NUM
1020/1040/1060
UNI-TELWAY
INTEGRATION
MANUAL

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Despite the care taken in the preparation of this document, NUM cannot guarantee the accuracy of the information it contains and cannot be held responsible for any errors therein, nor for any damage which might result from the use or application of the document.

The physical, technical and functional characteristics of the hardware and software products and the services described in this document are subject to modification and cannot under any circumstances be regarded as contractual.

The programming examples described in this manual are intended for guidance only. They must be specially adapted before they can be used in programs with an industrial application, according to the automated system used and the safety levels required.

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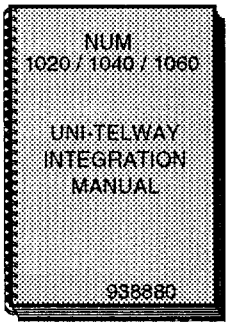
Record of Revision

Date	Index	Reasons for revision
12 - 93	0	Document creation.
04 - 94	1	Miscellaneous corrections.
07 - 96	2	Connection of a 1020/1040 CNC New cards: V2 machine processor and UCSII Miscellaneous corrections.

NUM 1000 Family Network Documentation Structure

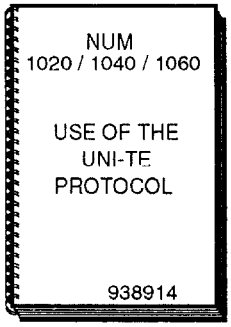
Integration Document

This document is designed for integration of NUM 1020, 1040 and 1060 numerical controls in a network.

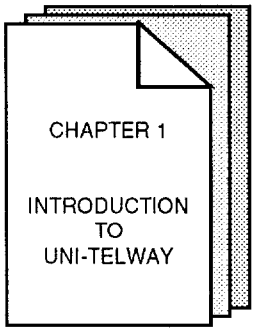


Operator Manual

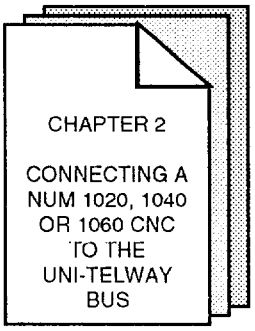
This document explains network transfers with a numerical control.



UNI-TELWAY Integration Manual

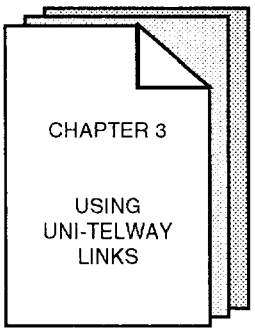


General description of UNI-TELWAY networks:
- Network description and operation,
- Communication architecture.

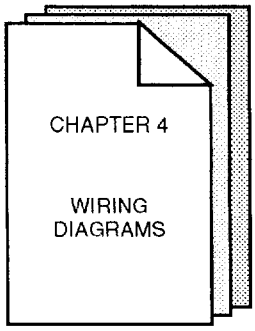


UNI-TELWAY Network Connection Principles.

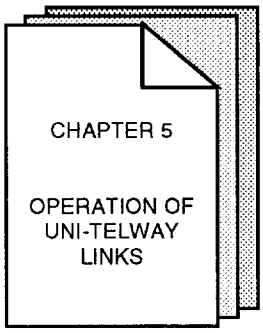
Connection of a NUM 1020, 1040 or 1060 CNC.



Setting UNI-TELWAY Link Parameters:
- Line number,
- Communication parameters,
- Timeouts.



Wiring diagrams of the cables used in different types of UNI-TELWAY links.



Addressing in a UNI-TELWAY network.

Link control by the master.

Message structure: frame coding.

Performance: execution times.

Agencies

The list of NUM agencies is given at the end of the volume.

Questionnaire

To help us improve the quality of our documentation, we kindly request you to return the questionnaire at the end of the volume.

1 Introduction to UNI-TELWAY

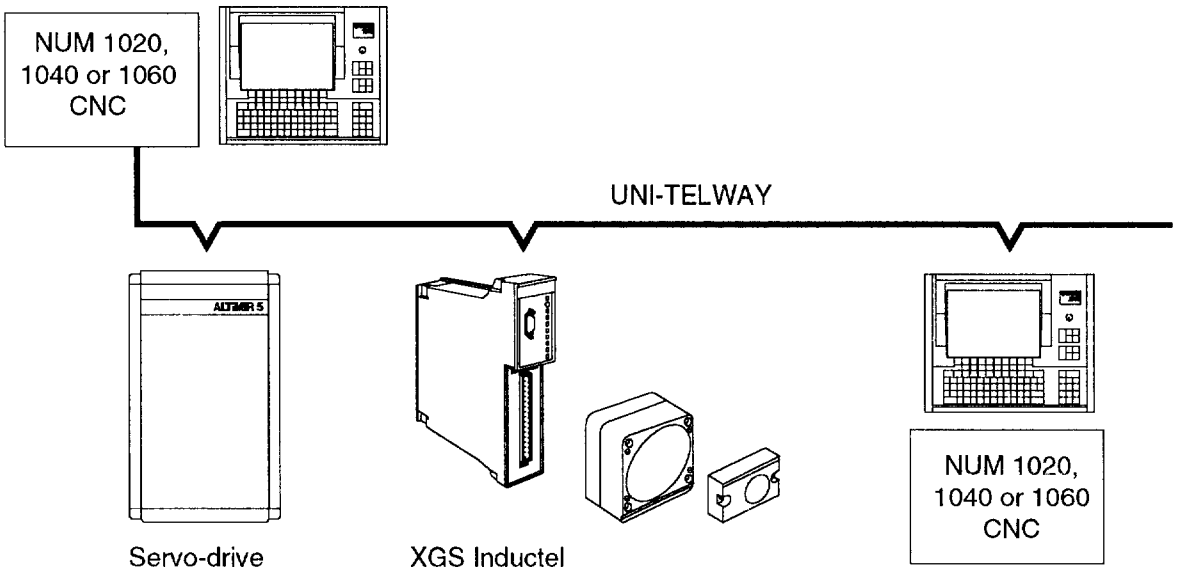
1.1 General Description of UNI-TELWAY

UNI-TELWAY is a communication protocol between Telemecanique units (programmable logic controllers (PLCs), dialogue terminals, servo-drives, 1020/1040 or 1060 numerical controls, weighing units, etc.).

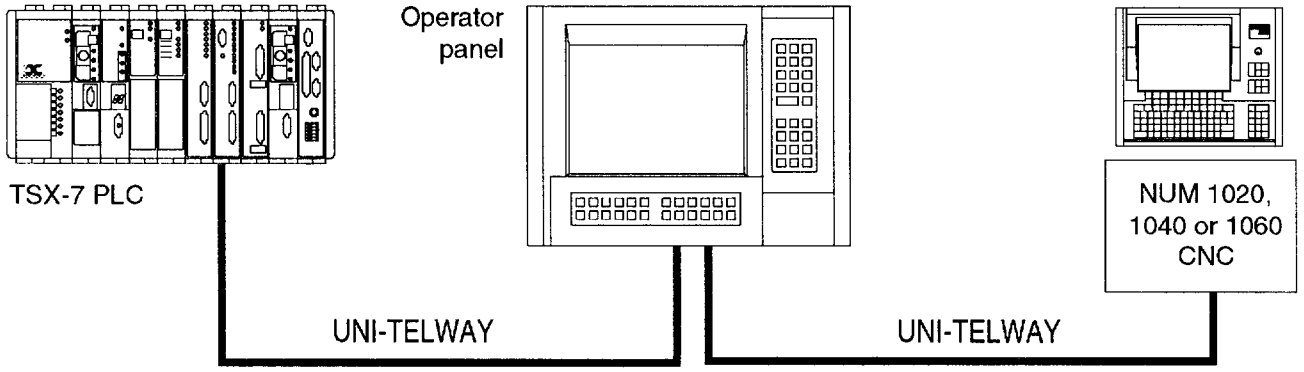
1.1.1 Purpose of UNI-TELWAY

UNI-TELWAY is designed for two types of applications:

Control of Control and Display Units by a PLC



Man/Machine Dialogue and Supervision Terminals



1.1.2 UNI-TELWAY Components

The following components are required for a UNI-TELWAY network:

One Master Station

This station supervises the link and monitors operation.

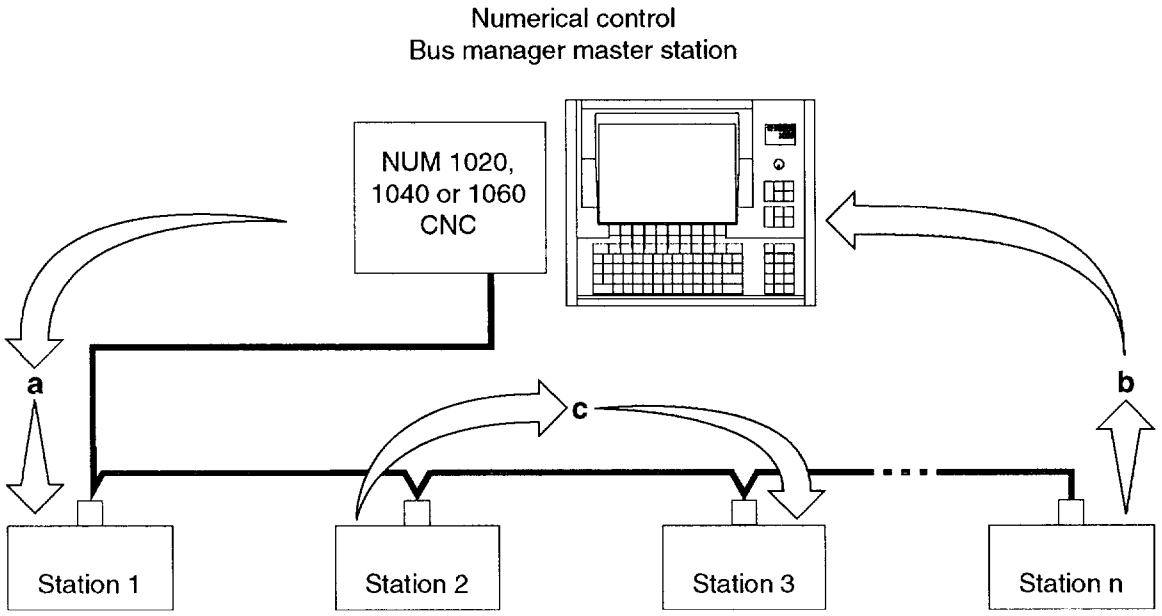
It manages the right to talk of the stations connected.

This station is a TSX series 7 PLC or a NUM CNC.

One to 27 Slave Stations

1.1.3 Operation of UNI-TELWAY

UNI-TELWAY allows egalitarian type communication. Messages can be sent:
- from master to slave (a),
- from slave to master (b),
- from slave to slave (c).

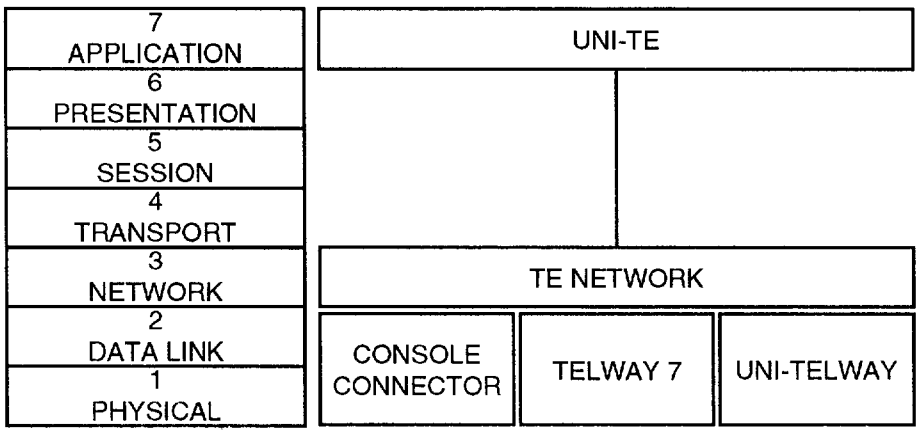


Communications from slave to slave are by two automatically sequenced steps:
- message routed from slave station to master station,
- message automatically rerouted to receiver slave station by master station without action by the master station PLC processor or application program.

The UNI-TELWAY bus and its UNI-TE protocol coordinate the activities between smart units. They allow:
- intercommunication between applications, e.g. between PLCs (to exchange text blocks),
- intercommunication between the application and system of a unit (e.g. data read/write, operating mode control).

1.2 Communication Architecture

UNI-TELWAY is an integral part of the TSX series 7 communication architecture. This architecture complies with the OSI reference model. It features an application layer (UNI-TE) and a network layer (address system) common to various communication media: PCL console connector, TELWAY 7 network and UNI-TELWAY industrial bus.



The following layers are used by UNI-TELWAY:

1.2.1 Physical Layer

This is the shielded multipoint bus complying with RS485, with a standard data rate of 9600 bauds.

This layer allows interconnection of a maximum of 28 stations over a distance of 1000 m with passive branches of 20 m at most.

1.2.2 UNI-TELWAY Data Link Layer

This layer controls access to the line by the units using a Master/Slave procedure.

A slave unit is identified by its link address(es).

The fixed master allocates the link to each of the link addresses in turn.

1.2.3 TSX 7 Network Layer

This layer handles routing of messages from source to sink. Each station is identified by a unique address.

1.2.4 UNI-TE Application Layer

This layer is a list of requests common to all the units (standard requests) or specific to certain units (requests specific to PLCs or CNCs).

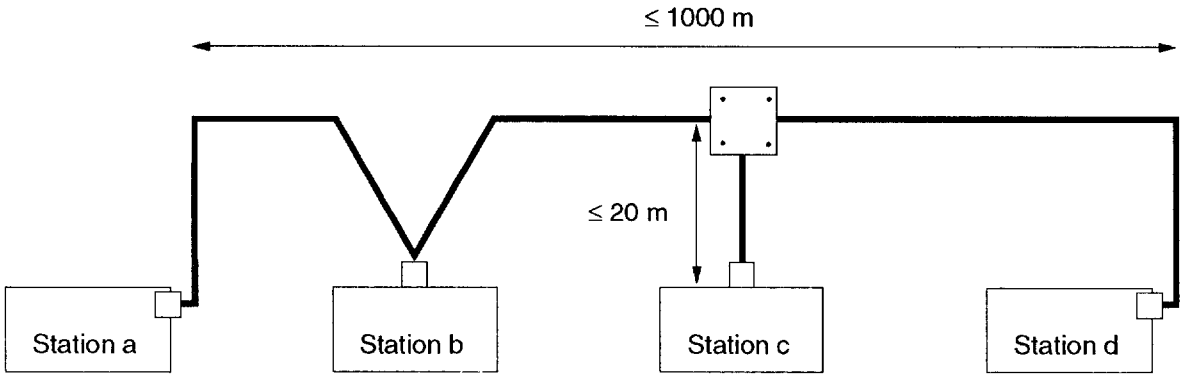
It offers the following services:
- read and write of objects (bits, words, etc.),
- operating mode control (INIT, RUN, STOP),
- bus and equipment diagnostic,
- programme file download and upload.

2 Connecting a NUM 1020, 1040 or 1060 CNC to the UNI-TELWAY Bus

2.1 Connection Methods

The UNI-TELWAY bus is a shielded line conforming to the RS485 standard.

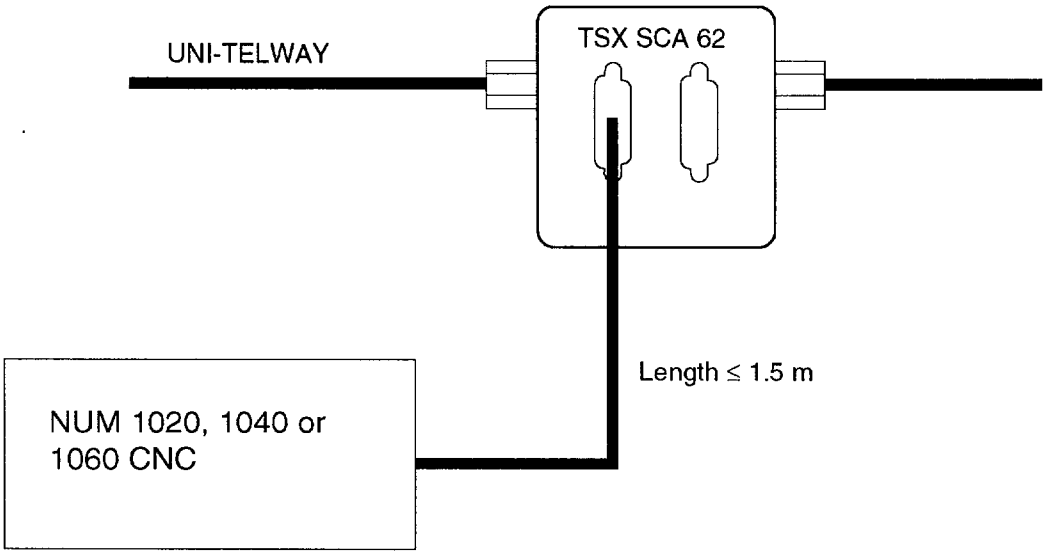
There are two possible ways of connecting to this bus:
- by direct chaining, without branches to the units (e.g. station b),
- via a junction box (e.g. station c), which facilitates connection of intermediate stations.



Both modes can be used together on a UNI-TELWAY bus.

2.1.1 Chaining

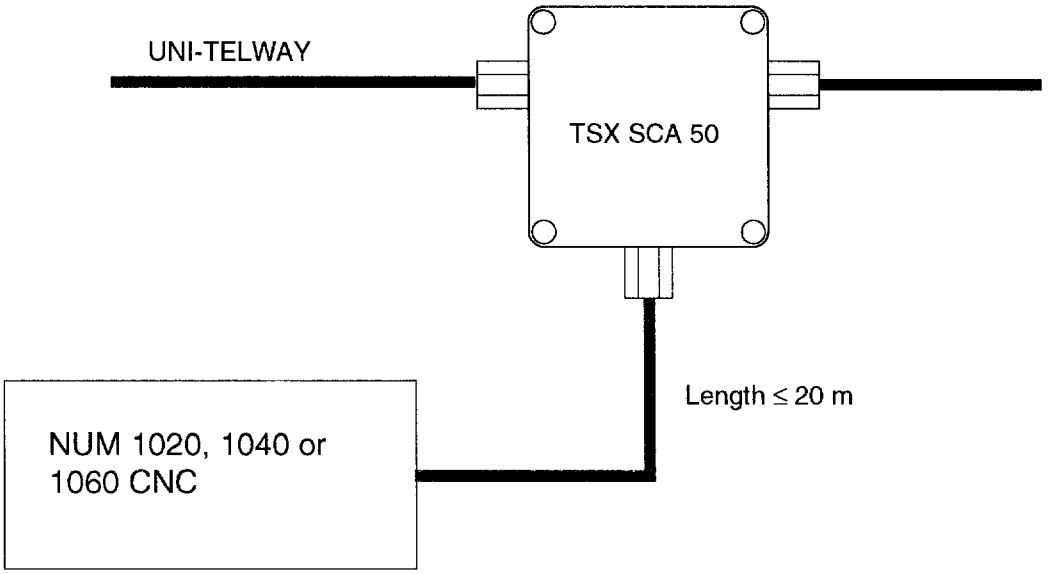
In this case, the subscriber connector or terminal board is directly connected to the main highway of the UNI-TELWAY bus.



2.1.2 Connection by a Branch Line

In this case, the same type of cable must be used for the branch as for the main UNI-TELWAY highway. The branch cable length must not exceed 20 m.

The signal continuity, including the shielding, is ensured directly in the junction box.



2.1.3 Special Case: RS232 Connection

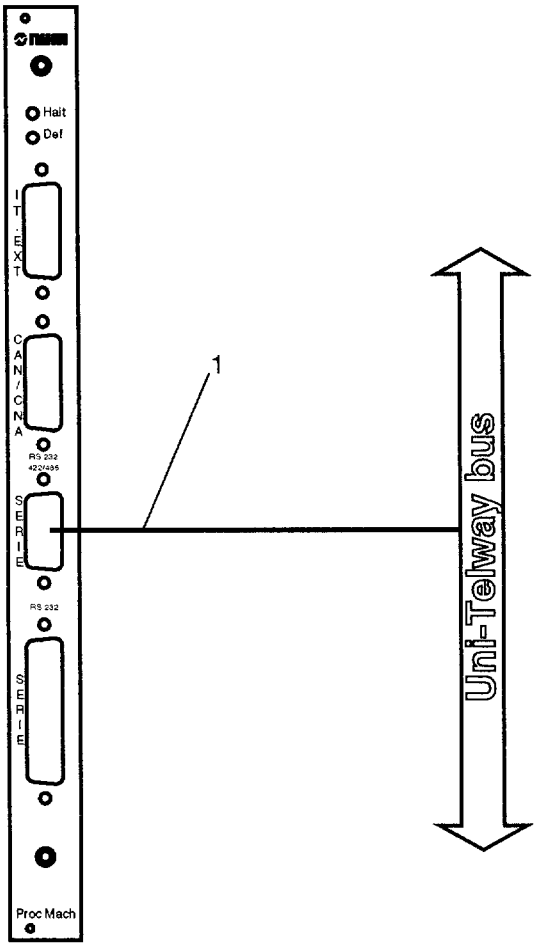
An RS232 serial link can be set up between units with this type of interface, for instance units using a TSX SCA 72 module (see UNI-TELWAY bus reference manual, Telemecanique document TSX D24 004F).

In this case, the link is a point-to-point link using UNI-TE protocols, and no longer strictly speaking a UNI-TELWAY bus.

2.2 Connection of a NUM 1060

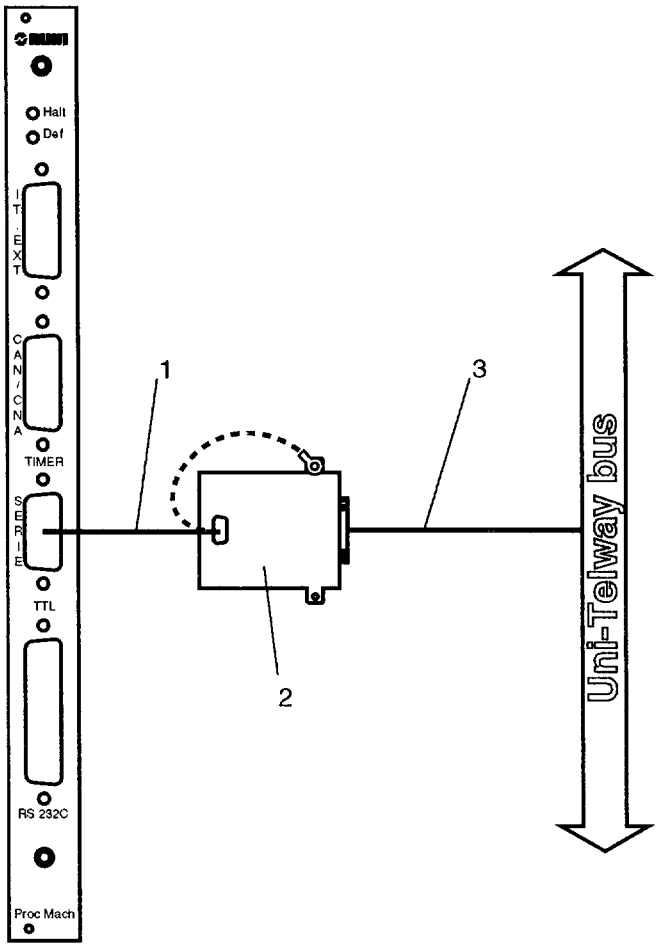
2.2.1 Connection to the UNI-TELWAY Bus via the Machine Processor

2.2.1.1 Connection via the V2 Machine Processor



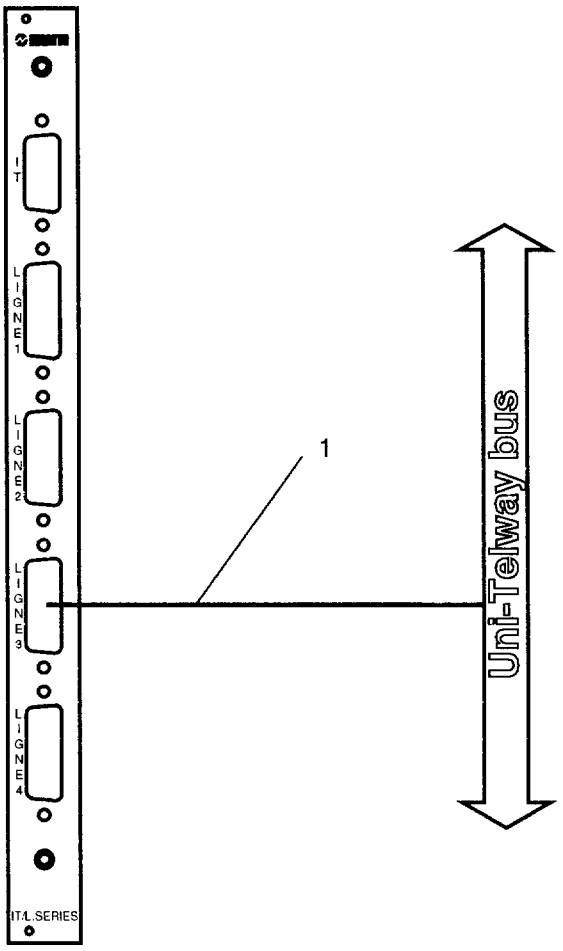
1 - UNI-TELWAY bus/RS485 connecting cable (see Sec. 4.3)

2.2.1.2 Connection via the V1 Machine Processor



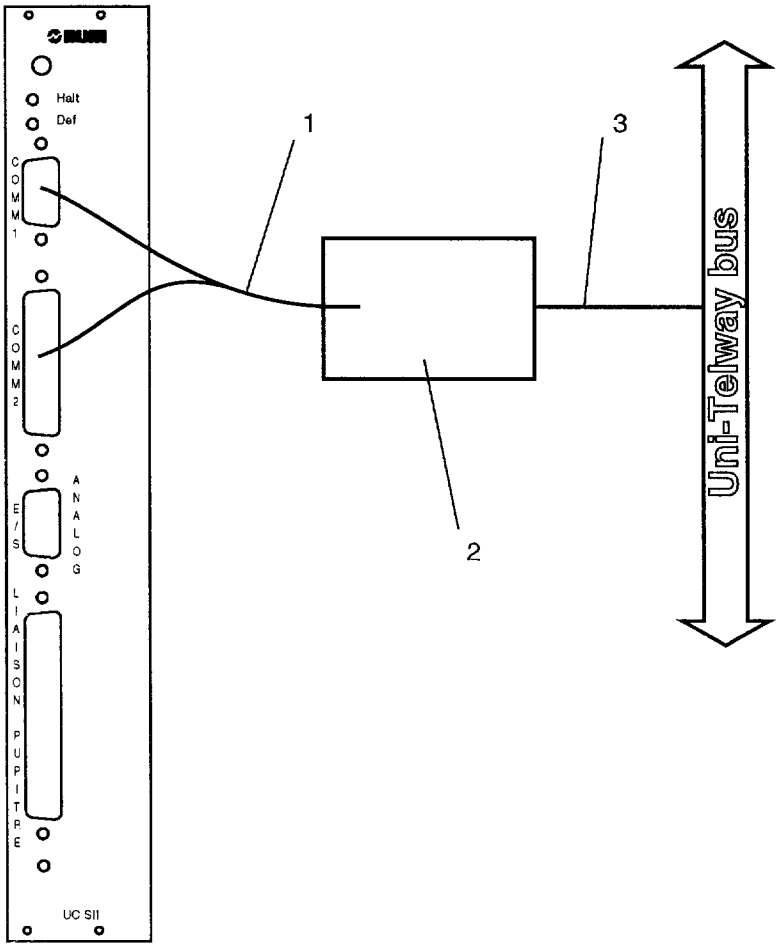
1 - TTL output/adapter connecting cable (see Sec. 6.12.21 of the Installation and Commissioning Manual 938816)
2 - TTL/RS485 adapter (P/N 205201339)
3 - UNI-TELWAY bus/RS485 adapter connecting cable (see Sec. 4.2)

2.2.2 Connection to the UNI-TELWAY Bus via an IT/Serial Line Card



1 - UNI-TELWAY bus/RS485 connecting cable (see Sec. 4.3)

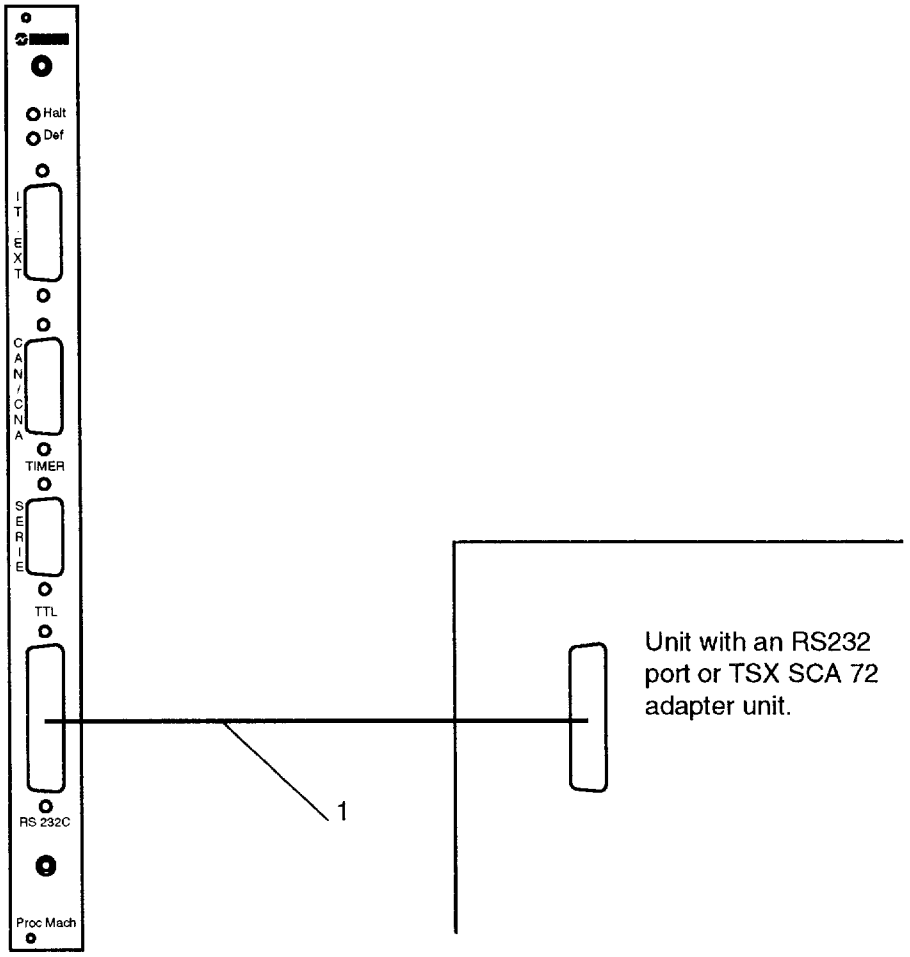
2.2.3 Connection to the UNI-TELWAY Bus via the UCSII Card



1 - TTL out/adapter connecting cable (see Sec. 6.12.21 of Installation and Commissioning Manual 938816)
2 - RS 232/RS485 adapter (not supplied by NUM)
3 - UNI-TELWAY bus/RS485 adapter connecting cable (see Sec. 4.2)

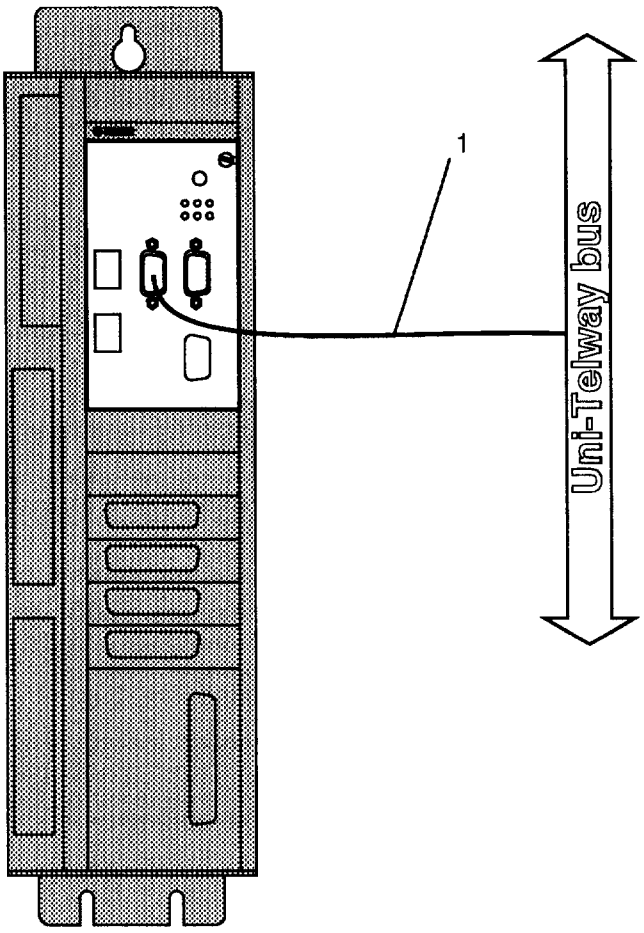
2.2.4 Connection to Another Unit via the Machine Processor RS232 Port

This connection sets up a point-to-point link between two units, i.e. the machine processor and another unit with an RS232 port.



1 - RS232 connecting cable (see Sec. 4.4)

2.3 Connection of a NUM 1020/1040



1 - UNI-TELWAY bus/RS485 connecting cable (see Sec. 4.3)

3 Using UNI-TELWAY Links

The UNI-TELWAY links must be declared and configured by NC machine parameters.

Refer to the Parameter Manual for further information on setting the machine parameters.

REMARK *The use of a UNI-TELWAY link by a NUM 1020, 1040 or 1060 CNC requires presence of the Intercoprocessor Exchange Protocol and UNI-TELWAY functionalities (bits 80 and 81 displayable on the Options page accessed by* [E/S] [8] [—] *and* [PREF] *).*

3.1 Setting the Parameters of a UNI-TELWAY Link Master Station (P110)

A master station is configured on the NC by machine parameter P110.

Parameter P110 includes eight bytes (N0 to N7) whose setting is specified as a hexadecimal value.

3.1.1 Description

The UNI-TELWAY master station settings involve:
- the line assigned to UNI-TELWAY,
- the communication parameters,
- the timeouts,
- the number of slaves,
- the number of the slave to which the NC and keyboard messages are sent.

3.1.2 Detail of the Bytes of P110

Byte N0

Sets the line number assigned to UNI-TELWAY.

In the case of a NUM 1060 CNC, the possible values are:
- H'00' for the machine processor TTL line,
- H'01' for the machine processor RS232 line,
- H'04' to H'0' for the IT/serial line card lines.

In the case of a NUM 1020/1040 CNC, the value is:
- H'01' for the serial line.

The serial line card slots and numbers are detailed in Section 3.3.1.

The default value is H'FF': no line assigned to a master station.

Byte N1

Sets the communication parameters.

The settings of these parameters are detailed in Section 3.3.2.

The default value of H'15' corresponds to the standard UNI-TELWAY settings:
- 1 parity bit,
- odd parity,
- 1 stop bit,
- 9600 baud data rate,
- Intel notation format.

Byte N2

Sets the turnaround time (as a number of characters).

The turnaround time is the minimum time that a unit must wait before beginning to send a message to allow the distant unit to set itself up for reception.

The turnaround time must be set for the slowest unit connected to the bus.

The default value is H'01': one-character turnaround time.

Byte N3

Sets the envelope timeout (as a number of characters).

If a received frame is recognised as incorrect, the mast considers that transmission ends on expiry of the envelope timeout.

The default value is H'05': 5-character envelope timeout.

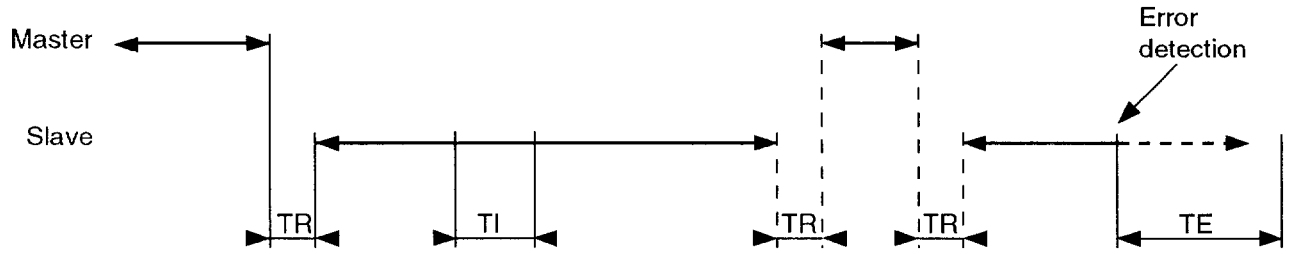
Byte N4

Sets the intercharacter gap (as a number of characters).

When a frame is being transmitted, the characters must follow one another with a maximum time between characters equal to the intercharacter gap.

The default value is H'05': intercharacter gap of five characters.

Schematic View of Timeouts Set in Bytes N2-N4



TR: turnaround time
TI: intercharacter gap
TE: envelope timeout

Byte N5

Sets the number of slaves that can be accessed on the network by the master.

The number of slaves is limited to 64 (H'40').

The default value is H'00': no slaves.

Byte N6

Sets the number of the slave to receive messages from the part programme ($n).

The default value is H'FF': no receiver slave.

Byte N7

Sets the number of polling cycles during which polling is stopped on a slave that has not answered.

The default value is H'14'.

3.2 Setting the Parameters of a UNI-TELWAY Link Slave Station (P111)

A slave station is configured on the NC by machine parameter P111.

Parameter P111 includes ten bytes (N0 to N9) whose setting is specified as a hexadecimal value.

3.2.1 Description

The UNI-TELWAY slave station settings involve:
- the line assigned to UNI-TELWAY,
- the communication parameters,
- the timeouts,
- the slave numbers (server/client),
- the series 7 address of the unit to which the NC and keyboard messages are sent.

3.2.2 Detail of the Bytes of P111

Byte N0

Sets the line number assigned to UNI-TELWAY.

In the case of a NUM 1060 CNC, the possible values are:
- H'00' for the machine processor TTL line,
- H'01' for the machine processor RS232 line,
- H'04' to H'0B' for the IT/serial line card lines.

In the case of a NUM 1020/1040 CNC, the value is:
- H'01' for the serial line.

The serial line card slots and numbers are detailed in Section 3.3.1.

The default value is H'FF': no line assigned to a slave station.

Byte N1

Sets the communication parameters.

The settings of these parameters are detailed in Section 3.3.2.

The default value of H'15' corresponds to the standard UNI-TELWAY settings:
- 1 parity bit,
- odd parity,
- 1 stop bit,
- 9600 baud data rate,
- Intel notation format.

Byte N2

Sets the turnaround time (as a number of characters).

The turnaround time is the minimum time that a unit must wait before beginning to send a message to allow the distant unit to set itself up for reception.

The turnaround time must be set for the slowest unit connected to the bus.

The default value is H'01': one-character turnaround time.

Byte N3

Sets the slave server number.

The slave number is limited to 64 (H'40').

The default value H'00' cannot be used as slave server number.

Byte N4

Sets the slave client number.

The slave number is limited to 64 (H'40').

The default value H'00' cannot be used as slave client number.

Message Receiver Address

The five following bytes set the series 7 address (see Sec. 5.1) of the unit to which messages from the part programme ($n) are sent.

Byte N5

Sets the receiver network address.

Byte N6

Sets the receiver station address.

Byte N7

Sets the receiver port address.

Byte N8

Sets the receiver module address.

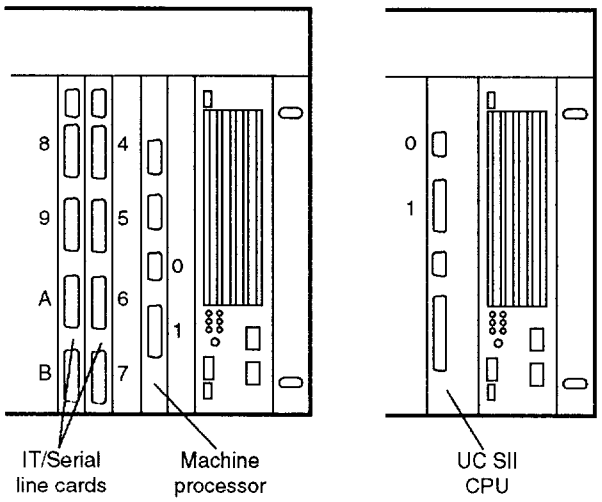
Byte N9

Sets the receiver channel address.

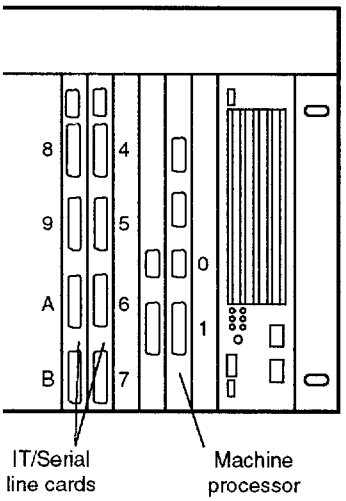
3.3 Items Common to Parameters P110 and P111

3.3.1 Serial Line Card Slots and Numbers (N0)

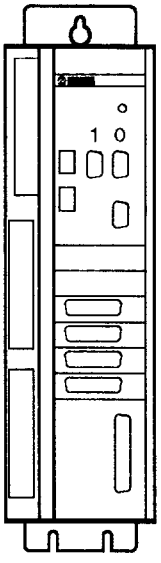
NUM 1060 SERIES II



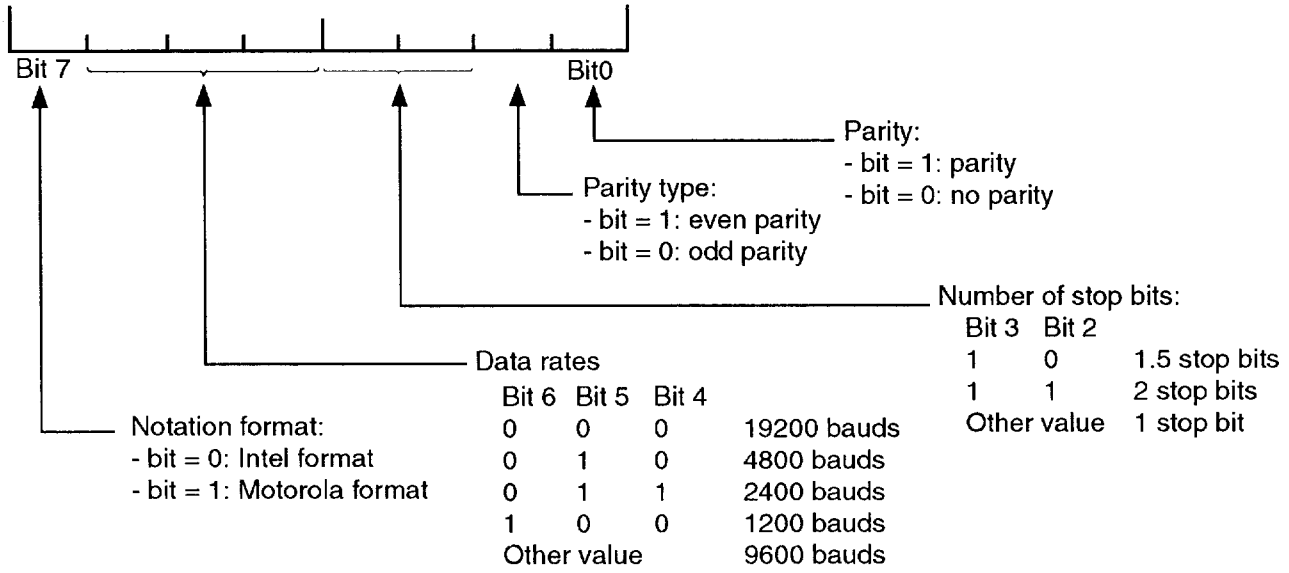
NUM 1060



NUM 1020/1040



3.3.2 Communication Parameter Settings (N1)



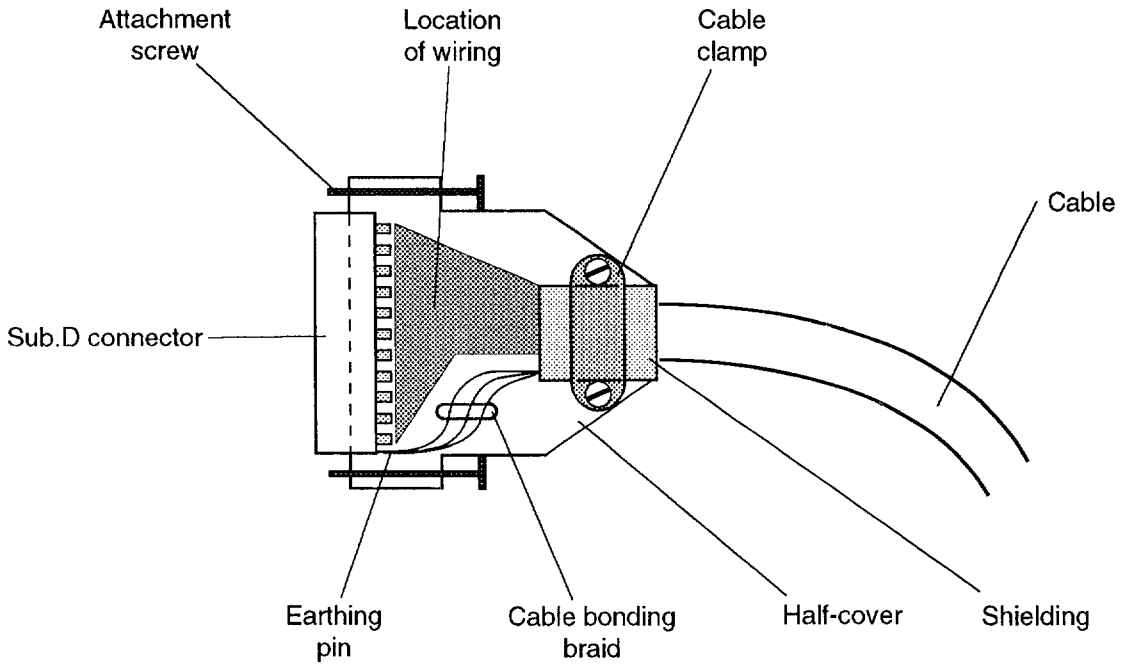
4 Wiring Diagrams

4.1 Wiring Recommendations

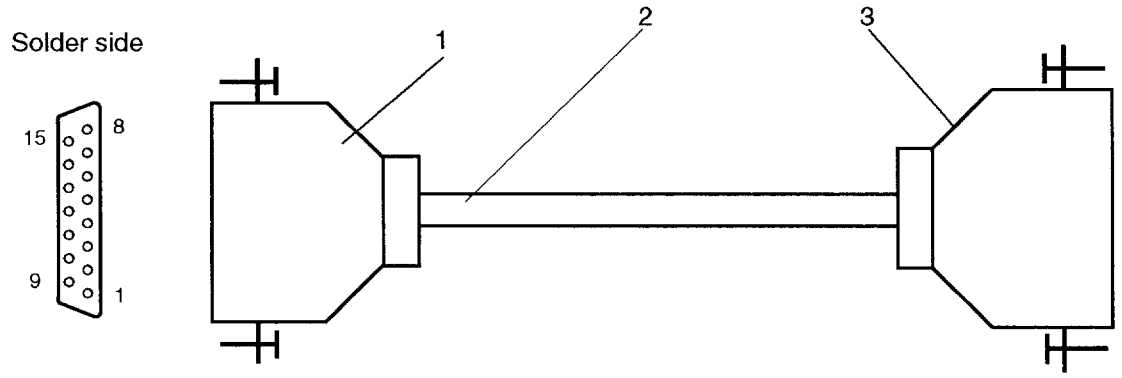
Wire with a reduction effect (small loops):
- cables applied against the trays and metal parts forming the function frame earth,
- both directions of two-way signals in the same cable (twisted pair).

Earth the logic signal cable shielding at both ends.

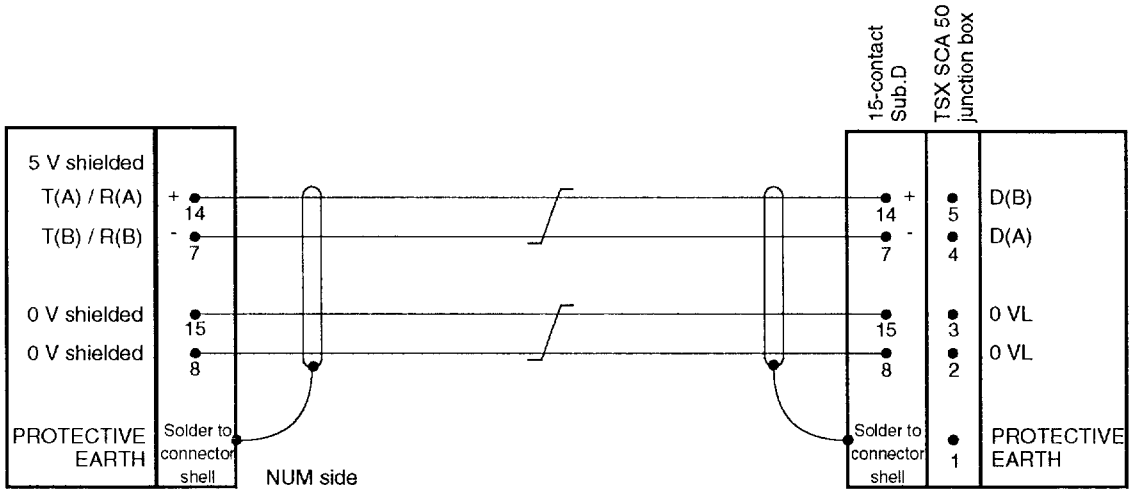
Earth the cable shieldings over 360 degrees:
- fold the bonding braids onto the cables over a length of 1 cm and clamp them in the cable clamp,
- then solder the bonding braids to the earthing pins.



4.2 UNI-TELWAY Bus/RS485 Adapter Connecting Cable



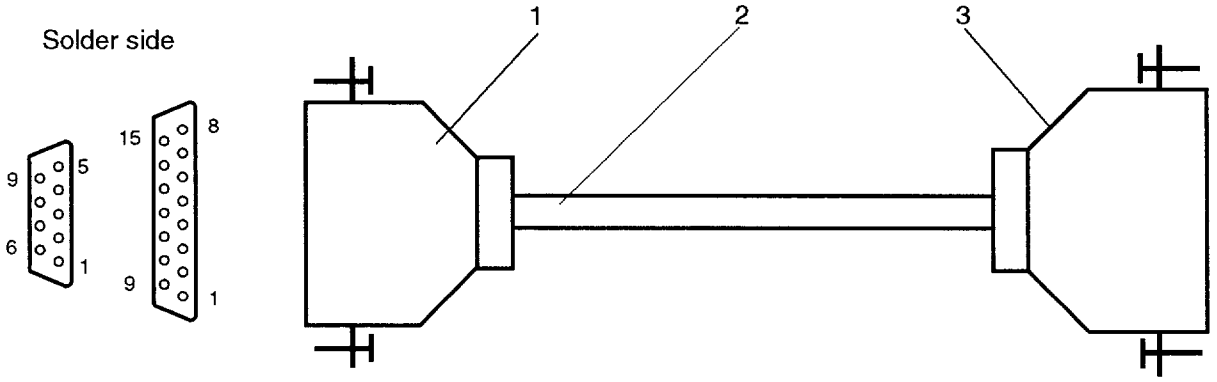
1 - 15-contact male Sub.D connector
2 - Shielded cable with 2 twisted pairs
3 - 15-contact male Sub.D connector or TSX SCA 50 junction box



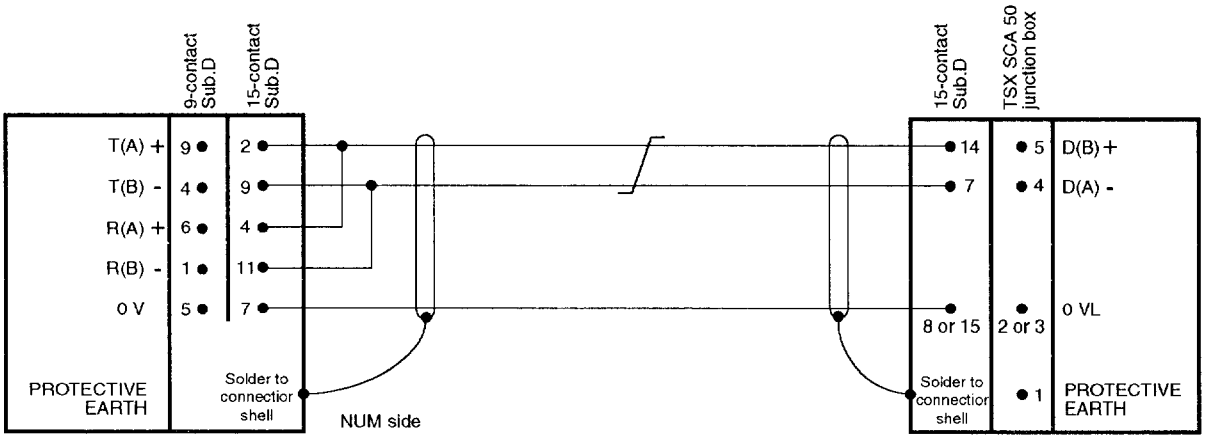
CAUTION

For correct interference suppression, the cable shielding must be earthed in accordance with the instructions of Sec. 4.1.

4.3 UNI-TELWAY Bus/RS485 Connecting Cable



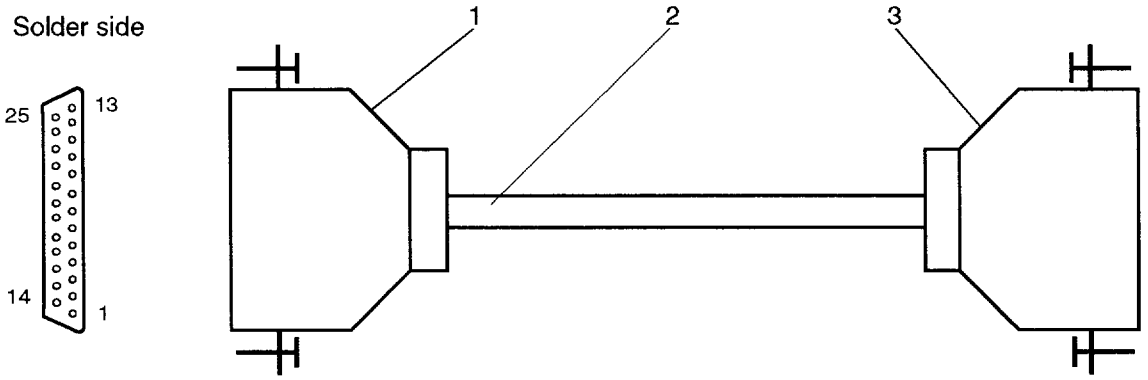
1 - 9- or 15-contact male Sub.D connector
2 - Shielded cable with one twisted pair and one separate wire
3 - 15-contact male Sub.D connector or TSX SCA 50 junction box



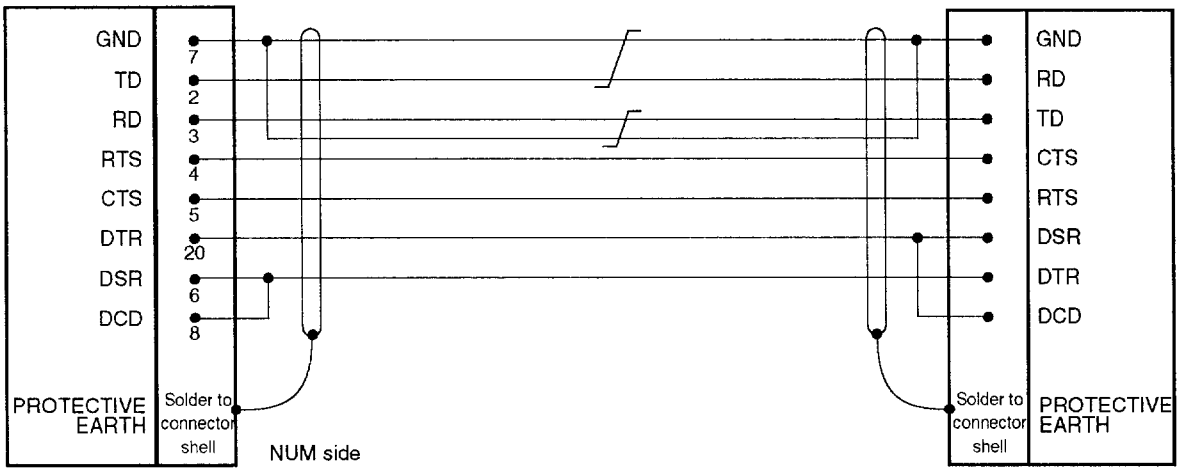
CAUTION

For correct interference suppression, the cable shielding must be earthed in accordance with the instructions of Sec. 4.1.

4.4 RS232 Connecting Cable



1 - 25-contact male Sub.D connector
2 - Shielded cable with one twisted pair and one separate wire
3 - Sub.D connector depending on station



CAUTION

For correct interference suppression, the cable shielding must be earthed in accordance with the instructions of Sec. 4.1.

5 Operation of UNI-TELWAY Links

Within the network, the link is managed by the master station, which polls each of the slave stations in succession and transmits the requests to them.

The master station and each of the slave stations is identified by a unique address.

5.1 Addressing - General

In the Telemecanique communication architecture, all message transfers are in point-to-point mode between two logic entities: the client and the server.

In the Telemecanique address system based on the TSX 7 PLC architecture, the addresses (sender and receiver) are encoded on five bytes:
- network number,
- station number,
- port number,
- module number,
- channel number.

The network number and station number bytes are used to identify the units connected to another network.

Network number

In the future, the network number will give access to other networks.

In a single network environment, it has a default value of H'00'.

Station number

In a multinetwork environment, the station number is used for a unit connected to another network (H'00' to H'0F').

In a single network environment, it has a default value of H'FE'.

Port number

The port number identifies the following logic entities:

System

For communication with preprogrammed functions giving access to the PLC PL7 objects or NUM numerical controls, the port number is H'00'.

NUM numerical control client application

Port numbers from H'50' to H'5F' can be used for a master station. The port number is always H'50' for a slave station.

Controllers

For communication with all the smart controllers of a PLC, in particular TSX SCM 2116 and TSX SCM 2146 of UNI-TELWAY, the port number is H'05'.

Text block

The port number is H'10' + the hexadecimal value of the text block number (e.g. TXT3 corresponds to port number H'13').

Module number

When a controller port is selected (H'05'), the hexadecimal module number specifies:

The master NC line number

The module number is equal to H'20' + line number (e.g. H'28' corresponds to line 8 of the master NC).

The rack number and the geographic location of the module in the rack on TSX Series 7 PLCs

For instance, H'03' specifies rack 0, slot 3.

That communication is on the same line

Specified by the default module number, H'FE'.

REMARK *For ports other than controller ports, the module number is not significant and must have the value H'00'.*

Channel number

When a controller port is selected (H'05'), the hexadecimal channel number specifies:

A logic entity of the controller

The channel number corresponds to the hexadecimal slave station link address plus H'64' (e.g. link address H'07' corresponds to channel number H'6B').

The subserver master of a NUM numerical control

The channel number is equal to H'63'. The subserver is accessible only to requests H'A2' to H'A4'.

A broadcast to all the slaves on the line

The channel number is equal to H'FF'.

REMARK *For ports other than controllers, the channel number is not significant and must have the value H'00'.*

5.2 Link Management, Message Routing

5.2.1 Bus Access

The master cyclically polls each station. The configuration specifies the number of link addresses to be polled.

The master polls each link address by increasing order.

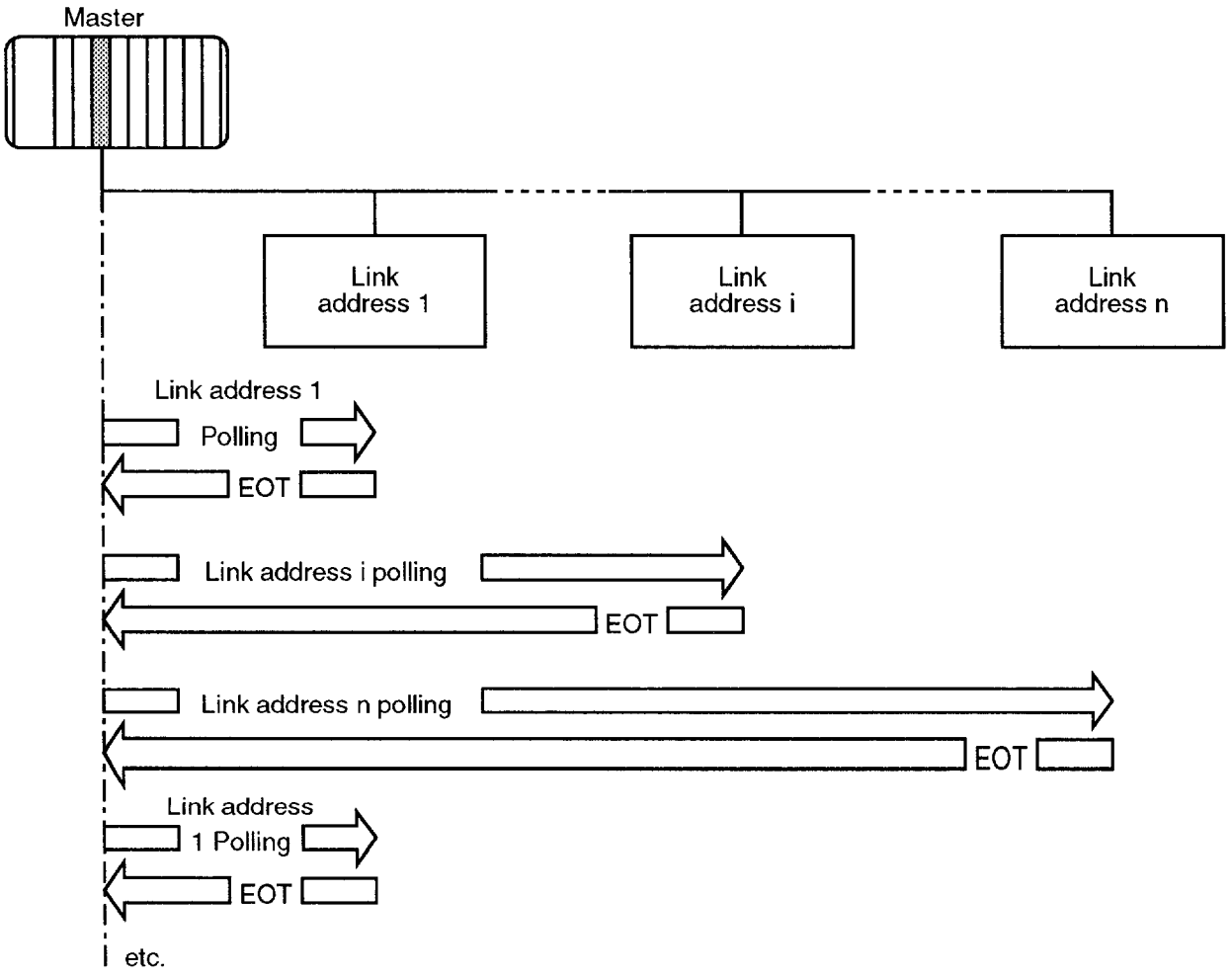
A polling message includes three characters, i.e. two header characters (DLE-ENQ) followed by a character representing the slave station link address.

The slave answer can be:
- an EOT character meaning that it does not have any data to send,
- a message (request or report) to be sent to another address.

The lack of an answer within time TE (envelope timeout) means that the station is absent. It is then temporarily deleted from the polling list.

The envelope timeout TE can be set on the master.

A polling cycle is as follows:



5.2.2 Sending a Message

5.2.2.1 Sending a Message from Master to Slave

The master can send a message at any time during the polling cycle. This operation is called selecting.

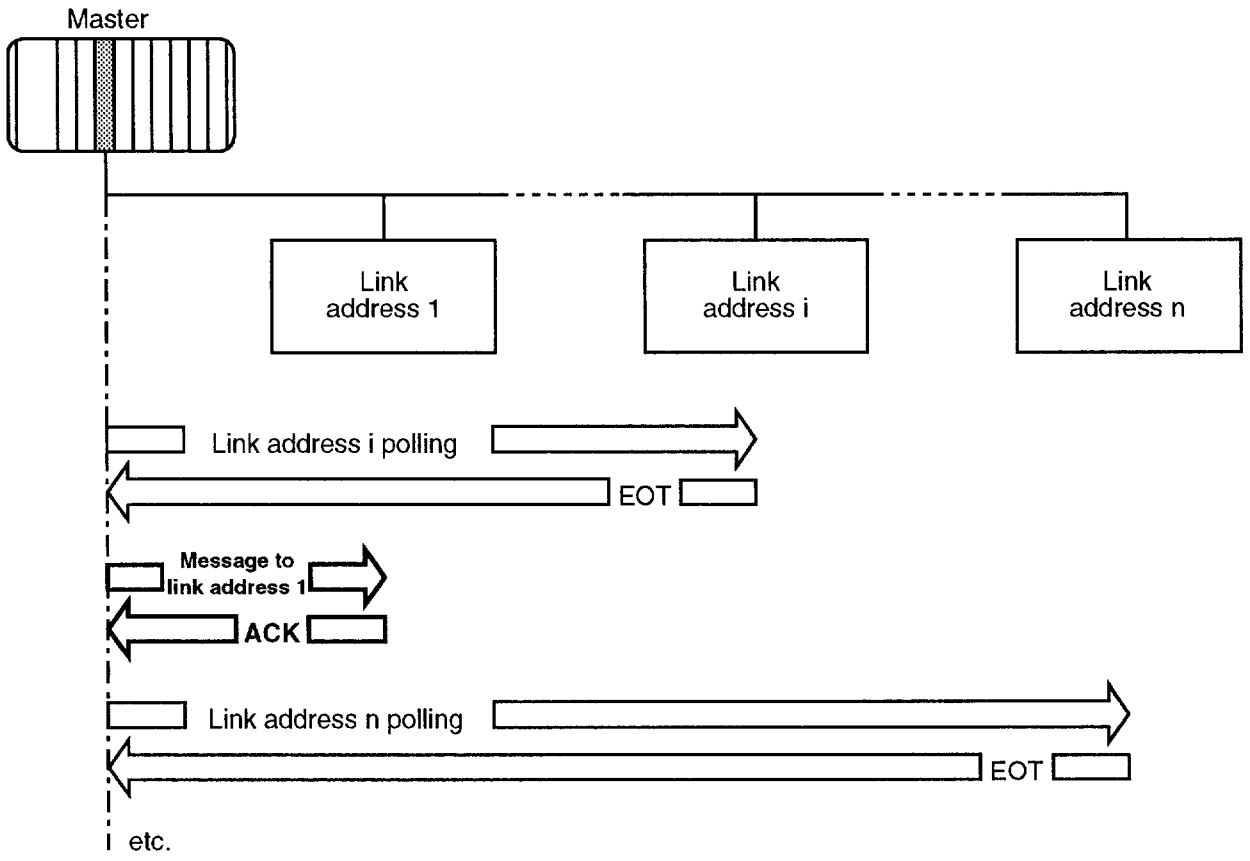
This message can be a request, a report or unsolicited data.

A message includes:
- two header characters (DLE-STX),
- a character representing the link address of the slave to which the message is to be sent,
- a character specifying the message length,
- the message body, including:
  - distant address (1 address type byte, 5 address bytes),
  - the request code followed by the data (1 to 128 characters),
  - a control character.

The slave can answer with:
- data indicating the message was correctly received (ACK)
- data indicating the message was received but will not be processed due to a lack of resources (NAK).

The lack of an answer within time TE (envelope timeout) means that the message was incorrect or that the slave was missing.

Example of message sent from master to 1

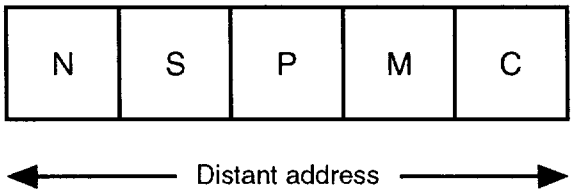


Addressing

For master-to-slave communication, the addresses are:

Sender address

This address, encoded on five bytes (see Sec. 5.1) is called distant address:



- N: network number,
- S: station number,
- P: port number,
- M: module number,
- C: channel number.

Receiver address

This address, encoded on one byte, is the link address of the message receiver.

5.2.2.2 Sending a Message from Slave to Master

A slave can only send a message when polled by the master.

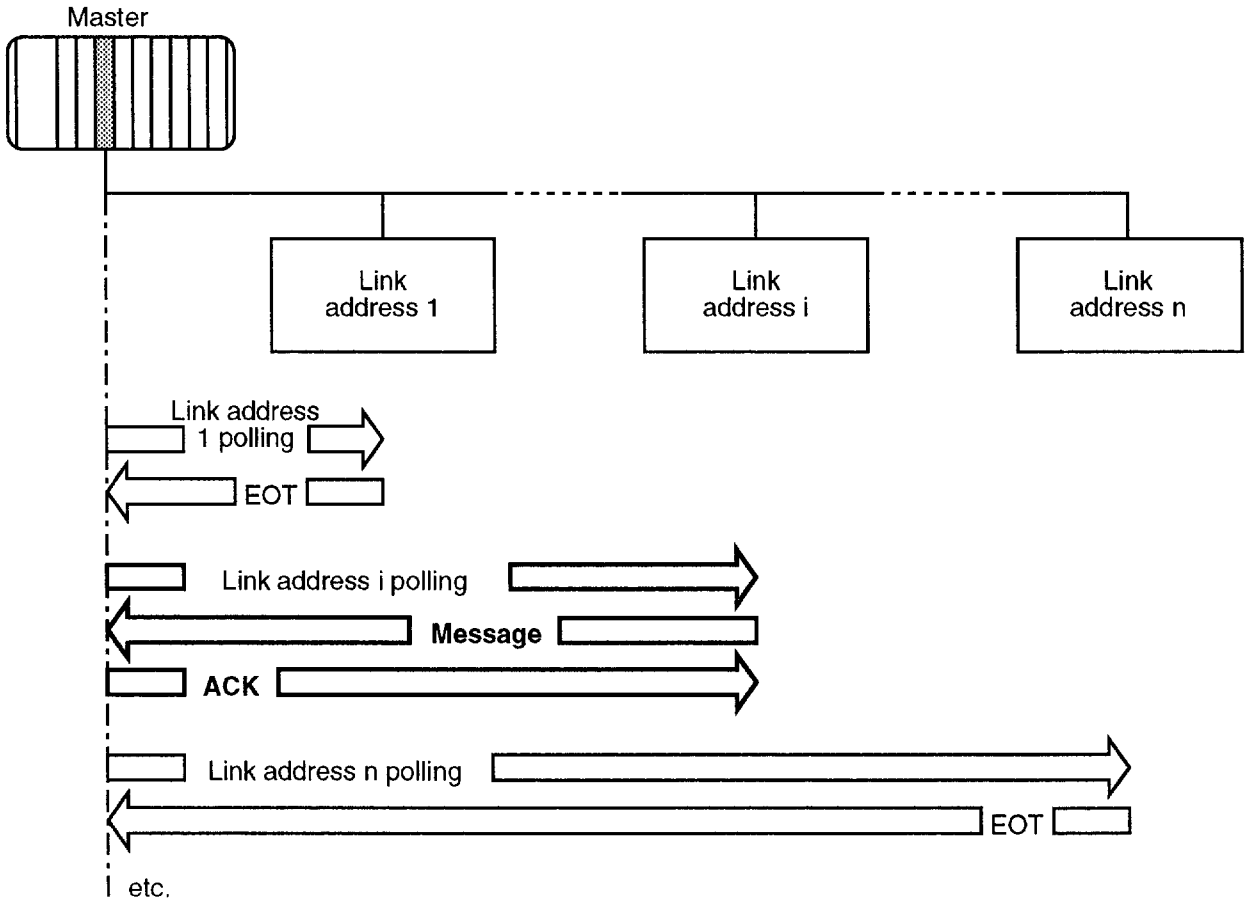
This message can be a request, a report or unsolicited data.

A message includes:
- two header characters (DLE-STX),
- a character representing the sender link address,
- a character specifying the message length,
- the message body, including:
  - distant address (1 address type byte, 5 address bytes),
  - the request code followed by the data (1 to 128 characters),
  - a control character (BCC).

The master can answer with:
- data indicating the message was correctly received (ACK),
- data indicating the message was received but will not be processed due to a lack of resources (NAK).

The lack of an answer within time TE (envelope timeout) means that the message was incorrect.

Example of message sent from i to master



Addressing

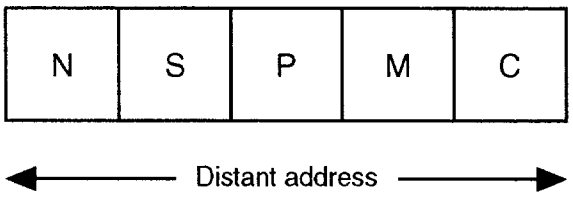
For slave-to-master communication, the addresses are:

Sender address

This address, encoded on one byte, is the link address of the message sender.

Receiver address

This address, encoded on five bytes (see Sec. 5.1) is called distant address:



- N: network number,
- S: station number,
- P: port number,
- M: module number,
- C: channel number..

5.2.2.3 Sending a Message from Slave to Slave

Slave transfers are in two steps, sequenced automatically by the link master:
- sender slave to master (see Sec. 5.2.2.2),
- master to receiver slave (see Sec. 5.2.2.1).

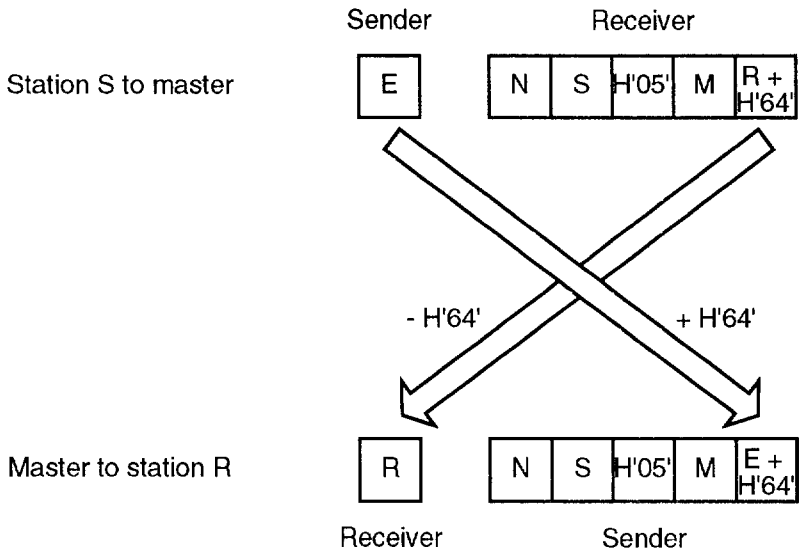
Message from sender slave to master

The sender address is the one-byte link address E of the message sender.

The receiver address (distant address) is encoded on five bytes, with:
- port number = H'05',
- channel number = H'64' + R (receiver link address).

Message from master to receiver slave

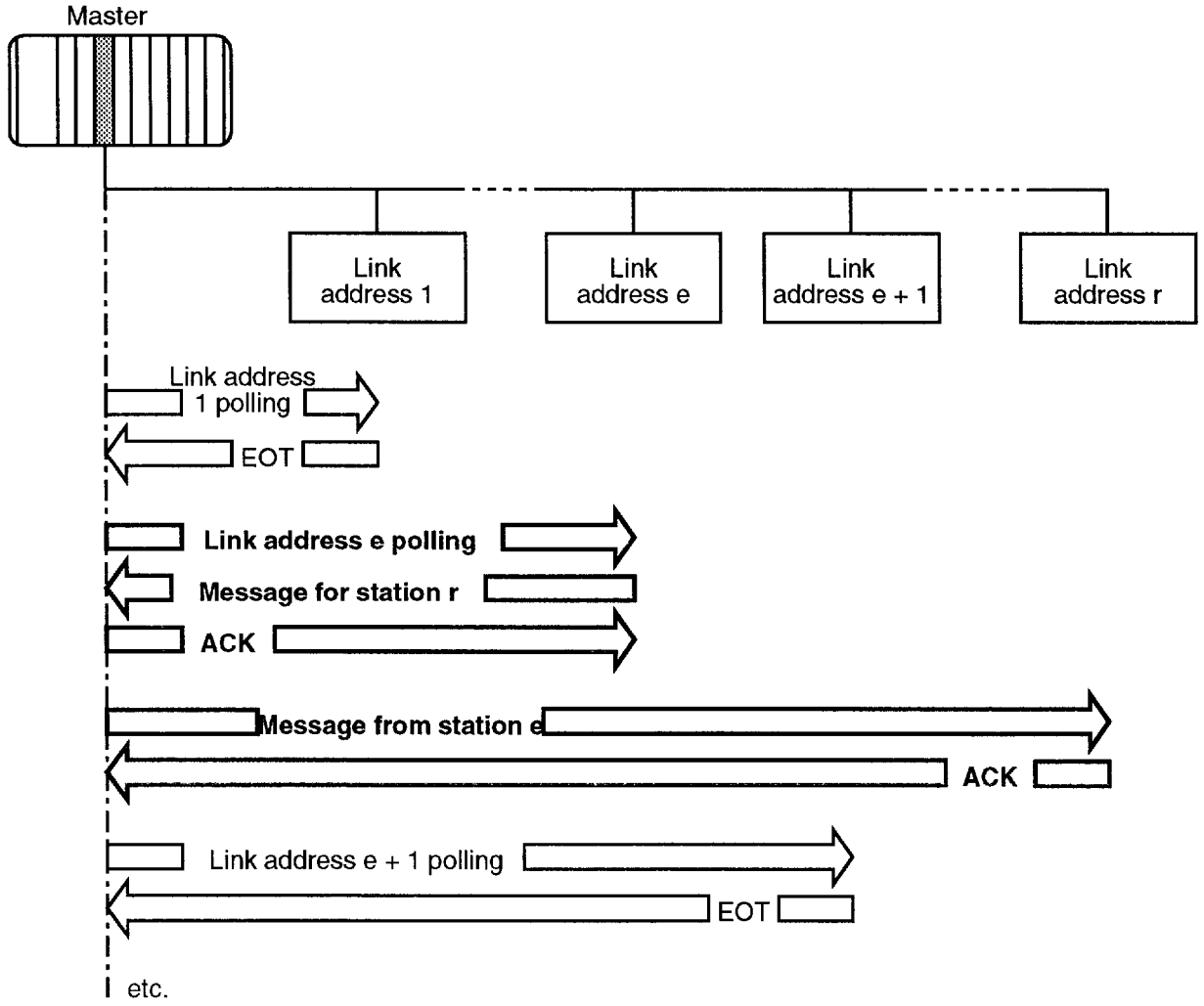
The master converts the address as shown in the diagram below:



The sender address (distant address) is encoded on five bytes, with:
- port number = H'05',
- channel number = H'64' + E (sender link address).

The receiver address is the one-byte link address of the message receiver R.

Example of message sent from e to r



5.2.3 Connecting and Disconnecting a Station

5.2.3.1 Disconnecting a Station

When a station does not answer two consecutive polling messages from the master (power failure, physical disconnection, etc.), it is declared absent.

The master polls the absent stations periodically (once every 10 cycles) to allow them to reconnect.

If the disconnected station is the master, the bus is inoperative.

5.2.3.2 Connecting a Station

If the new station is already included in the master configuration, it is connected automatically by the above mechanism when it comes on line.

If the new station is not included, it is not detected by the master. It is necessary to configure this station in the master.

5.3 Frame Coding

5.3.1 General

The general message format is as follows:

Start of message	Link address	Message length	Address type	Distant address	Data	End of message

The start of message identifier is:
- <DLE> <STX> for a data message
- <DLE> <ENQ> for a polling message.

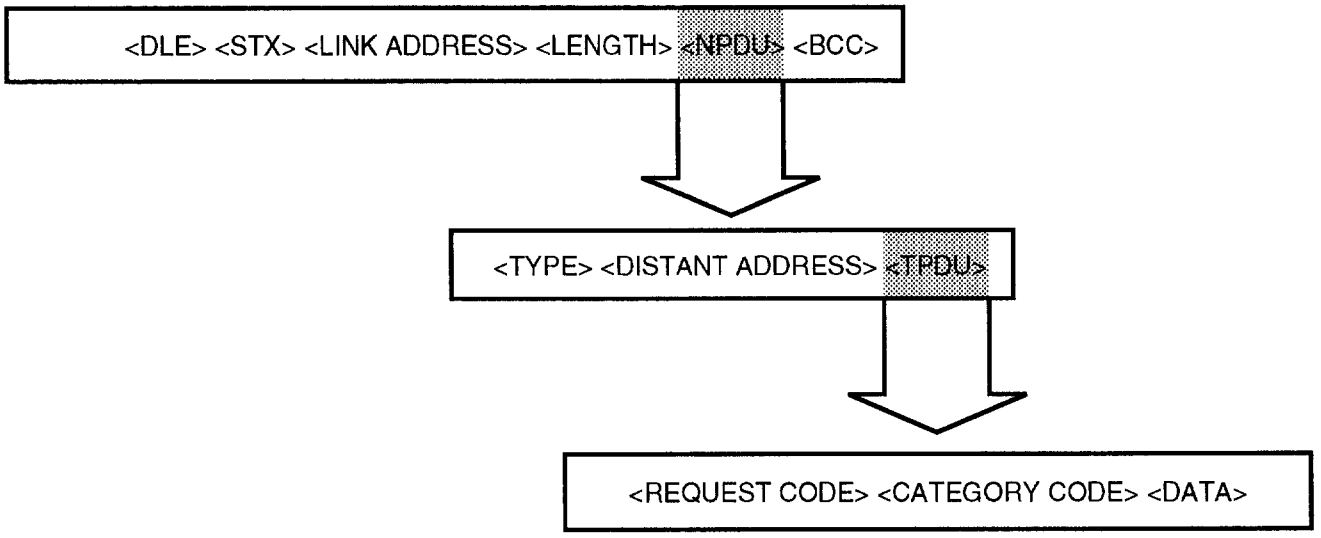
The address type is:
- H'00' for a simplified message (not used with NUM numerical controls)
- H'20' for a standard message
- H'22' for a service message (request not processed by the server).

The end of message identifier, <BCC>, is the sum modulo 250 of all the bytes between <DLE> and the last data byte inclusive.

REMARK *Any <DLE> character contained in the data field is doubled to ensure character transparency. In this case, the second <DLE> character is counted when computing the BCC.*

The other parameters are detailed in Sec. 5.2.2.

A message can be represented as follows:



- <NPDU>: Network protocol data unit,
- <TPDU>: Transport protocol data unit.

5.3.2 Selecting Message

The link frame is:

Master

Message : see Sec. 5.3.1

Slave

- <ACK> : message correctly received,
- <NAK> : message not processed,
- silence : message incorrect.

5.3.3 Polling Message

The link frame is:

Master

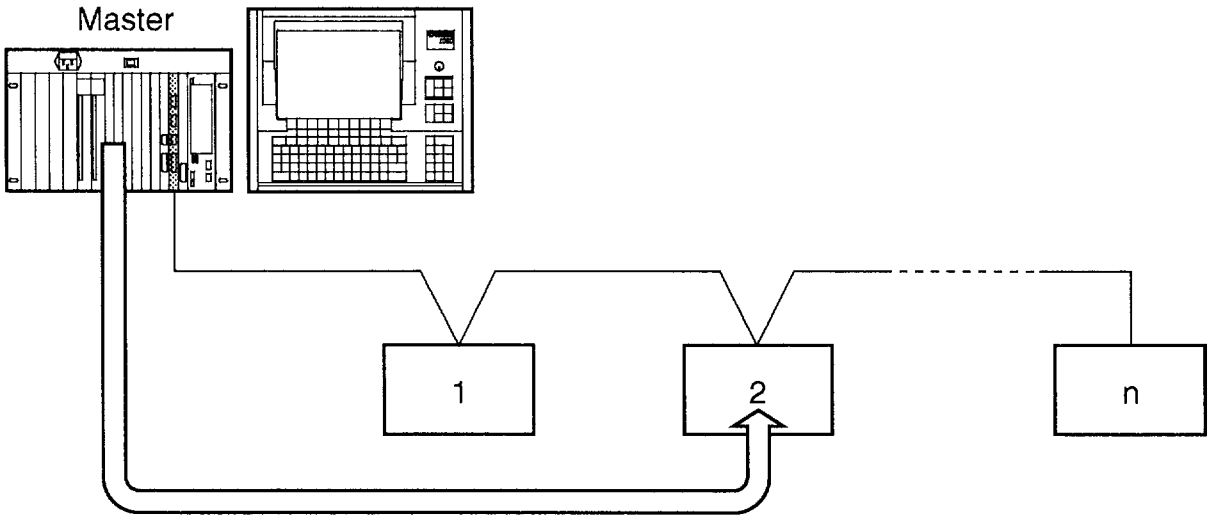
<DLE><ENQ><LINK ADDRESS>

Slave

- Message : see Sec. 5.3.1,
- <EOT> : no message to be sent,
- silence : slave missing.

5.3.4 Examples

5.3.4.1 Message from Master to Slave

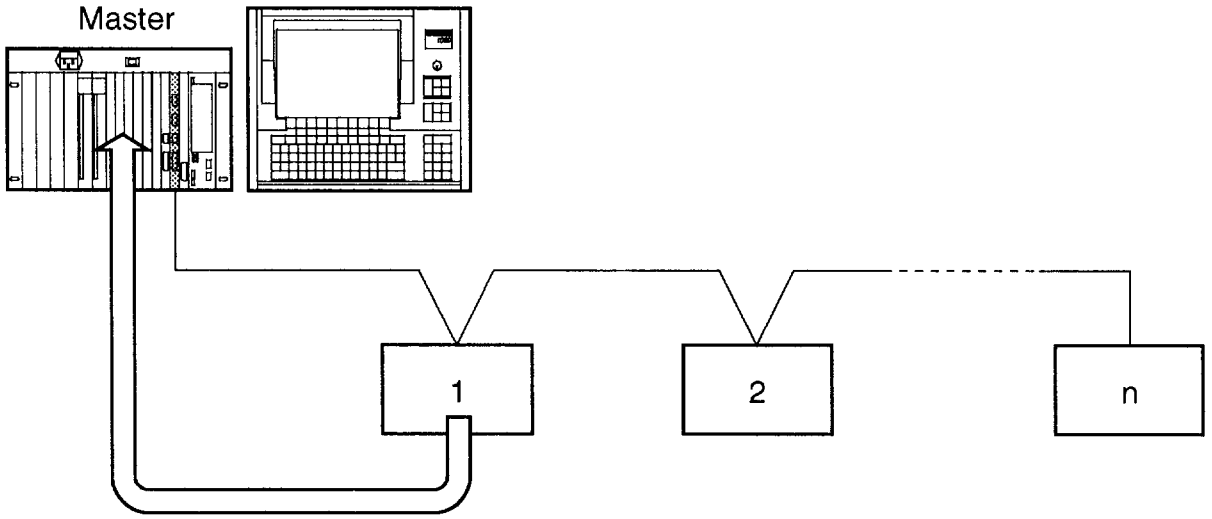


From NUM 1060 NC port H'54' to unit 2.

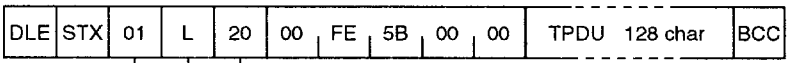
DLE	STX	02	L	20	00	FE	54	00	00	TPDU 128 char	BCC

Link address : Receiver
Message length : TPDU + 6
Standard address type
Distant address : Sender
- Network : default H'00'
- Station : default H'FE'
- Port : H'54'
- Module : H'00' (not significant)
- Channel : H'00' (not significant)

5.3.4.2 Message from Slave to Master

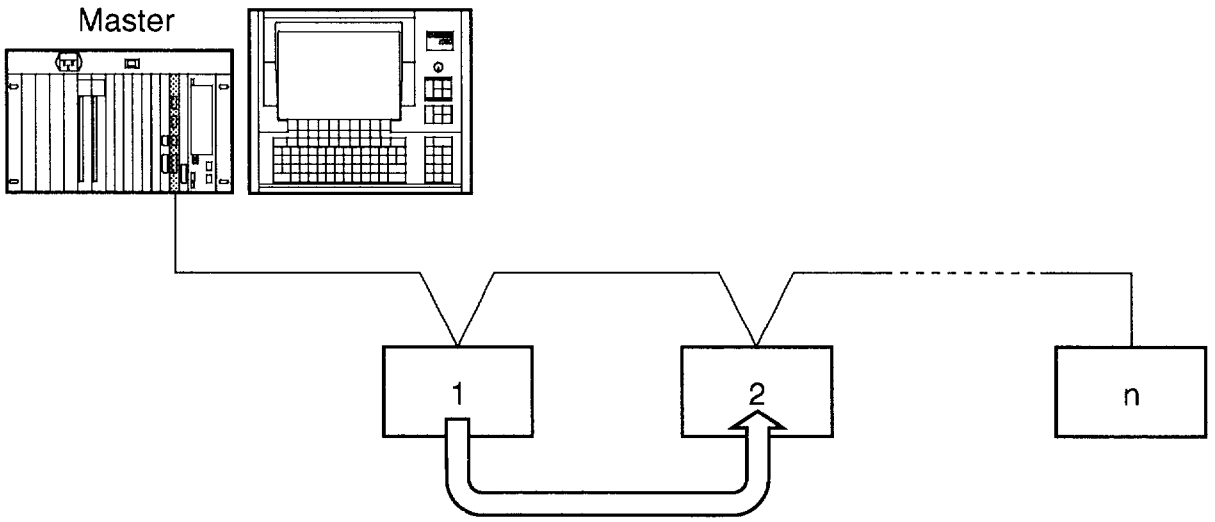


From unit 1 to NUM 1060 NC port H'5B'.



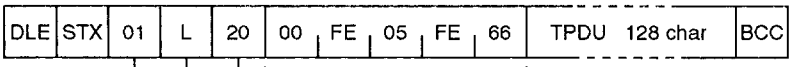
Link address : Sender
Message length : TPDU + 6
Standard address type
Distant address : Receiver
- Network : default H'00'
- Station : default H'FE'
- Port : H'5B'
- Module : H'00' (not significant)
- Channel : H'00' (not significant)

5.3.4.3 Message from Slave to Slave



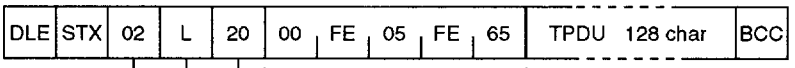
From unit 1 to unit 2. Communication is in two steps sequenced automatically by the master system tasks:
- unit 1 to master,
- master to unit 2.

Step 1: Unit 1 to Master



Link address : Sender
Message length : TPDU + 6
Standard address type
Distant address : Receiver
- Network : default H'00'
- Station : default H'FE'
- Port : H'05' (controller port)
- Module : default H'FE'
- Channel : H'66' = H'64' + H'02' (UNI-TELWAY offset + receiver link address)

Step 2: Master to Unit 2



Link address : Receiver
Message length : TPDU + 6
Standard address type
Distant address : Sender
- Network : default H'00'
- Station : default H'FE'
- Port : H'05' (controller port)
- Module : default H'FE'
- Channel : H'65' = H'64' + H'01' (UNI-TELWAY offset + sender link address)

5.3.5 Special Character Codes

Special characters used in frame codes:

Character	ASCII code	Meaning
ACK	H'06'	Message received
DLE	H'10'	First header character
ENQ	H'05'	Second header character for a polling message
EOT	H'04'	No data to send
NAK	H'15'	Message not processed
STX	H'02'	Second header character for a data message