Mitel Technical Specification 20

MiLINK Specification

Nell Sipkes Technical Requirements and Standards

Version A01 02 November 1992

Table of Contents

Document History

Introduction

Section A - Overview

Section B • General Concepts

Section C - Interface Requirements

Table of Contents

Table of Contents

Section D - Conformance Testing

Document History

Version	Date	Description
AOO	9-APR-1992	First draft review
AOO	15-SEP-1992	Second draft review
A01	02-NOV-1992	First release of MTS20

Introduction

Mitel Technical Specifications for MiLINK, MiLAP, and MiNET

Mitel Technical Specifications (MTS) for MiLINK, MiLAP, and MiNET define the physical, electrical, and procedural requirements (corresponding to Layers 1, 2, and 3 of the OSI Reference Model) for digital sets and MiLINK peripherals. In addition, the scope of the specifications for MiLAP and MiNET extends to the system level as well.

The purpose of the specifications is to ensure correct functioning and consistency of implementation.

These MTSs are based on internal documents generated by various development groups, and also reflect the latest status of the Protocols Working Group (PWG). Relevant test principles are included wherever possible to verify conformance to each specification. Wherever appropriate, safety or overvoltage requirements, electromagnetic compatibility limitations or other compatibility or regulatory requirements are also included for completeness.

The interpretation of these MTSs is the sole responsibility of the Technical Requirements and Standards Department. Periodic updates will be issued to ensure, amongst other things, compliance with the most recent decisions of the PWG.

The Mitel Technical Specifications for MiLINK, MiLAP, and MiNET are structured as follows:

MTS20 MiLINK Specification \

MTS21 MiLAP/MiLAP-S Specification

MTS22 MiNET Specification

Section A - Overview

Table of Contents

1 Document Format of MTS20

This Mitel Technical Specification (MTS20) is divided into four sections:

Section A Provides an overview of MiLINK.

Section B Provides a general introduction to the concepts of the MiLINK interface.

Section C Provides the MiLINK (layer 1) requirements. The functional characteristics, electrical characteristics and interface connectors are based on Mitel documents LYDE0001 [1] and FAD.26 [2]. The EMC, ESD, safety and protection requirements are based on the most strenuous specifications taken from the primary Canadian, U.S., and European standards, as applicable to desktop telephony applications.

Section D Details the conformance testing to be used in verifying the functional characteristics of Section C.

Text shown in a shaded box provides additional information or clarification.

2 Abbreviations and Acronyms Used in MTS20

AWG	American Wire Gauge
BSI	British Standards Institute
CCITT	Comite Consultatif International Telegraphique et Telephonique
CENELEC	Comite Europeen de Normalisation Electrotechnique
CISPR	Comite International Special des Perturbations Radioelectriques
CSA	Canadian Standards Association
EIA	Electronic Industries Association
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
EUT	Equipment Under Test
FCC	Federal Communications Commission
HDLC	High-level Data Link Control
IEC	International Electrotechnical Commission
MIU-RR	Measurement Instrument Unit - Reaction RMS
MTS	Mitel Technical Specification
OSI	Open System Interconnection
RMS	Root Mean Square
SELV	Safety Extra-Low Voltage (circuit)
TIA	Telecommunications Industries Association
TNV	Telecommunication Network Voltage
UL	Underwriter's Laboratory

3 References

[I] Mitel LYDE0001, MiLINK Technical Specification, Issue 1R03, 1991.

[2] Mitel FAD.26, Software Specification for the Implementation of DESKBUS, Issue A01, March 1992.

[3] Mitel PDS003, Peripheral Products ESD Immunity Specification, version 2R01, Sept. 1992.

[4] Mitel MTS21, MiLAP/MiLAP-S Specification, version AOO.

[5] Mitel MTS22, MiNET Specification, version AOO.

[6] Bellcore TA-NWT-001089, Electromagnetic Compatibility and Electrical Safety Generic Criteria for Network Telecommunication Equipment, Issue 1, 1990.

[7] BSI BS 6301, Electrical Safety Requirements for Apparatus for Connection to Telecommunication Networks, 1989.

[8] CCITT Recommendation X.211, Physical Service Definition of Open Systems Interconnection for CCITT Applications, 1988.

[9] CENELEC EN 41003, Particular Safety Requirements for Equipment to be Connected to Telecommunication Networks, 1991.

[10] CENELEC EN 50 081-1, Electromagnetic Compatibility - Generic Emission Standard (Domestic, Commercial and Light Industry).

[II] CENELEC EN 50 082-1, Electromagnetic Compatibility - Generic Immunity Standard (Domestic, Commercial and Light Industry).

[12] CENELEC EN 55022, Limits and Methods of Measurement of Radio Frequency Interference Characteristics of Information Technology Equipment, 1987.

[13] CENELEC prEN 55101 Electromagnetic Compatibility Requirements for Information Technology Equipment, Draft, 1990.

[14] CENELEC EN 60950, Safety of Information Technology Equipment, Including Electrical Business Equipment, 1988.

[15] CISPR 16, Specification for Radio Frequency Interference Measuring Apparatus and Measurement Methods, 2nd Edition, 1987.

[16] CSA 22.2 No. 225-M90, Equipment Electrically Connected to a Telecommunications Network - Requirements for Safety of Electrical Products, March 1990 (Updated to February 1991).

[17] FCC Part 15 Code of (US) Federal Regulations, Radio Frequency Devices.

[18] IEC 801-2, Electromagnetic Compatibility Requirements for Industrial Process Measurement and Control Equipment - ESD Requirements, 1984.

[19] IEC 801-5, Electromagnetic Compatibility Requirements for Industrial Process Measurement and Control Equipment - Surge Immunity Requirements, 1989.

[20] UL 1459, Standards for Safety - Telephone Equipment, Issue 2, December 1987 (Updated to March 1991).

Section B - General Concepts

Table of Contents

List of Figures

1 General

This specification (MTS20-B) describes in general terms the layer 1 characteristics *of* the MiLINK interface. The purpose of the MiLINK interface is to connect MiLINK peripherals to Mitel digital sets (including, but not necessarily limited to, SS410, SS420 and SS430). The reference configuration is shown in Figure 1/MTS20-B.

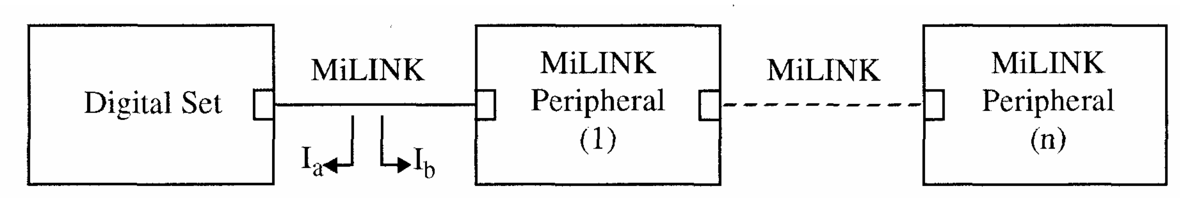

Figure 1/MTS20-B **Reference Configuration for MiLINK**

Up to seven MiLINK peripherals may be connected in series to a digital set, subject to a maximum cable length limitation of 5 meters from the set to the most distant peripheral. The set and peripherals interconnect via a "daisy chain" arrangement. The set provides a single MiLINK jack (output), whereas each peripheral provides two jacks (input and output). Each physical interface is identical.

2 Channel types and their use

2.1 B-channel

The B-channel is a 64 kbit/s bi-directional bearer channel. The B-channel does not carry in-band signalling information for circuit switching. MiLINK provides two independent B-channels.

2.2 D-channel

The D-channel is a 16 kbit/s bi-directional channel primarily intended to carry signalling information for circuit switching.

MiLINK provides a single D-channel, shared by all attached peripherals.

2.3 C-channel

The C-channel is a 32 kbit/s channel primarily intended to carry layer 1 status information. It is uni-directional from the set to the peripheral(s). MiLINK provides a single C-channel.

3 **Channel** access

Access of the B-channels by sets and peripherals is via layer 3 procedures (see MTS22 [5]).

Access of the D-channel is via layer 1 procedures (see MTS20-C) and layer 2 procedures (see MTS21 [4]).

Access procedures are not applicable to the C-channel. This channel is only monitored, not accessed, by peripherals.

Section C - Interface Requirements

Table of Contents

Table of Contents

List of Figures

List of Tables

1 Introduction

This specification (MTS20-C) provides technical specifications to ensure interoperability between digital sets and MiLINK peripherals via the MiLINK interface. The layer 1 requirements encompass functional characteristics, interface procedures, maintenance, electrical characteristics, safety, protection and EMC.

The requirements specified for safety, protection and EMC are specific to Canada, United States and the European Community.

The scope of this specification addresses interface reference point 1^, as shown in Figure 1/MTS20-B (i.e., the digital set is not included). However, requirements such as EMC are specified as a combination of digital set and MiLINK peripheral. Also, some information specific to the digital set is provided .when critical to the proper functioning of peripherals.

2 General characteristics

2.1 Service characteristics

Layer 1 provides the following services to layer 2:

the transmission capability, by means of appropriately encoded bit streams, for the Bl-, B2-, D- and C-channels, and the related timing and synchronization functions;

the signalling capability and the necessary procedures to allow MiLINK peripherals to gain access to the common resource of the D-channel in an orderly fashion while meeting the performance requirement of the D-channel signalling system. These D-channel access control procedures are defined in § 5.1.

indications to the higher layers of the status of layer 1.

2.2 Primitives between layer 1 and the other entities

Primitives represent, in an abstract way, the logical exchange of information and control between layer 1 and other entities. They neither specify nor constrain the implementation of entities or interfaces.

The primitives to be passed across the layer 1/2 boundary or to the management entity, and the parameters associated with these primitives, are defined in § 5. For a description of the syntax and use of the primitives, refer to CCITT Recommendation X.211 [8].

2.3 Mode of operation

On the MiLINK bus, only a single transmitter is active at a time on a given channel. For the D- and C-channels, multiple receivers may be active.

Peripherals do not communicate directly with each other over the MiLINK interface.

3 Cabling

For information on physical arrangements of jacks and plugs and contact assignments, refer to § 7.

For information on the electrical characteristics of the interconnect cable, refer to § 6.1.

3.1 Cabling integrity

The interconnect cable shall provide a one-to-one circuit relationship between the digital set jack and MiLINK peripheral jack, and between **MiLINK** peripheral jacks (ie. no signal lead crossovers).

3.2 Cabling length

The end-to-end cabling length from the digital set to the last MiLINK peripheral, as represented by the sum of all interconnecting stubs, shall not exceed 5 meters.

Peripherals shall be capable of sourcing and sinking applicable interchange circuits over the full 5 meter length.

4 Functional characteristics

4.1 Interface functions

The following functions are provided by the interface:

bit (signal element) timing to enable recovery and generation of the aggregate bit stream;

Note - The clock and data signals (SBclock, SBout, SBin) are not continuous. The overall information transfer rate is 192 kbit/s. During the active information transfer time, the transfer rate is 256 kbit/s.

frame alignment information to enable recovery and generation of the time division multiplexed channels;

for each direction of transmission, two independent 64 kbit/s channels for use as B-channels;

- for each direction of transmission, one 16 kbit/s channel for use as a D-channel;

a D-channel access procedure to enable MiLINK peripherals to gain access to the common resource of the D-channel in an orderly controlled fashion. The functions necessary for this procedure include the provision of a Dbusy interchange circuit. For the definition of the D-channel access procedure refer to § 5.1;

in one direction of transmission (from the digital set), one 32 kbit/s channel for use as a C-channel.

4.2 Interchange circuits

Two interchange circuits, one for each direction of transmission, shall be used to transfer the four time division multiplexed channels. One uni-directional interchange circuit (from the digital set) shall be used to transfer bit timing and frame alignment information. One signal shall be used to control the D-channel access procedure. One common digital ground circuit is provided from the digital set.

The following interchange circuit naming conventions shall be used. The interchange circuit names shall be the same at both the digital set and peripherals.

1) SBout - Time division multiplexed channels from the digital set (received by the MiLINK peripherals).

2) SBin - Time division multiplexed channels from the MiLINK peripherals (received by the digital set).

3) SBclock - Bit timing clock from the digital set.

4) Dbusy - D-channel busy signal.

Note - Dbusy is pulled high in the digital set. Peripherals shall drive Dbusy using open collector devices.

5) DG - Common signal path return from the digital set. The MiLINK interface does not provide any form of powering to peripherals.

Due to line powering of the digital set, all MiLINK interchange circuits (including digital ground) have a negative voltage bias with respect to earth ground. Digital ground shall not be connected to any ground reference external to the set or peripheral. Allowable values of leakage or impedance to such external ground references are subject to further study.

4.3 MiLINK discontinuity

MiLINK peripherals shall monitor the clock and the C-channel to detect a discontinuity in either the MiLINK connection or the digital link on the system side of the digital set. Such discontinuities can be caused by physical disconnection of cables, loss of synchronization by the digital set or loss of power to the digital set.

The C-channel bits (see § 4.5) will assume an all-zeros state in the event of such discontinuities.

Note - In the case of a physical disconnection of the MiLINK cable or power-down of the digital set, the signal SBclock will no longer be supplied to the peripheral.

Peripherals shall inform layer 2 of such occurrences via the PH-DEACTIVATE-indication primitive (see § 5.4). The primitive shall only be sent when the discontinuity has persisted for more than 200 ms.

4.4 Frame structure

In both directions of transmission, the bits of the time division multiplexed channels shall be grouped into frames of 24 bits each. The frame structure shall be identical in both directions of transmission. With the exception of circuit delays, the relative bit positions in each direction of transmission shall be coincident in time.

Each frame shall have a nominal duration of 93.744 (is, and repeats every 125 *is*. Each frame shall be synchronized with a 24-cycle SBclock burst. The clock and data signals shall be low during the 31.256 HS inactive time.

The frame structure and alignment with SBclock shall be as shown in Figure 1/MTS20-C.

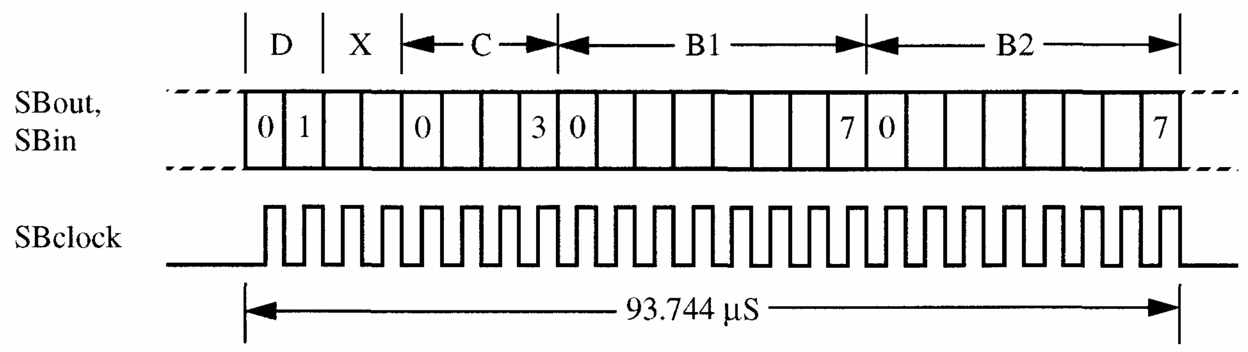

Figure 1/MTS20-C **MiLINK**

Frame Structure

Bits are transmitted in time from left to right. Signal coding is binary non-return-to-zero.

MiLINK peripherals shall use signal SBclock to receive SBout from the digital set and to transmit SBin to the digital set. All internal peripheral timing should be derived from SBclock. The rising edge of SBclock defines the nominal center of an SBout or SBin bit cell

Nominal signal amplitudes are 5 V peak-to-peak. *Note* -

The two bits indicated by X shall be set to 1.

4.5 C-channel bits

The bit allocations on the C-channel from the digital set to the **MiLINK** peripheral(s) shall be as shown in Figure 2/MTS20-C.

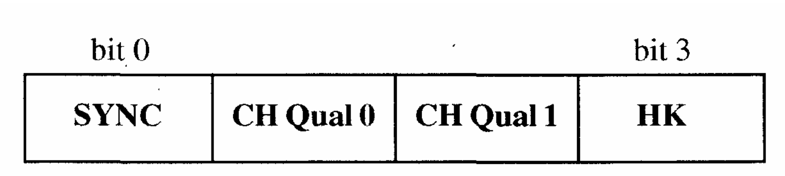

Figure 2/MTS20-C **C-channel**

bit allocations

The bits are defined as follows:

1) SYNC - When set to 1, indicates the digital set has achieved receiver synchronization to the system.

2) CH Qual 0, CH Qual 1 - Provide a relative, binary indication of the digital set's receiver noise margin to the system. Binary 0 represents poorest margin, while binary 3 represents best margin. CH Qual 0 represents the least-significant bit.

3) HK - Housekeeping bit. When set to 0, indicates the MiLINK peripheral(s) must use the D-channel access "go-ahead" protocol (see § 5.2). When set to 1, indicates the "go-ahead" protocol is not required.

5 Interface procedures

5.1 D-channel access procedure

The following procedure allows for up to seven MiLINK peripherals connected in a multipoint configuration to gain access to the D-channel in as orderly a fashion as possible. When a collision does occur, resolution is accomplished via layer 2.

Note - The maximum time over which a peripheral may hold access to the D-channel is 800 ms. A digital set has the ability to lock out all MiLINK peripherals from access to the D-channel if access hold time is excessive.

Whenever layer 1 cannot access the D-channel, it should inform the management entity using the MPH-ERROR-indication primitive as defined in § 5.4.

Figure 4/MTS20-C illustrates the logical flow for D-channel arbitration.

5.1.1 Reference timing model

Figure 3/MTS20-C illustrates the reference timing model for D-channel arbitration.

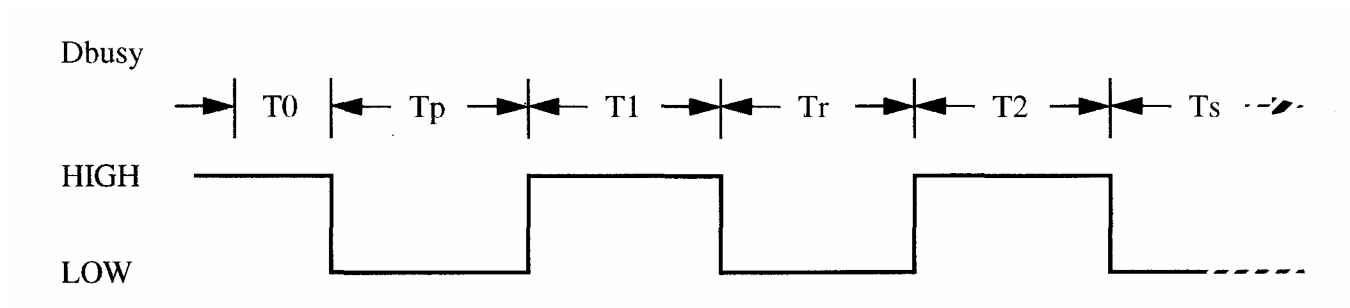

Figure 3/MTS20-C **Reference timing model for D-channel arbitration**

5.1.2 Priority mechanism

In order to ensure that all peripherals are given fair access to the D-channel, once a peripheral has completed the transmission of a frame successfully, it shall release the D-channel and assume the lowest level of priority. Peripherals that compete unsuccessfully for arbitration during the period Tp to Ts shall raise their level of priority. Peripherals that compete successfully for arbitration during the period Tp to Tr shall lower their level of priority (see § 5.1.3).

5.1.3 D-channel arbitration

D-channel access requests and collision avoidance by peripherals shall be accomplished via sampling and activation sequences of the Dbusy signal (see Figure 3/MTS20-C).

Note - To maximize resolution, peripherals should perform as many samples as possible within a given time interval.

During interval TO, a peripheral desiring access to the D-channel shall sample the Dbusy line, searching for a 200 *[is* (minimum) period wherein all contiguous samples are high. During this time, the peripheral's priority level shall remain unchanged. When 200 *[is* of contiguous high samples are detected, the peripheral shall pull the Dbusy signal low for the time period Tp. This time period is based on the peripheral's current priority level, and shall be between 60 *[is* (lowest priority) and 1500 *[is* (highest priority). On expiry of time Tp, the peripheral shall release the Dbusy signal.

During interval Tl, the peripheral shall again sample the Dbusy signal. The duration of this interval shall be at least 100 *[is.*

Note - In order to avoid sampling during transition of the Dbusy signal, its maximum rise time shall be assumed as 30 HS.

If any sample during interval Tl is low, the peripheral shall double its priority time value and enter the D-channel Not Seized state. The peripheral may then restart the arbitration sequence at the beginning of interval TO.

Note - The highest priority (1500 *[is)* is not a double of the previous value (960 u,s).

If all samples during interval Tl were high, the peripheral shall pull the Dbusy signal low for time interval Tr. This interval shall be a random time within the range 60 *[is* to 1500 *[is.*

Note - One acceptable method to establish time Tr is to use a bounded counter operating from a free-running clock. The signal SBclock shall not be used for this purpose. Times Tr and Tp are independent.

On expiry of time Tr, the peripheral shall again release the Dbusy signal.

During interval T2, the peripheral shall again sample the Dbusy signal. The duration of this interval shall be at least 100 (is.

If any sample during interval Tl is low, the peripheral shall double its priority value and enter the D-channel Not Seized state. The peripheral may then restart the arbitration sequence at the beginning of interval TO.

If all samples during interval Tl were high, the peripheral shall again pull the Dbusy signal low and enter time interval Ts. At this point, the peripheral shall enter the D-channel Seized state.

On expiry of interval Ts (ie. successful transmission of a D-channel frame), the peripheral shall set its priority time to 60 *[is* and release the Dbusy signal.

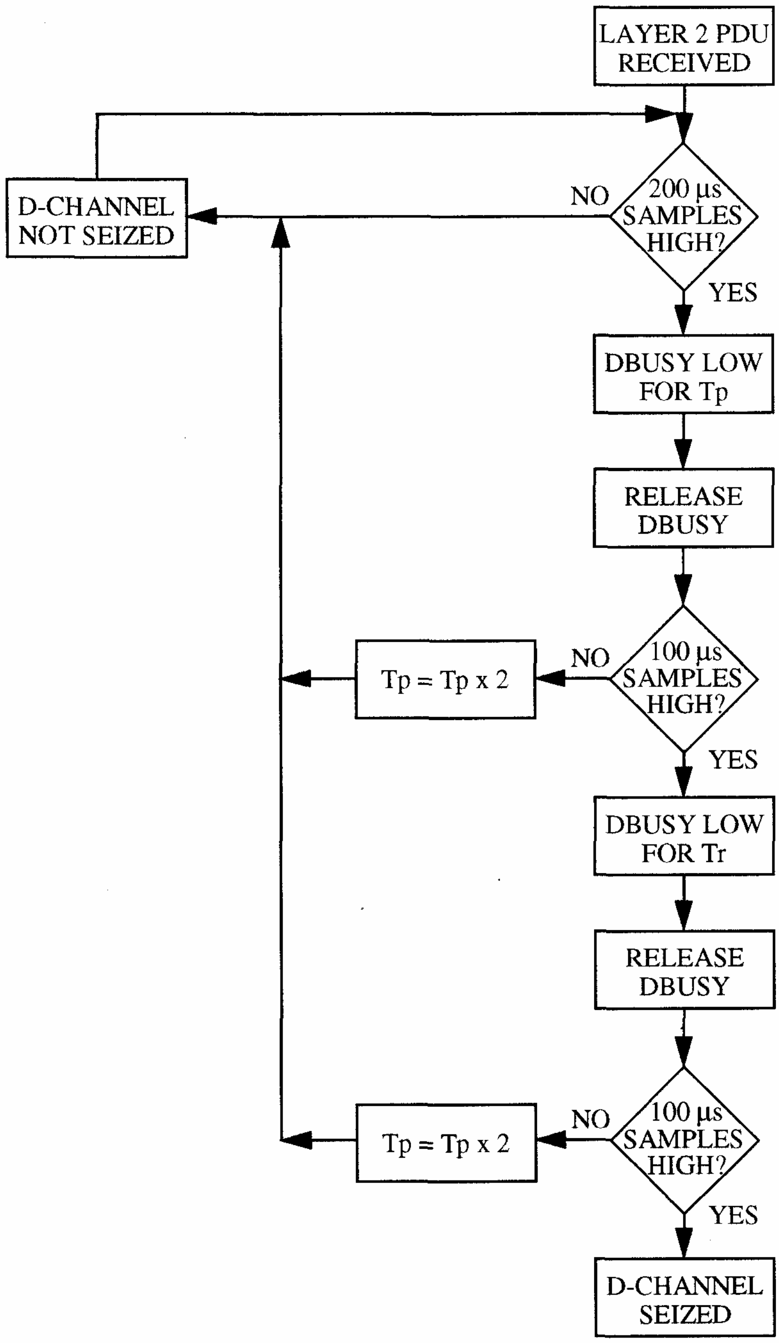

Figure 4/MTS20-C **Logical diagram for D-channel arbitration**

5.2 Go-ahead protocol

5.2.1 General

The go-ahead protocol is required when operating with systems which use shared HDLC resources. When the go-ahead mode is employed, higher-level entities (eg. PBX line card) are always able to transmit to lower-level entities (e.g., sets and peripherals), however the lower-level entities must request access to the shared resource.

Note - Go-ahead is currently the only mode supported.

Terminal equipment may support go-ahead only, non-go-ahead only, or a combination of both. Equipment supporting both modes shall use the C-channel HK bit to determine the operating mode of the system (see § 4.5). When the HK bit is set to 1 the go-ahead protocol shall be used. The HK bit is configured at system initialization and is not changed thereafter.

The go-ahead procedures, when required, shall be performed after each successful D-channel access as defined in § 5.1.

Although this protocol is mainly intended for use on the D-channel, it may also be employed on B-channel connections.

Figure 5/MTS20-C illustrates the normal D-channel go-ahead procedures.

5.2.2 D-channel procedures

A device not requiring access to the D-channel shall present a high impedance on the D-channel.

A peripheral device requiring access to the D-channel shall, after successful D-channel arbitration as specified in § 5.1, begin transmission of a continuous series of HDLC flags. A flag consists of one 0 bit followed by six contiguous 1 bits followed by one 0 bit (see MTS21).

During this time the higher-level entity may be transmitting a sequence of all-ones or continuous flags.

To grant go-ahead, the higher-level entity will change its pattern to a repeating sequence of a 0 bit followed by seven 1 bits. At least two such sequences shall be sent. The lower-level entity shall determine the presence of the go-ahead pattern on reception of a 0 bit followed by seven 1 bits followed by a zero bit.

On receipt of the go-ahead grant pattern, layer 1 shall inform its data link layer entity via the PH-ARBITRATE-con/7rw primitive. Layer 1 shall then transmit a single frame.

On completion of the transmission of a single frame, layer 1 shall then return to the high impedance state and release the D-channel by releasing Dbusy.

Note - During address negotiation (see § 5.3 below), the D-channel is not released, however go-ahead arbitration is required for each frame transmission.

The higher-level entity, having begun transmission of the go-ahead grant sequence, shall cease transmission of the sequence as soon as an incoming frame is received or the go-ahead request pattern is removed. In order to ensure that peripherals do not erroneously perceive two successive go-ahead grants, it is recommended that the higher-level entity restrict the number of go-ahead patterns to a maximum of 3.

5.2.3 B-channel procedures

For B-channel operation, all procedures shall be identical to D-channel operations (see § 5.2.2 above), except the lower-level entity must hold the idle all-ones pattern for at least 10 ms between successive transmission of frames.

Note - B-channel access is controlled via D-channel layer 3 messages. See MTS22 [5].

In addition, devices implementing go-ahead on a B-channel shall employ a "wait for go-ahead" timer, T211. The default value of this timer shall be 1 second.

Timer T211 shall be started on initiation of the go-ahead sequence, and shall be stopped on receipt of the go-ahead grant pattern.

On expiry of T211, the lower-level entity shall assume the higher-level entity is in a fault condition. In this event, the lower-level entity shall:

disconnect from the B-channel;
return to the D-channel via procedures defined in §§5.1 and 5.2; and inform system management via the *MPH-ERROR-indication* primitive.

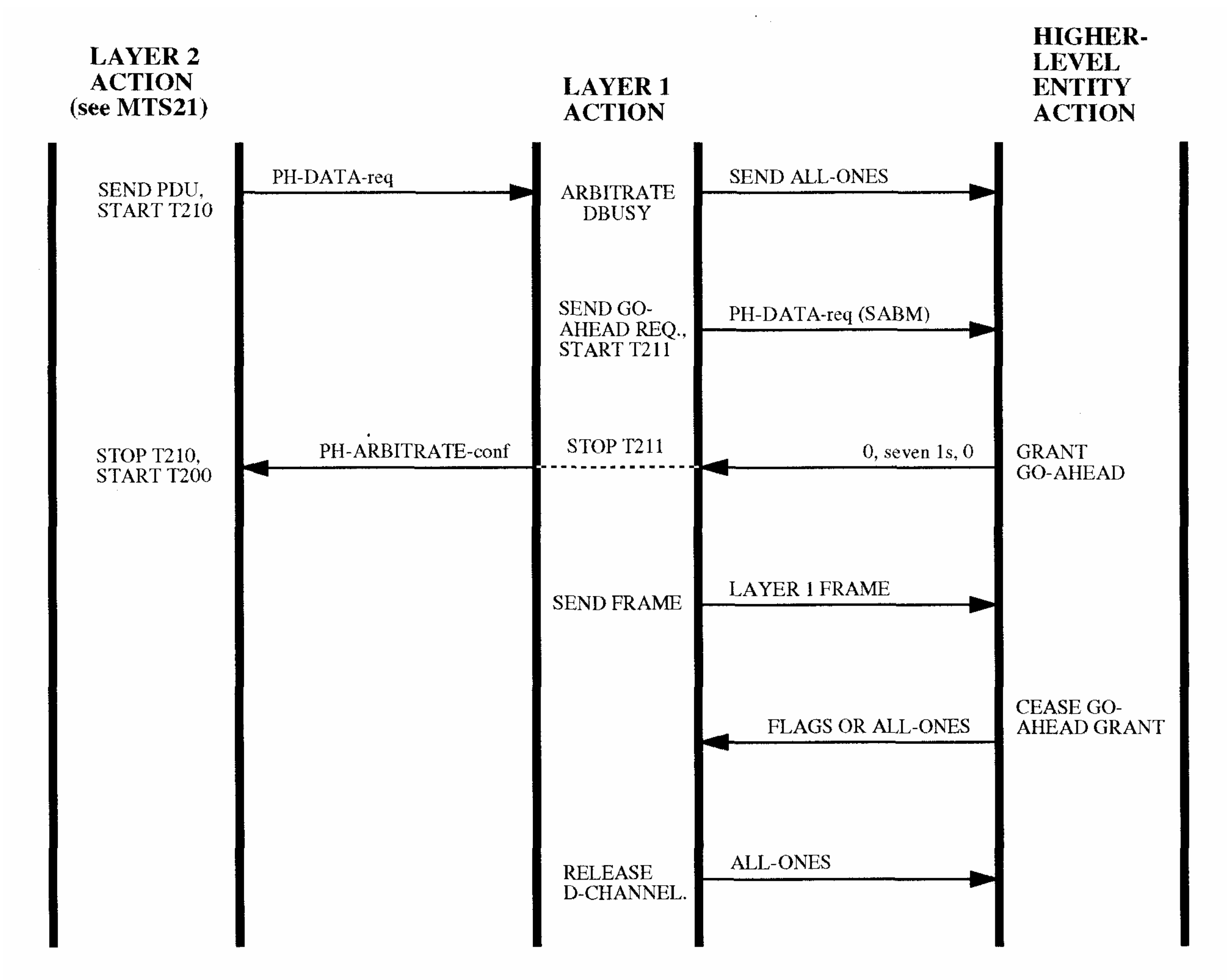

Figure 5/MTS20-C **Go-ahead procedures**

5.2.4 Non-go-ahead procedures

Upon receipt of a PDU from layer 2, a layer 1 entity not requiring go-ahead procedures shall:

arbitrate for the D-channel, as specified in § 5.1;

transmit the layer 2 frame immediately;

notify layer 2 via the PH-ARBITRATE-confirm primitive; and release the D-channel.

5.3 D-channel hold procedure

During address negotiation (refer to MTS21 [4]), a MiLINK peripheral arbitrates for D-channel access according to the procedures defined in § 5.1.

Once D-channel access has been granted, the peripheral must complete the entire address negotiation sequence before releasing the D-channel. This sequence requires more than the one frame limit as defined in § 5.1.3.

The D-channel arbitration and hold sequence shall be performed by layer 1 under the control of the data link layer.

The arbitration and hold sequence should be initiated by layer 1 upon receipt from the data link layer of the *P^-ROLD-request* primitive. Upon successful D-channel arbitration and hold, layer 1 should respond with the *PH-HOLD-confirm* primitive.

The D-channel hold sequence should be terminated by layer 1 upon receipt from the data link layer of the *PH-RELEASE-request* primitive. Upon successful release of the D-channel, layer 1 should respond with the PH-RELEASE-confirm primitive.

5.4 Definition of primitives

The actual implementation of primitives does not form part of this specification.

For further information on procedures related to primitives used between layer 1 and the data link layer, refer to MTS21[4].

5.4.1 Data transfer primitives

The following primitives should be used for the transfer of data between layers 1 and 2:

1) *PH-DAJA-request* (L2 to LI)
(Used by layer 2 to request a data transfer service from layer 1.)

2) *PH-DATA-indication* (LI to L2)
(Used by layer 1 to indicate the arrival of a data unit to layer 2.)

The message units contain the actual layer 2 data.

5.4.2 Activation primitives

The following primitives should be used by layer 1 to provide MiLINK status information to layer 2.

1) PH-DEACTIVATE- indication (LI to L2)
(Informs layer 2 of a MiLINK discontinuity. Data transfer is not possible.)

2) PH-ACTIVATE-indication (LI to L2)
(Informs layer 2 of the cessation of a MiLINK discontinuity.)

5.4.3 D-channel hold primitives

The following primitives should be used between layer 1 and the data link layer for control of the D-channel arbitrate and hold sequence required for address negotiation.

1) ***PH-HOLD-request*** (L2 to LI)
(Requests layer 1 to commence the sequence.)

2) *PH-HOLD-confirm* (LI to L2)
(Confirms successful completion of the sequence.)

3) *PH-RELEASE-request(L2toLI)*
(Requests layer 1 to terminate the hold state.)

4) PH-RELEASE-confirm (LI to L2)
(Confirms termination of the hold state.)

5.4.4 Management primitives

The following primitives should be used by layer 1 to provide MiLINK status information to the management entity.

1) MPH-DEACTIVATE-indication (LI to M)
(Informs the management entity of a MiLINK discontinuity. Data transfer is not possible.)

2) *MPH-ACTIVATE-indication* (LI to M)
(Informs the management entity of the cessation of a MiLINK discontinuity.)

3) *MPH-ERROR-indication* (LI to M)
(Informs the management entity of errors experienced by the physical layer.)

5.5 Idle channel codes

Peripherals shall establish a high impedance .(e.g., logic family tri-state) for channels on which they are not actively communicating.

6 Electrical characteristics

Note - All voltages are specified with respect to digital ground (DG).

6.1 Interconnect cable

The MiLINK shall be specified for operation over both unshielded and shielded twisted-pair cable. The cable characteristics shall be as defined in §§ 6.1.1 and 6.1.2.

6.1.1 Unshielded cable

The characteristics of the unshielded cable shall be as follows:

Maximum resistance = 0.33 ohms/meter

Maximum capacitance = 70 pF/meter

6.1.2 Shielded cable

The characteristics of the shielded cable shall be as follows:

Maximum resistance = 0.33 ohms/meter

Maximum capacitance =150 pF/meter

The shield conductor shall be connected to pin 1 at each plug. Each peripheral shall tie pin 1 to digital ground internally.

Note1 - The use of a shielded cable may be required to meet European EMC requirements. See in particular §8.1.3.2.

Note2 - Due to the increased capacitance of the shielded cable, it may be necessary to limit the overall cable length to less than 3 meters.

Note3 - The value shown for maximum shielded cable capacitance is considered representative at this time, but is subject to ongoing study.

6.2 Maximum peripheral loading

The maximum loading of a MiLINK signal output, being the sum of all cable resistances and the sum of cable capacitances plus peripheral input capacitances, shall be as shown in Figure 6/MTS20-C.

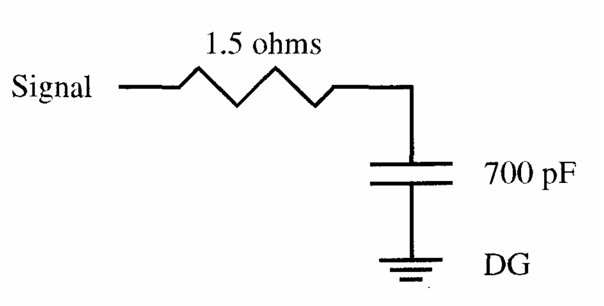

Figure 6/MTS20-C **Maximum peripheral loading**

6.3 Receiver input characteristics

Peripheral clock and data signal receivers shall exhibit characteristics as shown in Table 1/MTS20-C.

Table 1/MTS20-C **Receiver input characteristics**

Parameter	Value
Low state current	0.2 mA max.
High state current	50 µA max.
Low state voltage	0.7 V max.
High state voltage	2.0 V min.
Capacitance	40 pF max.

6.4 Transmitter output characteristics

Peripheral clock and data signal transmitters shall exhibit, characteristics as shown in Table 2/MTS20-C.

Table 2/MTS20-C **Transmitter output characteristics**

Parameter	Value
Series resistance	100 ohms (rec.)
Low state current	20 mA min.
High state current	15 mA min.
Low state voltage	0.4 V max.
High state voltage	2.7 V min.

Note - The series resistance value in Table 2/MTS20-C is shown as a recommended value to dampen signal ringing.

6.5 Timing relationships

Figure 7/MTS20-C and Table 3/MTS20-C define the timing relationships between SBout, SBin and SBclock.

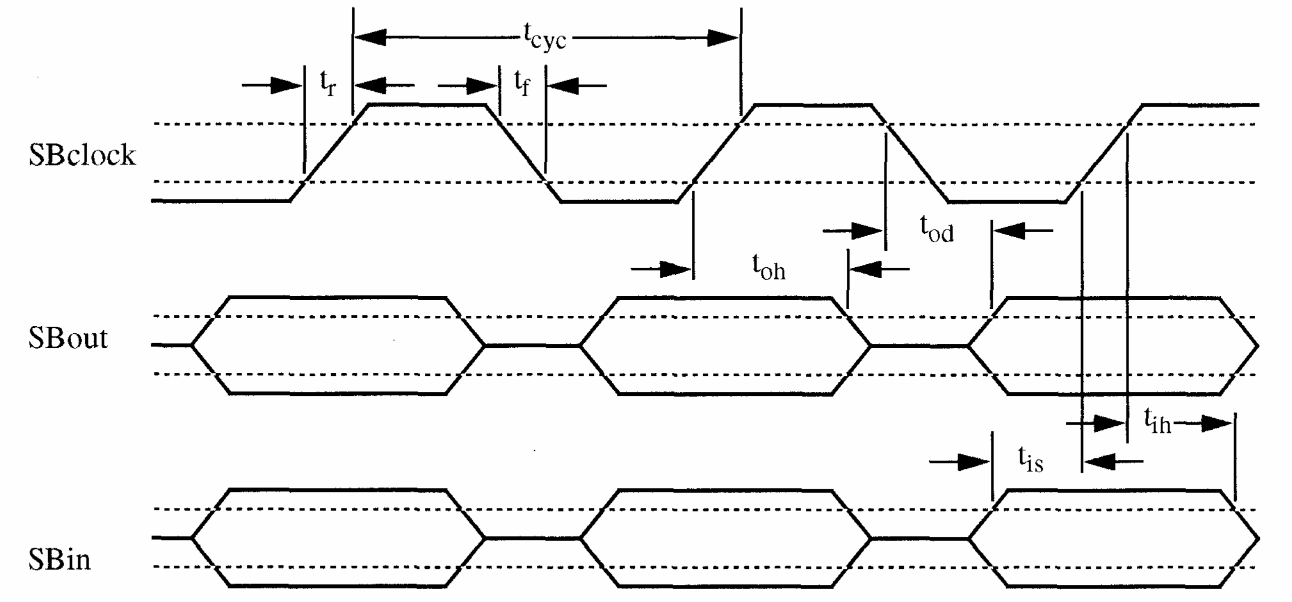

Figure 7/MTS20-C **MiLINK timing relationships**

Note1 - The states of SBout and SBin between active bit cells is indeterminate.

Note2 - Input (i) and output (o) parameters are with respect to the digital set.

Note3 - Maximum rise time of the Dbusy signal is 30 (AS. Dbusy is not shown, as it has no timing relationship to other signals.

Note4 - The start of the first SBin/SBout bit cells in a frame precede the first SBclock rising edge by 1/2 *t* nominally.

Table 3/MTS20-C **MiLINK timing values**

	Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
1	Rise time, fall time	tr, tf	150		500	ns	Min. to max. loading
2	Clock period	t cyc		3906		ns	
3	Output delay	t od			800	ns	
4	Output hold time	toh	1000			ns	
5	Input setup time	tis	200			ns	
6	Input hold time	tih	100			ns	

Note - To minimize EMI, t;. and tf should be equalized.

6.6 Waveshaping

This section is included for information purposes only.

In order to reduce emissions, the digital set applies the network shown in Figure 8/MTS20-C internally on the SBclock and SBout signal lines.

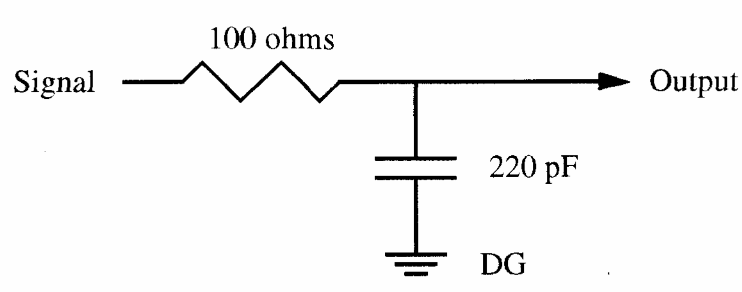

Figure 8/MTS20-C **Digital set waveshaping network**

7 Interface connector contact assignments

7.1 Interface connectors

Figure 9/MTS20-C shows an example of the MiLINK interface cord and jack. The jack and plugs shall be of the offset latch type to prevent inadvertent connection to telephony circuits. The cord's conductors shall be 26 ga AWG stranded copper. Tinsel construction shall not be used.

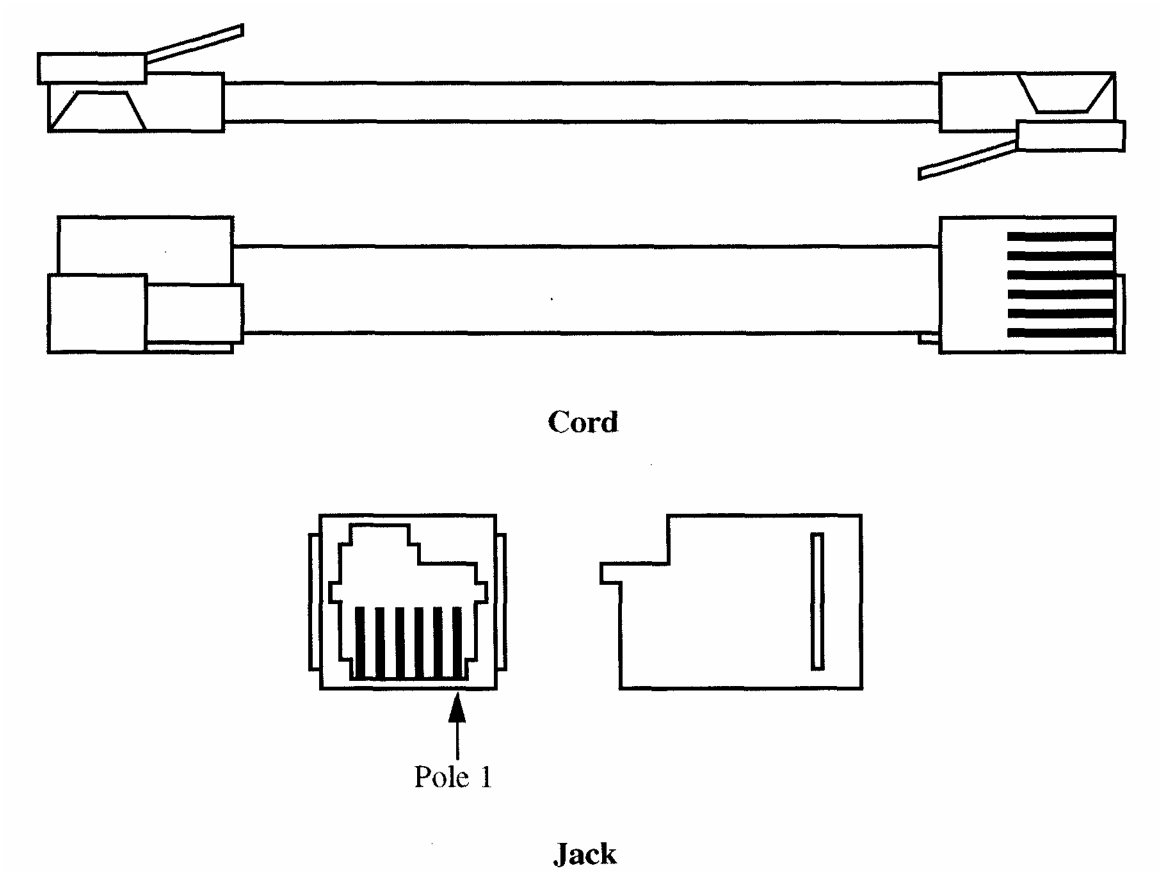

Figure 9/MTS20-C **MiLINK interface connectors**

7.2 Connector contact assignments

Connector contact assignments shall be as illustrated in Table 4/MTS20-C.

Table 4/MTS20-C **MiLINK connector contact assignments**

Pole	Circuit	Pole	Circuit
1	DG	4	Dbusy
2	SBclock	5	SBin
3	Reserved	6	SBout

Note1 - For **EMC** purposes, a shielded cable may be required in some cases. When provided, the shield shall be connected to pole 1 at the jack and plug.

Note2 - The same interchange circuit naming convention shall be used at both the digital set and peripherals.

Note3 - Pole 3 shall not be connected at the peripheral.

8 Electromagnetic compatibility

This section contains the electromagnetic compatibility (EMC) requirements for both emissions and immunity at a MiLINK interface. The requirements represent the combined performance of the interface and peripheral.

8.1 Emission requirements

In this section, the requirements are given for radiated emissions, and for conducted emissions on signal leads and AC and DC power leads. The measurements shall be performed with a quasi-peak radio noise meter conforming to CISPR 16 [15].

8.1.1 Radiated emissions

8.1.1.1 Canada/US requirements

Radiated emissions shall not exceed the electric field strength limits over the frequency range from 10 kHz to 10 GHz, as shown by Figure 10/MTS20-C. The requirements are taken from Bellcore TA-NWT-001089 [6], for a measurement distance of 10 metres. FCC Part 15 [17] Class B requirements are the subset of Bellcore in the frequency range above 30 MHz.

8.1.1.2 European requirements

Radiated emissions shall not exceed the electric field strength limits over the frequency range from 30 MHz to 1 GHz, as shown by Figure 11/MTS20-C. The requirements are taken from EN55022 [12], for a measurement distance of 10 metres. The requirements correspond to Class B.

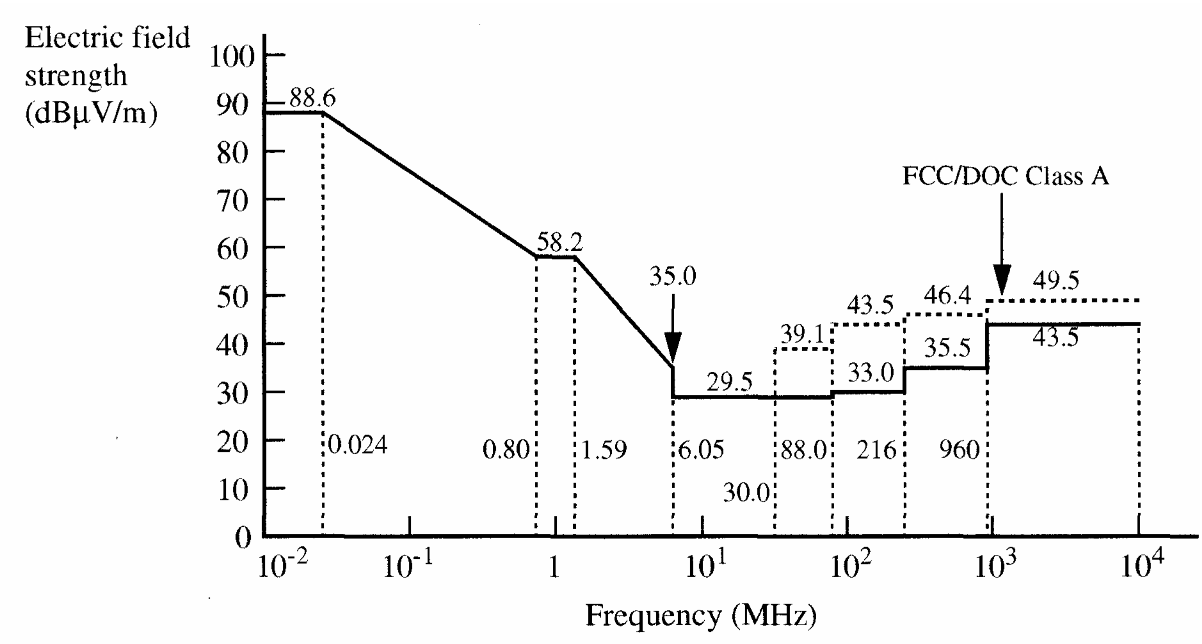

Figure 10/MTS20-C **Limits for radiated emissions at 10 metres (Canada/US)**

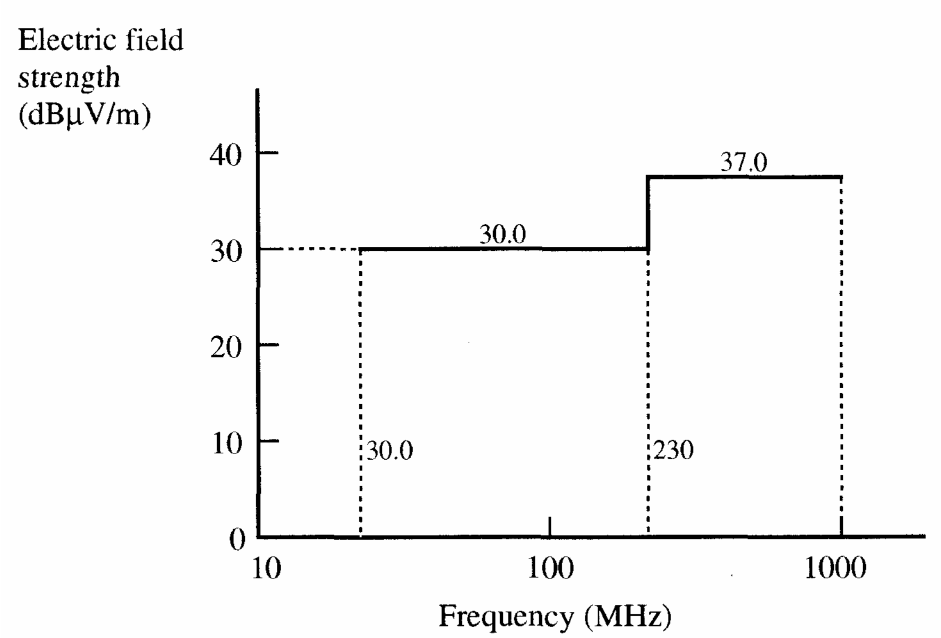

Figure 11/MTS20-C **Limits for radiated emissions at 10 metres (Europe)**

8.1.2 Conducted emissions *on* AC power leads

8.1.2.1 Canada/US requirements

The conducted emissions onto low voltage AC (mains) power leads shall not exceed the limits shown in Figure 12/MTS20-C. The values shown are quasi-peak. The requirements are taken from Bellcore TA-NWT-001089 [6] and are equal to FCC Part 15 [17] Class B.

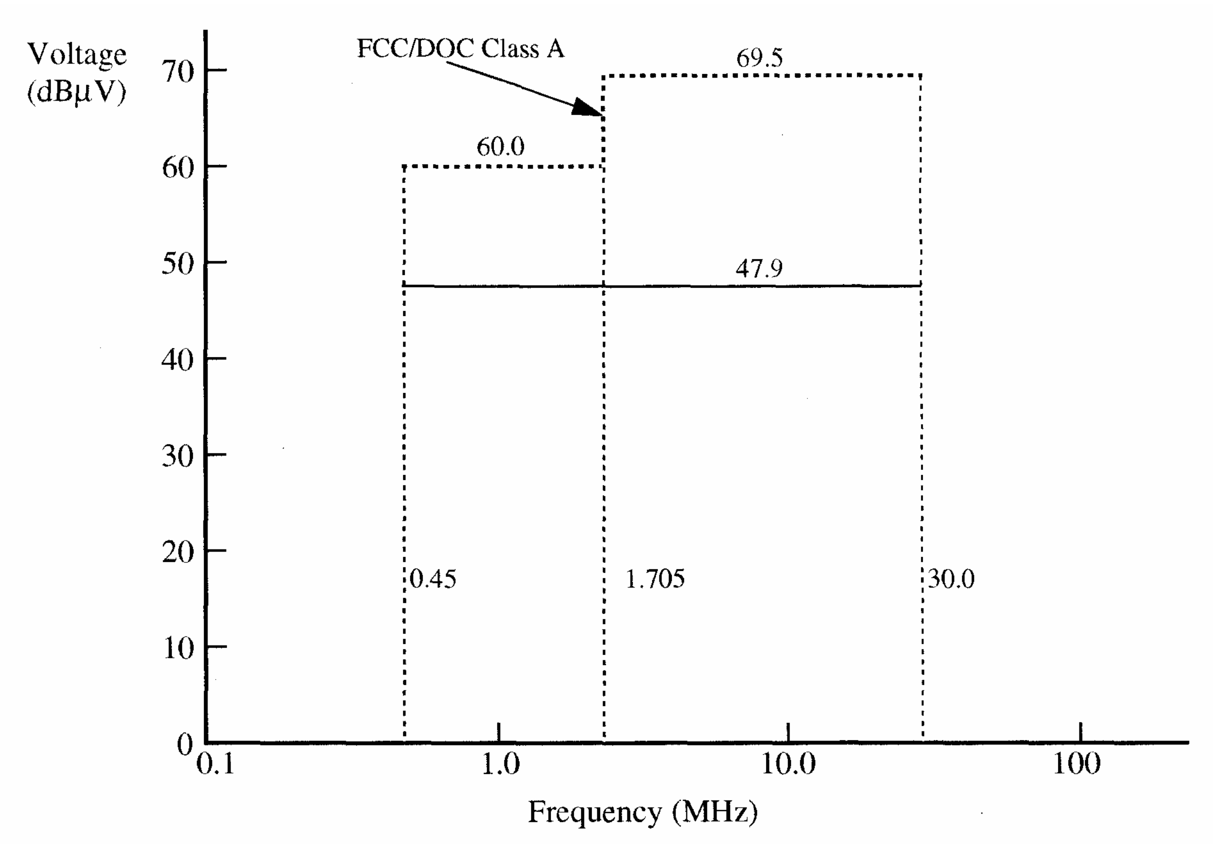

Figure 12/MTS20-C Limits for conducted emissions on AC power leads (Canada/US)

8.1.2.2 European requirements

The conducted emissions onto low voltage AC (mains) power leads shall not exceed the Class B limits shown in Figure 13/MTS20-C. The values shown are quasi-peak. The requirements are taken from EN 55022 [12].

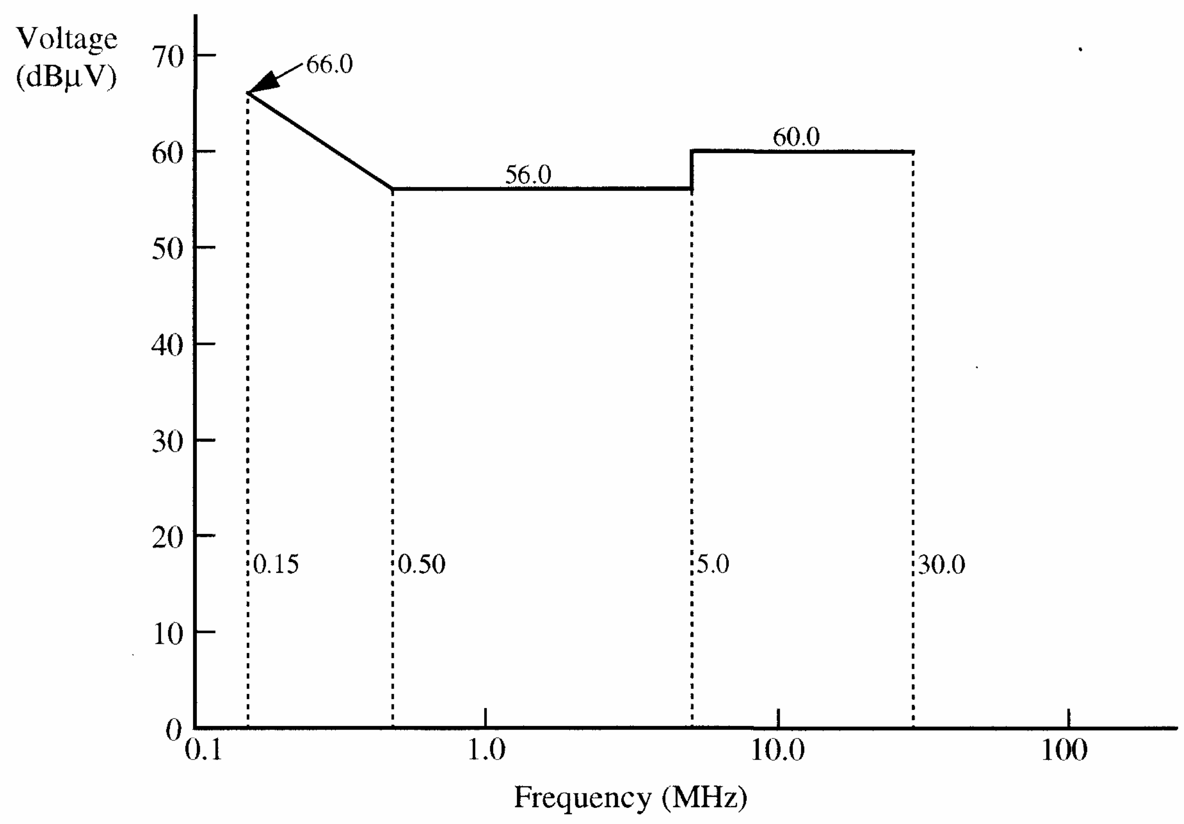

Figure 13/MTS20-C **Limits for conducted emissions on AC power leads (Europe)**

8.1.3 Conducted emissions on signal and DC power leads

In terms of signal leads, the requirements in this section do not apply to the MiLINK interface itself, but do apply to the DNIC line port of the digital set and any balanced interfaces connected to MiLINK peripherals.

8.1.3.1 Canada/US requirements

Conducted emissions onto the signal and DC power leads shall not exceed the limits shown in Figure 14/MTS20-C. The requirements are taken from Bellcore TA-NWT-001089 [6]. They are not mandatory for regulatory purposes.

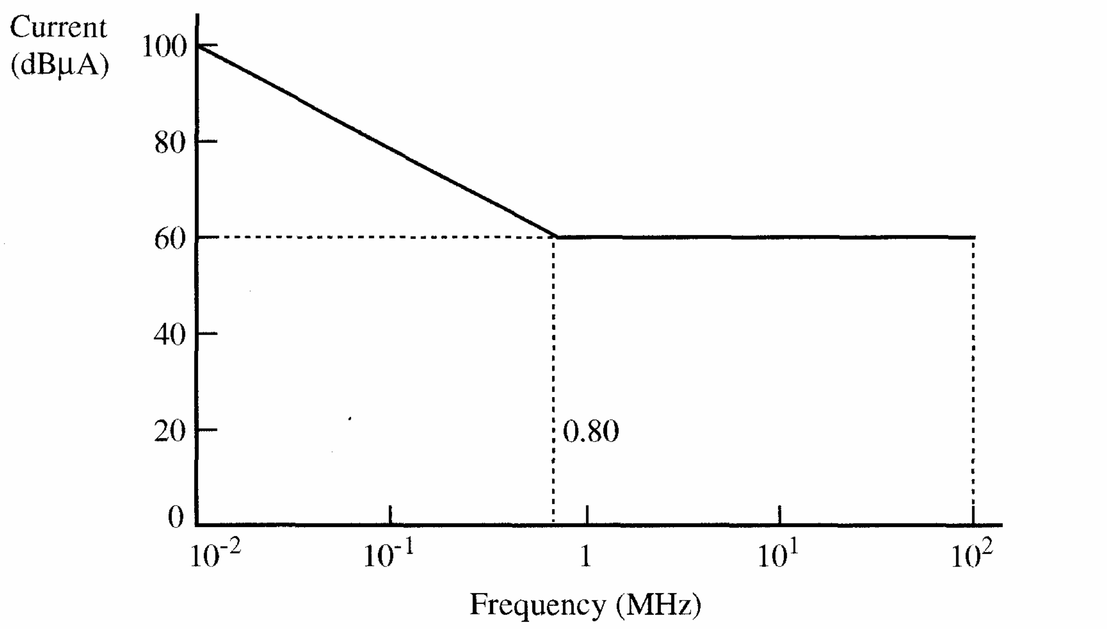

Figure 14/MTS20-C

Limits for conducted emissions on signal and DC power leads (Canada/US)

8.1.3.2 European requirements

Conducted emissions onto the signal and DC power leads shall not exceed the limits shown in Figure 15/MTS20-C (measured quasi-peak). The requirements are taken from EN 55022 [12].

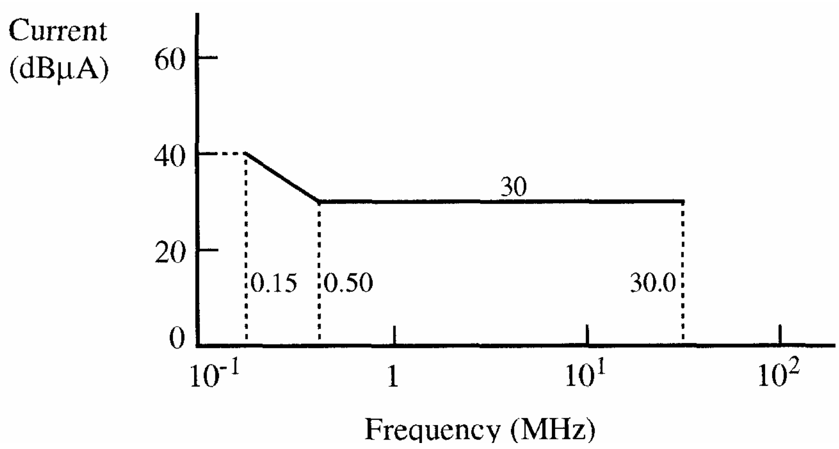

Figure 15/MTS20-C Limits for conducted emissions on signal and DC power leads (Europe)

8.2 Immunity requirements

This subsection contains the immunity requirements for both radiated and conducted electromagnetic immunity. Immunity requirements are not mandatory for regulatory purposes in Canada and the US.

8.2.1 Immunity to radiated electric fields

8.2.1.1 Canada/US requirements

Equipment shall continue to meet all performance objectives while subjected to the radiated electric fields in the range of 10 kHz to 10 GHz as shown in Figure 16/MTS20-C. The requirements are taken from Bellcore TA-NWT-001089 [6].

Note - Bellcore indicates an objective level of 140 dBμV/m over the range 10 kHz to 10 GHz.

8.2.1.2 European requirements

Equipment shall continue to meet all performance objectives while subjected to radiated electric fields in the range of 80 MHz to 1 GHz with a field strength of 3 V/m (129.5 dBμV/m).

Note - Temporary disturbances (eg. display change) which are self-clearing and non-recurring are allowed, but bit errors are not allowed.

The requirement has been taken from EN 50 082-1 [11].

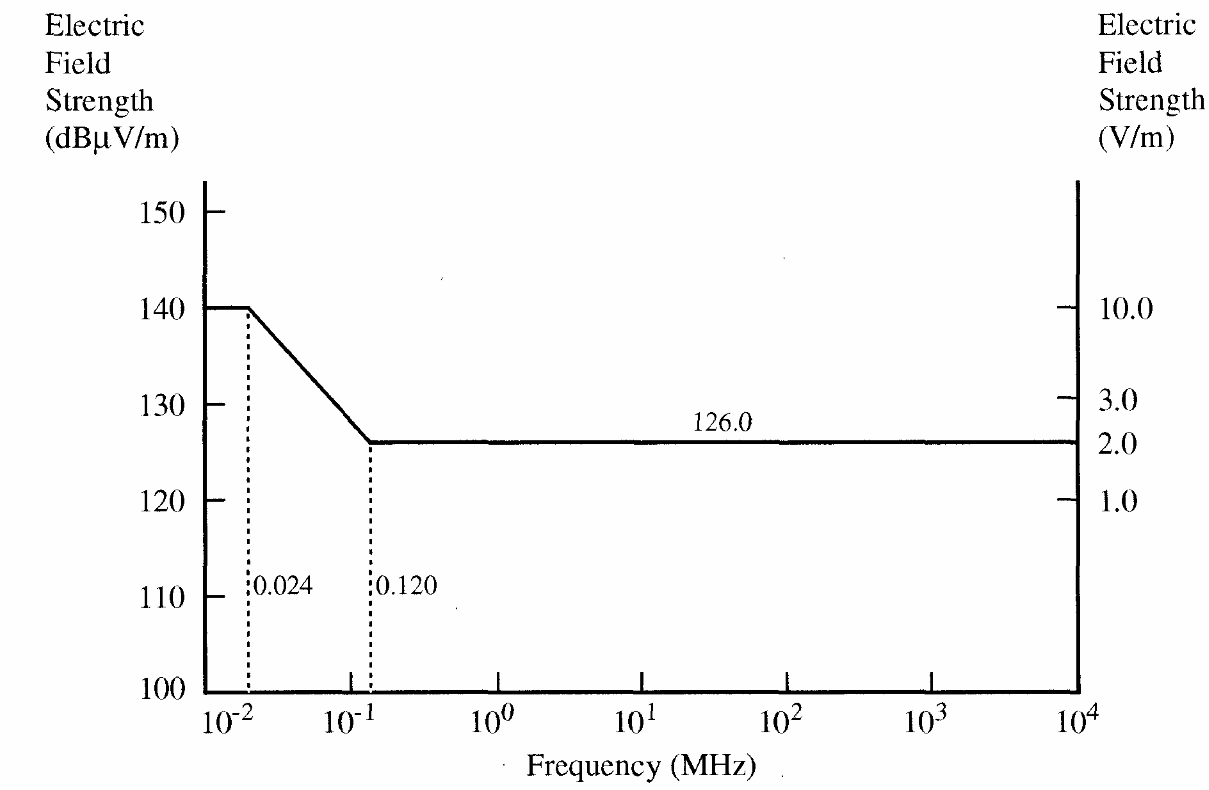

Figure 16/MTS20-C **Radiated immunity requirements**

(Canada/US)

8.2.2 Immunity to radiated magnetic fields

8.2.2.1 Canada/US requirements

Equipment shall continue to meet all performance specifications while subjected to the radiated magnetic fields shown in Figure 17/MTS20-C. The requirements are taken from Bellcore TA-NWT-001089 [6].

8.2.2.2 European requirements

Equipment shall continue to meet all performance specifications while subjected to a radiated magnetic field at a frequency of 50 Hz with a field strength of 130 dBmA/m. The requirement has been taken from EN 50 082-1 [11].

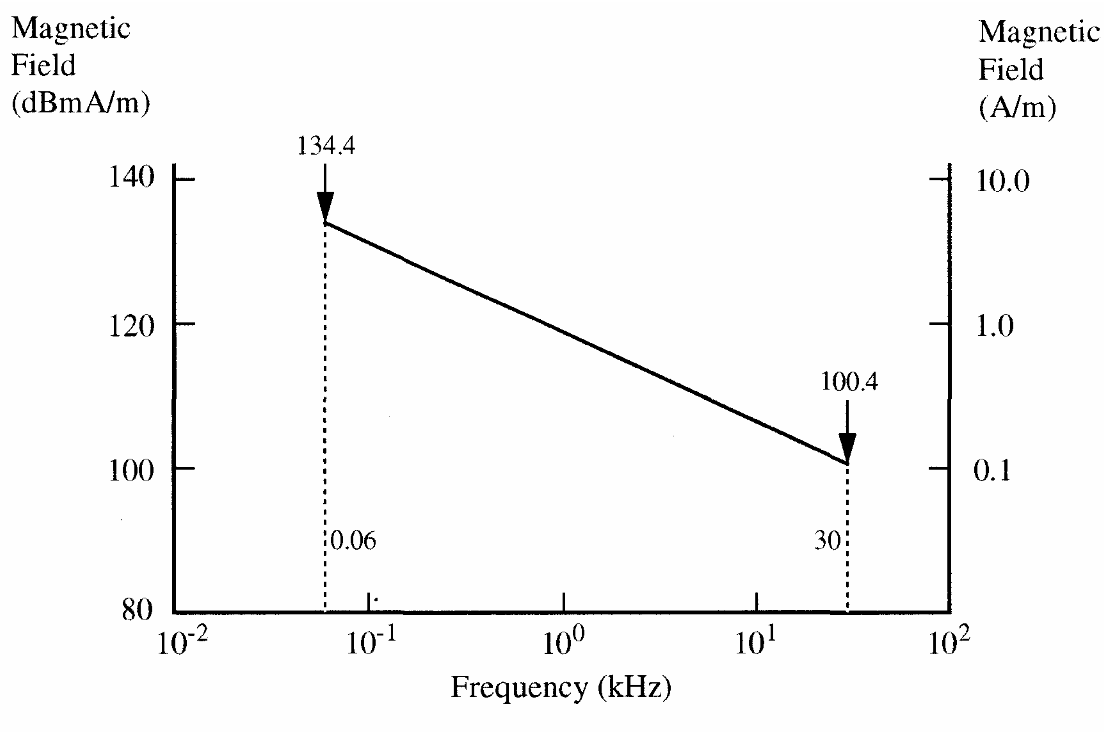

Figure 17/MTS20-C **Radiated magnetic field requirements (Canada/US)**

8.2.3 Conducted immunity on signal leads and AC and DC power leads

8.2.3.1 Canada/US requirements

Equipment shall continue to meet all performance specifications while subjected to the conducted levels as shown in Figure 18/MTS20-C. The requirements have been taken from Bellcore TA-NWT-001089 [6].

8.2.3.2 European requirements

Equipment shall continue to meet all performance specifications while subjected to a conducted level of 86 dBμA over the frequency range of 150 KHz to 80 MHz. The requirement is taken from EN 55101 [13].

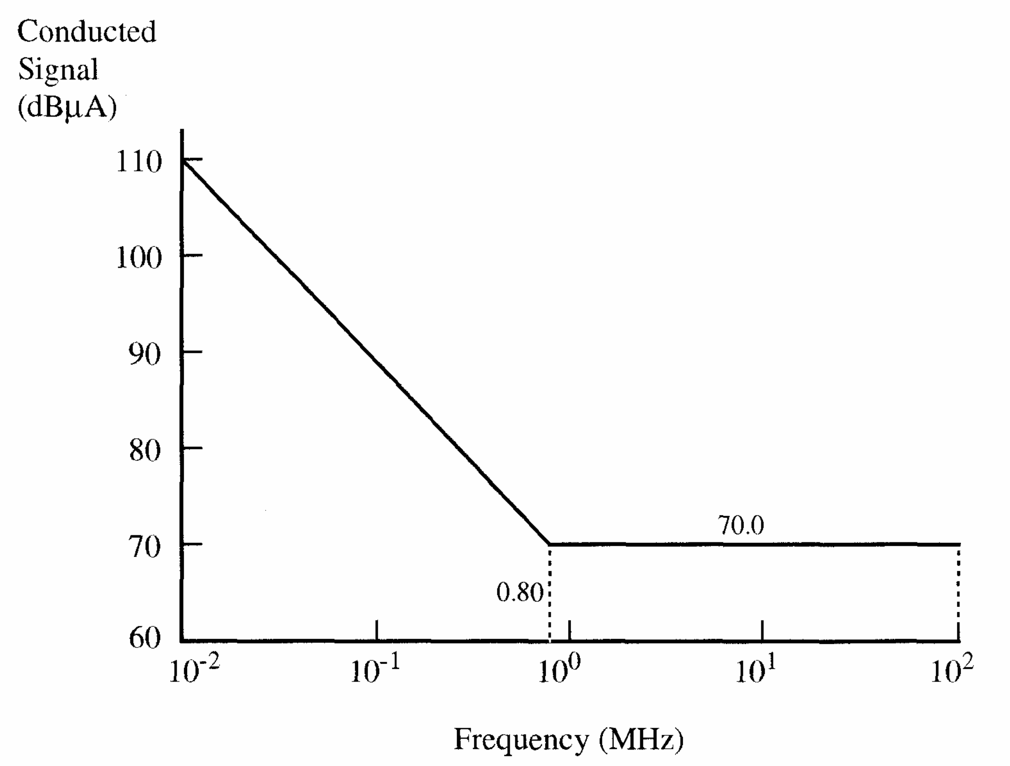

Figure 18/MTS20-C

Conducted immunity requirements on signal leads and AC and DC power leads (Canada/US)

8.2.4 Electrostatic discharge

The requirements in this section are taken from Mitel document PDS003 [3].

The requirements are based on a concept of normal and limited user access. Limited access may be characterized by those areas of a device which are accessed only during installation. Examples of limited access areas are the MiLINK connectors and cables, and the physical device address switches.

The EUT shall not exhibit faults of the type indicated up to the voltage specified for each test in Table 5/MTS20-C. Minor effects are allowable within a no-fault classification, but shall self-clear in less than 1 second. Soft faults are characterized by a momentary interruption in normal operation. Soft faults shall self-clear within 10 seconds, but may also include a dropped call. Hard faults are characterized by loss of service to a user, requiring repair or replacement. Conditions requiring a unit to be powered down for fault correction shall be considered hard faults.

The discharges shall be applied by a test generator exhibiting a storage capacitance of 150 pF and a series output resistance of 330 ohms. A total of 10 discharges (5 of each polarity) shall be applied at each maximum voltage. The discharge repetition rate shall not exceed once every 5 seconds.

Table 5/MTS20-C **Electrostatic discharge requirements**

Air discharge		
Access	Soft fault	Hard fault
Normal	15 kV	18 kV
Limited	8kV	10 kV
Contact discharge		
Access	Soft fault	Hard fault
Normal	8kV	10 kV
Limited	6kV	8kV

9 Electrical protection and safety

9.1 Introduction

9.1.1 General

This section addresses the electrical protection and safety requirements for MiLINK peripherals. It covers the protection of both equipment and people from voltages and currents caused by lightning and AC power faults. The requirements relate specifically to interfaces, and do not cover product aspects such as acoustic shock, enclosure and component flammability, enclosure impact tests or enclosure mold stress relief.

For the purpose of safety and protection, the MiLINK interface shall be considered a TNV circuit not exceeding the voltage limits for SELV circuits.

The requirements presented here meet the applicable requirements from EN 60950 [14|, BS 6301 (1989) [7], Bellcore TA-NWT-001089 [6], UL 1459 [20] and CSA 22.2 No. 225 [16].

9.1.2 Protection and safety levels

Two levels are used for electrical protection and safety levels. MiLINK peripherals must pass both test levels to meet this specification. The levels are as follows:

1. Equipment protection (hereafter referred to as protection).

2. Personnel safety (hereafter referred to as safety).

To meet the equipment protection level, the EUT shall not be damaged and shall not require manual intervention to restore complete functionality.

To meet the safety level, the EUT shall not present a fire, fragmentation or electrical safety hazard. The EUT may suffer permanent damage as a result of safety tests.

The fire hazard indicator shall be the ignition or charring of cheese cloth sufficient to destroy its structural integrity when two single plies are wrapped tightly around the EUT. The required cheese cloth has the following characteristics:

1. Bleached, untreated cotton;

2. Weight of 28 to 30 m/kg (14 to 15 yd/lb);

3. Thread count of 32 threads/inch by 28 threads/inch.

A fragmentation hazard is defined as the expulsion of foreign material with sufficient force or at elevated temperatures to cause injury to persons.

An electrical hazard is defined as any voltage in excess of 42.4 Vac peak or 60 Vdc with a current-carrying capacity greater than 0.1 MIU-RR (see § 9.3.1), and/or an electrical energy level of either 240 VA or 20 joules existing at a potential greater than 2 V.

9.2 Requirements and limits for SELV circuits

A SELV circuit shall be so designed and protected that, under normal and single-fault conditions, the voltage between any two accessible parts, or between one accessible part and the equipment protective grounding (earthing) terminal (for class I equipment), does not exceed a safe value. Examples of single-fault conditions are the breakdown of basic insulation or the failure of a single component.

Under normal conditions, as specified in §2.3.2 of EN 60950 [14], the accessible voltage shall not exceed 42.4 V peak, or 60 **V DC.**

In the event of a single failure of basic or supplementary insulation, or of a component (excluding components with double or reinforced insulation), voltages in excess of the above limits shall not be exhibited for more than 0.2 seconds, nor shall the excessive voltages ever exceed 65 V peak or DC.

9.3 Electrical protection and safety requirements

The MiLINK interface shall be considered unexposed wiring (ie. not subject to voltages exceeding 300 V rms.

9.3.1 Earth leakage current from **AC** mains

The leakage current from AC mains shall not exceed 0.1 MIU-RR per MiLINK peripheral, when measured in accordance with UL 1459 [20].

9.3.2 Short circuit tests at the interface

The purpose of the short circuit test is to ensure that the EUT can withstand the application of a temporary short circuit (resistance less. than 1 *Q.)* between its leads and ground.

The requirements for this test are based on Bellcore TA-NWT-001089 [6].

9.3.2.1 Equipment protection

With the EUT powered, it shall meet the equipment protection requirement of § 9.1.2 (with the exception that manual intervention shall be allowed) following the application of a short circuit for 30 minutes across each of the following terminals of the 6-pole connector (see Table 4/MTS20-C).

1. Each pole and all other poles individually;
2. All poles simultaneously and ground.

9.3.2.2 Safety

During the tests in § 9.3.2.1, the EUT shall meet the safety requirement of § 9.1.2.

Under any single fault condition, the maximum current shall not exceed 1.3 A under the condition of maximum load, including short circuit on the connector contacts (see Table 4/MTS20-C) taken between contacts or from a contact to ground (protective or signalling earth).

Note1- The term "single fault" shall be taken as meaning exclusive of shorting an overcurrent protective device designed to permit no greater than 1.3 A to flow from the source of supply.

Note2- The short circuit test does not apply if the terminal displays dielectric isolation of at least 1000 Vac when tested in accordance with § 9.3.3.

9.3.3 Dielectric tests

The EUT shall meet the dielectric voltage levels as shown in Table 6/MTS20-C applied between the points indicated for a period of at least one minute. The requirements have been selected to meet applicable specifications from EN 41003 [9], EN 60950 [14], BS 6301 [7], UL 1459 [20] and CSA 22.2 No. 225 [16].

Table 6/MTS20-C

Dielectric test levels

Test Points	Test Voltage	Comments
MiLINK interface and other communications ports	1500 Vac rms (EU) 1000 Vac rms (NA)	Supplementary insulation
MiLINK interface and AC power connections	3000 Vac rms (EU) 1500 Vac rms (NA)	Reinforced insulation Basic insulation (see Note 3)
Protective earth and other telecommunications ports connected to exposed plant	1500 Vac rms	Supplementary insulation

Note1- In Europe, EN41003 [9] allows for a choice of impulse tests (10x700 µS) or electric strength tests. For the impulse tests, the level is normally 1.5 kV peak between the telecommunications port and other accessible parts or ports, except in the case of hand-held parts where the level is 2.5 kV peak. For Austria, the normal level is 2.0 kV peak.

Note2- For Norway, an impulse test is applied between the telecommunications port and the AC mains. The level is 10 kV peak for power distribution systems where no surge suppressor is installed, and 2.5 kV peak where surge suppressors are installed. Refer to Annex B of EN41003 [9].

Note3- The NA requirement applies only to equipment powered via an AC connector composed of two conductors and a protective ground.

Note4- The equivalent DC level for all tests is 1.414 times the value shown.

9.3.4 Lightning surge tests

The purpose of the lightning surge tests is to ensure that the EUT can withstand lightning-derived surges applied to its AC power port. The requirements have been selected to meet applicable specifications from Bellcore TA-NWT-001089 [6] (North American tests) and IEC 801-5 [19] (European tests). Surges shall be applied while the EUT is powered.

Due to fundamental differences, North American and European requirements are shown separately.

The reference waveform for the lightning surge voltage is shown in Figure 19/MTS20-C. The specified voltage is the open-circuit peak voltage, while the specified current is the short-circuit peak current.

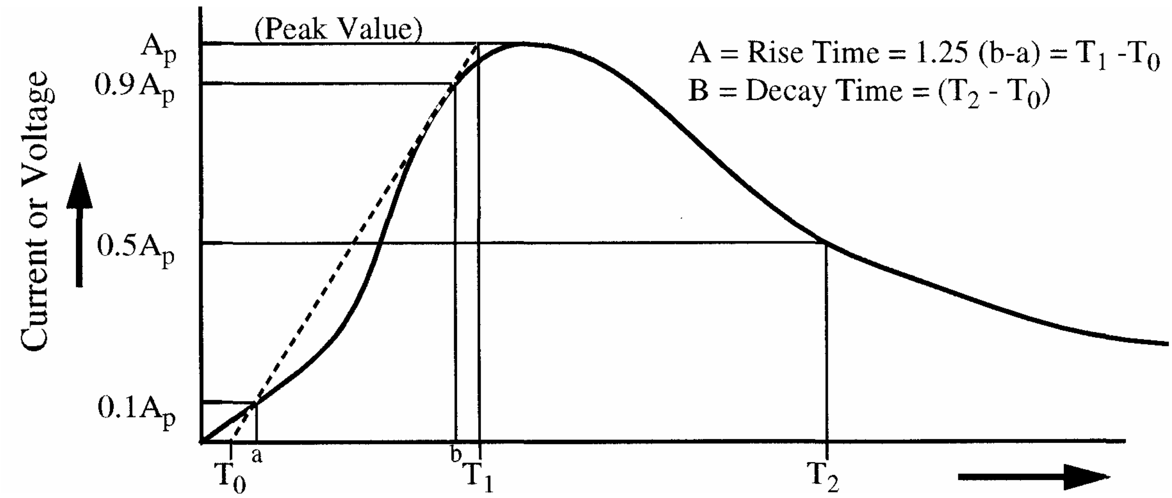

Figure 19/MTS20-C **Lightning surge reference waveform**

9.3.4.1 North American tests

For both tests following, the surges shall be applied between phase and neutral, phase and ground, and neutral and ground.

9.3.4.1.1 Equipment protection

The EUT shall meet the equipment protection requirements of § 9.1.2 when subjected to the surge limits as shown in Table 7/MTS20-C. The waveform is as defined in Figure 19/MTS20-C.

Table 7/MTS20-C North American AC power surge for equipment protection

Minimum Peak Voltage (Volts)	Maximum Rise/ Minimum Delay Time (^S)	Minimum Current per Conductor (Amperes)	Repetitions of Each Polarity
+/- 2500	2/10	1000	4

9.3.4.1.2 Safety

The EUT shall meet the safety requirements of § 9.1.2 when subjected to the surge limits as shown in Table 8/MTS20-C. The waveform is as defined in Figure 19/MTS20-C.

Table 8/MTS20-C **North American AC power surge for safety**

Minimum Peak Voltage (Volts)	Maximum Rise/ Minimum Delay Time(^S)	Minimum Current per Conductor (Amperes)	Repetitions of Each Polarity
+/-5000	2/10	1000	1

9.3.4.2 European tests

The EUT may exhibit temporary degradation or loss of function which is self-recoverable when subjected to the surges as shown in Table 9/MTS20-C. No system reset shall occur, nor shall the EUT display any damage.

The surges are applied to all commercial AC inputs, in both differential and common modes. The source resistance shall be 2 Q in differential mode, and 12 Q in common mode. The surges shall be applied in synchronization to the voltage phase at both the zero-crossing and the peak (positive and negative).

Table 9/MTS20-C **European AC power surge**

Test Mode	Minimum Peak Voltage (Volts)	Maximum Rise/ Minimum Delay Time (μS)	Repetitions of Each Polarity
Differential	+/- 1000	1.2/50[1]	5
Common	+/- 2000	8.0/20[2]	•5

Notes to Table 9/MTS20-C:
1. Open-circuit voltage waveform.
2. Short-circuit current waveform.

Section D - Conformance Testing

Table of Contents

1 Conformance Tests

Conformance tests for MiLINK are for further study.