Proposed American National Standard

ctrical and Mechanical Characteristics for Digital Control Interface

PH22.207M

1. General

ope. This standard defines the electrical echanical characteristics of an interface comprised of a general purpose communi- channel and interface device(s) used for nsfer of data and digital control signals n equipment utilized in the production, oduction, and/or transmission of visual al information. It is intended that the com- ion channel and device(s) described in ndard be part of an overall equipment e, allowing interconnection of program- and nonprogrammable control and aces- quipment as required to configure an onal system with a defined function. The d is also intended to allow rapid recon- on of a system providing more than one function utilizing a given group of equip-

The electrical and mechanical specifica- t forth in this standard are intended for oth fixed plant and field operational en- nts. These specifications take into account uirement to function reliably without caus- due interference with other signals nor- ound in these environments.

This standard defines the electrical and ical characteristics of the communication and the associated interface device(s), to lusion of design specifications, perform- quirements, safety requirements, and the nications protocol used in or by such ent.

The primary intent of this standard is to h an electrical and mechanical interface mmunication channel for the purpose of interconnecting equipment by external means. This standard, or sections thereof, may be applied to the interconnection of elements within an item of equipment.

1.2 Definitions. For the purposes of this standard, the following definitions shall apply:

Equipment means either a single device which connects to the interface system or a group of interconnected devices, providing a specified operational function, having one common connection to the interface system.

Interface Bus refers to the communication channel.

1.3 Object. The intent of this standard is to:

Define a general-purpose interface system for use in the environment specified in 1.1

Specify equipment-independent electrial, mechanical, and functional interface characteristics which permit equipment to connect and communicate unambiguously via the interface system

Specify terminology and definitions related to the electrical and mechanical portion of the interface system

Enable the interconnection of independently manufactured equipment into a single functional system

Permit equipment with a wide range of operational capabilities to be connected to the interface system simultaneously

Define a system which is user configurable

Define a system based on readily obtainable standard components

1.4 Interface System Overview

1.4.1 This standard applies to systems, or portions of systems, which have the following characteristics:

A full-duplex four-wire communications channel is utilized

A nominal maximum bus length of 1220 m (4003 ft)

Data is transmitted asynchronously, bit serial, word serial

Standard transmission rate on the interface bus is 38.4 kilobits per second (kb/s)

Data exchange between devices is digital (as distinct from analog)

1.4.2 The function of the interface system is to provide an effective communications link over which messages are carried in an unambiguous way among a group of interconnected devices.

1.4.3 The interface system described in this standard assigns one of two operational characteristics to all devices:

Bus Controller. Each interface system contains one bus controller which supervises all tributaries in the system. This supervision is exercised through the use of interface protocol. The bus controller may also perform one or more functions in the operational plant in addition to its interface supervision. Although only one bus controller may be part of any particular interface system, it is recognized that an operational plant may make use of more than one interface system.

Tributary. A tributary transfers messages to and from an operational device via the interface system as specified in the interface system protocol. A tributary communicates messages through the interface bus only via the bus controller.

1.4.4 The basic message paths and the bus structure shall be as follows:

The basic message path utilizes asynchronous, bit serial/word serial transmission via a balanced wire pair

The interface bus may be utilized in either point-to-point or multi-point configuration including but not limited to

A point-to-point bus connectir bus controller

A multipoint bus connecting to a singe bus controller

The interface bus is a four which will effect two-way con separate wire pair for each tion; communication betwee complished through the bus c

1.4.5 The data word and BI ized by the interface system sh

The standard serial data wor bit data byte; the complete se sists of one start bit (SPACE), e BYTE), a parity bit (EVEN), (MARK).

A BREAK character, compris SPACE and a minimum of 2 b to synchronize all devices con face bus.

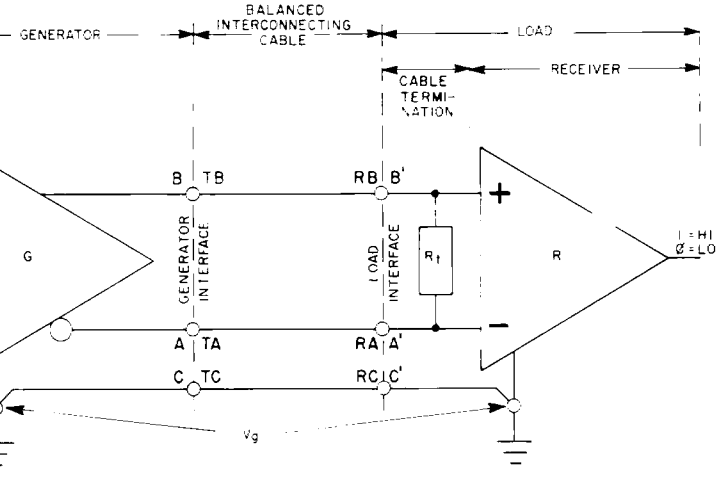
2. Electrical Char

2.1 Interface Circuit. The bal tal interface circuit is shown i consists of three parts: the g anced interconnecting cable, load may consist of one or mo an optional cable termination electrical characteristics of th ceiver are specified in terms measurements while the inter specified in terms of its elec characteristics.

2.2 Generator Characterist characteristics of the generat accordance with measurement through 2.2.6 and illustrated generator circuit meeting the sults in a low impedance (10 anced voltage source produ voltage applied to the interc the range of 2 to 6 volts. The the voltages appearing acros ing cable are defined as follow

al of the generator shall be positive to the A terminal for a binary 1

The B terminal of the generator shall be negative with respect to the A terminal for a binary 0 (SPACE) state.



LEGEND

R_t	=	CABLE TERMINATION RESISTANCE
Vg	=	GROUND POTENTIAL DIFFERENCE
A,B	=	GENERATOR INTERFACE POINTS
A',B'	=	LOAD INTERFACE POINTS
C	=	GENERATOR CIRCUIT GROUND
C'	=	LOAD CIRCUIT GROUND

Fig. 1
Balanced Digital Interface Circuit

circuit measurement for either bin- ll be made in accordance with Fig. lts of this measurement shall be as

de of the differential voltage (Vo) tween the two generator output ter- ot be more than 6.0 volts.

de of the voltage between either of r output terminals and generator and Vob) shall not be more than

2.2.2 The test termination measurement shall be made with a test load of two resistors, 50 ohm ± 1%, connected in series between the generator output terminals as shown in Fig. 2b. The results of this measurement shall be as follows:

The magnitude of the differential voltage (Vt) measured between the two output terminals shall not be less than either 2.0 volts or 50% of the magnitude of Vo, whichever is greater. For the opposite binary state the polarity of Vt shall be reversed.

The magnitude of the difference in the magnitude of Vt and $\overline{Vt}$ shall be less than 0.4 volts.

The magnitude of the generator offset voltage, Vos, measured between the center point of the

test load and generator ci greater than 3.0 volts.

The magnitude of the differe tudes of Vos for one binary st opposite binary state shall be

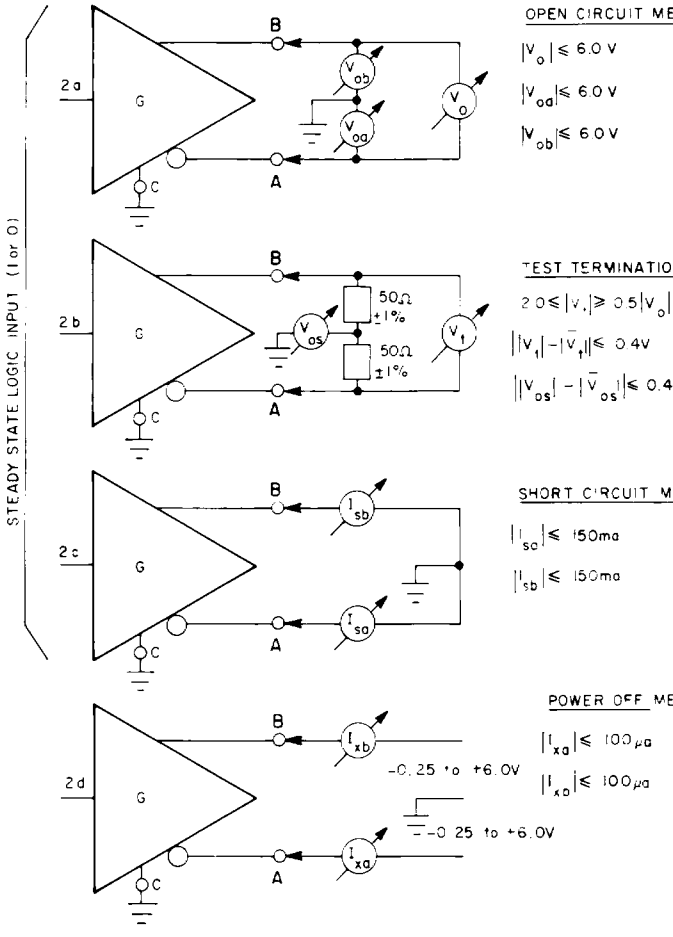


Fig. 2
Generator Parameter Measurement

short circuit measurement shall be
ne generator output terminals short-
enerator circuit ground as illustrated
ne magnitudes of the currents flow-
each generator output terminal dur-
nall not exceed 150 milliamperes for
state.

ower-off measurement shall be made
-off conditions and as illustrated in
magnitude of the generator output

leakage currents (Ixa and Ixb), with voltages ranging between +6.0 and —0.25 volts applied between each output terminal and generator circuit ground, shall not exceed 100 microamperes.

2.2.5 The output signal waveform measurement shall be made using a test load consisting of a noninductive resistor with a value of 100 ohms ± 10% connected between the generator output terminals, as illustrated in Fig. 3. During transitions of the generator output between alternating

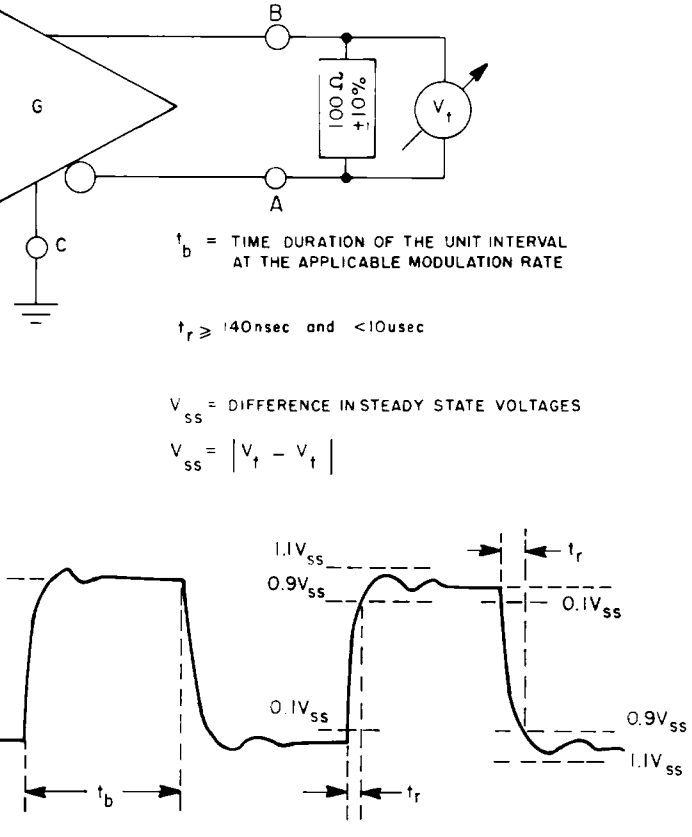


Fig. 3
Generator Output Signal Waveform

binary states (one-zero-one-zero, etc.), the differential signal measured across the test load shall be such that the voltage monotonically changes between 10% and 90% of Vss at not less than 140 nanoseconds. Thereafter, the signal voltage shall not vary more than 10% of Vss from the steady state value, until the next binary transition occurs. At no time shall the instantaneous magnitude of Vt or $\overline{Vt}$ exceed 6.0 volts nor be less than 2.0 volts. Vss is defined as the voltage difference between the steady state values of the generator output.

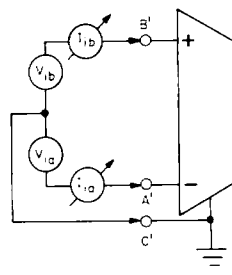
2.2.6 The generator output shall be capable of being placed in a high-impedance state and when in such state shall withstand a common mode voltage swing of up to 7 volts.

2.3 Load Characteristics. The load consists of one or more receivers (R) and an optional cable termination resistance (Rt) as shown in Fig. 1. The electrical characteristics of a single receiver excluding both cable termination and fail-safe provision are specified in terms of the measurements described in 2.3.1 through 2.3.7 and illustrated in Figs. 4 through 6. A circuit meeting these requirements results in a differential receiver having a high-input impedance (> 4 kohms), a small input threshold transition region between —0.5 and +0.5 volts and allowance for an internal bias voltage not to exceed 3 volts in magnitude.

2.3.1 The input current/voltage measurements shall be made with the voltage via (or Vib) ranging between —10.0 and +10.0 volts, while Vib (or Via) is held at 0.0 volts (ground). This measurement shall be made with the power supply to the receiver in both the power-on and power-off condition. The resultant input current Iia (or Iib) shall remain within the shaded region shown in Fig. 4.

2.3.2 The input sensitivity measurement shall be made as illustrated in Fig. 5 over the entire common mode voltage (Vcm) range of —15 to +15 volts. The receiver shall not require a differential input voltage of more than 500 millivolts to correctly assume the intended binary state. Reversing the polarity of Vi shall cause the receiver to assume the opposite binary state. The receiver is required to maintain correct operation for differ-

ential input signal voltages ra
millivolts and 6 volts in magni
voltage (signal plus common
tween either receiver input te
circuit ground shall not excee
tude. Application of voltages
mum voltage (signal plus co
volts or a maximum differenti
at the receiver input termina
operational failure of the re
mode voltage (Vcm) is defin
mean of the two voltages a
ceiver input terminals (A' an
the receiver circuit ground (C
minating hardware should b
signal transitions with noise p
to instability or oscillatory c
ceiving device and appropria
be implemented to prevent su
ample, adequate hysteresis m
into the receiver to prevent th



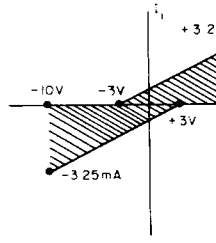
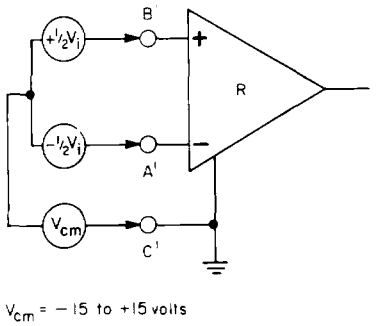


Fig. 4
Receiver Input Current-Volt



V_{cm} = −15 to +15 volts

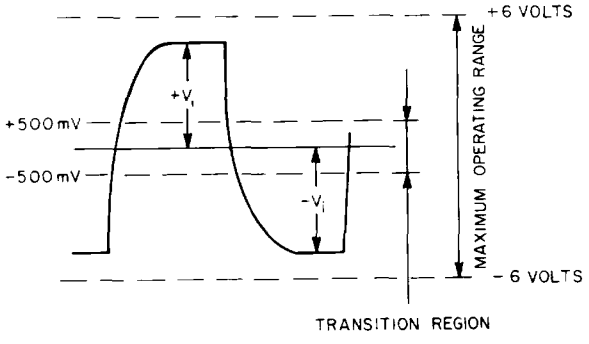


Fig. 5
Receiver Input Sensitivity Measurement

nput balance measurement shall be strated in Fig. 6. The balance of the t voltage/current characteristics and shall be such that the receiver will e intended binary state when a dif- age (Vi) of 500 millivolts is applied ohms ± 1% to each input terminal aried between —15 and +15 volts. larity of Vi is reversed, the opposite shall be maintained under the same

se of a noninductive cable termina- e (Rt) is recommended. A distributed or a combined R/C load may be required in some cases (see 4.2.1) and the use of an active cable termination resistance is desirable for the purpose of reducing cross coupling when the bus controller is placed in a high-impedance state (see 4.2.2). Care must be taken not to exceed the limits on total load resistance or sensitivity. Refer to 2.3.7 for limits on the total load resistance.

2.3.5 The use of multiple receivers may be employed. Caution must be exercised to avoid performance degradation due to signal reflective effects from stub lines emanating from the load interface point to the receivers.

2.3.6 The interface system shall fail safe. This shall be accomplished by automatic disconnection of a tributary from the interface system in the event of a malfunction or power failure and incorporating in the receiver provisions to provide a steady binary MARK to protect against the following conditions:

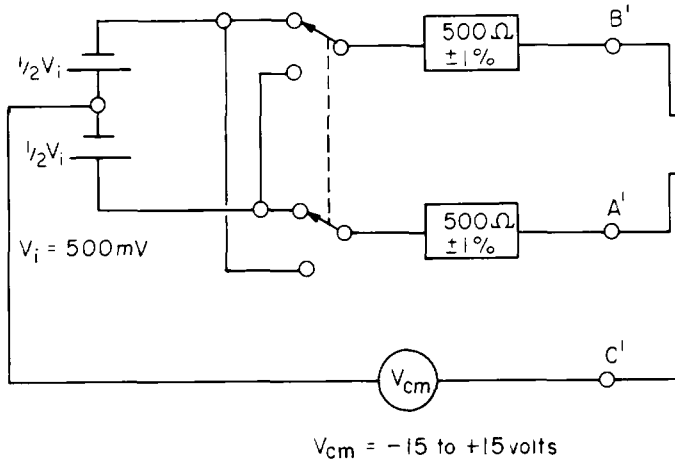
Generator power-off

Generator in high-impedance

Both signal wires open or sh mon return still connected)

Generator not implemented (may not be present)

Open connector (Both signal mon signal return are open si



V_{cm} = −15 to +15 volts

Fig. 6
Receiver Input Balance Measurement

2.3.7 The total load characteristics, including multiple receivers, fail-safe provision, and cable termination shall have a combined resistance greater than 90 ohms between its input points (A' and B' [Fig. 1]) and shall not require a differential input voltage of more than 500 millivolts for all receivers to assume the intended binary state.

2.4 Interconnecting Cable Characteristics. The physical and electrical characteristics of the interconnecting cable are given in 2.4.1 through 2.4.4 with additional guidance given in Sec. 4. An interconnecting cable conforming to this standard will result in a transmission line with a nominal characteristic impedance in the order of 100 ohms at frequencies greater than 100 kilohertz, and a DC series loop res ing 240 ohms over an operati nominally 1220 m. The cable of twisted or nontwisted (flat possessing the characteristics through 2.4.4. Most common used for telephone applicatio meet these specifications.

2.4.1 *Each conductor of t* cable shall be composed of solid copper wire whose unifo the conductor is 24 AWG or copper conductors is allowed of sufficient size to yield a DC exceeding 30 ohms per 1000

al pair capacitance, that is, the capa-
reen one wire in the pair and the
the pair, shall not exceed 20 pico-
, and the value shall be reasonably
the entire length of the cable.

capacitance, the capacitance be-
ire in the cable and all others in the
with all others connected to ground,
eed 40 picofarads per ft and shall
ly uniform over the entire length of
any given conductor.

o-pair balanced crosstalk is defined
alk between one pair of wires and
air of wires in the same cable. This
ll be attenuated a minimum of 40 dB
red at 150 kHz with each cable pair
n its characteristic impedance.

ment. A balance voltage digital in-
it conforming to this standard will
sfactorily at a data rate of 38.4 kb/s
at the following operational con-
imultaneously observed.

nnecting cable length is a nominal
220 m and the cable is appropriately

mode voltage at the receiver is less
s (peak). Common mode voltage is
any uncompensated combination of
or/receiver ground potential differ-
nerator offset voltage (Vos), and the
ly coupled peak random noise vol-
ured between the receiver circuit
cable, with the generator end of the
circuited to ground.

Protection. The balanced-voltage
face generator and receiver device,
power-on or power-off condition and
vith this standard, shall not be dam-
the following conditions:

pen circuit

across the balanced interconnecting

to any other lead using electrical
cs in compliance with this standard

to ground

(The above faults may cause the power dissipation in the interface device to approach the maximum power dissipation tolerable by a typical integrated circuit (IC) package. Caution should, therefore, be exercised when multiple generators or receivers are implemented in a single IC package since only one such fault per package may be tolerated at any one time without experiencing IC failure. It should also be noted that the generator and receiver device(s) complying with this standard may be damaged by spurious voltages applied between the input/output terminals and circuit ground. In applications where the interconnect cable may be subject to severe electromagnetic environment or the possibility exists that it may be inadvertently connected to circuits not in compliance with this standard, additional protection should be employed as may be appropriate.)

3. Mechanical Characteristics

3.1 Interface Connector. The interface connector shall be a 9-pin D-subminature female (DB-9S). A single interface connector shall be associated with any particular tributary device. Multiple interface connectors may be utilized on a bus controller in the case of a multipoint system or when the bus controller must communicate with more than one interface system.

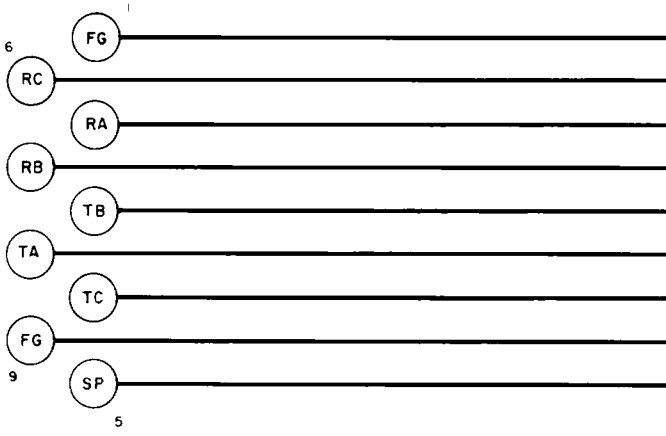
3.2 Pin Assignment. The pin assignments for the bus controller and tributary shall be as shown in Fig. 7. Use of the spare pin for unspecified communication or supervision is not in compliance with this standard. If used, it may not interfere with the normal operation of the standard interface system.

4. Guidelines

When interconnecting equipment using the interface system described in this standard, consideration should be given to some of the problems that may be encountered due to the characteristics of the interconnecting cable, cable termination, the number of devices in use, and grounding arrangements.

4.1 Cable. The interconnecting cable electrical characteristics are specified in 2.4. The following is intended to be used as additional guidance when considering the operational constraints placed on the system by the cable parameters.

4.1.1 The maximum length of cable separating the generator and receiver (load) is a function of modulation rate (influenced by the tolerable signal distortion), transmission losses, the amount of longitudinally coupled noise, and ground potential difference introduced bet
and receiver circuit grounds
balance. Increasing the phys
interconnecting cable length
erator and receiver (load)
creases the system exposure
noise, signal distortion, and
imbalance. Users are advis
length to the minimum consist
tor/receiver (load) separatio
whenever possible to utilize c
signed for balanced data circ



BUS CONTROLLER

FG	FRAME GROUND
TA	TRANSMIT "A"
TB	TRANSMIT "B"
TC	TRANSMIT SIGNAL COMMON
RA	RECEIVE "A"
RB	RECEIVE "B"
RC	RECEIVE SIGNAL COMMON
SP	SPARE

A < B "
A > B "S

Fig. 7
Connector Pin Assignment

nominal maximum cable length of based on empirical data using 24- paded, twisted-pair telephone cable a 100-ohm resistive load. This length signal quality of:

nd fall time equal to or less than 10

voltage loss between the generator (load) of 6 dB

cautioned that the nominal limit of not take into account cable imbal- mon mode noise beyond the limits ndard. Operation within the limit of ld result in a degradation of signal will not exceed a zero-crossing am- 05 unit interval. It is recognized that ations can tolerate a timing and am- tion greater than this amount and in rrespondingly greater cable lengths oyed. The use of cables specifically the transmission of balanced data lso result in the ability to operate ially increased cable lengths.)

Termination. The characteristics of mination are specified in 2.3.4. The intended to be used as additional en considering the operational con- d on the system by the termination

etermination of the type of cable tilized and its value must take into haracteristic impedance of twisted- hich is a function of operating fre- size, wire type, and the kind of in- erials used. The characteristic im- 4-gauge, copper conductor, plastic sted-pair telephone cable is in the ohms when measured with a 100- e.

ristic impedance of any cable typ- ns an inductive component which ely affect the wave shape over ex- lengths. Use of a composite R/C tion with a time constant of approxi- s the propagation delay of the cable a significant improvement in the wave shape and a reduction in driving power requirements.

4.2.2 The presence of stray capacitance between the interconnect cable and any adjacent cable (Fig. 8) can result in interference being coupled to an adjacent cable when a transition occurs that is other than balanced. During normal operation, inter-cable coupling is at a minimum due to the use of a balanced transmission mode along with control of signal rise-times (2.2). When the driving device is placed in a high-impedence state, however, this control is no longer applied and the conductor in the pair that was at a positive value will transition to a less positive value. This transition, being uncontrolled and of an unbalanced type, may be coupled into adjacent cables.

Capacitive coupling of this type can be reduced or eliminated by utilizing shielded cables specifically designed for the transmission of digital data information. Although this approach is practical when installing the interface system in new plants, it may not be possible when working in existing facilities. When utilizing nonshielded cable, the use of an active termination is recommended. An active termination of the type shown in Figs. 9 and 10 will result in a balanced transition to a voltage that is equal on both conductors of the cable pair. The circuit shown in Fig. 9 also provides a failsafe bias on the bus and allows for higher impedance terminations while the circuit shown in Fig. 10 is balanced with respect to the interface bus and does not introduce a differential bias on the line.

4.2.3 In general, reliable operation of the balanced interface circuit is not particularly sensitive to the presence or absence of the cable termination resistor when operating at 38.4 kb/s. The termination of the cable with a noninductive load in the order of 90 to 250 ohms tends to result in the preservation of the rise time in the generated signal and a reduction of line noise. Caution must be exercised in the value of termination selected as too low a value would result in a reduction in signal amplitude to the point where reliable operation of the system would be affected.

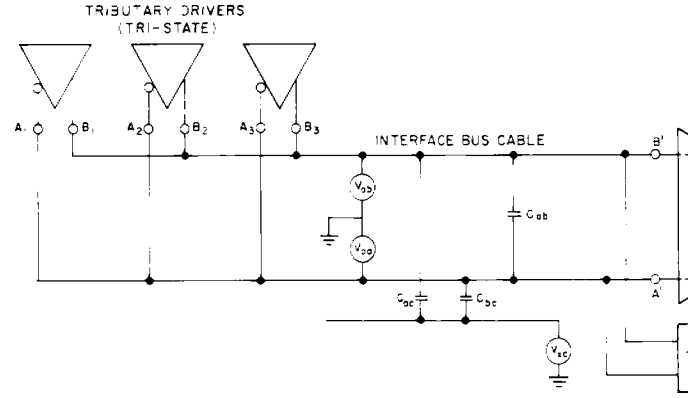


Fig. 8
Cable Model

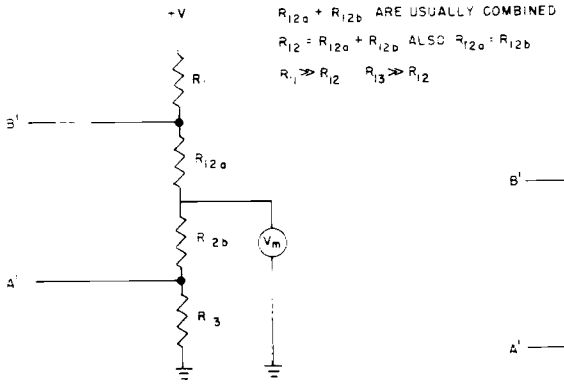


Fig. 9
Terminator Circuit 1

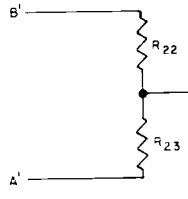


Fig.
Terminato

4.3 The data rate of 38.4 kb/s can result in a system response time within one television frame when the total number of tributaries is less than thirty-two. Higher data rates may be used when the operation of a specific system indicates this need. When higher data rates are used, the device(s) shall first establish com kb/s. Operation at data rate kb/s is expressly prohibited confusion of certain data BREAK sequence.