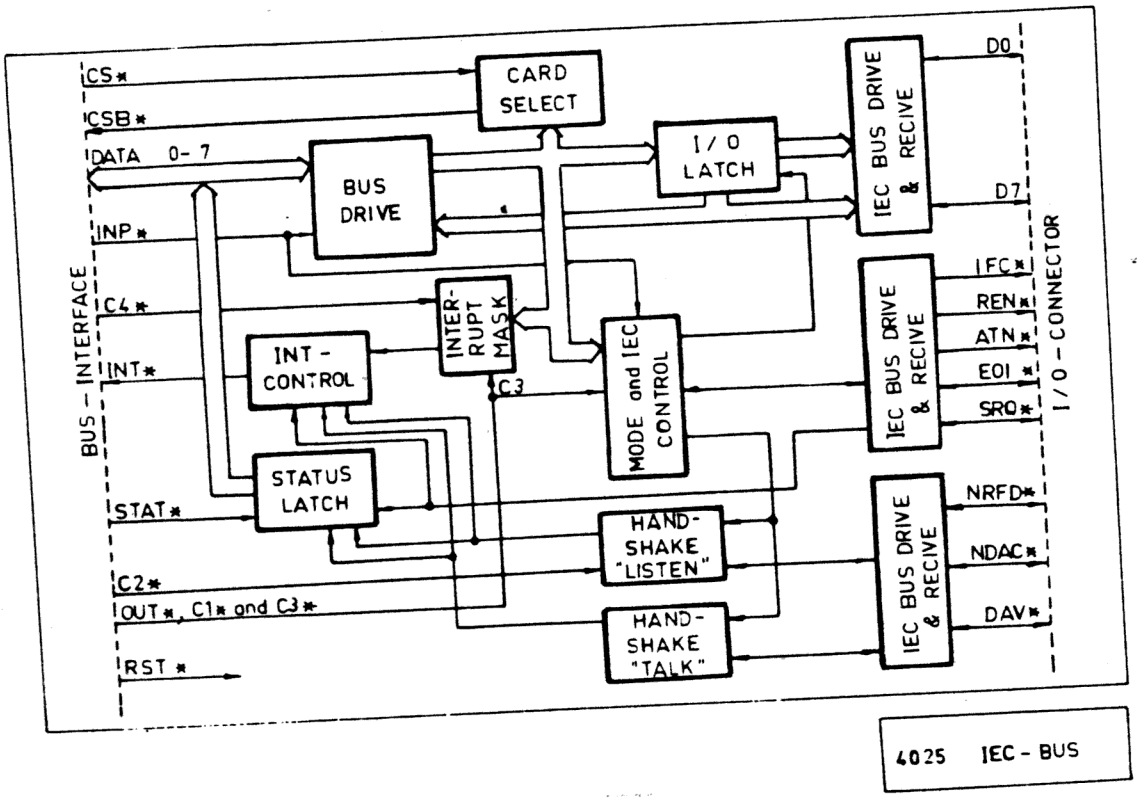


4025 IEC - BUS

4025 provides DATABOARD 4680 users interfacing to the IEC-bus.

It conforms fully to the specification with respect to the three basic functional elements:

1) listener
2) talker
3) controller

These basic functions are defined as subsets C1, C2, C3, C4 and C25 of the standard. 4025 acts as the supreme controller of the connected IEC-bus.

C1= System Controller
C2= Send IFC and Take Charge
C3= Send REN
C4= Respond to SRQ
C25= Send I.F. Messages
Parallell Poll
Take Control Synchronously

Software Support is available through options in Extended Basic and Basic for ABC 80.

SPECIFICATION

Power supply	+5V ± 5 % 500 mA
Peripheral interface	Conforms fully to the specification IEC 66.22 of the "IEC-bus".
Connectors	B 64 pin two-row Europe connector on the bus as well as on the I/O sides.
Bus connection	On the I/O side of the 4680-bus, provides the signal CSB^X for use at bus expansion.
Size	Standard Europe card 100 x 160 mm.
JUMPERS	None
CARD SELECT	Is done by code plug – position 2B on board. See System Manual about the coding. Standard = 61Q(031H).

COMMANDS

INP DATA	Reads 8 bits received data. Data is valid only when statusbit 7 is active.
INP STAT	Reads status. The bits have the following significance:
D0	not used
D1	not used
D2	NRFD (Not Ready For Data). Active 0.
D3	NDAC (Not Data Accepted). Active 0.
D4	EOI (End Or Identify). Active 0.
D5	SRQ (Service ReQuest). Active 0.
D6	Data accepted ("talk"-mode). Active 0.
D7	Data valid ("listen"-mode). Active 0.
OUT DATA	Output 8 bits of data for transmission. The command is allowed only in "talk"-mode.
OUT C1	Controls mode of activity and control-signalling. The data-byte is used in the following way:
	D0 - D2 = Address
	D7 Controls the state of the concerned function:
	D7 = 0 = Reset
	D7 = 1 = Set

Address

0	Not IFC (InterFace Clear).
1	REN (Remote ENable).
2	EOI.
3	ATN.
4	"talk"-mode.
5	"listen"-mode.
6	"Not automatic ready" in "listen"-mode.
7	not used.

Note: "talk"- and "listen"-modes are not allowed to be active at the same time. If both are commanded actives the "talk"-mode is set up.

OUT C2 Controls the handshake in "listen"-mode when "Not automatic ready" is activated. Next transfer will follow.

OUT C3 Clear interface. Has the same function as RST-command but is controlled by the cardselection.

OUT C4 Selective INTERRUPT ENABLE. The data-byte is evaluated as follows:

D0	not used
D1	not used
D2	not used
D3	not used
D4	= 1, interruptsignal if EOI is active.
D5	= 1, interruptsignal if SRQ is active.
D6	= 1, interruptsignal if "Data accepted" is active ("talk"-mode).
D7	= 1, interruptsignal if "Data valid" is active ("listen"-mode).

IEC-CABLE, PRODUCT NUMBER 7225

A special adaptor cable is supplied. It connects to 4025 and provides a standard IEC-bus connector (Amphenol 17-20250) ready to connect to the first instrument to be interfaced. Other equipment is connected in daisy-chain.

Length = 2 m.

The following table shows the interchange between IEC-cable and 4025 I/O-connector.

The colour-code is the same as specified for the Philips IEC-cable.

IEC		4025 (DIN 41612)	
1	white	3B	D0*
2		4B	D1*
3	gray	5B	D2*
4		6B	D3*
5	white/brown	7B	REN*
6		8B	EOI*
7	white/green	9B	DAV*
8		10B	NRFD*
9	white/grey	11B	NDAC*
10		12B	IFC*
11	white/blue	13B	SRQ*
12		14B	ATN*
13	screen	15B	
14		16B	D4*

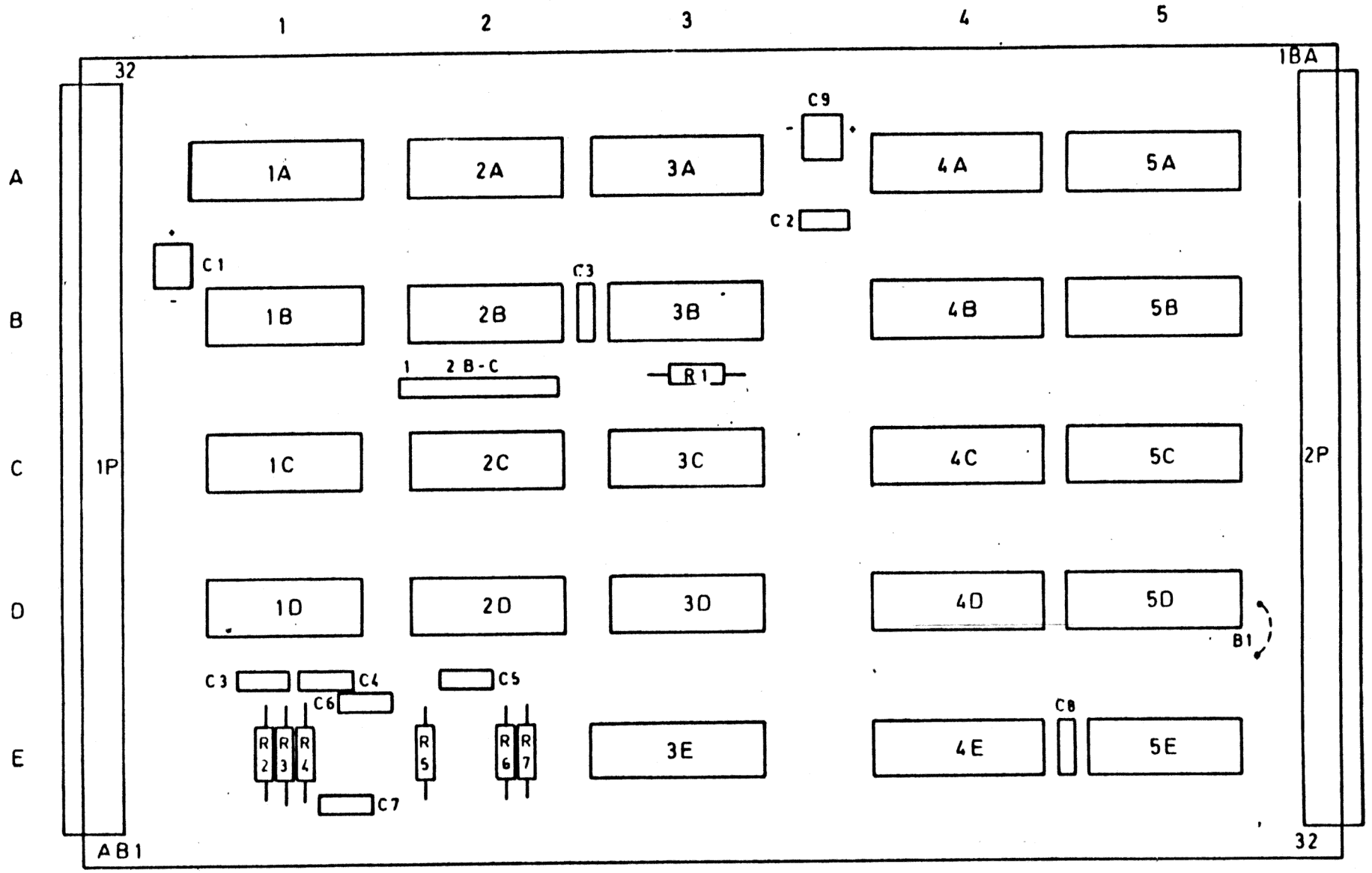
Contd.

IEC			4025 (DIN 41612)	
15	yellow		17B	D5*
16		rose	18B	D6*
17	red		19B	D7*
18		yellow/green	7A	
19	blue/red		8A	
20		brown/green	9A	
21	yellow/brown		10A	
22		grey/brown	11A	
23	rose/brown		12A	
24		brown/blue	13A	
25	brown/red		14A	

REFERENCES

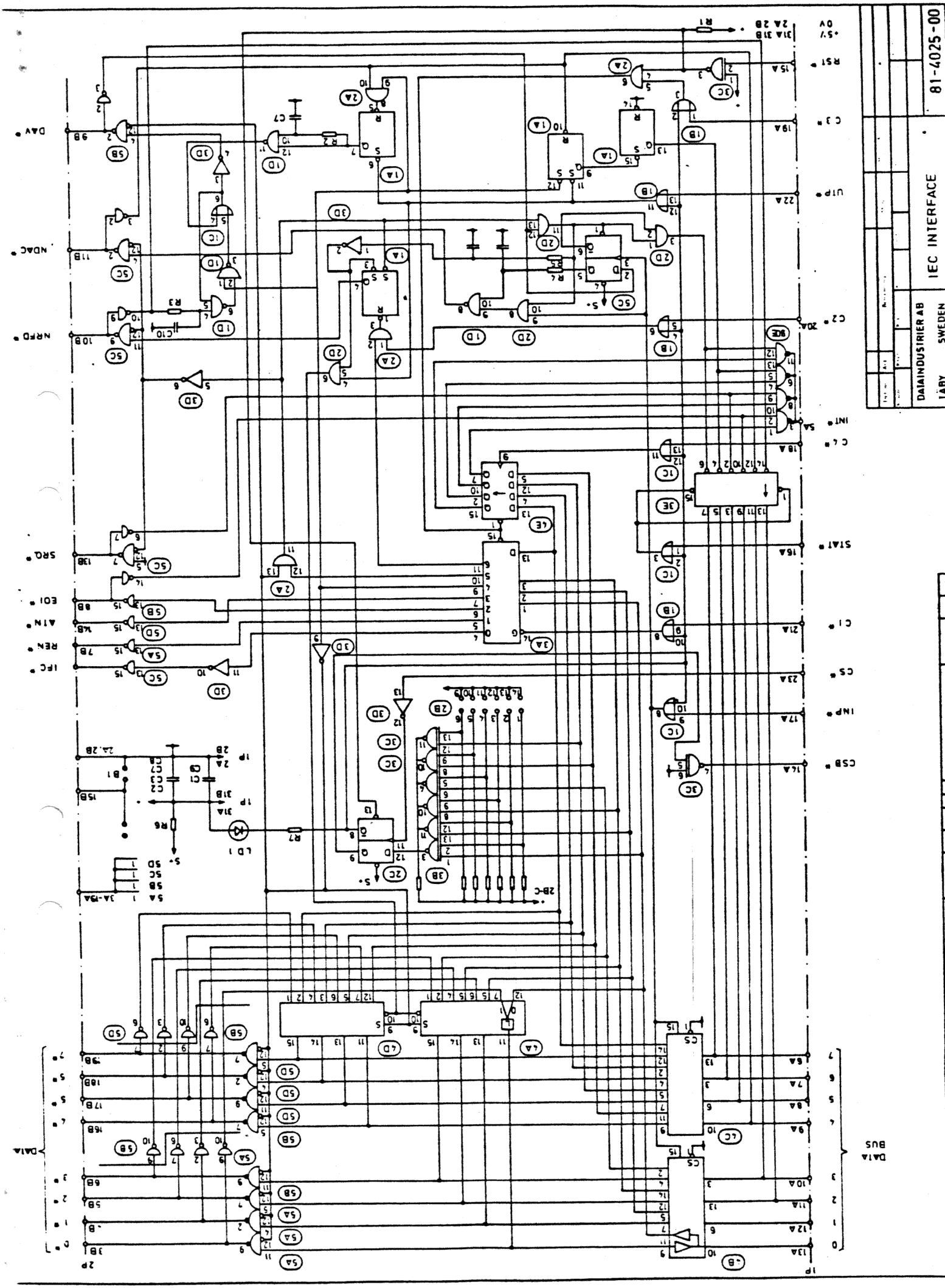
IEEE Standard Digital Interface for Programmable Instrumentation.
IEEE Standard 488 - 1975.

Datorteknik "Datoranvändning med IEC-buss" Sune Windisch,
Liberförlaget (lärobok för användning av 4025 genom IEC-optionerna
i Basic).



COMMENT: 2B = CODE PLUG FOR CHANNEL SELECTION.
JUMPER B1 NOT INSTALLED = SHIELD NOT CONNECTED TO 4680 SYSTEM 0V.

	C	REV NR	DATAINDUSTRIER AB	INTERFACE	82-4025-00
	7903	DATUM	TABY SWEDEN		


81-4025-00
IEC INTERFACE
DATAINDUSTRIER AB
LÄBY SWEDEN
DAV
NDAC
NRFD
SRQ
EOI
ATN
REN
IFC
RST
C3
UTP
C2
INT
C4
STAT
C1
CS
INP
CSB
DATA BUS
DATA

The IEC-bus is a standard approach to interconnect instrumentation. It is issued by "International Electro-Technical Committee" as specification IEC 66.22. It was published 1975 as ANSI-Standard IEEE 488, IEEE Standard Digital Interface for Programmable Instrumentation.

The IEC-bus interfaces to DataBoard 4680 through the I/O-module 4025. It provides a simple means of interfacing instrumentation equipment to a DataBoard 4680 computer and as well ABC 80(expanded with DataBoard 4680 expansion chassis as Datadisk 80).

The DataBoard 4680 IEC-bus interface packet comprises:

- I/O interface module, prod. No. 4025
- IEC cable, prod. No. 7225
- Software support in Basic
  a) Option in Extended Basic
  b) PROMed program driver for ABC 80/Datadisk 80 application.

Cable and Interface module are described by datasheet 4025.

The above program drivers offer through Basic users a quick availability to the technique of handling the IEC-bus in programming. This document describes how to use these IEC-options. Direct control of 4025 is still available and, if faster data transfers are required, is controlled by an Assembler program. Data sheet 4025 provides the complete list and description of the I/O-commands.

The next sections describe:

- IEC OPTION
  Details and how to use the optional program driver f or Basic
- IEC BUS SPEC - 4025
  Describes the standard of IEC bus as applied to 4025.

Tables and figures are located in the end. The Remote Message coding as the 7-bit ISO-code is given.

IEC-OPTION

Specification

Program driver: Option in Extended Basic
Volume = 1 K

PROMed program driver for ABC 80/Datadisk 80 applications:
Volume = 1K (2708)
Mem. allocation: On the DOS PROM-module
(1:st mem. circuit on the second row)

Channel address: Standard 61_8 (49_{10})

Interrupt-driven: No

Controller
Talker Address: "U"

Controller
Listener Address: "5"

Not supported functions of 4025:
Automatic Ready (OUT C1) (requires interrupt handling)

Parallel Poll (SRQ) (available through direct I/O-commanding.

General

The user programming is naturally dependent on the instrumentation equipment connected. Each instrumentation is specified by a manual with respect to the use in an IEC-bus configuration. The basic action to be made is selection of the device address which normally is done by jumpers.

The user programming requires following steps:

1) Connect the user program to the IEC-option known to the system as "IEC:".
   See "OPEN- and CLOSE statements".

2) Commanding data transfer on the IEC-bus.
   See "Commanding".

3) Handling received data.
   See "IEC$"

4) Disconnection of the user program from the IEC-option. Makes the IEC-bus free for another user (essential in Multi-user Basic).
   See OPEN- and CLOSE-statements.

The user has, however, not access to all functions so we describe the "Restrictions" and how to handle them.

OPEN- and CLOSE-statements

OPEN issues	IFC	(Interface clear) false signal
	REN	(Remote enable) true signal
CLOSE issues	IFC	Signal true
	REN	Signal false

Format is shown by the following:

```
10   OPEN "IEC:"   AS FILE 31

100  CMD  "U6"...  } Body of the user program

999  CLOSE  31
```

The channel number is not significant. OPEN and CLOSE are necessary for initialization of the IEC-bus.

Commanding

Format: [statement number] CMD [A1$] , C1$, A2$, C2$,...

Where: A1$;A2$ etc

are string expressions which define the TALKER(s) and LISTENER(s). Each string character defines a device address. The first parameter (A1$) is optional as talker(s) and listener(s) can be the same as commanded before. The ATN signal on the IEC-bus is sent true.

C1$,C2$ etc are string expressions, character by character, to control the device(s) connected to the IEC-bus.

The ATN signal is sent false.

The parameter delimiter","switches the IEC- option from one mode to the other, that is the ATN message from true to false etc.

Example 1: 100 CMD "?U1","BCD1F2A"

Where: "?U1" corresponds to A1$

"BCD1F2A" corresponds to C1$

"?" = UNL (unlisten), refer to table 3, which resets all listener(

"u" defines the new talker (=controller) and "1" defines the new listener.

"BCD1F2A" contain commands to the listener as specified for the specific instrument.

Example 2: 110 CMD "?U1" +CHR$(8)

Where: CHR$(8) adds the string value [8] (=backspace) as the last character of the address-string. The function CHR$ gives us a way to handle non-attributed codes.

Talker(s) require no reset , refer to table 3. In this case the 4025 (="U") is specified as talker. Any talker will automatically be reset as only one talker at a time is allowed.

The listener has the address "1".

Note: Talker- and listeneraddresses are allowed in opposite order.

IEC$

The function IEC$(arg) provides the user the received data.

Example:

```
110 OPEN "IEC:" AS FILE 35
120 CMD  "?U7"+CHR$(8)
130 CMD  "?5R"
140 PRINT IEC$(13)
150 GOTO 120
```

Line 130 commands the 4025 as listener and an instrument as talker. The received information (13 characters) is then transferred at line 140:- from the buffer of the IEC-option to the program by using the function IEC$.

Format: IEC$(<arg>)

Where: <arg> is limited only by memory-space available. The IEC-option reads the number of characters that is specified by the argument.

Restrictions

SRQ (service request) is not implemented in the IEC-option. The user has to solve this signalling which concerns PP (parallel Poll) by explicit I/O-commanding of the 4025.

As stated before, "automatic ready" is not used. This is significant when using the 4025 by I/O-interrupt-signal.

Messages

A remote message is sent or received by the interface via one or several of the signal lines.

A message derived from or sent as state of one line is referred to as uniline message (U) and if two or more lines are used, then the message is referred to as multiline message (M).

A uniline message is valid as soon as its corresponding state is detected. A multiline message is valid within the context of SH (STRS - Source TRansfer State) and AH (ACDS - ACcept Data State) functions.

Note: AH = Acceptor Handshake
SH = Source Handshake

Interface Messages

Each interface message is sent to cause a state transition within another interface. The interface messages are sent when the ATN message is true. The message coding is defined in table 3 and corresponds to ISO-7 bit code.

Device Dependent Messages

After a talker and listener(s) have been addressed via interface messages, any common binary, BCD or alphanumeric code may be used when the ATN message is false.

Remote Message Coding

Table 2))shows the coding of each remote specific message as sent by one source.

The conventions and the symbols used in the table are specified as follows:

Ø = logical zero
1 = logical one
x = "don't care" for receive
x = "must not drive" for send

Level assignments:

Ø = high state signal level
1 = low state signal level

Symbols:

U = Uniline message
M = Multiline message
AC = Addressed Command
AD = ADress - talk or listen
DD = Device Dependent
HS = HandShake
UC = Universal Command
SE = SEcondary
ST = STatus

Notes:

1) D1 - D8, databits
2) E1 - E8, code for EOS message
3) L1 - L5, listen address
4) T1 - T5, talk address
5) S1 - S5, secondary address
6) S, specifies the sense of PPR
   P1 - P3, specify the PPR message in parallel poll
7) D1 - D4, specify bits that must be sent all zeros but do not need to be decoded
8) S1 - S6, specify the device dependent status. Databit S8 6 is used for the RQS message.
9) If LACS is inactive, the true message value must be ignored
10) If ATN is false, the true message value must be ignored
11) IDY message is sent true only when ATN is true.
12) END message is sent true when ATN is false.

State Diagrams

The controller functions are graphically described by state diagrams. The handshake signalling is not presented as it is implemented in hardware.

The controller, as referred to in the text, shall be considered as a compound function of the user program driver and the 4025 itself. The controller states shall be treated as software states. Some of the states are of no significance to the software control. They are nevertheless shown for reference to the specification of the general standard. The handshake signalling is a dynamic sequence of hardware states on the INP DATA and OUT DATA commands with the overlaying controller states.

The diagrams are described with a short description of every state. The terms "true" and "false" are assumed to mean the quaranteed value received. Passive true and false terms mean that the values are not guaranteed to be received and that they are allowed to be overread.

The diagrams use the following conventions:

A_local_message (a program control of 4025) is represented by a three-letters mnemonic written in lower case.

A_remote_message is represented by a three-letters mnemonic written in upper case.

A_linkage to other state diagrams is represented by a four-letters mnemonic enclosed as the following exapmle to the LISTENER function, which stands for 'listener active state'.
(LACS)
The user will, however, by using the IEC-options not be interfered with the controller states, that is I/O-commanding 4025.

Talk (T) and listen (L) functions

4025 is provided with the capability to act either as a talker, as a listener or as a passive listener on the bus. These functions correspond to complementary functions of the devices. The ATN message is false When the conversation partner(s) are chosen, 4025 is set to the concerned mode with the C1 command.

Option for automatic ready-signalling in listen-mode is provided. The ready signal is executed with the C2 command. EOI, used by a bi-directional slave, is provided as interrupt and status.

Service Request (S R)

The SR function provides a device with the capability to asynchronously request service from the controller. "Service request" is provided as interrupt and status.

Parallell Poll (P P)

The PP function is used by the controller to periodically conduct a parallell poll of device service requests. Each of the devices can be assigned their own statusbit on the data bus. This allows eight devices, although any number can be handled through sharing data lines.

Controller (C) Function

The C function provides the capability to send device addresses, universal commands and addressed commands to devices over the interface. It provides also the capability to conduct parallell polls to determine which device(s) require service. These capabilities are exercised only when it is sending the ATN message.

The state diagrams of figure 1) and table 1) specify the set of messages and states required to effect transitions from one active state to another. They present also the messages sent during each state.

The following table specifies the messages that must be sent and the interactions required while each state is active.

CONTROLLER STATE DESCRIPTION

CACS (Controller ACtive State)
The ATN message must be sent continuously true. The IDY message must be sent continuously false. While these conditions are met the multiline messages specified by the following table may be sent.

CPWS (Controller Parallell poll Wait State)
C conducts a parallel poll but waits for the data lines to settle. The ATN and IDY messages must be sent true.

CSBS (Controller StandBy State)
Allows two or more devices to participate in a conversation as TALKER and LISTENER (S). Device dependant messages are sent over the interface. The ATN must be sent false. The IDY message must be sent passive false.

CSWS (Controller Synchronous Wait State)
C is in the process of entering the CAWS but waits for a specified time to make sure that the current active talker recognizes the ATN message. The ATN message must be sent true. The IDY message must be sent active or passive false.

CAWS (Controller Active Wait State)
C waits for a period before CACS. This fact guarantees that the EOI line has settled. The ATN message must be sent true. The IDY message must be sent false.

CSRS (Controller Service Requested State)
Notifies that at least one device on the interface is requesting service. Does not provide remote message sending.

CSNS (Controller Service Not requested State)

Notifies that no device on the interface is requesting service. Does not provide remote message sending.

SNAS (System Control not Active State)
All system control capabilities are relinquished. Does not provide remote message sending.

SACS (System Control Active State)
C is allowed to exercise its system control capabilities (in SIIS and SRIS). Does not provide remote message sending.

SIIS (System control Interface clear Idle State)

SINS (System control Interface clear Not active State)
The IFC message is sent false.

SIAS (System control Interface clear Active State)
Clears the interface. All interface functions connected to the system must respond with a transfer to a known initial state. The IFC message must be sent true.

SRIS (System control Remote Idle State)
C has now remote enable capability. The C functions set up will remain unchanged.

SRNS (System control Remote enable Not active State)
C is not engaged in enabling remote operation of other devices over the interface.

SRAS (System control Remote enable Active State)
C is actively engaged in enabling remote operations of other devices over the interface. The REN message must be sent continuously true.

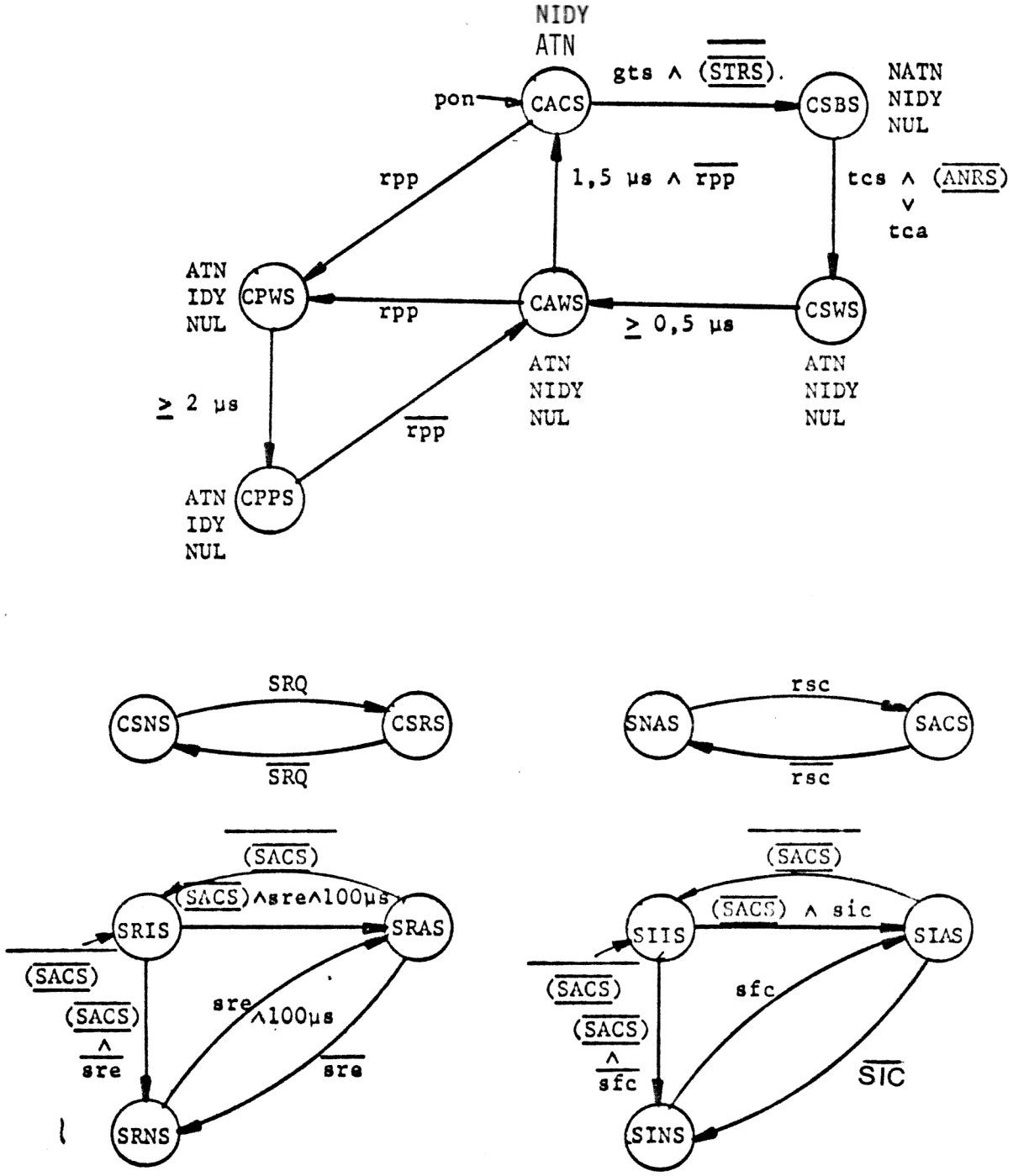


Figure 1. Controller State Diagram

TABLE 1

C M N E M O N I C S

pon = power on

rsc = request system control

rpp = request parallell poll

gts = go to standby

tca = take control asynchronously

tcs = take control synchronously

sic = send interface clear

sre = send remote enable

ATN = attention

($\overline{\text{ANRS}}$) = acceptor not ready state (AH function)

($\overline{\text{STRS}}$) = source transfer state (SH function)

CACS = controller active state

CPWS = controller parallell poll wait state

CPPS = controller parallell poll state

CSBS = controller stanby state

CAWS = controller active wait state

CSWS = controller synchronous wait state

CSRS = controller service requested state

CSNS = controller service not requeste state

SNAS = system control not active state

SACS = system control active state

SRIS = system control remote enable state

SRNS = system control remote not active state

SRAS = system control remote enable active state

SIIS = system control interface clear idle state

SINS = system control interface clear not active state

SIAS = system control interface clear active state

TABLE 2

REMOTE MESSAGE CODING

MNEMONIC	MESSAGE NAME		TYPE	CLASS	DATA 8	7	6	5	4	3	2	1	NNDRDAFAVDC	ATN	EOI	SRQ	IFC	REN
					Bus signal line(s) and coding that asserts the true value of the message													
ACG	addressed command group	(10)	M	AC	X	Ø	Ø	Ø	X	X	X	X	XXX	X	X	X	X	X
ATN	attention		U	UC	X	X	X	X	X	X	X	X	XXX	1	X	X	X	X
DAB	data byte	(1,9)	M	DD	D8	D7	D6	D5	D4	D3	D2	D1	XXX	X	X	X	X	X
DAC	data accepted		U	HS	X	X	X	X	X	X	X	X	XXØ	X	X	X	X	X
DAV	data valid		U	HS	X	X	X	X	X	X	X	X	1XX	X	X	X	X	X
DCL	device clear	(10)	M	UC	X	Ø	Ø	1	Ø	1	Ø	Ø	XXX	X	X	X	X	X
END	end	(9,11)	U	ST	X	X	X	X	X	X	X	X	XXX	X	1	X	X	X
EOS	end of string	(2,9)	M	DD	E8	E7	E6	E5	E4	E3	E2	E1	XXX	X	X	X	X	X
GET	group executive trigger	(10)	M	AC	X	Ø	Ø	Ø	1	Ø	Ø	Ø	XXX	X	X	X	X	X
GTL	go to local	(10)	M	AC	X	Ø	Ø	Ø	Ø	Ø	Ø	1	XXX	X	X	X	X	X
IDY	identify	(10,11)	U	UC	X	X	X	X	X	X	X	X	XXX	X	1	X	X	X
IFC	interface clear		U	UC	X	X	X	X	X	X	X	X	XXX	X	X	X	1	X
LAG	listen address group	(10)	M	AD	X	Ø	1	X	X	X	X	X	XXX	X	X	X	X	X
LLO	local lock out	(10)	M	UC	X	Ø	Ø	1	Ø	Ø	Ø	1	XXX	X	X	X	X	X
MLA	my listen address	(3,10)	M	AD	X	Ø	1	L5	L4	L3	L2	L1	XXX	X	X	X	X	X
MTA	my talk address	(4,10)	M	AD	X	1	Ø	T5	T4	T3	T2	T1	XXX	X	X	X	X	X
MSA	my secondary address	(5,10)	M	SE	X	1	1	S5	S4	S3	S2	S1	XXX	X	X	X	X	X
NUL	null byte		M	DD	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	XXX	X	X	X	X	X
OSA	other secondary address	(10)	M	SE	(OSA = SCG ∧ $\overline{\text{MSA}}$)													
OTA	other talk address	(10)	M	AD	(OTA = TAG ∧ $\overline{\text{MTA}}$)													

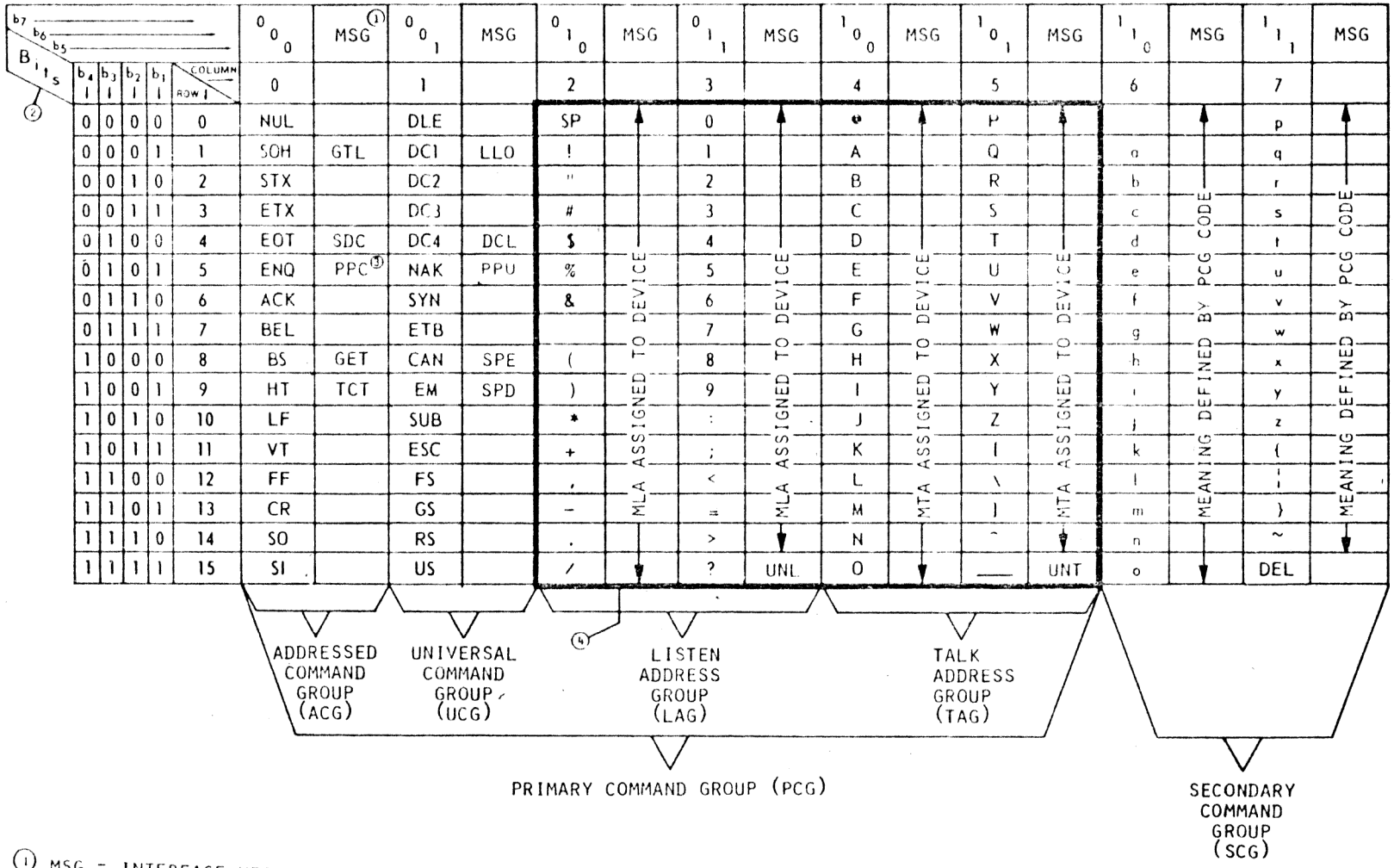
TABLE 2, Continued

MNEMONIC	MESSAGE NAME		TYPE	CLAS	DAT8	Bus singal line(s) and coding that asserts the true value of the message: 7	6	5	4	3	2	1	NDRDAFAVDC	NATN	EOIT	SRQ	IFC	REN
PCG	primary command group	(10)	M	-	(PCG = ACG v							UCG v	LAG v	TAG)					
PPC	parallel poll configure	(10)	M	AC	X	Ø	Ø	Ø	Ø	1	Ø	1	XXX	X	X	X	X	X
PPE	parallel poll enable	(6,10)	M	SE	X	1	1	Ø	S	P3	P2	P1	XXX	X	X	X	X	X
PPD	parallel poll disable	(7,10)	M	SE	X	1	1	1	D4	D3	D2	D1	XXX	X	X	X	X	X
PPR1	parallel poll response 1		U	ST	X	X	X	X	X	X	X	1	XXX	X	X	X	X	X
PPR2	parallel poll response 2		U	ST	X	X	X	X	X	X	1	X	XXX	X	X	X	X	X
PPR3	parallel poll response 3		U	ST	X	X	X	X	X	1	X	X	XXX	X	X	X	X	X
PPR4	parallel poll response 4		U	ST	X	X	X	X	1	X	X	X	XXX	X	X	X	X	X
PPR5	parallel poll response 5		U	ST	X	X	X	1	X	X	X	X	XXX	X	X	X	X	X
PPR6	parallel poll response 6		U	ST	X	X	1	X	X	X	X	X	XXX	X	X	X	X	X
PPR7	parallel poll response 7		U	ST	X	1	X	X	X	X	X	X	XXX	X	X	X	X	X
PPR8	parallel poll response 8		U	ST	1	X	X	X	X	X	X	X	XXX	X	X	X	X	X
PPU	parallel poll unconfigure	(10)	M	UC	X	Ø	Ø	1	Ø	1	Ø	1	XXX	X	X	X	X	X
REN	remote enable		U	UC	X	X	X	X	X	X	X	X	XXX	X	X	X	X	1
RFD	ready for data		U	HS	X	X	X	X	X	X	X	X	XØX	X	X	X	X	X
RQS	request service	(9)	U	ST	X	1	X	X	X	X	X	X	XXX	X	X	X	X	X
SCG	secondary command group	(10)	M	SE	X	1	1	X	X	X	X	X	XXX	X	X	X	X	X
SDC	select device clear	(10)	M	AC	X	Ø	Ø	Ø	Ø	1	Ø	Ø	XXX	X	X	X	X	X
SPD	serial poll disable	(10)	M	UC	X	Ø	Ø	1	1	Ø	Ø	1	XXX	X	X	X	X	X
SPE	serial poll enable	(10)	M	UC	X	Ø	Ø	1	1	Ø	Ø	Ø	XXX	X	X	X	X	X

TABLE 2, Continued

MNEMONIC	MESSAGE NAME		TYPE	CLASS	DATA 8	Bus signal line(s) and coding that asserts the true value of the message: 7	6	5	4	3	2	1	NNDRDAFAVDC	ATN	EOI	SRQ	IFC	REN
SRQ	service request		U	ST	X	X	X	X	X	X	X	X	XXX	X	X	1	X	X
STB	status byte	(8,9)	M	ST	S8	X	S6	S5	S4	S3	S2	S1	XXX	X	X	X	X	X
TCT	take control	(10)	M	AC	X	Ø	Ø	Ø	1	Ø	Ø	1	XXX	X	X	X	X	X
TAG	talk address group	(10)	M	AD	X	1	Ø	X	X	X	X	X	XXX	X	X	X	X	X
UCG	universal command group	(10)	M	UC	X	Ø	Ø	1	X	X	X	X	XXX	X	X	X	X	X
UNL	unlisten	(10)	M	AD	X	Ø	1	1	1	1	1	1	XXX	X	X	X	X	X
UNT	untalk	(10)	M	AD	X	1	Ø	1	1	1	1	1	XXX	X	X	X	X	X

Table 3.



NOTES: (1) MSG = INTERFACE MESSAGE
(2) b_1 = DIO1...b_7 = DIO7
(3) REQUIRES SECONDARY COMMAND
(4) DENSE SUBSET (COLUMN 2 THROUGH 5)

MULTILINE INTERFACE MESSAGES: ISO-7 BIT CODE REPRESENTATION

(SENT AND RECEIVED WITH ATN=1)