approach digital signal levels on longer cables. Again, the 135 ohm termination and 40 Hz to 30 kHz filter characteristic are assumed. Measurements are made at a fixed threshold, and the crossing of that level is considered an impulse event. Following any crossing of the threshold, additional crossings are ignored for a period of 200 ms.

The impulse thresholds are given in Table 4:

Table 4.
Impulse Noise Requirements

Data Rate	Impulse Noise Threshold
2.4 kb/s	-26 dBm
4.8 kb/s	-29 dBm
9.6 kb/s	-37 dBm
19.2 kb/s	-40 dBm
56.0 kb/s	-40 dBm

2.5.   19.2 Kb/s Loop Format

The loop format for 19.2 kb/s is identical to the subrates. 2.4, 4.8, and 9.6 kb/s, as specified in Section 3.1 and 3.4.1 of TA-TSY-000077 and Section 3 of TA-TSY-000083, except for the higher bit rate. Data bits are generated at 19.2 kb/s.

All control codes and XOV sequences remain the same as those currently being used.

Pulse amplitudes are identical to that as specified for 2.4, 4.8, and 56.0 kb/s in Section 3.1.2 of this document. A single pulse shaping pole at 1.3 times the bit rate must be provided. The additional loss (notch filters) specified for subrates should NOT be used.

The local facility design is 34 dBm at the nyquist frequency of 9.2 Khz. For 26 gauge cable this criteria corresponds to a maximum length of 21 Kft.

Until standards for 19.2 Kb/s are developed by the responsible agencies the bridged tap limitations, background noise and impulse noise requirements are the same as those for 56 kb/s.

3. Transmitted Pulse Shaping Requirements

The basic digital service bipolar coding scheme utilized a 50% duty cycle return to zero pulse format. It is the purpose of this section to define strict requirements on amplitude and pulse shaping to provide a signal which can be properly recovered by a digital service OCU and to minimize the risk of interference in the loop plant. Interference limitations are discussed in Section 3.1 and standard signal limitations in Section 3.2.

3.1. Interference Limitations

To minimize the risk of crosstalk interference in the loop plant, it is necessary to constrain the frequency distribution of energy in the digital service signal. The development of the constraint is as follows.

A. The digital service pulse sequence used is a basic bipolar format and a restricted class of bipolar violations. For the sequence rules, considerations of amplitude and duty cycle are temporarily set aside, and the rules are assumed to define a sequence of normalized pulse coefficients (+1, 0 and -1) applicable at each of the 4 signaling rates.

B. For each rate a nominal pulse waveform is defined, and the signal stream then consists of a sequence of these pulses occurring at the service bit rate, and with multiplying coefficients satisfying the bipolar sequence rule. By establishing frequency domain constraints on the individual pulse, the spectral energy distribution of the bipolar pulse sequence is controlled.

3.1.1. Frequency Distribution of Pulse Energy

Although the frequency on the single pulse does not specify details of realization, the expression of that constraint may be most clear if it is made in terms of practical digital service signaling. Thus, the following development is made first in terms of a nominal realization form, and then related to a more general frequency domain constraint.

3.1.2. Rectangular Driving Pulse

Prior to any frequency shaping filters, the system excitation is defined by an ideal 50% duty-cycle rectangular pulse. The relation of bit rate, R, in kb/s and maximum allowable driving pulse amplitude, A, in volts is given in Table 5.

Table 5.
Maximum Driving Pulse Amplitude

Pulse Rate (R) kb/s	Maximum Amplitude (A) volts
2.4	3.32
4.8	3.32
9.6	1.66
56.0	3.32

The 50% duty cycle implies that the pulse maintains a constant value. A, for a duration of nominally 1/2 the pulse interval, 1/(2R), and is zero at all other times. The bipolar sequence is to be applied as a synchronous modulation of such pulses with a jitter of no more than ±5 percent of the baud interval around an ideal clock at the rate, R.

The amplitude for 9.6 kb/s corresponds to a 0 dBm average power transfer in a system with matched 135 ohm driving and terminating resistances. The average power transfer assumes a random bipolar sequence (0 or ± 1 equiprobable in each pulse interval) and a low pass shaping filter as described in 3.1.4. The other rates are allowed double that amplitude or approximately +6 dBm. This difference in levels for 9.6 kbps circuits is necessary to ensure crosstalk compatibility with other loop transmission systems.

Note that these values establish the upper limits of the constraint for the purpose of interference limitation. Nominal design center values are discussed in Section 3.2.

3.1.3. Equivalent Frequency Domain Constraint

Because deviations from the nominal pulse might have effects in particular frequency bands which would be large relative to the apparent differences from a nominal time domain pulse, the realization requirement is stated directly in terms of the frequency domain Fourier transform.

$$P(f) = \frac{A}{\pi \, f} \quad SIN(\pi \, f/2R)$$

of an isolated rectangular pulse p(t) meeting the requirements of 3.1.2.

To allow for tolerances in the pulse width, this requirement is relaxed in the vicinity of the zeros of the Fourier transform. The modified frequency domain limit is given by the greater of 2 possible values:

$$D(f) = \begin{array}{c} P(f) \\ \text{or} \\ \dfrac{A}{10\text{''}f} \end{array} \qquad (\text{For } f > R)$$

3.1.4.   Low Pass Shaping Filter

For all rates the driving pulse must be subsequently shaped by a single-pole low pass filter whose transfer function H(f) is given by:

$$H(f) = \frac{1}{1 + j\dfrac{f}{1.3R}}$$

3.1.5. Specific Band Rejection Filter

To protect certain other services having specific frequency band assignments, rejection requirements are needed in addition to the high-frequency roll-off provided by the shaping filter. These requirements apply only at 2.4, 4.8 and 9.6 kb/s, and the amounts of additional rejection are specified in Table 6.

Table 6.
Minimum Additional Rejection

Rate (R) kb/s	Rejection Band	
	24-32 kHz	72-80 kHz
2.4	5 dB	1 dB
4.8	13 dB	9 dB
9.6	17 dB	8 dB

The additional rejection requirement is weighted within each band by "C-message" weighting over the double speech sidebands around a carrier in the middle of the band (28 kHz and 76 kHz). The weighting characteristic is defined in "Transmission Parameters Affecting Voiceband Data Transmission - Measuring Techniques", (IEEE Standard 743-1984 which replaces PUB 41009). This characteristic is summarized in Figure 1.

At any frequency within the band, but more than 1 kHz from the carrier at the band center, the specific rejection of Table 6 may be reduced by an amount equal to the C-message weight for a frequency equal to the absolute difference between the frequency in question and the carrier frequency. Minimum rejection is never less than 0 dB, i.e., the weight does not justify a gain over the system without rejection (rejection does not apply anywhere outside the two 8 kHz bands specified).

Figure 1. C-MESSAGE WEIGHTING
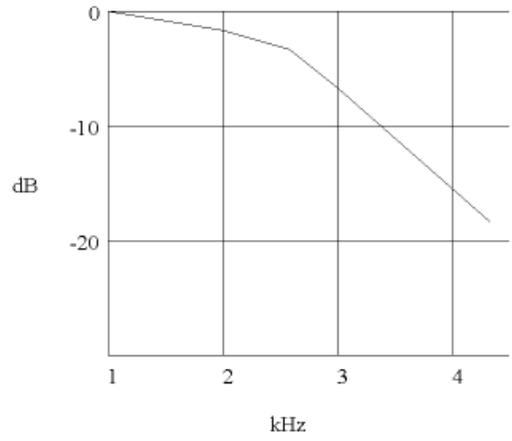
3.1.6.   General Realization Constraint

The preceding description of frequency domain limits has been given in terms of an illustrative realization. It is not intended to specify a particular realization. What is required is that the individual pulses (exclusive of the bipolar coding requirements given in 3.1.2) must satisfy a frequency domain bound describable in terms of the three components given in 3.1.3 through 3.1.5.

This composite frequency domain bound is:

$L(f) = D(f)\ H(f)\ R(f)$

Where D(f) AND H(f) are as given and R(f) imposes the rejection band values of Table 6 as modified by the C-message weighting characteristic as shown in Figure 1.

These values are intended as upper limits. Design center values and component tolerances must reliably maintain the pulse spectral amplitude distribution within these limits.

3.1.7.   Line Coupling

The pulse constraint, L(f), as defined above may be considered as a requirement on an ideal voltage source in series with a 135 ohm resistive source impedance. However, it is recognized that it may be economical to realize some of the filtering requirements reactively in the output stage of the line driver.

In that case, the signal constraint shall be considered to be satisfied if the signal presented to a known load meets the bound, L(f), reduced by the coupling ratio of 135 ohms driving into that load. For the purposes of this specification, load requirements of 135 ohms (coupling ratio = 0.5) and 600 ohms (coupling ratio 0.816) must be satisfied.

Figure 2 shows the signal source under test with a known resistive load and measurement across that load.

Figure 2. LOAD DEPENDENCE OF OUTPUT CONSTRAINT
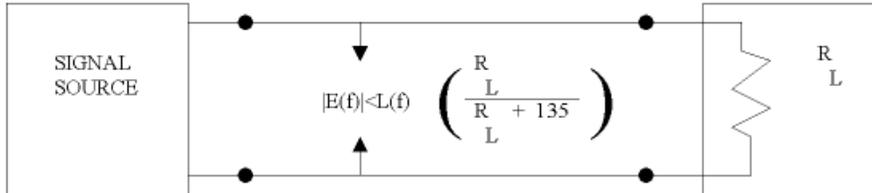
To establish the load dependence characteristic, it is sufficient to measure only the metallic (differential) component of the output voltage.

3.1.8. Longitudinal Balance

A longitudinal balance requirement is necessary to control the magnitude of longitudinal (common mode) voltage induced in the cable. Longitudinal voltage crosstalks from pair to pair in a cable with a much lower attenuation than metallic (differential) voltage therefore stringent requirements must be applied.

In addition to any longitudinal voltage requirements imposed by FCC Part 68, Terminal Equipment Registration Requirements, a digital service terminal must meet the following longitudinal balance requirement at both transmitting and receiving ports independent of the state of the terminal (i.e., transmitting, receiving, quiescent, power off):

- 60 dB up to 1 kHz

- 40 dB up to 15 kHz

- 35 dB up to upper frequency constraint of Table 7

3.1.9. Frequency Range of Applicability

The general realization constraint of Section 3.1.6 would become arbitrarily small at frequencies above the useful signal bands. For purposes of verification, the applicable upper limit of the constraint is given in Table 7.

Table 7.
Frequency Constraint Limit

Rate (R) kb/s	Upper Constraint Frequency kHz
2.4	100
4.8	150
9.6	150
56.0	1750

3.2.   Standard Signal Levels

The interference limiting constraints of Section 3.1 provide a margin above standard digital service signal levels to allow for circuit tolerances. Design center values for best performance with

5.   Customer Provided Equipment Requirements

Section 2 has provided loop characteristics for digital loop cable distribution systems, while Sections 3 and 4 have treated the signal conditioning requirements for line drivers and line receivers. This section provides detailed requirements for customer equipment connected to the local facility.

5.1.   Isolation From Ground

Both transmit and receive pairs should be isolated from the local ground reference. Resistance from any lead to ground should exceed 300 kohms. Stray capacitance of any lead should not exceed 500 pf to ground, and the difference between the capacitance to ground of the 2 leads of any pair should not exceed 100 pf.

5.2.   Simplex Path

A dc current path must be provided on a balanced basis between transmit and receive pairs. The balance, which may be established in terminating resistance or coupling transformers should be held to a maximum difference of +5%, in resistance value to self inductance as appropriate. The simplex termination must be such that if a dc simplex voltage of either polarity is imposed between the receive pair (T & R) and the transmit pair (T1 and R1), then the following current limitations will be satisfied.

   A.   For a minimum simplex voltage of 7 volts, the magnitude of the current through the simplex termination will be at least 4 ma.

   B.   For a maximum simplex voltage of 28 volts, the simplex current will not exceed 20 ma.

   C.   For equal voltage on both wires of a pair, the current difference between the wires of the pair will not exceed 1 ma.

   The presence of simplex current in the range of 4 to 20 ma is normally assured by a source in the OCU. Temporary absence of the current should not affect the data transmission operations of the station apparatus. This dc current path is necessary to provide sealing current for the loop and also provide a signaling path for channel loopback as discussed in 5.3.

5.3.   Channel Loopback

2 signals intended to result in loopback of the customer's received signal to the transmit side of the channel may be utilized by the A.O.C. Implementation of loopback circuitry in customer pro-

vided terminal equipment provides for remote testing of the digital service circuit and to some extent isolation of trouble conditions between the A.O.C. and customer equipment. Response by the customer provided terminal equipment to the first loopback control signal described below is mandatory, response to the optional loopback control signal is recommended.

5.3.1. Mandatory Channel Loopback

The mandatory loopback test for digital service uses reversal of the local cable simplex polarity to signal a loopback test to the station apparatus. In the normal polarity the line driver pair (T1, R1) is kept positive with respect to the line receiver pair (T, R). Reversal of this polarity must be sensed in the simplex termination to control the channel loopback. The sensing circuit must respond to the minimum 4 ma current described in Section 5.2. To accomplish this mandatory channel loopback, it is necessary for the station apparatus to perform full equalization and filtering of the received signal. The loopback path should return this signal to the line driving circuitry of the transmitter for shaping in accordance with requirements of Section 3. This loopback should be designed to minimize penetration into the customer provided terminal equipment.

5.3.2. Optional Channel Loopback

The optional loopback control signal, when transmitted by the A.O.C. is utilized to loopback customer provided terminal equipment at a point of logical separation between customer's data communications equipment and customer's terminal equipment. The optional loopback state should be entered when 3 successive bipolar violation codes of the form (see notation in Section 6.1) OOBOXOV for 56 kbps service or OBOXOV for subrate services are received. During testing the signal will consist of alternating bytes of loopback code and test bytes.

The loopback should be terminated upon receipt of 5 successive byte intervals without the loopback code indication. Implementation of this loopback in customer equipment is recommended.

5.4. Restriction Due To Safety Consideration

All safety criteria of Transmission Specifications for Private Line Metallic Circuits - (PUB 43401*) shall apply to equipment connected to a digital service circuit. Attention is specifically directed to Sections 4.3, 4.4, 5.1 and 5.2 of that document.

5.5. Performance

Excellent error performance on digital service will only be realized from a customer viewpoint when customer provided terminal equipment properly equalizes, filters, and samples the received signal, and meets the requirements for the transmitted signal. Properly designed terminal equipment will provide virtually error free signal reception when connected to most digital service loops. It is assumed that customer wiring will not significantly change the noise specifications in Section 2.4.

A.   PUB 43401 is available through Bell Communications Research, Information Operations Center, 60 New England Avenue, Piscataway, NJ 08854.

6.   Digital Service Coding Requirements

Detailed specifications for transmission using digital service are discussed in this section. Included are the encoding and decoding requirements that the customer's equipment must observe in order to operate over a digital service channel.

6.1.   Alternate Bipolar Format

Baseband, bipolar return-to-zero signaling is used for transmission over the local loop and is described by the following coding rules: a binary 0 is transmitted as zero volts. A binary 1 is transmitted as either a positive or negative pulse, opposite in polarity of the previous binary 1.

Through the use of bipolar violations, additional information capacity is achieved to provide a convenient way of transmitting network control information. A bipolar violation occurs when the alternate polarity rule is violated. For example, the bipolar rule is violated if the last 1 was transmitted as a positive pulse and the next 1 is also transmitted as a positive pulse. The following notations apply:

Q - Denotes zero volts transmitted

B - Denotes ±A volts (polarity determine by bipolar rule) - BINARY ONE

V - Denotes ±A volts (polarity in violation of bipolar rule) - BINARY ONE

X - Denotes O or B (depending on desired polarity of a violation)

6.2.   Encoding and Decoding Rules

To be compatible with digital service, the transmit and receive data signals must use bipolar violations to indicate control information (Idle and Out-Of-Service) and Zero Suppression. The Zero Suppression sequence is necessary since long sequence of zeros do not provide the transitions necessary to maintain timing recovery. The encoding and decoding rules that the customer must follow as well as the network signaling are outlined in the following paragraphs.

Unrestricted insertion of violations in the pulse stream would produce as undesirable dc component. A means of solving this problem is to reserve a time slot prior to a violation for application of a binary pulse or non-pulse in such a way that successive violations (V) alternate in polarity. The reserved time slot is determined by the symbol V. The desired polarity alternation of Vs is achieved by assigning a value O or B to the X such that the total number of Bs since the last V is odd.

If pulses of the same polarity were adjacent, performance would be degraded. Therefore, X and V bits are separated by a zero, resulting in an XOV pattern in each bipolar violation sequence.

6.2.1.   Transmitting Sequences Containing Bipolar Violations

    A.   Idle Sequence

This sequence may be used as a supervisory signal. The example, it could indicate that the terminal does not have data to transmit. Such usage is analogous to the Request-to-Send OFF indication in EIA Standard RS 232C. The Idle sequence consists of one or more repetitions of the sequence BBBXOV at 2.4, 4.8 or 9.6 kb/s or BBBBXOV at 56 kb/s/

    B.   Zero Suppression Sequence

At 2.4, 4.8 or 9.6 kb/s any sequence of 6 consecutive Os must be encoded as 000X0V: at 56 kb/s, any sequence of 7 consecutive 0s must be encoded as 0000X0V.

6.2.2.   Receiving Sequences Containing Bipolar Violations

    A.   Idle Sequence

This is the same as the transmitting Idle sequence described above.

    B.   Zero Suppression Sequence

Reception of 000X0V for any speed must be decoded as 6 zeros.

    C.   Out-of-Service Sequence

This sequence is an indication of trouble in the digital service. It consists of 1 or more repetitions of the sequence 00BX0V at 2.4, 4.8 or 9.6 kb/s or 000BX0V at 56 kb/s.

    D.   Out-of-Frame Sequence

This sequence is an indication of trouble in the digital service. It consists of 1 or more repetitions of the sequence 0BBX0V at 2.4, 4.8 or 9.6 kb/s or 00BBXoV at 56 kb/s.

    E.   Loopback Sequence

This sequence requests the loopback of the received signal onto the transmit circuit. It consists of 3 successive repetitions of the sequence 0B0X0V at 2.4, 4.8 or 9.6 kb/s or 00B0X0V at 56 kb/s. (See Section 5.3.2).

6.2.3.   System Response to Bipolar Violation Sequences

The customer's data terminal may transmit Idle Sequences through a digital service channel for supervisory signaling purposes. The transmission delay will not necessarily by the same for Idle Sequences as for data. This difference in delay may cause signals to be modified when going between the Idle and data modes. The transition from data to Idle adds a number of pulses between the last data bit and the first pulse of the Idle sequence. The transition from Idle to data will replace the same number of the initial data bits with the bits of the Idle sequence. The additional delay for Idle sequences will be less than 6 bits at 2.4, 4.8 and 9.6 kb/s. At 56 kb/s the additional delay will be less than 7 bits.

It is important to note that a Zero Suppression sequence may not be received when one was transmitted and vice versa. If a Zero Suppression sequence follows a B00000 data sequence, then the received data could have 10 consecutive zeros at 2.4, 4.8 or 9.6 kb/s or 11 consecutive zeros at 56 kb/s. However, the pulse density will be maintained with minimum 1 in 6 at the subrate speeds or 1 in 7 at 56 kb/s.

7.   Timing And Jitter

7.1.   Timing Accuracy

Definition: This term describes the difference between the frequency of the received pulses and the nominal data rate.

Specification:

A.   Customer to Network - The transmitted data must be synchronous with the received data.

B.   Network to Customer - Under normal conditions, the frequency of the received data will agree with the nominal data rate to within ±2 parts in 10(9). Some trouble conditions will allow the frequency difference to vary ±0.005% of the nominal data rate.

7.2.   Isochronous And Peak Individual Distortion (Jitter)

A.   Customer to Network

Specification:

The peak individual distortion of the data signals from the customer to the Network shall not exceed 5% of a bit interval relative to a reference clock in phase with the

mean of the significant transitions when receiving random data from the Network. The bit interval is the reciprocal of the data rate.

The isochronous distortion of data signals from the customer to the Network shall not exceed 10% of a bit interval when receiving random data or periodic patterns from the Network.

B.   Network or Customer:

The effects of random noise, intersymbol interference and data pattern variations may cause data transitions to occur anywhere within the unit signaling interval. However, it is expected that intersymbol interference and pattern variations will be dominant in establishing the average statistics of the received data signal.

8.   Physical Network Interface

The interface consists of 4 leads which are paired to provide a receive data pair and transmit data pair. The 4 leads are provided on a miniature 8 position series jack without a shorting bar as shown in FCC Rules and Regulations. Part 68, Subpart F, Figures 68.500 (d) (1) and (d) (2). The following are the pin assignments for the jack.

Pin Number	Function	Signal Direction
8	Receive Data (R)	From Network Interface to Customer
7	Receive Data (T)	From Network Interface to Customer
2	Transmit Data (T1)	From Customer to Network Interface
1	Transmit Data (R1)	From Customer to Network Interface

The other 4 pins will not be connected. Provision of the network interface on a terminal block or strip will be allowed on an interim basis in place of the connector at the A.O.C.'s discretion.

APPENDIX A - Appendix A: Channel Interface Specification

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

26 GAUGE PIC CABLE AT 120. DEGREES F

FREQ (HZ)	R (OHMS/ MI)	L (MH/MI)	G (MU-MH0/ MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI)	(DEG/MI)
1.	488.83	0.9935	0.000	0.08300	21654.80	-J*21642.81	0.098	0.65
5.	488.83	0.9935	0.001	0.08300	9684.07	-J*9679.21	0.219	1.45
10.	488.83	0.9935	0.002	0.08300	6847.76	-J*6844.14	0.310	2.05
15.	488.83	0.9935	0.003	0.08300	5591.30	-J*5588.10	0.380	2.61
20.	488.83	0.9935	0.004	0.08300	4842.33	-J*4839.32	0.439	2.89
30.	488.83	0.9935	0.005	0.08300	3953.96	-J*3951.07	0.537	3.54
50.	488.83	0.9935	0.008	0.08300	3063.08	-J*3060.13	0.593	4.57
70.	488.83	0.9935	0.011	0.08300	2589.09	-J*2585.97	0.820	5.41
100.	488.83	0.9935	0.016	0.08300	2166.59	-J*2163.18	0.980	6.47
150.	488.83	0.9935	0.022	0.08300	1769.57	-J*1755.68	1.200	7.93
200.	488.83	0.9934	0.028	0.08300	1532.97	-J*1528.65	1.385	9.13
300.	488.84	0.9934	0.040	0.08300	1252.46	-J*1247.35	1.695	11.22
500.	488.84	0.9933	0.063	0.08300	971.39	-J*964.98	2.186	14.57
700.	488.85	0.9933	0.084	0.08300	822.03	-J*814.52	2.583	17.19
1,000.	488.86	0.9932	0.115	0.08300	589.03	-J*680.19	3.082	20.59
1,500.	488.89	0.9930	0.164	0.08300	564.44	-J*553.62	3.762	25.29
2,000.	488.91	0.9923	0.210	0.08300	490.39	-J*477.94	4.331	29.30
3,000.	488.97	0.9924	0.299	0.08300	402.98	-J*387.78	5.271	36.12
5,000.	489.11	0.9917	0.466	0.08300	316.18	-J*296.63	6.719	47.23
7,000.	489.26	0.9910	0.525	0.08300	270.66	-J*247.58	7.852	56.60
10,000.	489.53	0.9899	0.853	0.08300	230.83	-J*203.32	9.212	68.96
15,000.	490.07	0.9881	1.213	0.08300	194.53	-J*161.02	10.943	87.18
20,000.	490.71	0.9863	1.558	0.08300	173.80	-J*135.34	12.264	103.85
30,000.	492.30	0.9826	2.217	0.08300	150.77	-J*104.35	14.183	135.14
50,000.	496.65	0.9733	3.458	0.08300	130.57	-J*72.93	16.522	195.05
70,000.	502.51	0.9617	4.634	0.08300	121.52	-J*56.59	17.948	354.36
100,000.	513.93	0.9502	6.320	0.08300	115.23	-J*42.76	19.373	344.29
150,000.	536.26	0.9375	8.993	0.08300	110.70	-J*30.96	21.043	496.15
200,000.	561.79	0.9291	11.550	0.08300	108.62	-J*24.79	22.469	649.07
300,000.	622.63	0.9139	16.436	0.08300	106.58	-J*18.66	25.378	955.39
500,000.	746.31	0.8910	25.633	0.08300	104.51	-J*13.69	31.025	1561.34
700,000.	862.21	0.8717	34.351	0.08300	103.12	-J*11.45	36.327	2156.88
1,000,000.	1013.99	0.8495	46.849	0.08300	101.62	-J*9.56	43.357	3036.30
1,500,000.	1222.70	0.8271	66.665	0.08300	100.13	-J*7.80	53.063	4487.69
2,000,000.	1398.54	0.8133	85.624	0.08300	99.22	-J*6.75	61.254	5929.23
3,000,000.	1693.35	0.7965	121.841	0.08300	98.12	-J*5.51	75.003	8795.36
5,000,000.	2160.47	0.7794	190.021	0.08300	xxx97.00	xxxx-J*4.27	96.813	14491.28

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

26 GAUGE PULP CABLE AT 120. DEGREES F

FREQ (HZ)	R (OHMS/ MI)	L (MH/MI)	G (MU-MH0/ MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI)	(DEG/MI)
1.	488.83	0.9691	0.560	0.08190	23625.25	-J*9211.7	0.156	0.40
5.	488.83	0.9691	0.566	0.08185	10619.93	-J*9536.13	0.243	1.29
10.	488.83	0.9691	0.574	0.08183	7245.15	-J*6480.47	0.326	1.92
15.	488.83	0.9691	0.582	0.08181	5830.42	-J*5405.87	0.392	2.40
20.	488.83	0.9691	0.590	0.08180	5010.50	-J*4729.92	0.448	2.79
30.	488.83	0.9691	0.606	0.08178	4058.58	-J*3900.62	0.544	3.45
50.	488.83	0.9691	0.639	0.08175	3123.51	-J*3044.86	0.697	4.48
70.	488.83	0.9691	0.672	0.08173	2632.71	-J*2581.69	0.821	5.32
100.	488.83	0.9691	0.722	0.08171	2198.49	-J*2165.07	0.979	6.38
150.	488.83	0.9690	0.808	0.08168	1792.81	-J*1750.78	1.197	7.83
200.	488.83	0.9690	0.895	0.08166	1551.97	-J*1534.66	1.380	9.05
300.	488.84	0.9690	1.076	0.08162	1267.15	-J*1253.63	1.687	11.09
500.	488.85	0.9689	1.456	0.08157	982.41	-J*970.78	2.173	14.34
700.	488.86	0.9688	1.860	0.08154	831.31	-J*819.82	2.567	16.99
1,000.	488.87	0.9687	2.502	0.08150	696.89	-J*684.91	3.061	20.35
1,500.	488.90	0.9684	3.655	0.08145	570.93	-J*557.71	3.737	24.99
2,000.	488.93	0.9682	4.893	0.08141	496.11	-J*481.61	4.301	28.94
3,000.	489.00	0.9678	7.575	0.08135	407.79	-J*390.92	5.234	35.66
5,000.	489.15	0.9669	13.580	0.08127	320.05	-J*299.20	6.673	46.59
7,000.	489.33	0.9660	20.237	0.08121	274.03	-J*249.84	7.799	55.79
10,000.	489.63	0.9646	31.164	0.08114	232.72	-J*205.30	9.155	67.90
15,000.	490.23	0.9624	51.321	0.08106	196.93	-J*162.72	10.885	85.72
20,000.	490.94	0.9601	73.387	0.08099	175.89	-J*136.88	12.212	101.99
30,000.	492.67	0.9556	121.941	0.08089	152.44	-J*105.67	14.155	132.43
50,000.	497.33	0.9460	232.178	0.08075	131.74	-J*73.99	16.569	190.50
70,000.	503.52	0.9335	355.449	0.08065	122.54	-J*57.44	18.076	247.88
100,000.	515.44	0.9221	558.820	0.08053	115.95	-J*43.38	19.627	334.75
150,000.	538.53	0.9092	935.452	0.08038	111.26	-J*31.31	21.510	481.25
200,000.	564.72	0.8996	1348.793	0.08027	109.10	-J*24.96	23.151	628.64
300,000.	626.65	0.8851	2259.977	0.08010	107.03	-J*18.61	26.510	923.49
500,000.	752.12	0.8615	4332.104	0.07986	104.95	-J*13.39	33.129	1505.34
700,000.	869.26	0.8418	6651.430	0.07986	103.46	-J*10.99	39.510	2077.96
1,000,000.	1022.62	0.8190	10480.000	0.07986	101.85	-J*8.95	48.276	2922.72
1,500,000.	1233.50	0.7959	16181.359	0.07986	100.24	-J*7.10	60.522	4316.08
2,000,000.	1411.18	0.7817	22011.598	0.07986	99.25	-J*6.00	71.273	5699.09
3,000,000.	1709.05	0.7643	33940.115	0.07986	98.05	-J*4.69	90.187	8447.15
5,000,000.	2181.04	0.7463	58504.338	0.07986	96.81	-J*3.36	122.473	13904.18

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

26 GAUGE PIC CABLE AT 70. DEGREES F

FREQ (HZ)	R (OHMS/ MI)	L (MH/MI)	G (MU-MH0/ MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI) (DEG/MI)	
1.	440.75	0.9861	0.000	0.08300	20562.46	-J*20551.04	0.093	0.61
5.	440.75	0.9861	0.001	0.08300	9195.60	-J*9190.92	0.208	1.37
10.	440.75	0.9861	0.002	0.08300	6502.38	-J*6498.85	0.294	1.94
15.	440.76	0.9861	0.003	0.08300	5309.30	-J*5306.16	0.361	2.38
20.	440.76	0.9861	0.004	0.08300	4598.12	-J*4595.14	0.416	2.75
30.	440.76	0.9861	0.005	0.08300	3754.58	-J*3751.69	0.510	3.36
50.	440.76	0.9861	0.008	0.08300	2908.66	-J*2905.67	0.658	4.34
70.	440.76	0.9861	0.011	0.08300	2458.60	-J*2455.41	0.779	5.14
100.	440.76	0.9861	0.016	0.08300	2057.43	-J*2053.93	0.931	6.15
150.	440.76	0.9861	0.022	0.08300	1680.47	-J*1676.45	1.139	7.53
200.	440.76	0.9860	0.028	0.08300	1455.83	-J*1451.35	1.315	8.70
300.	440.76	0.9860	0.040	0.08300	1189.51	-J*1184.20	1.610	10.66
500.	440.77	0.9859	0.063	0.08300	922.69	-J*916.00	2.075	13.78
700.	440.78	0.9859	0.084	0.08300	780.91	-J*773.09	2.452	16.33
1,000.	440.79	0.9858	0.115	0.08300	654.74	-J*645.46	2.924	19.56
1,500.	440.81	0.9856	0.164	0.08300	536.48	-J*525.19	3.569	24.04
2,000.	440.83	0.9854	0.210	0.08300	466.25	-J*453.25	4.107	27.86
3,000.	440.88	0.9850	0.299	0.08300	383.39	-J*367.51	4.995	34.36
5,000.	441.01	0.9843	0.466	0.08300	301.19	-J*280.76	5.360	44.99
7,000.	441.15	0.9836	0.625	0.08300	258.16	-J*234.04	7.422	53.99
10,000.	441.39	0.9825	0.853	0.08300	220.58	-J*191.85	8.692	65.90
15.000.	441.87	0.9807	1.213	0.08300	186.46	-J*151.47	10.294	83.56
20,000.	442.45	0.9789	1.558	0.08300	167.08	-J*126.94	11.503	99.83
30,000.	443.88	0.9753	2.217	0.08300	145.71	-J*97.35	13.232	130.60
50,000.	447.81	0.9660	3.458	0.08300	127.25	-J*67.47	15.285	190.10
70,000.	453.09	0.9546	4.634	0.08300	119.21	-J*52.05	16.509	249.33
100,000.	463.39	0.9432	6.320	0.08300	113.56	-J*39.12	17.726	339.29
150,000.	485.80	0.9306	8.993	0.08300	109.61	-J*28.32	19.253	491.26
200,000.	513.04	0.9212	11.550	0.08300	107.80	-J*22.81	20.676	644.17
300,000.	575.17	0.9062	16.436	0.08300	105.92	-J*17.35	23.590	949.49
500,000.	699.61	0.8816	25.633	0.08300	103.87	-J*12.91	29.264	1551.77
700,000.	812.95	0.8614	34.351	0.08300	102.45	-J*10.86	34.477	2142.83
1,000,000.	956.65	0.8381	46.849	0.08300	100.90	-J*9.09	41.198	3041.78
1,500,000.	1154.38	0.8146	66.665	0.08300	99.35	-J*7.42	50.493	4452.71
2,000,000.	1321.07	0.8001	85.624	0.08300	98.39	-J*6.43	58.348	5879.86
3,000,000.	1600.68	0.7823	121.841	0.08300	97.23	-J*5.25	71.551	8715.35
5,000,000.	2044.07	0.7638	190.021	0.08300	96.02	-J*4.08	92.534	14344.97

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

26 GAUGE PULP CABLE AT 70. DEGREES F

FREQ (HZ)	R (OHMS/ MI)	L (MH/MI)	G (MU-MHO/ MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI)	(DEG/MI)
1.	440.75	0.9619	0.000	0.08190	22433.50	-J*8746.51	0.148	0.38
5.	440.75	0.9619	0.001	0.08185	10084.25	-J*8105.51	0.231	1.22
10.	440.76	0.9619	0.002	0.08183	6879.72	-J*6153.53	0.309	1.82
15.	440.76	0.9619	0.003	0.08181	5536.36	-J*5133.12	0.372	2.27
20.	440.76	0.9619	0.004	0.08180	4757.81	-J*4194.26	0.425	2.65
30.	440.76	0.9619	0.005	0.08178	3853.92	-J*3703.78	0.516	3.28
50.	440.76	0.9619	0.008	0.08175	2966.04	-J*2891.17	0.661	4.26
70.	440.76	0.9619	0.011	0.08173	2500.01	-J*2451.35	0.780	5.05
100.	440.76	0.9619	0.016	0.08171	2087.72	-J*2055.73	0.930	6.06
150.	440.76	0.9618	0.022	0.08168	1702.53	-J*1681.30	1.136	7.43
200.	440.76	0.9618	0.028	0.08166	1473.86	-J*1457.06	1.310	8.59
300.	440.76	0.9618	0.040	0.08162	1203.46	-J*1190.17	1.602	10.54
500.	440.77	0.9617	0.063	0.08157	933.15	-J*921.52	2.063	13.62
700.	440.78	0.9616	0.084	0.08154	789.71	-J*778.13	2.437	16.14
1,000.	440.79	0.9615	0.115	0.08150	662.15	-J*649.95	2.905	19.33
1,500.	440.82	0.9612	0.164	0.08145	542.64	-J*529.07	3.545	23.76
2,000.	440.85	0.9610	0.210	0.08141	471.67	-J*456.74	4.079	27.52
3,000.	440.91	0.9606	0.299	0.08135	387.94	-J*370.50	4.960	33.92
5,000.	441.05	0.9597	0.466	0.08127	304.86	-J*283.21	6.317	44.38
7,000.	441.21	0.9588	0.525	0.08121	261.34	-J*236.20	7.374	53.21
10,000.	441.48	0.9574	0.853	0.08114	223.30	-J*193.73	8.639	64.88
15.000.	442.02	0.9552	1.213	0.08106	188.71	-J*153.09	10.243	82.15
20,000.	442.66	0.9530	1.558	0.08099	169.02	-J*128.41	11.459	99.02
30,000.	444.22	0.9485	2.217	0.08089	147.24	-J*98.61	13.215	127.95
50,000.	448.42	0.9380	3.458	0.08075	128.31	-J*68.46	15.344	185.59
70,000.	454.00	0.9266	4.634	0.08065	120.03	-J*52.83	16.647	242.87
100,000.	464.75	0.9153	6.320	0.08053	114.19	-J*39.66	17.986	329.77
150,000.	487.85	0.9025	8.993	0.08038	110.11	-J*28.51	19.720	476.40
200,000.	515.72	0.8930	11.550	0.08027	108.24	-J*22.93	21.354	623.81
300,000.	578.88	0.8776	16.436	0.08010	106.35	-J*17.25	24.712	917.73
500,000.	705.05	0.8524	25.633	0.07986	104.30	-J*12.59	31.350	1496.09
700,000.	819.59	0.8318	34.351	0.07986	102.78	-J*10.39	37.631	2054.43
1,000,000.	964.79	0.8080	46.849	0.07986	101.12	-J*8.46	46.071	2902.03
1,500,000.	1164.58	0.7840	66.665	0.07986	99.45	-J*6.72	57.877	4282.48
2,000,000.	1333.00	0.7690	85.624	0.07986	98.42	-J*5.67	68.261	5651.71
3,000,000.	1615.52	0.7506	121.841	0.07986	97.15	-J*4.43	86.569	8370.41
5,000,000.	2063.53	0.7314	190.021	0.07986	95.83	-J*3.18	117.896	13763.95

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

26 GAUGE PIC CABLE AT 0. DEGREES F

FREQ (HZ)	R (OHMS/ MI)	L (MH/MI)	G (MU-MHO/ MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI)	(DEG/MI)
1.	373.45	0.9758	0.000	0.08300	18927.57	-J*18917.02	0.086	0.57
5.	373.45	0.9758	0.001	0.08300	8464.51	-J*8460.10	0.192	1.26
10.	373.45	0.9758	0.002	0.08300	5985.45	-J*5982.07	0.271	1.79
15.	373.45	0.9758	0.003	0.08300	4887.25	-J*4884.19	0.332	2.19
20.	373.45	0.9758	0.004	0.08300	4232.63	-J*4229.69	0.383	2.53
30.	373.45	0.9758	0.005	0.08300	3456.18	-J*3453.27	0.469	3.10
50.	373.45	0.9758	0.008	0.08300	2677.55	-J*2674.49	0.606	4.00
70.	373.45	0.9757	0.011	0.08300	2263.30	-J*2260.00	0.717	4.73
100.	373.45	0.9757	0.016	0.08300	1894.07	-J*1890.40	0.857	5.66
150.	373.46	0.9757	0.022	0.08300	1547.13	-J*1542.89	1.049	6.93
200.	373.46	0.9757	0.028	0.08300	1340.40	-J*1335.54	1.210	8.01
300.	373.46	0.9757	0.040	0.08300	1095.32	-J*1089.66	1.481	9.32
500.	373.46	0.9756	0.063	0.08300	849.83	-J*842.68	1.909	12.69
700.	373.47	0.9755	0.084	0.08300	719.41	-J*711.03	2.255	15.04
1,000.	373.48	0.9754	0.115	0.08300	603.39	-J*593.44	2.689	18.03
1,500.	373.50	0.9752	0.164	0.08300	494.70	-J*482.58	3.280	22.17
2,000.	373.52	0.9751	0.210	0.08300	430.19	-J*416.23	3.772	25.70
3,000.	373.56	0.9747	0.299	0.08300	354.15	-J*337.10	4.582	31.74
5,000.	373.67	0.9740	0.466	0.08300	278.88	-J*256.93	5.820	41.66
7,000.	373.78	0.9733	0.625	0.08300	239.59	-J*213.68	6.777	50.10
10,000.	373.99	0.9722	0.853	0.08300	205.41	-J*174.55	7.908	61.37
15,000.	374.40	0.9704	1.213	0.08300	174.60	-J*137.06	9.314	78.25
20,000.	374.89	0.9687	1.558	0.08300	157.27	-J*114.27	10.354	93.97
30,000.	376.10	0.9651	2.217	0.08300	138.45	-J*86.81	11.800	124.09
50,000.	379.43	0.9559	3.458	0.08300	122.63	-J*59.32	13.440	183.20
70,000.	383.91	0.9446	4.634	0.08300	115.92	-J*45.35	14.385	242.45
100,000.	392.63	0.9333	6.320	0.08300	111.30	-J*33.81	15.323	332.57
150,000.	415.15	0.9208	8.993	0.08300	108.15	-J*24.53	16.676	484.71
200,000.	444.79	0.9115	11.550	0.08300	106.69	-J*19.98	18.112	637.55
300,000.	508.72	0.8955	16.436	0.08300	105.02	-J*15.48	21.045	941.38
500,000.	634.23	0.8685	25.633	0.08300	102.97	-J*11.81	26.761	1538.37
700,000.	743.98	0.8468	34.351	0.08300	101.51	-J*10.03	31.846	2123.09
1,000,000.	876.38	0.8222	46.849	0.08300	99.88	-J*8.41	38.125	2984.48
1,500,000.	1058.74	0.7972	66.665	0.08300	98.25	-J*6.88	46.830	4403.34
2,000,000.	1212.60	0.7816	85.624	0.08300	97.22	-J*5.97	54.202	5810.13
3,000,000.	1470.94	0.7624	121.841	0.08300	95.96	-J*4.89	66.620	8602.15
5,000,000.	1881.11	0.7420	190.021	0.08300	94.63	-J*3.81	86.410	14137.64

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

26 GAUGE PULP CABLE AT 120. DEGREES F

FREQ (HZ)	R (OHMS/ MI)	L (MH/MI)	G (MU-MHO/ MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI)	(DEG/MI)
1.	373.45	0.9518	0.560	0.08190	20649.83	-J*8051.05	0.136	0.35
5.	373.45	0.9518	0.566	0.08185	9282.50	-J*7460.99	9.212	1.13
10.	373.45	0.9518	0.574	0.08183	6332.78	-J*5664.19	0.285	1.68
15.	373.45	0.9518	0.582	0.08181	5096.25	-J*4724.90	0.342	2.09
20.	373.45	0.9518	0.590	0.08180	4379.61	-J*4134.06	0.392	2.44
30.	373.45	0.9518	0.606	0.08178	3547.61	-J*3409.17	0.475	3.01
50.	373.45	0.9518	0.639	0.08175	2730.36	-J*2661.14	0.609	3.92
70.	373.45	0.9518	0.672	0.08173	2301.42	-J*2256.26	0.718	4.65
100.	373.45	0.9518	0.722	0.08171	1921.94	-J*1892.06	0.856	5.57
150.	373.46	0.9517	0.808	0.08168	1567.43	-J*1547.35	1.046	6.84
200.	373.46	0.9517	0.895	0.08166	1356.99	-J*1340.90	1.206	7.91
300.	373.46	0.9517	1.076	0.08152	1108.15	-J*1095.16	1.474	9.70
500.	373.47	0.9516	1.456	0.08157	859.44	-J*847.76	1.898	12.55
700.	373.47	0.9515	1.860	0.08154	727.51	-J*715.68	2.241	14.87
1,000.	373.49	0.9514	2.502	0.08150	610.20	-J*597.58	2.671	17.82
1,500.	373.51	0.9511	3.655	0.08145	500.35	-J*486.16	3.257	21.90
2,000.	373.53	0.9509	4.893	0.08141	435.16	-J*419.45	3.746	25.39
3,000.	373.58	0.9505	7.575	0.08135	358.32	-J*339.86	4.550	31.33
5,000.	373.70	0.9496	13.580	0.08127	382.22	-J*259.20	5.781	41.08
7,000.	373.84	0.9487	20.237	0.08121	242.47	-J*215.68	6.734	49.37
10,000.	374.07	0.9474	31.164	0.08114	207.87	-J*176.31	7.864	60.40
15,000.	374.53	0.9452	51.321	0.08106	176.61	-J*138.57	9.273	76.90
20,000.	375.07	0.9430	73.387	0.08099	158.99	-J*115.63	10.323	92.22
30,000.	375.39	0.9385	121.941	0.08089	139.78	-J*87.97	11.798	121.49
50,000.	379.95	0.9281	232.178	0.08075	123.51	-J*60.20	13.514	178.72
70,000.	384.68	0.9169	355.449	0.08065	116.60	-J*46.01	15.537	236.02
100,000.	393.78	0.9056	558.820	0.08053	111.82	-J*34.24	14.591	323.07
150,000.	416.90	0.8930	935.452	0.08038	108.56	-J*24.71	17.141	469.92
200,000.	447.11	0.8836	1348.793	0.08027	107.07	-J*20.01	18.784	617.30
300,000.	512.01	0.8672	2259.977	0.08010	105.40	-J*15.31	22.153	909.83
500,000.	639.17	0.8397	4332.104	0.07986	103.38	-J*11.44	28.821	1483.15
700,000.	750.06	0.8177	6651.430	0.07986	101.82	-J* 9.53	34.960	2045.42
1,000,000.	883.84	0.7927	10480.00	0.07986	100.09	-J*7.76	42.932	2872.91
1,500,000.	1068.09	0.7672	16181.359	0.07986	98.34	-J*6.16	54.107	4235.08
2,000,000.	1223.55	0.7512	22011.598	0.07986	97.24	-J*5.21	63.967	5584.79
3,000,000.	1484.58	0.7315	33940.115	0.07986	95.88	-J*4.06	81.401	8261.85
5,000,000.	1899.02	0.7105	58504.338	0.07986	94.44	-J*2.91	111.348	13565.25

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

26 GAUGE PIC CABLE AT 120. DEGREES F

FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI)	(DEG/MI)
1.	307.43	0.9935	0.000	0.08300	17173.07	-J*17163.43	0.078	0.51
5.	307.43	0.9935	0.001	0.08300	7679.95	-J*7678.80	0.174	1.15
10.	307.43	0.9935	0.002	0.08300	5430.72	-J*5427.44	0.246	1.62
15.	307.43	0.9935	0.003	0.08300	4434.34	-J*4431.31	0.301	1.99
20.	307.43	0.9935	0.004	0.08300	3840.43	-J*3837.46	0.348	2.29
30.	307.43	0.9935	0.005	0.08300	3135.98	-J*3132.98	0.426	2.81
50.	307.43	0.9935	0.008	0.08300	2429.59	-J*2426.33	0.550	3.63
70.	307.43	0.9935	0.011	0.08300	2053.78	-J*2050.23	0.650	5.29
100.	307.43	0.9935	0.016	0.08300	1718.83	-J*1714.83	0.777	5.13
150.	307.43	0.9934	0.022	0.08300	1404.12	-J*1399.46	0.951	6.29
200.	307.43	0.9934	0.028	0.08300	1216.62	-J*1211.36	1.098	4.37
300.	307.43	0.9934	0.040	0.08300	994.38	-J*988.08	1.343	8.91
500.	307.44	0.9933	0.063	0.08300	771.81	-J*763.83	1.730	11.53
700.	307.45	0.9932	0.084	0.08300	653.63	-J*644.26	2.043	13.61
1,000.	307.47	0.9931	0.115	0.08300	548.54	-J*537.40	2.435	16.39
1,500.	307.49	0.9928	0.164	0.08300	450.17	-J*436.59	2.967	20.17
2,000.	307.52	0.9925	0.210	0.08300	391.86	-J*376.21	3.409	23.41
3,000.	307.59	0.9921	0.299	0.08300	323.23	-J*304.12	4.134	28.87
5,000.	307.75	0.9912	0.466	0.08300	255.53	-J*230.94	5.231	38.17
7,000.	307.94	0.9902	0.625	0.08300	220.39	-J*191.37	6.069	46.09
10,000.	308.27	0.9889	0.853	0.08300	190.03	-J*155.53	7.046	56.77
15,000.	308.97	0.9866	1.213	0.08300	163.00	-J*121.15	8.233	73.05
20,000.	309.82	0.9843	1.558	0.08300	148.07	-J*100.30	9.089	88.48
30,000.	311.98	0.9796	2.217	0.08300	132.24	-J*75.39	10.247	118.53
50,000.	318.10	0.9649	3.458	0.08300	119.33	-J*51.11	11.580	178.26
70,000.	326.39	0.9535	4.634	0.08300	114.12	-J*39.17	12.424	238.68
100,000.	339.90	0.9417	6.320	0.08300	110.52	-J*29.48	13.359	330.23
150,000.	367.43	0.9273	8.993	0.08300	107.92	-J*21.76	14.791	483.67
200,000.	398.81	0.9166	11.550	0.08300	106.61	-J*17.93	16.252	637.08
300,000.	460.98	0.8978	16.436	0.08300	104.95	-J*14.03	19.084	940.75
500,000.	574.39	0.8678	25.633	0.08300	102.81	-J*10.71	24.275	1536.00
700,000.	669.04	0.8467	34.351	0.08300	101.40	-J*9.04	28.703	2120.94
1,000,000.	790.12	0.8273	46.849	0.08300	100.12	-J*7.56	34.293	2991.62
1,500,000.	955.50	0.8084	56.665	0.08300	98.89	-J*6.17	41.993	4432.05
2,000,000.	1094.84	0.7970	85.624	0.08300	98.14	-J*5.34	48.488	5864.55
3,000,000.	1328.44	0.7831	121.841	0.08300	97.23	-J*4.36	59.387	8715.85
5,000,000.	1698.58	0.7729	190.021	0.08300	96.56	-J*3.37	76.478	14425.81

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

24 GAUGE PULP CABLE AT 120. DEGREES F

FREQ (HZ)	R (OHMS/ MI)	L (MH/MI)	G (MU-MHO/ MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI) (DEG/MI)	
1.	307.43	0.9300	0.560	0.08540	18476.34	-J*7426.75	0.124	0.33
5.	307.43	0.9300	0.566	0.08535	8226.58	-J*6670.77	0.196	1.05
10.	307.43	0.9300	0.574	0.08533	5616.74	-J*5046.52	0.263	1.56
15.	307.43	0.9300	0.582	0.08531	4522.14	-J*4205.41	0.317	1.94
20.	307.43	0.9300	0.590	0.08530	3887.31	-J*3677.78	0.362	2.26
30.	307.43	0.9300	0.606	0.08528	3149.81	-J*3031.51	0.440	2.80
50.	307.43	0.9299	0.639	0.08525	2424.89	-J*2365.47	0.584	3.63
70.	307.43	0.9299	0.672	0.08523	2044.22	-J*2005.23	0.665	4.31
100.	307.43	0.9299	0.722	0.08521	1707.37	-J*1681.29	0.793	5.17
150.	307.43	0.9299	0.808	0.08518	1392.63	-J*1374.77	0.968	6.34
200.	307.44	0.9298	0.895	0.08516	1205.79	-J*1191.21	1.117	7.33
300.	307.44	0.9297	1.076	0.08512	984.85	-J*972.72	1.365	8.99
500.	307.45	0.9296	1.456	0.08507	764.07	-J*752.73	1.757	11.64
700.	307.47	0.9294	1.860	0.08504	646.97	-J*635.25	2.074	13.80
1,000.	307.49	0.9292	2.502	0.08500	542.90	-J*530.20	2.471	16.54
1,500.	307.53	0.9288	3.655	0.08495	445.51	-J*431.03	3.012	20.35
2,000.	307.57	0.9284	4.893	0.08491	387.76	-J*371.62	3.461	23.60
3,000.	307.67	0.9276	7.575	0.08485	319.78	-J*300.69	4.198	29.17
5,000.	307.89	0.9260	13.580	0.08477	252.62	-J*228.70	5.320	38.37
7,000.	308.14	0.9245	20.237	0.08471	217.70	-J*189.81	6.181	46.25
10,000.	308.57	0.9221	31.164	0.08464	187.44	-J*154.60	7.192	56.84
15.000.	309.44	0.9181	51.321	0.08456	160.35	-J*120.85	8.437	72.86
20,000.	310.48	0.9141	73.387	0.08449	145.26	-J*100.40	9.351	87.94
30,000.	313.05	0.9061	121.941	0.08439	129.04	-J*75.93	10.628	117.08
50,000.	320.02	0.8904	232.178	0.08425	115.61	-J*51.89	12.162	174.63
70,000.	329.14	0.8795	355.449	0.08415	110.13	-J*39.92	13.171	232.73
100,000.	343.77	0.8678	558.820	0.08403	100.31	-J*30.11	14.323	320.62
150,000.	372.85	0.8531	935.452	0.08388	1203.53	-J*22.19	16.081	467.75
200,000.	405.52	0.8420	1348.793	0.08377	102.13	-J*18.23	17.861	614.62
300,000.	469.90	0.8223	2259.977	0.08360	100.39	-J*14.15	21.334	904.52
500,000.	586.42	0.7908	4332.104	0.08336	98.15	-J*10.60	27.816	1470.11
700,000.	684.39	0.7686	6651.430	0.08336	96.58	-J*8.79	33.587	2025.50
1,000,000.	807.82	0.7479	10480.000	0.08336	95.13	-J*7.16	41.233	2850.55
1,500,000.	977.55	0.7275	16181.359	0.08336	93.71	-J*5.68	51.915	4212.81
2,000,000.	1120.56	0.7148	22011.598	0.08336	92.83	-J*4.79	61.324	5565.15
3,000,000.	1360.30	0.6992	33940.115	0.08336	91.74	-J*3.73	77.940	8252.09
5,000,000.	1740.17	0.6864	58504.338	0.08336	90.84	-J*2.54	106.297	13620.90

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

24 GAUGE PIC CABLE AT 70. DEGREES F

FREQ (HZ)	R (OHMS/ MI)	L (MH/MI)	G (MU-MH0/ MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI) (DEG/MI)	
1.	277.19	0.9861	0.000	0.08300	16306.82	-J*16297.63	0.074	0.49
5.	277.19	0.9861	0.001	0.08300	7292.58	-J*7288.57	0.165	1.09
10.	277.19	0.9861	0.002	0.08300	5156.83	-J*5153.61	0.234	1.54
15.	277.19	0.9861	0.003	0.08300	4210.72	-J*4207.71	0.286	1.89
20.	277.19	0.9861	0.004	0.08300	3646.77	-J*3643.81	0.330	2.18
30.	277.19	0.9861	0.005	0.08300	2977.38	-J*2974.85	0.404	2.67
50.	277.19	0.9861	0.008	0.08300	2307.15	-J*2303.82	0.522	3.45
70.	277.19	0.9861	0.011	0.08300	1950.32	-J*1946.67	0.617	4.08
100.	277.19	0.9861	0.016	0.08300	1632.29	-J*1632.29	0.738	4.88
150.	277.20	0.9860	0.022	0.08300	1333.50	-J*1328.66	0.903	5.98
200.	277.20	0.9860	0.028	0.08300	1155.49	-J*1150.02	1.042	6.90
300.	277.20	0.9860	0.040	0.08300	944.50	-J*937.95	1.275	8.46
500.	277.21	0.9859	0.063	0.08300	733.25	-J*724.93	1.642	10.95
700.	277.22	0.9858	0.084	0.08300	621.10	-J*611.32	1.939	12.99
1,000.	277.23	0.9857	0.115	0.08300	521.40	-J*509.77	2.310	15.58
1,500.	277.25	0.9854	0.164	0.08300	428.12	-J*413.93	2.813	19.18
2,000.	277.28	0.9852	0.210	0.08300	372.85	-J*356.50	3.230	22.28
3,000.	277.34	0.9848	0.299	0.08300	307.87	-J*287.90	3.913	27.59
5,000.	277.48	0.9839	0.466	0.08300	243.87	-J*218.18	4.942	36.43
7,000.	277.66	0.9829	0.625	0.08300	210.75	-J*180.44	5.723	44.07
10,000.	277.96	0.9816	0.853	0.08300	182.25	-J*146.22	6.625	54.45
15,000.	278.58	0.9793	1.213	0.08300	157.04	-J*113.38	7.706	70.38
20,000.	279.35	0.9770	1.558	0.08300	143.23	-J*93.49	8.472	85.59
30,000.	281.30	0.9723	2.217	0.08300	128.79	-J*69.79	9.487	115.44
50,000.	286.82	0.9577	3.458	0.08300	117.22	-J*46.91	10.628	175.12
70,000.	294.29	0.9464	4.634	0.08300	112.62	-J*35.78	11.351	235.56
100,000.	308.41	0.9347	6.320	0.08300	109.50	-J*27.00	12.235	327.18
150,000.	337.22	0.9204	8.993	0.08300	107.21	-J*20.10	13.665	480.49
200,000.	369.03	0.9087	11.550	0.08300	105.96	-J*16.69	15.131	633.20
300,000.	431.55	0.8885	16.436	0.08300	104.31	-J*13.22	17.975	935.01
500,000.	541.69	0.8570	25.633	0.08300	102.12	-J*10.17	23.048	1525.69
700,000.	632.08	0.8350	34.351	0.08300	100.67	-J*8.60	27.284	2105.53
1,000,000.	746.04	0.8146	46.849	0.08300	99.33	-J*6.20	32.639	2967.99
1,500,000.	902.84	0.7947	66.665	0.08300	98.03	-J*5.88	40.026	4393.68
2,000,000.	1035.03	0.7825	85.624	0.08300	97.23	-J*5.10	46.267	5810.54
3,000,000.	1256.77	0.7676	121.841	0.08300	96.26	-J*4.17	56.753	8628.57
5,000,000.	1608.38	0.7523	190.021	0.08300	95.26	-J*3.23	73.405	14231.83

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

24 GAUGE PULP CABLE AT 70. DEGREES F

FREQ (HZ)	R (OHMS/ MI)	L (MH/MI)	G (MU-MH0/ MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI)	(DEG/MI)
1.	277.19	0.9231	0.560	0.08540	17544.33	-J*7052.10	0.118	0.31
5.	277.19	0.9231	0.566	0.08535	7811.63	-J*6334.24	0.186	0.99
10.	277.19	0.9231	0.574	0.08533	5333.46	-J*4791.90	0.250	1.48
15.	277.19	0.9230	0.582	0.08531	4294.08	-J*3993.21	0.301	1.85
20.	277.19	0.9230	0.590	0.08530	3691.29	-J*3192.19	0.344	2.15
30.	277.19	0.9230	0.606	0.08528	2991.00	-J*2878.50	0.418	2.65
50.	277.19	0.9230	0.639	0.08525	2302.67	-J*2245.03	0.535	3.45
70.	277.20	0.9230	0.672	0.08523	1941.23	-J*1903.95	0.631	4.10
100.	277.20	0.9230	0.722	0.08521	1621.40	-J*1596.33	0.752	4.91
150.	277.20	0.9229	0.808	0.08518	1322.57	-J*1305.23	0.919	6.02
200.	277.20	0.9229	0.895	0.08516	1145.18	-J*1130.90	1.060	6.95
300.	277.21	0.9228	1.076	0.08512	935.44	-J*923.38	1.296	8.64
500.	277.22	0.9227	1.456	0.08507	725.87	-J*714.42	1.668	11.06
700.	277.23	0.9225	1.860	0.08504	614.75	-J*602.81	1.968	13.11
1,000.	277.25	0.9223	2.502	0.08500	516.01	-J*502.97	2.344	15.72
1,500.	277.29	0.9219	3.655	0.08495	423.64	-J*408.70	2.856	19.35
2,000.	277.32	0.9215	4.893	0.08491	368.90	-J*352.20	3.280	22.45
3,000.	277.41	0.9207	7.575	0.08485	304.51	-J*284.70	3.975	27.78
5,000.	277.61	0.9192	13.580	0.08477	241.02	-J*216.13	5.028	36.61
7,000.	277.83	0.9176	20.237	0.08471	208.07	-J*179.05	5.831	44.21
10,000.	278.23	0.9152	31.164	0.08464	179.64	-J*145.43	6.767	54.48
15,000.	279.01	0.9113	51.321	0.08456	154.33	-J*113.20	7.905	70.13
20,000.	279.95	0.9073	73.387	0.08449	140.34	-J*93.67	8.728	84.98
30,000.	282.27	0.8993	121.941	0.08439	125.48	-J*70.38	9.857	113.87
50,000.	288.54	0.8837	232.178	0.08425	113.39	-J*44.66	11.187	171.31
70,000.	296.77	0.8729	355.449	0.08415	108.54	-J*36.46	12.061	229.41
100,000.	311.93	0.8613	558.820	0.08403	105.22	-J*27.56	13.148	317.41
150,000.	342.20	0.8468	935.452	0.08388	102.78	-J*20.47	14.893	464.47
200,000.	375.24	0.8348	1348.793	0.08377	101.47	-J*16.93	16.672	610.69
300,000.	439.90	0.8138	2259.977	0.08360	99.75	-J*13.29	20.149	898.87
500,000.	553.04	0.7810	4332.104	0.08336	97.48	-J*10.03	26.493	1460.14
700,000.	645.81	0.7579	6651.430	0.08336	95.87	-J*8.32	32.046	2010.68
1,000,000.	762.77	0.7364	10480.000	0.08336	94.37	-J*6.78	39.419	2827.95
1,500,000.	923.69	0.7151	16181.359	0.08336	92.89	-J*5.38	49.736	4175.28
2,000,000.	1059.34	0.7018	22011.598	0.08336	91.97	-J*4.53	58.839	5513.86
3,000,000.	1286.91	0.6854	33940.115	0.08336	90.82	-J*3.53	74.945	8169.52
5,000,000.	1647.76	0.6581	58504.338	0.08326	89.61	-J*2.51	102.642	13437.76

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

24 GAUGE PIC CABLE AT 0. DEGREES F

FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MH0/MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI)	(DEG/MI)
1.	234.87	0.9758	0.000	0.08300	15010.30	-J*15001.78	0.068	0.45
5.	234.87	0.9758	0.001	0.08300	6712.82	-J*6709.00	0.152	1.00
10.	234.87	0.9758	0.002	0.08300	4746.90	-J*4743.76	0.215	1.42
15.	234.87	0.9758	0.003	0.08300	3876.04	-J*3873.05	0.263	1.74
20.	234.87	0.9758	0.004	0.08300	3356.95	-J*3353.96	0.304	2.01
30.	234.87	0.9758	0.005	0.08300	2741.27	-J*2738.17	0.372	2.46
50.	234.87	0.9757	0.008	0.08300	2123.91	-J*2120.45	0.480	3.17
70.	234.87	0.9757	0.011	0.08300	1795.49	-J*1791.65	0.568	3.75
100.	234.87	0.9757	0.016	0.08300	1502.79	-J*1498.43	0.679	4.49
150.	234.87	0.9757	0.022	0.08300	1227.82	-J*1222.68	0.831	5.50
200.	234.87	0.9757	0.028	0.08300	1064.01	-J*1058.19	0.959	6.36
300.	234.87	0.9756	0.040	0.08300	869.90	-J*862.89	1.173	7.80
500.	234.88	0.9755	0.063	0.08300	675.58	-J*666.66	1.510	10.09
700.	234.89	0.9755	0.084	0.08300	572.47	-J*561.98	1.782	11.97
1,000.	234.90	0.9753	0.115	0.08300	480.45	-J*468.36	2.122	14.36
1,500.	234.92	0.9751	0.164	0.08300	395.19	-J*379.95	2.582	17.71
2,000.	234.94	0.9749	0.210	0.08300	344.49	-J*325.93	2.962	20.58
3,000.	234.99	0.9744	0.299	0.08300	284.95	-J*263.52	3.582	25.54
5,000.	235.11	0.9735	0.466	0.08300	226.58	-J*198.97	4.507	33.85
7,000.	235.26	0.9726	0.625	0.08300	196.51	-J*163.97	5.200	41.10
10,000.	235.51	0.9713	0.853	0.08300	170.82	-J*132.18	5.989	51.04
15.000.	236.04	0.9690	1.213	0.08300	148.38	-J*101.67	6.910	66.50
20,000.	236.69	0.9667	1.558	0.08300	136.31	-J*83.24	7.543	81.45
30,000.	238.35	0.9621	2.217	0.08300	123.97	-J*61.44	8.351	111.12
50,000.	243.03	0.9476	3.458	0.08300	114.36	-J*40.74	9.231	170.85
70,000.	249.35	0.9365	4.634	0.08300	110.62	-J*30.87	9.792	231.37
100,000.	264.34	0.9249	6.320	0.08300	108.13	-J*23.43	10.620	323.09
150,000.	294.92	0.9107	8.993	0.08300	106.24	-J*17.74	12.060	476.17
200,000.	327.32	0.8976	11.550	0.08300	105.06	-J*14.93	13.536	627.84
300,000.	390.34	0.8756	16.436	0.08300	103.42	-J*12.06	16.400	927.00
500,000.	495.92	0.8419	25.633	0.08300	101.15	-J*9.40	21.303	1511.20
700,000.	579.22	0.8136	34.351	0.08300	99.63	-J*7.96	25.264	2083.81
1,000,000.	684.34	0.7969	46.849	0.08300	98.21	-J*6.68	30.281	2934.63
1,500,000.	829.13	0.7756	65.665	0.08300	96.82	-J*5.47	37.219	4339.44
2,000,000.	951.29	0.7623	85.624	0.08300	95.95	-J*4.75	43.093	5734.12
3,000,000.	1156.42	0.7459	121.841	0.08300	94.88	-J*3.89	52.982	8505.14
5,000,000.	1482.09	0.7235	190.021	0.08300	93.41	-J*3.04	66.983	13955.74

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

22 GAUGE PIC CABLE AT 120. DEGREES F

FREQ (HZ)	R (OHMS/ MI)	L (MH/MI)	G (MU-MH0/ MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI)	(DEG/MI)
1.	193.28	0.9935	0.000	0.08300	13614.46	-J*13610.95	0.062	0.41
5.	193.28	0.9935	0.001	0.08300	6088.90	-J*6086.67	0.138	0.91
10.	193.28	0.9935	0.001	0.08300	4305.83	-J*4303.60	0.195	1.29
15.	193.28	0.9935	0.001	0.08300	3515.97	-J*3513.60	0.239	1.58
20.	193.28	0.9935	0.002	0.08300	3045.16	-J*3042.63	0.276	1.82
30.	193.28	0.9935	0.003	0.08300	2486.76	-J*2483.90	0.338	2.23
50.	193.28	0.9935	0.005	0.08300	1926.86	-J*1923.41	0.436	2.88
70.	193.28	0.9935	0.006	0.08300	1629.02	-J*1625.06	0.515	3.41
100.	193.28	0.9935	0.009	0.08300	1363.59	-J*1358.97	0.616	4.07
150.	193.28	0.9934	0.013	0.08300	1114.27	-J*1108.70	0.753	4.99
200.	193.28	0.9934	0.017	0.08300	965.77	-J*959.40	0.869	5.77
300.	193.29	0.9934	0.024	0.08300	789.83	-J*782.09	1.063	7.08
500.	193.29	0.9932	0.040	0.08300	613.79	-J*603.87	1.368	9.17
700.	193.30	0.9931	0.054	0.08300	520.43	-J*508.73	1.613	10.88
1,000.	193.32	0.9930	0.076	0.08300	437.56	-J*423.60	1.919	13.07
1,500.	193.35	0.9927	0.110	0.08300	360.18	-J*343.12	2.332	16.14
2,000.	193.39	0.9924	0.145	0.08300	314.47	-J*294.80	2.671	18.79
3,000.	193.47	0.9918	0.211	0.08300	260.96	-J*236.93	3.220	23.39
5,000.	193.66	0.9906	0.341	0.08300	208.77	-J*177.87	4.029	31.19
7,000.	193.90	0.9895	0.467	0.08300	182.16	-J*145.79	4.623	38.10
10,000.	194.33	0.9877	0.652	0.08300	159.72	-J*116.65	5.285	47.72
15,000.	195.26	0.9847	0.954	0.08300	140.54	-J*88.80	6.035	62.99
20,000.	196.43	0.9817	1.248	0.08300	130.52	-J*72.14	6.537	77.99
30,000.	199.48	0.9744	1.284	0.08300	120.57	-J*52.87	7.186	108.07
50,000.	208.10	0.9762	2.943	0.08300	112.99	-J*35.31	8.000	168.81
70,000.	217.24	0.9443	4.032	0.08300	110.04	-J*27.03	8.575	230.15
100,000.	234.48	0.9309	5.630	0.08300	107.93	-J*20.82	9.437	322.50
150,000.	266.20	0.9141	8.229	0.08300	106.16	-J*16.02	10.894	475.81
200,000.	296.40	0.8993	10.772	0.08300	104.97	-J*13.53	12.268	627.29
300,000.	353.55	0.8749	15.744	0.08300	103.25	-J*10.94	14.878	925.52
500,000.	446.65	0.8430	25.396	0.08300	101.14	-J*8.46	19.191	1510.96
700,000.	522.27	0.8252	34.796	0.08300	99.97	-J*7.15	22.704	2090.95
1,000,000.	617.56	0.8090	48.587	0.08300	98.91	-J*5.98	27.138	2955.28
1,500,000.	748.59	0.7933	71.014	0.08300	97.88	-J*4.88	33.244	4387.17
2,000,000.	858.98	0.7838	92.958	0.08300	97.27	-J*4.23	38.391	5812.92
3,000,000.	1144.05	0.7759	135.865	0.08300	96.75	-J*3.44	46.925	8672.28
5,000,000.	1337.29	0.7585	219.158	0.08300	96.26	-J*2.66	60.427	14381.09

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

22 GAUGE PULP CABLE AT 120. DEGREES F

FREQ (HZ)	R (OHMS/ MI)	L (MH/MI)	G (MU-MH0/ MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI) (DEG/MI)	
1.	193.28	0.9201	0.560	0.08540	14649.91	-J*5888.58	0.099	0.26
5.	193.28	0.9201	0.566	0.08535	6523.00	-J*5289.08	0.155	0.83
10.	193.28	0.9201	0.574	0.08533	4453.73	-J*4001.14	0.209	1.24
15.	193.28	0.9201	0.582	0.08531	3585.88	-J*3334.17	0.251	1.54
20.	193.28	0.9201	0.590	0.08530	3082.57	-J*2915.78	0.287	1.79
30.	193.28	0.9201	0.606	0.08528	2497.88	-J*2403.28	0.349	2.22
50.	193.28	0.9201	0.639	0.08525	1923.21	-J*1875.06	0.447	2.88
70.	193.28	0.9200	0.672	0.08523	1621.48	-J*1589.33	0.527	3.42
100.	193.28	0.9200	0.722	0.08521	1354.51	-J*1332.37	0.628	4.10
150.	193.28	0.9200	0.808	0.08518	1105.12	-J*1089.16	0.767	5.03
200.	193.29	0.9199	0.895	0.08516	957.11	-J*943.48	0.884	5.82
300.	193.29	0.9198	1.076	0.08512	782.18	-J*770.01	1.080	7.14
500.	193.31	0.9196	1.456	0.08507	607.49	-J*595.23	1.389	9.25
700.	193.32	0.9194	1.860	0.08504	514.96	-J*501.80	1.639	10.98
1,000.	193.35	0.9190	2.502	0.08500	432.84	-J*418.14	1.949	13.18
1,500.	193.40	0.9185	3.655	0.08495	356.17	-J*339.03	2.369	16.27
2,000.	193.45	0.9180	4.893	0.08491	310.85	-J*291.53	2.715	18.92
3,000.	193.56	0.9169	7.575	0.08485	257.76	-J*234.65	3.277	23.52
5,000.	193.83	0.9147	13.580	0.08477	205.84	-J*176.66	4.111	31.27
7,000.	194.15	0.9126	20.237	0.08471	179.26	-J*145.18	4.730	38.10
10,000.	194.71	0.9093	31.164	0.08464	156.70	-J*116.61	5.429	47.54
15,000.	195.85	0.9038	51.321	0.08456	137.20	-J*89.31	6.243	62.38
20,000.	197.26	0.8983	73.387	0.08449	126.82	-J*72.96	6.809	76.84
30,000.	200.80	0.8671	121.941	0.08439	116.26	-J*53.94	7.575	105.59
50,000.	210.36	0.8702	232.178	0.08425	108.24	-J*36.29	8.562	163.66
70,000.	220.31	0.8587	355.449	0.08415	105.06	-J*27.86	9.281	222.21
100,000.	238.57	0.8454	558.820	0.08403	102.80	-J*21.46	10.339	310.29
150,000.	271.68	0.8280	935.452	0.08388	100.90	-J*16.45	12.114	456.17
200,000.	303.09	0.8127	1348.793	0.08377	99.64	-J*13.82	13.806	599.90
300,000.	361.99	0.7871	2259.977	0.08360	97.82	-J*11.05	17.044	881.75
500,000.	457.89	0.7535	4332.104	0.08336	95.58	-J*8.36	22.617	1432.10
700,000.	535.80	0.7344	6651.430	0.08336	94.24	-J*6.90	27.428	1977.09
1,000,000.	633.96	0.7166	10480.000	0.08336	93.00	-J*5.58	33.853	2787.50
1,500,000.	768.93	0.6991	16181.359	0.08336	91.78	-J*4.39	42.851	4127.08
2,000,000.	882.64	0.6883	22044.598	0.08336	91.02	-J*3.67	50.830	5458.27
3,000,000.	1073.29	0.6779	33940.115	0.08336	90.29	-J*2.81	64.949	8122.70
5,000,000.	1375.35	0.6674	58504.338	0.08336	89.54	-J*1.93	89.469	13428.78

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

22 GAUGE PIC CABLE AT 70. DEGREES F

FREQ (HZ)	R (OHMS/ MI)	L (MH/MI)	G (MU-MH0/ MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI)	(DEG/MI)
1.	174.27	0.9861	0.000	0.08300	12927.71	-J*12924.34	0.059	0.39
5.	174.27	0.9861	0.001	0.08300	5781.80	-J*5779.59	0.131	0.86
10.	174.27	0.9861	0.001	0.08300	4088.69	-J*4086.44	0.185	1.22
15.	174.27	0.9861	0.001	0.08300	3338.69	-J*3336.28	0.227	1.50
20.	174.27	0.9861	0.002	0.08300	2891.65	-J*2889.05	0.262	1.73
30.	174.27	0.9861	0.003	0.08300	2361.43	-J*2358.49	0.321	2.12
50.	174.27	0.9861	0.005	0.08300	1829.81	-J*1826.24	0.414	2.73
70.	174.27	0.9861	0.006	0.08300	1547.02	-J*1542.91	0.489	3.24
100.	174.27	0.9861	0.009	0.08300	1295.02	-J*1290.21	0.585	3.87
150.	174.27	0.9860	0.013	0.08300	1058.32	-J*1052.52	0.715	4.74
200.	174.27	0.9860	0.017	0.08300	917.35	-J*910.71	0.825	5.48
300.	174.28	0.9860	0.024	0.08300	750.35	-J*742.28	1.009	6.73
500.	174.29	0.9858	0.040	0.08300	583.30	-J*572.94	1.298	8.71
700.	174.29	0.9857	0.054	0.08300	494.74	-J*482.52	1.530	10.35
1,000.	174.31	0.9856	0.076	0.08300	416.16	-J*401.58	1.819	12.43
1,500.	174.34	0.9853	0.110	0.08300	342.84	-J*325.02	2.209	15.36
2,000.	174.37	0.9850	0.145	0.08300	299.57	-J*279.02	2.528	17.90
3,000.	174.44	0.9844	0.211	0.08300	249.00	-J*223.89	3.043	22.32
5,000.	174.62	0.9833	0.341	0.08300	199.83	-J*167.56	3.796	29.85
7,000.	174.83	0.9821	0.467	0.08300	174.89	-J*136.92	4.342	36.58
10,000.	175.22	0.9804	0.652	0.08300	154.00	-J*109.09	4.942	46.01
15,000.	176.06	0.9774	0.954	0.08300	136.34	-J*82.53	5.609	61.10
20,000.	177.11	0.9744	1.248	0.08300	127.25	-J*66.72	6.045	76.04
30,000.	179.86	0.9672	1.824	0.08300	118.37	-J*48.55	6.600	106.10
50,000.	187.64	0.9491	2.943	0.08300	111.68	-J*32.21	7.298	166.85
70,000.	197.71	0.9372	4.032	0.08300	109.12	-J*24.81	7.871	228.24
100,000.	215.55	0.9237	5.630	0.08300	107.24	-J*19.27	8.732	320.43
150,000.	247.57	0.9055	8.229	0.08300	105.52	-J*14.99	10.193	472.95
200,000.	277.95	0.8898	10.772	0.08300	104.33	-J*12.77	11.575	623.45
300,000.	333.39	0.8642	15.744	0.08300	102.56	-J*10.38	14.124	919.38
500,000.	421.57	0.8309	25.396	0.08300	100.38	-J*8.05	18.250	1499.65
700,000.	493.24	0.8123	34.796	0.08300	99.16	-J*6.81	21.617	2074.02
1,000,000.	583.59	0.7950	48.587	0.08300	98.04	-J*5.70	25.873	2929.37
1,500,000.	707.91	0.7783	71.014	0.08300	96.95	-J*4.66	31.742	4345.26
2,000,000.	812.72	0.7681	92.958	0.08300	96.26	-J*4.04	36.698	5753.82
3,000,000.	988.53	0.7557	135.865	0.08300	95.48	-J*3.30	45.021	3558.60
5,000,000.	1267.31	0.7429	219.158	0.08300	94.64	-J*2.56	58.244	14139.61

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

26 GAUGE PULP CABLE AT 70. DEGREES F

FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI)	(DEG/MI)
1.	174.27	0.9133	0.560	0.08540	13910.92	-J*5591.52	0.094	0.25
5.	174.27	0.1331	0.566	0.08535	6193.99	-J*5022.23	0.147	0.79
10.	174.27	0.9133	0.574	0.08533	4229.12	-J*3799.25	0.198	1.17
15.	174.27	0.9133	0.582	0.08531	3405.06	-J*3165.91	0.238	1.46
20.	174.27	0.9132	0.590	0.08530	2927.15	-J*2768.61	0.273	1.70
30.	174.27	0.9132	0.606	0.08528	2371.98	-J*2281.94	0.321	2.11
50.	174.27	0.9132	0.639	0.08525	1826.33	-J*1780.34	0.424	2.74
70.	174.27	0.9132	0.672	0.08523	1539.84	-J*1509.00	0.500	3.25
100.	174.27	0.9132	0.722	0.08521	1286.38	-J*1264.96	0.596	3.88
150.	174.28	0.9131	0.808	0.08518	1049.61	-J*1033.98	0.728	4.79
200.	174.28	0.9131	0.895	0.08516	909.11	-J*895.62	0.840	5.53
300.	174.28	0.9130	1.076	0.08512	743.05	-J*730.84	1.025	6.79
500.	174.30	0.9127	1.456	0.08507	577.28	-J*564.78	1.318	8.79
700.	174.31	0.9125	1.860	0.08504	489.50	-J*475.98	1.554	10.44
1,000.	174.33	0.9122	2.502	0.08500	411.62	-J*396.45	1.848	12.54
1,500.	174.38	0.9117	3.655	0.08495	338.96	-J*321.20	2.244	15.48
2,000.	174.42	0.9111	4.893	0.08491	296.06	-J*275.99	2.570	18.02
3,000.	174.53	0.9101	7.575	0.08485	245.85	-J*221.81	3.098	22.43
5,000.	174.77	0.9079	13.580	0.08477	196.90	-J*166.51	3.875	29.91
7,000.	175.03	0.9058	20.237	0.08471	171.95	-J*136.45	4.446	36.55
10,000.	175.56	0.9025	31.164	0.08464	150.91	-J*109.16	5.083	45.79
15,000.	176.59	0.8971	51.321	0.08456	132.89	-J*83.12	5.812	60.43
20,000.	177.86	0.8916	73.387	0.08449	123.42	-J*67.57	6.310	74.80
30,000.	181.05	0.8805	121.941	0.08439	113.93	-J*49.60	6.973	103.49
50,000.	189.68	0.8637	232.178	0.08425	106.82	-J*33.12	7.829	161.56
70,000.	200.51	0.8523	355.449	0.08415	104.08	-J*25.56	8.537	220.19
100,000.	219.32	0.8389	558.820	0.08403	102.07	-J*19.83	9.588	308.14
150,000.	252.66	0.8203	935.452	0.08388	100.26	-J*15.36	11.362	453.31
200,000.	284.22	0.8041	1348.793	0.08377	99.00	-J*13.01	13.058	596.12
300,000.	341.35	0.7775	2259.977	0.08360	97.15	-J*10.46	16.224	875.82
500,000.	432.18	0.7427	4332.104	0.08336	94.86	-J*7.92	21.584	1421.29
700,000.	506.01	0.7229	6651.430	0.08336	93.47	-J*6.54	26.224	1961.02
1,000,000.	599.08	0.7043	10480.000	0.08336	92.18	-J*5.29	32.435	2763.00
1,500,000.	727.15	0.6859	16181.359	0.08336	90.89	-J*4.16	41.144	4087.62
2,000,000.	835.11	0.6745	22011.598	0.08336	90.09	-J*3.48	48.882	5402.74
3,000,000.	1016.21	0.6603	33940.115	0.08336	89.10	-J*2.67	62.677	8016.21
5,000,000.	1303.38	0.6452	58504.338	0.08336	88.04	-J*1.84	86.675	13203.32

Channel Interface Specification

Cable Characteristics 1 Hz to 5 MHz

22 GAUGE PULP CABLE AT 0. DEGREES F

FREQ (HZ)	R (OHMS/ MI)	L (MH/MI)	G (MU-MHO/ MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI)	(DEG/MI)
1.	147.66	0.9037	0.560	0.08540	12804.89	-J*5146.91	0.086	0.23
5.	147.66	0.9037	0.566	0.08535	5701.58	-J*4622.83	0.136	0.73
10.	147.66	0.9037	0.574	0.08533	3892.97	-J*3497.06	0.182	1.08
15.	147.66	0.9037	0.582	0.08531	3134.45	-J*2914.06	0.219	1.35
20.	147.66	0.9037	0.590	0.08530	2694.56	-J*2548.33	0.251	1.57
30.	147.66	0.9037	0.606	0.08528	2183.56	-J*2100.32	0.305	1.94
50.	147.66	0.9036	0.639	0.08525	1681.34	-J*1638.55	0.391	2.52
70.	147.66	0.9036	0.672	0.08523	1417.68	-J*1388.75	0.460	2.99
100.	147.66	0.9036	0.722	0.08521	1184.42	-J*1164.06	0.549	3.58
150.	147.66	0.9035	0.808	0.08518	956.55	-J*951.37	0.570	4.40
200.	147.67	0.9035	0.895	0.08516	837.28	-J*823.95	0.772	5.09
300.	147.67	0.9034	1.076	0.08512	684.54	-J*672.17	0.943	6.25
500.	147.68	0.9032	1.456	0.08507	532.11	-J*519.15	1.212	8.11
700.	147.69	0.9029	1.860	0.08504	451.45	-J*437.29	1.428	9.63
1,000.	147.71	0.9026	2.502	0.08500	379.94	-J*363.92	1.696	11.57
1,500.	147.75	0.9021	3.655	0.08495	313.30	-J*294.44	2.057	14.31
2,000.	147.79	0.9016	4.893	0.08491	274.01	-J*252.65	2.353	16.68
3,000.	147.88	0.9005	7.575	0.08485	228.16	-J*202.50	2.828	20.82
5,000.	148.08	0.8984	13.580	0.08477	183.69	-J*151.20	3.519	27.91
7,000.	148.32	0.8963	20.237	0.08471	161.23	-J*123.28	4.018	34.27
10,000.	148.75	0.8931	31.164	0.08464	142.49	-J*97.93	4.562	43.24
15,000.	149.63	0.8877	51.321	0.08456	126.75	-J*73.80	5.165	57.66
20,000.	150.70	0.8822	73.387	0.08449	118.66	-J*59.50	5.563	71.93
30,000.	153.40	0.8712	121.941	0.08439	110.73	-J*43.18	6.084	100.62
50,000.	160.71	0.8547	232.178	0.08425	104.93	-J*28.51	6.765	158.74
70,000.	172.78	0.8434	355.449	0.08415	102.77	-J*22.24	7.468	217.47
100,000.	192.36	0.8298	558.820	0.08403	101.09	-J*17.50	8.517	305.23
150,000.	226.04	0.8094	935.452	0.08388	99.36	-J*13.81	10.291	449.33
200,000.	257.80	0.7921	1348.793	0.08377	98.11	-J*11.86	11.995	590.84
300,000.	312.47	0.7640	2259.977	0.08360	96.22	-J*9.62	15.057	867.48
500,000.	396.18	0.7276	4332.104	0.08336	93.83	-J*7.29	20.113	1406.07
700,000.	464.30	0.7067	6651.430	0.08336	92.38	-J*6.02	24.507	1938.33
1,000,000.	550.26	0.6871	10480.000	0.08336	91.02	-J*4.86	30.411	2728.38
1,500,000.	668.65	0.6675	16181.359	0.08336	89.65	-J*3.83	38.704	4031.75
2,000,000.	768.55	0.6551	22011.598	0.08336	88.77	-J*3.20	46.096	5324.06
3,000,000.	936.29	0.6357	33940.115	0.08336	87.41	-J*2.47	59.413	7864.73
5,000,000.	1202.61	0.6141	58504.338	0.08336	85.89	-J*1.71	82.642	12881.04

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

22 GAUGE PIC CABLE AT 0. DEGREES F

FREQ (HZ)	R (OHMS/ MI)	L (MH/MI)	G (MU-MH0/ MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI)	(DEG/MI)
1.	147.66	0.9758	0.000	0.08300	11899.87	-J*11896.69	0.054	0.36
5.	147.66	0.9758	0.001	0.08300	5322.17	-J*5319.98	0.121	0.79
10.	147.66	0.9758	0.001	0.08300	3763.72	-J*3761.42	0.170	1.12
15.	147.66	0.9758	0.001	0.08300	3073.37	-J*3070.88	0.209	1.38
20.	147.66	0.9758	0.002	0.08300	2661.89	-J*2659.19	0.241	1.59
30.	147.66	0.9758	0.003	0.08300	2173.87	-J*2170.77	0.295	1.95
50.	147.66	0.9758	0.005	0.08300	1684.57	-J*1680.78	0.381	2.52
70.	147.66	0.9757	0.006	0.08300	1424.31	-J*1419.94	0.450	2.98
100.	147.66	0.9757	0.009	0.08300	1192.41	-J*1187.27	0.538	3.56
150.	147.66	0.9757	0.013	0.08300	974.61	-J*968.40	0.658	4.37
200.	147.66	0.9757	0.017	0.08300	844.92	-J*837.80	0.759	5.05
300.	147.67	0.9756	0.024	0.08300	691.31	-J*682.65	0.928	6.20
500.	147.67	0.9755	0.040	0.08300	537.72	-J*526.60	1.193	8.03
700.	147.68	0.9754	0.054	0.08300	456.36	-J*443.23	1.406	9.54
1,000.	147.69	0.9752	0.076	0.08300	384.21	-J*368.55	1.670	11.48
1,500.	147.72	0.9749	0.110	0.08300	317.00	-J*297.85	2.024	14.21
2,000.	147.74	0.9747	0.145	0.08300	277.40	-J*255.32	2.313	16.58
3,000.	147.80	0.9741	0.211	0.08300	231.24	-J*204.27	2.776	20.73
5,000.	147.95	0.9729	0.341	0.08300	186.64	-J*152.00	3.443	27.88
7,000.	148.13	0.9718	0.467	0.08300	164.24	-J*123.53	3.918	34.35
10,000.	148.47	0.9701	0.652	0.08300	145.71	-J*97.68	4.426	43.54
15,000.	149.17	0.9671	0.954	0.08300	130.39	-J*73.12	4.969	58.44
20,000.	150.07	0.9642	1.248	0.08300	122.70	-J*58.62	5.312	73.32
30,000.	152.39	0.9570	1.824	0.08300	115.38	-J*42.20	5.737	103.42
50,000.	158.98	0.9391	2.943	0.08300	109.93	-J*27.73	6.283	164.23
70,000.	170.37	0.9274	4.032	0.08300	107.90	-J*21.62	5.860	225.67
100,000.	189.06	0.9137	5.630	0.08300	106.30	-J*17.05	7.727	317.62
150,000.	221.48	0.8935	8.229	0.08300	104.64	-J*13.52	9.196	468.97
200,000.	252.11	0.8765	10.772	0.08300	103.43	-J*11.68	10.591	618.07
300,000.	305.18	0.8492	15.744	0.08300	101.60	-J*9.59	13.052	910.76
500,000.	386.45	0.8140	25.396	0.08300	99.31	-J*7.46	16.911	1483.70
700,000.	452.58	0.7941	34.796	0.08300	98.02	-J*6.32	20.068	2050.12
1,000,000.	536.03	0.7755	48.587	0.08300	96.81	-J*5.30	24.067	2892.73
1,500,000.	650.97	0.7574	71.014	0.08300	95.63	-J*4.35	29.594	4285.93
2,000,000.	747.95	0.7460	92.958	0.08300	94.88	-J*3.77	34.274	5670.06
3,000,000.	910.79	0.7275	135.865	0.08300	93.67	-J*3.10	42.282	8396.87
5,000,000.	1169.33	0.7071	219.158	0.08300	92.33	-J*2.42	55.088	13794.46

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

19 GAUGE PIC CABLE AT 120. DEGREES F

FREQ (HZ)	R (OHMS/ MI)	L (MH/MI)	G (MU-MH0/ MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI)	(DEG/MI)
1.	96.42	0.9935	0.000	0.08300	9617.43	-J*9612.55	0.044	0.29
5.	96.42	0.9935	0.001	0.08300	4301.53	-J*4298.38	0.097	0.64
10.	96.42	0.9935	0.002	0.08300	3042.12	-J*3038.94	0.138	0.91
15.	96.42	0.9935	0.003	0.08300	2484.27	-J*2480.89	0.169	1.11
20.	96.42	0.9935	0.004	0.08300	2151.79	-J*2148.18	0.195	1.29
30.	96.42	0.9935	0.006	0.08300	1757.49	-J*1753.42	0.238	1.57
50.	96.43	0.9935	0.010	0.08300	1362.23	-J*1357.32	0.308	2.03
70.	96.43	0.9935	0.013	0.08300	1152.04	-J*1146.41	0.364	2.41
100.	96.43	0.9934	0.019	0.08300	964.80	-J*958.23	0.434	2.88
150.	96.43	0.9934	0.027	0.08300	789.04	-J*781.14	0.531	3.54
200.	96.43	0.9934	0.036	0.08300	684.44	-J*675.40	0.612	4.09
300.	96.44	0.9933	0.053	0.08300	560.66	-J*549.70	0.747	5.02
500.	96.45	0.9931	0.087	0.08300	437.13	-J*423.08	0.959	6.53
700.	96.46	0.9930	0.120	0.08300	371.86	-J*355.28	1.127	7.78
1,000.	96.48	0.9927	0.168	0.08300	314.17	-J*294.42	1.334	9.38
1,500.	96.52	0.9923	0.247	0.08300	260.73	-J*236.61	1.608	11.68
2,000.	96.57	0.9919	0.325	0.08300	229.49	-J*201.71	1.828	13.71
3,000.	96.67	0.9911	0.479	0.08300	193.51	-J*159.65	2.170	17.34
5,000.	96.95	0.9894	0.780	0.08300	159.65	-J*116.44	2.638	23.85
7,000.	97.31	0.9877	1.075	0.08300	143.35	-J*92.97	2.949	29.98
10,000.	98.00	0.9850	1.511	0.08300	130.57	-J*71.95	3.261	39.01
15,000.	99.53	0.9805	2.225	0.08300	120.79	-J*52.65	3.580	54.13
20,000.	101.49	0.9758	2.927	0.08300	116.24	-J*41.84	3.794	69.46
30,000.	105.97	0.9603	4.310	0.08300	111.75	-J*30.29	4.120	100.17
50,000.	117.05	0.9400	7.017	0.08300	108.42	-J*20.69	4.692	161.97
70,000.	129.74	0.9255	9.672	0.08300	106.90	-J*16.61	5.275	223.58
100,000.	148.00	0.9067	13.593	0.08300	105.39	-J*13.45	6.105	314.88
150,000.	176.56	0.8815	20.012	0.08300	103.63	-J*10.88	7.409	464.45
200,000.	201.29	0.8622	26.332	0.08300	102.36	-J*9.41	8.552	611.69
300,000.	242.74	0.8385	38.769	0.08300	100.81	-J*7.68	10.475	903.61
500,000.	308.42	0.8137	63.114	0.08300	99.19	-J*5.95	13.531	1481.89
700,000.	361.77	0.8000	87.003	0.08300	98.31	-J*5.03	16.019	2056.18
1,000,000.	429.00	0.7877	122.267	0.08300	97.51	-J*4.21	19.158	2913.65
1,500,000.	521.43	0.7794	180.012	0.08300	96.86	-J*3.43	23.430	4345.88
2,000,000.	599.31	0.7746	236.850	0.08300	96.65	-J*2.96	27.029	5775.92
3,000,000.	729.87	0.7694	348.725	0.08300	96.31	-J*2.41	33.059	8633.03
5,000,000.	937.61	0.7647	567.710	0.08300	96.01	-J*1.86	42.650	14343.37

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

19 GAUGE PULP CABLE AT 120. DEGREES F

FREQ (HZ)	R (OHMS/ MI)	L (MH/MI)	G (MU-MH0/ MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI)	(DEG/MI)
1.	96.42	0.9001	0.560	0.08440	10388.93	-J*4140.24	0.070	0.18
5.	96.42	0.9001	0.566	0.08435	4638.18	-J*3751.05	0.109	0.58
10.	96.42	0.9001	0.574	0.08433	3166.36	-J*2840.18	0.146	0.87
15.	96.42	0.9001	0.582	0.08431	2549.22	-J*2367.23	0.176	1.08
20.	96.43	0.9001	0.590	0.08430	2191.41	-J*2070.29	0.202	1.26
30.	96.43	0.9001	0.606	0.08428	1775.86	-J*1706.37	0.245	1.56
50.	96.43	0.9000	0.639	0.08425	1367.60	-J*1331.07	0.314	2.03
70.	96.43	0.9000	0.672	0.08423	1153.34	-J*1127.96	0.370	2.40
100.	96.43	0.9000	0.722	0.08421	963.85	-J*945.22	0.440	2.88
150.	96.43	0.8999	0.808	0.08418	786.95	-J*772.15	0.538	3.54
200.	96.44	0.8998	0.895	0.08416	682.04	-J*668.41	0.619	4.10
300.	96.45	0.8996	1.076	0.08412	558.19	-J*544.75	0.755	5.04
500.	96.47	0.8992	1.456	0.08407	434.79	-J*419.92	0.969	6.54
700.	96.49	0.8989	1.860	0.08404	369.64	-J*353.02	1.139	7.79
1,000.	96.52	0.8984	2.502	0.08400	312.05	-J*292.94	1.350	9.39
1,500.	96.58	0.8975	3.655	0.08395	258.64	-J*235.88	1.629	11.58
2,000.	96.65	0.8966	4.893	0.08391	227.36	-J*201.46	1.855	13.68
3,000.	96.81	0.8948	7.575	0.08385	191.23	-J*160.01	2.209	17.25
5,000.	97.19	0.8912	13.580	0.08377	156.94	-J*117.48	2.704	23.57
7,000.	97.67	0.8875	20.237	0.08371	140.21	-J*94.39	3.043	29.47
10,000.	98.53	0.8820	31.164	0.08364	126.82	-J*73.67	3.397	38.05
15.000.	100.37	0.8726	51.321	0.08356	116.20	-J*54.55	3.783	52.27
20,000.	102.63	0.8631	73.387	0.08349	110.99	-J*43.74	4.057	66.54
30,000.	107.66	0.8497	121.941	0.08339	106.11	-J*31.90	4.468	95.34
50,000.	119.61	0.8308	232.178	0.08325	102.46	-J*21.88	5.178	153.25
70,000.	133.00	0.8166	355.449	0.08315	100.81	-J*17.56	5.890	210.88
100,000.	152.17	0.7976	558.820	0.08303	99.19	-J*14.18	6.909	296.02
150,000.	181.82	0.7716	935.452	0.08288	97.29	-J*11.39	8.517	434.85
200,000.	207.48	0.7517	1348.93	0.08277	95.92	-J*9.78	9.961	570.91
300,000.	250.49	0.7266	2259.977	0.08260	94.23	-J*7.86	12.476	839.61
500,000.	318.64	0.6996	4332.104	0.08236	92.45	-J*5.89	16.714	1369.13
700,000.	373.99	0.6844	6651.430	0.08236	91.37	-J*4.81	20.423	1894.56
1,000,000.	443.74	0.6702	10480.000	0.08236	90.37	-J*3.83	25.446	2677.05
1,500,000.	539.65	0.6591	16181.359	0.08236	89.57	-J*2.95	32.468	3980.58
2,000,000.	620.45	0.6522	22011.598	0.08236	89.08	-J*2.42	38.772	5278.98
3,000,000.	755.91	0.6440	33940.115	0.08236	88.48	-J*1.78	50.150	7866.70
5,000,000.	971.46	0.6354	58504.338	0.08236	87.87	-J*1.14	70.344	13022.34

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

19 GAUGE PIC CABLE AT 70. DEGREES F

FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI)	(DEG/MI)
1.	86.94	0.9861	0.000	0.08300	9132.32	-J*9127.63	0.041	0.27
5.	86.94	0.9861	0.001	0.08300	4084.62	-J*4081.48	0.092	0.61
10.	86.94	0.9861	0.002	0.08300	2888.76	-J*2885.55	0.131	0.86
15.	86.94	0.9861	0.003	0.08300	2359.07	-J*2355.63	0.160	1.06
20.	86.94	0.9861	0.004	0.08300	2043.38	-J*2039.68	0.185	1.21
30.	86.94	0.9861	0.006	0.08300	1669.00	-J*1664.81	0.226	1.50
50.	86.94	0.9861	0.010	0.08300	1293.72	-J*1288.64	0.292	1.93
70.	86.94	0.9861	0.013	0.08300	1094.17	-J*1088.33	0.345	2.29
100.	86.94	0.9860	0.019	0.08300	916.43	-J*909.60	0.412	2.74
150.	86.95	0.9860	0.027	0.08300	749.60	-J*741.37	0.504	3.36
200.	86.95	0.9860	0.036	0.08300	650.34	-J*640.91	0.581	3.89
300.	86.95	0.9859	0.053	0.08300	532.90	-J*521.46	0.709	4.78
500.	86.96	0.9857	0.087	0.08300	415.75	-J*401.08	0.909	5.21
700.	86.97	0.9856	0.120	0.08300	353.90	-J*336.59	1.068	7.40
1,000.	86.99	0.9853	0.168	0.08300	299.30	-J*278.66	1.263	8.94
1,500.	87.03	0.9849	0.247	0.08300	246.78	-J*223.59	1.520	11.15
2,000.	87.07	0.9845	0.325	0.08300	219.32	-J*190.30	1.725	13.10
3,000.	87.17	0.9837	0.479	0.08300	185.51	-J*150.15	2.041	16.63
5,000.	87.42	0.9820	0.780	0.08300	153.94	-J*108.88	2.467	22.99
7,000.	87.74	0.9803	1.075	0.08300	138.92	-J*86.50	2.744	29.05
10,000.	88.36	0.9777	1.511	0.08300	127.32	-J*66.35	3.015	38.04
15,000.	89.74	0.9732	2.225	0.08300	118.60	-J*48.35	3.287	53.15
20,000.	91.51	0.9686	2.927	0.08300	114.61	-J*38.26	3.469	68.49
30,000.	96.03	0.9531	4.310	0.08300	110.69	-J*27.71	3.770	99.22
50,000.	107.61	0.9327	7.017	0.08300	107.73	-J*19.14	4.342	160.94
70,000.	120.42	0.9171	9.672	0.08300	106.26	-J*15.51	4.927	222.24
100,000.	138.79	0.8972	13.593	0.08300	104.74	-J*12.69	5.761	312.96
150,000.	166.50	0.8707	20.012	0.08300	102.94	-J*10.32	7.033	461.37
200,000.	189.91	0.8507	26.332	0.08300	101.63	-J*8.94	8.127	607.35
300,000.	229.18	0.8258	38.769	0.08300	100.02	-J*7.31	9.968	896.55
500,000.	291.46	0.7997	63.114	0.08300	98.32	-J*5.67	12.901	1468.89
700,000.	342.08	0.7852	87.003	0.08300	97.38	-J*4.80	15.292	2036.81
1,000,000.	405.89	0.7719	122.267	0.08300	96.52	-J*4.02	18.315	2883.98
1,500,000.	493.70	0.7591	180.012	0.08300	95.69	-J*3.29	22.482	4288.84
2,000,000.	567.72	0.7513	236.860	0.08300	95.18	-J*2.85	26.002	5688.11
3,000,000.	691.90	0.7418	348.725	0.08300	94.56	-J*2.33	31.919	8476.66
5,000,000.	888.83	0.7318	567.710	0.08300	93.92	-J*1.80	41.333	14031.41

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

19 GAUGE PULP CABLE AT 120. DEGREES F

FREQ (HZ)	R (OHMS/ MI)	L (MH/MI)	G (MU-MH0/ MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI)	(DEG/MI)
1.	86.94	0.8934	0.560	0.08440	9864.89	-J*3931.37	0.066	0.17
5.	86.94	0.8934	0.566	0.08435	4404.26	-J*3561.77	0.104	0.55
10.	86.94	0.8934	0.574	0.08433	3006.72	-J*2696.83	0.139	0.82
15.	86.94	0.8934	0.582	0.08431	2420.73	-J*2247.71	0.167	1.03
20.	86.94	0.8934	0.590	0.08430	2080.98	-J*1965.74	0.192	1.20
30.	86.94	0.8934	0.606	0.08428	1686.43	-J*1620.14	0.232	1.48
50.	86.94	0.8933	0.639	0.08425	1298.80	-J*1263.74	0.298	1.92
70.	86.95	0.8933	0.672	0.08423	1095.38	-J*1070.84	0.351	2.28
100.	86.95	0.8933	0.722	0.08421	915.49	-J*897.27	0.418	2.74
150.	86.95	0.8932	0.808	0.08418	747.58	-J*732.87	0.510	3.36
200.	86.95	0.8931	0.895	0.08416	648.02	-J*634.31	0.588	3.89
300.	86.96	0.8929	1.076	0.08412	530.50	-J*516.81	0.717	4.79
500.	86.98	0.8925	1.456	0.08407	413.47	-J*398.15	0.919	6.22
700.	87.00	0.8922	1.860	0.08404	351.71	-J*334.52	1.080	7.41
1,000.	87.03	0.8917	2.502	0.08400	297.18	-J*277.34	1.278	8.95
1,500.	87.08	0.8908	3.655	0.08395	246.67	-J*223.00	1.540	11.14
2,000.	87.15	0.8899	4.893	0.08391	217.15	-J*190.18	1.751	13.07
3,000.	87.29	0.8881	7.575	0.08385	183.15	-J*150.62	2.080	16.52
5,000.	87.63	0.8845	13.580	0.08377	151.10	-J*110.01	2.532	22.70
7,000.	88.06	0.8809	20.237	0.08371	135.62	-J*87.97	2.837	28.51
10,000.	88.84	0.8754	31.164	0.08354	123.39	-J*68.25	3.149	37.03
15.000.	90.50	0.8662	51.321	0.08356	112.83	-J*50.18	3.483	51.21
20,000.	92.54	0.8567	73.387	0.08349	109.21	-J*40.05	3.720	65.48
30,000.	97.56	0.8433	121.941	0.08339	104.94	-J*29.20	4.097	94.31
50,000.	109.97	0.8244	232.178	0.08325	101.73	-J*20.23	4.801	152.17
70,000.	123.45	0.8091	355.449	0.08315	100.16	-J*16.38	5.512	209.53
100,000.	142.71	0.7892	558.820	0.08303	98.55	-J*13.36	6.533	294.14
150,000.	171.46	0.7622	935.452	0.08288	96.63	-J*10.79	8.103	431.91
200,000.	195.75	0.7416	1348.793	0.08277	95.23	-J*9.27	9.490	566.80
300,000.	236.50	0.7156	2259.977	0.08260	93.49	-J*7.45	11.910	832.99
500,000.	301.11	0.6875	4332.104	0.08236	91.64	-J*5.59	16.001	1357.07
700,000.	353.63	0.6717	6651.430	0.08236	90.51	-J*4.56	19.590	1876.67
1,000,000.	419.85	0.6567	10480.000	0.08236	89.44	-J*3.63	24.463	2649.75
1,500,000.	510.95	0.6419	16181.359	0.08236	88.39	-J*2.80	31.323	3928.32
2,000,000.	587.75	0.6326	22011.598	0.08236	87.72	-J*2.30	37.491	5198.72
3,000,000.	716.59	0.6208	33940.115	0.08236	86.88	-J*1.71	48.632	7724.21
5,000,000.	920.92	0.6081	58504.338	0.08236	85.96	-J*1.10	68.373	12739.12

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

19 GAUGE PIC CABLE AT 0. DEGREES F

FREQ (HZ)	R (OHMS/ MI)	L (MH/MI)	G (MU-MHO/ MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI)	(DEG/MI)
1.	73.67	0.9758	0.000	0.08300	8406.26	-J*8401.84	0.038	0.25
5.	73.67	0.9758	0.001	0.08300	3759.96	-J*3756.85	0.085	0.56
10.	73.67	0.9758	0.002	0.08300	2659.23	-J*2655.96	0.120	0.79
15.	73.67	0.9758	0.003	0.08300	2171.70	-J*2168.14	0.147	0.97
20.	73.67	0.9758	0.004	0.08300	1881.13	-J*1877.28	0.170	1.12
30.	73.67	0.9758	0.006	0.08300	1536.58	-J*1532.16	0.208	1.38
50.	73.67	0.9757	0.010	0.08300	1191.22	-J*1185.83	0.269	1.78
70.	73.67	0.9757	0.013	0.08300	1007.60	-J*1001.38	0.318	2.11
100.	73.67	0.9757	0.019	0.08300	844.07	-J*836.78	0.379	2.52
150.	73.67	0.9757	0.027	0.08300	690.62	-J*681.82	0.463	3.09
200.	73.67	0.9756	0.036	0.08300	599.35	-J*589.25	0.534	3.58
300.	73.67	0.9755	0.053	0.08300	491.41	-J*479.14	0.651	4.40
500.	73.68	0.9754	0.087	0.08300	383.84	-J*368.09	0.834	5.73
700.	73.69	0.9752	0.120	0.08300	327.13	-J*308.54	0.979	6.84
1,000.	73.71	0.9750	0.168	0.08300	277.14	-J*254.98	1.115	8.28
1,500.	73.74	0.9746	0.247	0.08300	231.05	-J*203.99	1.387	10.35
2,000.	73.77	0.9742	0.325	0.08300	204.28	-J*173.12	1.569	12.20
3,000.	73.86	0.9734	0.479	0.08300	173.76	-J*135.83	1.847	15.57
5,000.	74.07	0.9717	0.780	0.08300	145.67	-J*97.49	2.209	21.76
7,000.	74.35	0.9700	1.075	0.08300	132.62	-J*76.77	2.436	27.73
10,000.	78.87	0.9675	1.511	0.08300	122.79	-J*58.45	2.649	36.68
15.000.	76.04	0.9630	2.225	0.08300	115.63	-J*42.02	2.857	51.82
20,000.	77.54	0.9584	2.927	0.08300	112.43	-J*33.05	2.997	67.18
30,000.	82.12	0.9431	4.310	0.08300	109.27	-J*24.00	3.266	97.95
50,000.	94.39	0.9226	7.017	0.08300	105.79	-J*16.94	3.842	159.53
70,000.	107.39	0.9053	9.672	0.08300	105.37	-J*13.95	4.431	220.38
100,000.	125.91	0.8837	13.593	0.08300	103.84	-J*11.61	5.272	310.27
150,000.	152.41	0.8555	20.012	0.08300	101.98	-J*9.54	6.500	457.05
200,000.	173.98	0.8344	26.332	0.08300	100.61	-J*8.28	7.522	601.23
300,000.	210.20	0.8081	38.769	0.08300	98.91	-J*6.78	9.247	886.58
500,000.	267.71	0.7801	63.114	0.08300	97.09	-J*5.28	12.001	1450.52
700,000.	314.50	0.7644	87.003	0.08300	96.07	-J*4.47	14.254	2009.39
1,000,000.	373.55	0.7497	122.267	0.08300	95.11	-J*3.75	17.107	2841.93
1,500,000.	454.88	0.7307	180.012	0.08300	93.88	-J*3.09	21.116	4207.70
2,000,000.	523.51	0.7186	236.850	0.08300	93.09	-J*2.69	24.520	5562.86
3,000,000.	638.74	0.7031	348.725	0.08300	92.07	-J*2.21	30.270	8252.76
5,000,000.	820.54	0.6858	567.710	0.08300	90.91	-J*1.72	39.421	13582.64

Channel Interface Specification

Cable Characteristics 1Hz to 5MHz

19 GAUGE PULP CABLE AT 0. DEGREES F

FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)	ZO (OHMS)		GAMMA (DB/MI)	(DEG/MI)
1.	73.67	0.8841	0.560	0.08440	9080.56	-J*3618.74	0.061	0.16
5.	73.67	0.8840	0.566	0.08435	4054.17	-J*3278.46	0.095	0.51
10.	73.67	0.8840	0.574	0.08433	2767.79	-J*2482.25	0.128	0.76
15.	73.67	0.8840	0.582	0.08431	2228.42	-J*2068.81	0.154	0.95
20.	73.67	0.8840	0.590	0.08430	1915.72	-J*1809.24	0.176	1.10
30.	73.67	0.8840	0.606	0.08428	1552.58	-J*1491.07	0.214	1.36
50.	73.67	0.8840	0.639	0.08425	1195.85	-J*1162.93	0.274	1.77
70.	73.67	0.8839	0.672	0.08423	1008.67	-J*985.32	0.323	2.10
100.	73.67	0.8839	0.722	0.08421	843.15	-J*825.47	0.385	2.52
150.	73.67	0.8838	0.808	0.08418	688.69	-J*674.05	0.469	3.10
200.	73.68	0.8837	0.895	0.08416	597.13	-J*583.24	0.540	3.59
300.	73.68	0.8835	1.076	0.08412	489.11	-J*474.94	0.659	4.41
500.	73.70	0.8832	1.456	0.08407	381.62	-J*365.50	0.843	5.74
700.	73.71	0.8828	1.860	0.08404	324.97	-J*306.75	0.990	6.85
1,000.	73.74	0.8823	2.502	0.08400	275.02	-J*253.91	1.170	8.28
1,500.	73.79	0.8814	3.655	0.08395	228.89	-J*203.61	1.407	10.33
2,000.	73.84	0.8806	4.893	0.08391	202.02	-J*173.19	1.595	12.16
3,000.	73.96	0.8788	7.575	0.08385	171.25	-J*136.47	1.885	15.45
5,000.	74.25	0.8752	13.580	0.08377	142.62	-J*98.73	2.274	21.43
7,000.	74.61	0.8717	20.237	0.08371	129.05	-J*78.30	2.527	27.13
10,000.	75.28	0.8662	31.164	0.08364	118.57	-J*60.14	2.777	35.59
15,000.	76.68	0.8571	51.321	0.08356	110.60	-J*43.72	3.039	49.77
20,000.	78.41	0.8477	73.387	0.08349	106.80	-J*34.65	3.226	64.05
30,000.	83.43	0.8345	121.941	0.08339	103.38	-J*25.30	3.563	92.93
50,000.	96.46	0.8155	232.178	0.08325	100.73	-J*17.87	4.264	150.71
70,000.	110.09	0.7987	355.449	0.08315	99.25	-J*14.69	4.974	207.66
100,000.	129.46	0.7774	558.820	0.08303	97.66	-J*12.19	5.998	291.51
150,000.	156.95	0.7490	935.452	0.08288	95.70	-J*9.93	7.516	427.77
200,000.	179.33	0.7274	1348.793	0.08277	94.25	-J*8.54	8.820	561.01
300,000.	216.91	0.7003	2259.977	0.08260	92.43	-J*6.87	11.104	823.66
500,000.	276.57	0.6707	4332.104	0.08236	90.48	-J*5.15	14.983	1340.03
700,000.	325.12	0.6539	6651.430	0.08236	89.28	-J*4.21	18.400	1851.35
1,000,000.	386.39	0.6378	10480.000	0.08236	88.13	-J*3.34	23.057	2611.09
1,500,000.	470.77	0.6179	16181.359	0.08236	86.71	-J*2.59	29.678	3853.98
2,000,000.	541.97	0.6051	22011.598	0.08236	85.79	-J*2.14	35.644	5084.23
3,000,000.	661.53	0.5885	33940.115	0.08236	84.58	-J*1.59	46.439	7520.19
5,000,000.	850.16	0.5698	58504.338	0.08236	83.21	-J*1.03	65.518	12331.69