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Micro488/p User's Manual

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Introduction

1.1 Description

The Micro488/p Bus Controller converts a host RS-232 computer into an IEEE 488 bus talker, listener, and controller. It provides the basic IEEE 488-1978 bus implementation required for a system controller. The Micro488/p may be located up to fifty feet from the host and may control as many as eight IEEE 488 bus instruments.

The Micro488/p interprets simple high level commands sent from the computer's serial port and performs the necessary, and usually complex, bus control and handshaking. The commands and protocol are similar to those used by the Hewlett Packard HP-85 computer.

1.2 Available Accessories

Available accessories for the Micro488/p include:

CA-7-1	1.5 foot IEEE 488 Cable.
CA-7-2	6 foot IEEE 488 Cable.
CA-7-3	6 foot shielded IEEE 488 Cable.
CA-7-4	6 foot reverse entry IEEE 488 Cable.
CA-35	Cable Set; includes one IBM PC/XT/PS2 to Micro488/p RS-232 Cable and one IBM AT to Micro488/p RS-232 Cable.
CN-20	Right Angle IEEE 488 adapter, male and female.
CN-22	IEEE 488 Multi-tap bus strip, four female connectors in parallel.
CN-23	IEEE 488 panel mount feed-through connector, male and female.
ABC488	IEEE 488 ABC switch.

1.3 Specifications

IEEE 488-1978

Implementation: C1, C2, C3, C4 and C28 controller subsets.

Terminators: Selectable CR, LF, LF-CR and CR-LF with EOI.

Connector: Standard IEEE 488 connector with metric studs.

Serial Interface

EIA RS-232C: AB, BA, BB, CA, CB.

Character Set: Asynchronous bit serial.

Output Voltage: 5 volts min. (RS-232C).

Input Voltage: 3 volts min.; 15v max.

Baud Rate: Selectable 300, 1200, 2400, 4800, 9600, and 19200.

Data Format: 8 data bits; 1 or 2 stop bits, no parity.

Duplex: Full with Echo/No Echo.

Serial Control: Selectable CTS/RTS or XON/XOFF.

Terminators: Selectable CR, LF, LF-CR and CR-LF.

Connector: 25-pin Sub-D male. RS-232C DCE Configured.

General

Data Buffer: 120 character input buffer.

Power: Draws less than 5mA from the DTR or DSR serial lines on the host computer.

Max. Dimensions: 50mm x 60mm x 25mm (2" x 2.3" x 0.9").

Weight: 51.2 grams (1.8 oz).

Environment: 0° to 50°C; 0 to 90% R.H. non-condensing.

Controls: All settings auto or software configurable.

Note: Specifications subject to change without notice.

1.4 Abbreviations

The following IEEE 488 abbreviations are used throughout this manual:

addr n	IEEE bus address "n"
ATN	Attention line
CR	Carriage Return
data	Data String
DCL	Device Clear
GET	Group Execute Trigger
GTL	Go To Local
LAG	Listen Address Group
LF	Line Feed
LLO	Local Lock Out
MLA	My Listen Address
MTA	My Talk Address
REN	Remote Enable
SDC	Selected Device Clear
SPD	Serial Poll Disable
SPE	Serial Poll Enable
SRQ	Service Request
TA	Talker Active
TAD	Talker Address
term	Terminator
UNL	Unlisten
UNT	Untalk
*	Unasserted

Notes:

Getting Started

2.1 Inspection

The Micro488/p was carefully inspected, both mechanically and electrically, prior to shipment. When you receive the interface, carefully unpack all items from the shipping carton and check for any obvious signs of physical damage which may have occurred during shipment. Immediately report any such damage found to the shipping agent. Remember to retain all shipping materials in the event that shipment back to the factory becomes necessary.

Every Micro488/p is shipped with the following....

- Micro488/p IEEE488 Bus Controller
- *Micro488/p User's Manual*, p/n 232-0901

2.2 Serial Configuration

Some of the Micro488/p serial communication parameters are pre-configured, and can not be changed. The following list describes the parameters which are fixed and, therefore, can not be changed:

Parameter	Setting
Data Bits	8 Bit ASCII
Stop Bits	1 or 2
Parity	None
Receive Terminator	CR

The rest of the parameters are configured through software, after power on. The following is a list of the software-configurable parameters:

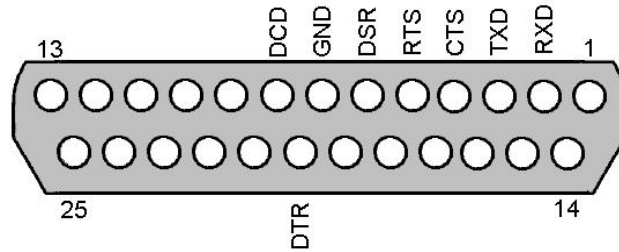
Parameter	Setting
Baud Rate	300, 1200, 2400, 4800, 9600, 19200
Duplex	Full with echo/no-echo
Transmit Terminator	LF, CR, LF-CR, CR-LF
Handshaking	XON/XOFF or CTS/RTS

2.3 Serial Signal Descriptions

The Micro488/p serial connector is configured as DCE type equipment for RS-232 communications. This means the Micro488/p always transmits data on Pin 3 and always receives data on Pin 2.

Note that the Micro488/p is equipped with a standard DB-25S connector and requires a standard DB-25P mating connector.

Refer to the following figure and table to understand the relationship of the Micro488/p connector's pins and the associated RS-232 signals. [Section 2.4](#) of this document includes wiring information for making your own cables.



Micro488p Serial Connector Pinout

The following table identifies the above connector pins in regard to signal name and I/O type.

Micro/488p Serial Connection			
Pin	Signal Name	I/O	Function
2	RxD Receive Data	Input	Accepts serial data sent by the RS-232 host. The signal level is low true.
3	TxD Transmit Data	Output	Transmits serial data to the RS-232 host. The signal level is low true.
4	CTS Clear To Send	Input	<p>The CTS input is used as a hardware handshake line to prevent the Micro488/p from transmitting serial data when the RS-232 host is not ready to accept it.</p> <p>When RTS/CTS handshake is selected, the Micro488/p will not transmit data out TxD while this line is un-asserted (low).</p> <p>If XON/XOFF handshake is selected, the CTS line is not tested to determine if it can transmit data.</p>
5	RTS Request To Send	Output	The RTS output is used as a hardware handshake line to prevent the RS-232 host from transmitting serial data if the Micro488/p is not ready to accept it.
6	DSR Data Set Ready	Input	This pin is used to provide power for the Micro488/p if the DTR pin is in its false (LOW) state, this pin must be in its true (HIGH) state in order for the Micro488/p to operate properly.
7	Gnd Ground	N/A	This pin sets the ground reference point for the other RS-232 inputs and outputs.
8	DCD Data Carrier Detect	Output	The function of this pin is similar to the CTS pin. This pin is tied internally to its true (HIGH) state.
20	DTR Data Terminal Ready	Input	Used to provide power for the Micro488/p when the DSR pin (pin 6) is in its false (LOW) state. Note that the DTR pin (pin 20) must be in its true (HIGH) state in order for the Micro488/p to operate properly.

2.4 Serial Cable Wiring

If a cable was not purchased with the interface, the following diagrams will be helpful in making your own cable. Simple soldering skills and attention to detail will ensure successful construction.

IBM PC/XT/PS2 to Micro488/p				IBM AT to Micro488/p			
<u>DB25, Female</u>		<u>DB25, Male</u>		<u>DB9, Female</u>		<u>DB25, Male</u>	
TXD	2	→	2 TXD	DCD	1	→	8 DCD
RXD	3	←	3 RXD	RXD	2	←	3 RXD
RTS	4	→	4 RTS	TXD	3	→	2 TXD
CTS	5	←	5 CTS	DTR	4	→	20 DTR
DSR	6	←	6 DSR	GND	5	↔	7 GND
GND	7	↔	7 GND	DSR	6	←	6 DSR
DCD	8	←	8 DCD	RTS	7	→	4 RTS
DTR	20	→	20 DTR	CTS	8	←	5 CTS

Two Scenarios for Making an Interface Cable (RS-232)

2.5 Hardware Installation

Installation of the Micro488/p consists of plugging the device into an available serial port on the host computer.

2.6 Is Anyone Out There?

In order to properly operate the Micro488/p, the DTR and DSR lines on the COM port must be initialized first. Usually this can be accomplished by closing and then opening the serial port. **Appendix C includes a *Sample Initialization Program*.**

Once the DTR and DSR lines have been initialized, the next step is to initialize the baud rate to be used with the Micro488/p. This is done by sending the Micro488/p five carriage returns, separated by a 0.1 second delay. Now send the Micro488/p the following command:

```
"I" <CR>.
```

The Micro488/p should respond with the prompt ">" character. Now the IEEE488 bus is initialized, and the Micro488/p ready for operation.

2.7 Programming the Micro488/p

The next step involves writing a simple dumb terminal program to communicate with the Micro488/p. The dumb terminal program is written in QuickBASIC for any IBM PC compatible computer, and allows simple communication with IEEE 488 devices connected to the Micro488/p.

The first task is to open the serial port to which the Micro488/p is connected. If the Micro488/p is connected to serial port 1, then the following line will open that serial port with the following parameters:

```
Baud Rate - 19200  
Parity - NONE  
Data Bits - 8  
Stop Bits - 2
```

```
OPEN "COM1:19200,N,8,2,cs,ds" FOR RANDOM AS #1
```

Next, wait a moment for the Micro488/p's power supply to stabilize.

```
t = TIMER  
DO WHILE t + .1 > TIMER  
LOOP
```

Now that the Micro488/p is powered on, send it five carriage returns for the baud rate detection circuitry to set the internal baud rate. Place a short time delay between the characters to ensure that the proper baud rate will be detected.

```
FOR i = 1 TO 5
  PRINT #1, CHR$(13);
  t = TIMER
  DO WHILE t + .2 > TIMER
    LOOP
NEXT i
```

Next, initialize the Micro488/p with the following command:

```
PRINT #1, "I"
```

Now, set up the Micro488/p with the following parameters:

```
Serial echo - OFF
Hardware Handshake - ON
XON/XOFF handshaking - OFF
Serial terminator - CARRIAGE RETURN
IEEE bus terminator - CARRIAGE RETURN, LINE FEED
```

```
PRINT #1, "EC;0"
PRINT #1, "H;1"
PRINT #1, "X;0"
PRINT #1, "TC;2"
PRINT #1, "TB;4"
```

After a short delay for command processing, input any garbage characters that may be in the PC's serial input buffer.

```
t = TIMER
DO WHILE t + .5 > TIMER
  LOOP
```

```
a$ = INPUT$(LOC(1), #1)
```


Now the Micro488/p is ready for operation. Simply set up an infinite loop to check for user keypresses and to look for serial data in the PC's serial input buffer.

```
PRINT "Ready!"

DO
  IF LOC(1) THEN PRINT INPUT$(LOC(1), 1);           'If anything is in the
                                                    'PC's serial input
                                                    'buffer
                                                    'print it to the screen.
  k$ = INKEY$                                       'Get key press
  PRINT #1, k$;                                     'Send it to the
                                                    'Micro488/p
  PRINT k$;                                         'Echo keypress to screen
LOOP
```

The following is a complete listing of 'DUMBTERM.BAS'

```
'Micro488/p Dumb Terminal Program
'Copyright 1992 IOtech Inc.

CLS
PRINT "Initializing..."
OPEN "COM1:19200,N,8,2,cs,ds" FOR RANDOM AS #1
t = TIMER
DO WHILE t + .1 > TIMER
LOOP

FOR i = 1 TO 5
  PRINT #1, CHR$(13);
  t = TIMER
  DO WHILE t + .2 > TIMER
  LOOP
NEXT i

PRINT #1, "I"
PRINT #1, "EC;0"
PRINT #1, "H;1"
PRINT #1, "X;0"
PRINT #1, "TC;2"
PRINT #1, "TB;4"
t = TIMER
```

```
DO WHILE t + .5 > TIMER  
LOOP
```

```
a$ = INPUT$(LOC(1), #1)
```

```
PRINT "Ready!"
```

```
DO
```

```
  IF LOC(1) THEN PRINT INPUT$(LOC(1), 1);
```

```
  k$ = INKEY$
```

```
  PRINT #1, k$;
```

```
  PRINT k$;
```

```
LOOP
```

Section 3 contains detailed command descriptions which are applicable Micro488/p.

Command Descriptions

3.1 Introduction

This section contains detailed descriptions of each of the low and high-level commands available for the Micro488/p. There are two types of commands: bus commands and system commands. Bus commands communicate with the IEEE 488 bus. System commands configure or request information from the Micro488/p.

Bus Commands:

A	(ABORT I/O)
C	(DEVICE CLEAR)
C;<addr>	(DEVICE CLEAR w/device specified)
EO;n	(EOI ENABLE/DISABLE)
EN	(ENTER)
EN;<addr>	(ENTER w/device specified)
L	(LOCAL)
L;<addr>	(LOCAL w/device specified)
LL	(LOCAL LOCKOUT)
O;cmd\$	(OUTPUT)
OA;<addr>;cmd\$	(OUTPUT w/device specified)
RE	(REMOTE)
RE;<addr>	(REMOTE w/device specified)
RS	(RESUME)
SP;<addr>;	(SERIAL POLL)
SQ	(SRQ CHECK)
TR	(TRIGGER)
TR;<addr>	(TRIGGER w/device specified)
/A	(LOW-LEVEL COMMAND)
/L;<addr>	(SEND LISTEN ADDRESS w/device specified)
/ML	(LOW-LEVEL COMMAND)
/MT	(LOW-LEVEL COMMAND)
/T;<addr>	(SEND TALK ADDRESS w/device specified)
/UL	(LOW-LEVEL COMMAND)
/UT	(LOW-LEVEL COMMAND)

System Commands:

<CTRL> A	(ESCAPE)
<CTRL> Q	(XON)
<CTRL> S	(XOFF)
EC;n	(ECHO)
H;n	(HARDWARE HANDSHAKE)
I	(INIT)
TB;n	(IEEE BUS TERMINATOR)
TC;n	(SERIAL TERMINATOR)
X;n	(XOFF/XON)

3.2 Command Description Format

Each command description includes syntax, response, bus states, and examples.

3.2.1 Syntax

The syntax portion of the command description describes the proper command syntax which must be sent to the Micro488/p using the IBM BASIC PRINT# command, or its equivalent in other languages, to the COM port. The following conventions apply throughout the syntax descriptions:

- The Micro488/p is case insensitive; i.e., system commands may be in upper or lower case.
- Commands to an individual IEEE device must conform to the device's particular syntax.
- Items in lower case, such as *addr* or *n*, represent parameters which must be substituted with an appropriate value.
- Numeric parameters (those that are given as numbers) are decimal unless preceded by *&H*, in which case they are considered to be hexadecimal. For example, *100* is decimal 100, *&H64* is hexadecimal 64 which equals decimal 100, *&HFF* is decimal 255, and *0FF* is invalid because F is not a valid decimal digit.

Note: Bus addresses are the only exception to the numeric parameters rule.

- Bus addresses, both primary and secondary, must be specified as two-digit decimal numbers. Hexadecimal bus addresses are not allowed.

3.2.1.1 Bus Addressing

The following conventions apply to bus addressing:

- addr** An IEEE bus address in the range from 00 through 30.
- cmd\$** An arbitrary command string which is sent to the particular IEEE device being addressed.
- CR** The carriage return character (\$13, \$&H0D).
- LF** The line feed character (\$10, \$&H0A).

3.2.1.2 Terminators

The following conventions apply to terminators:

- term** Any single character, specified as CR, LF, 'X', as described previously; part of terminator sequence used to mark the end of lines of data and commands.
- EOI** The IEEE bus End-Or-Identify signal; when asserted during the transfer of a character, EOI signals that character as the last in the transfer. On input, EOI, if specified, causes the input to stop. On output, EOI causes the bus EOI signal to be asserted during transmission of the last character transferred.

3.2.2 Response

This portion of the command description describes the response that the user's program should read from the serial host's COM port after sending the command. If a response is provided, it must be read to maintain proper program sequence.

3.2.3 Bus States

This portion of the command description describes the bus command and data transfers using IEEE bus mnemonics as listed in the following table.

Bus States		DIO lines							
		8	7	6	5	4	3	2	1
ATN	Attention								
data	Data String								
DCL	Device Clear	x	0	0	1	0	1	0	0
GET	Group Execute Trigger	x	0	0	0	1	0	0	0
GTL	Go To Local	x	0	0	0	0	0	0	1
IFC	Interface Clear								
LAG	Listen Address Group	x	0	1	a	d	d	r	n
LLO	Local Lock Out	x	0	0	1	0	0	0	1
MLA	My Listen Address	x	0	1	a	d	d	r	n
MTA	My Talk Address	x	1	0	a	d	d	r	n
REN	Remote Enable								
SDC	Selected Device Clear	x	0	0	0	0	1	0	0
SPD	Serial Poll Disable	x	0	0	1	1	0	0	1
SPE	Serial Poll Enable	x	0	0	1	1	0	0	0
SRQ	Service Request								
TAG	Talker Address Group	x	1	0	a	d	d	r	n
UNL	Unlisten	x	0	1	1	1	1	1	1
UNT	Untalk	x	1	0	1	1	1	1	1

x = "don't care"
 addrn = IEEE bus address "n"

If a command is preceded by an asterisk, it is unasserted. For example, *REN states that the remote enable line is unasserted; REN without the asterisk states that the line is asserted.

3.2.4 Examples

This portion of the command description includes programming examples written in BASIC.

3.3 The Commands

Command descriptions, relevant to Micro488/p, now follow.

/A

The /A command is a low level IEEE command which asserts the attention line. After completion of this command, the Micro488/p is left in the controller active state.

SYNTAX	/A
RESPONSE	None
BUS STATES	ATN
EXAMPLE	PRINT#1, "/A"

/L

The /L command is a low level IEEE command which sends the LAG command to the specified device. After completion of this command, the Micro488/p is left in the controller active state.

SYNTAX	/L
RESPONSE	None
BUS STATES	ATN,LAG
EXAMPLE	PRINT#1, "/L;10" Send LAG10 on the IEEE bus.

/ML

The /ML command is a low level IEEE command which places the Micro488/p in the listen state. After completion of this command, the Micro488/p is ready to listen as soon as the RESUME (RS) command is issued.

SYNTAX	/ML
RESPONSE	None
BUS STATES	ATN
EXAMPLE	PRINT#1, "/ML"

/MT

The /MT command is a low level IEEE command which places the Micro488/p in the talk state. After completion of this command, the Micro488/p is ready to talk as soon as the RESUME (RS) command is issued.

SYNTAX	/MT
RESPONSE	None
BUS STATES	ATN,UNT
EXAMPLE	PRINT#1, "/MT"

/T

The /T command is a low level IEEE command which issues the talk command to the specified IEEE device.

SYNTAX	/T;addr
RESPONSE	None
BUS STATES	ATN,TAG
EXAMPLE	PRINT#1, "/T;10" Issue TAG to device 10.

/UL

The /UL command is a low level IEEE command which sends the UNL command to the IEEE bus. This command instructs all devices on the IEEE bus to get off the IEEE bus.

SYNTAX	/UL
RESPONSE	None
BUS STATES	ATN,UNL
EXAMPLE	PRINT#1, "/UL"

/UT

The /UT command is a low level IEEE command which sends the UNT command to the IEEE bus. This command instructs all devices on the IEEE bus to get off the IEEE bus.

SYNTAX	/UT
RESPONSE	None
BUS STATES	ATN,UNT
EXAMPLE	PRINT#1, "/UT"

A

ABORT I/O

The ABORT I/O command causes the Interface Clear (IFC) bus management line to be pulsed. By asserting IFC, the Micro488/p regains control of the bus even if one of the devices has locked it up during a data transfer. ABORT I/O forces all IEEE bus device interfaces into a quiescent idle state.

SYNTAX	A
RESPONSE	None
BUS STATES	*REN, IFC, *IFC, ATN, REN
EXAMPLE	PRINT#1, "A"

C

DEVICE CLEAR

The DEVICE CLEAR command causes the Device Clear (DCL) bus command to be issued by the Micro488/p. If the optional addresses are included, the Selected Device Clear (SDC) command is issued to the specified devices. IEEE 488 bus devices which receive a Device Clear or Selected Device Clear command normally reset to their power-on state.

SYNTAX	C[;addr]
RESPONSE	None
BUS STATES	ATN, DCL (all devices) ATN, UNL, UNT, LAG, SDC (selected devices)
EXAMPLES	PRINT #1, "C" Issue a Device Clear to all devices. PRINT #1, "C;10" Issue a Selected Device Clear to device 10.

EC

ECHO

The system command ECHO instructs the Micro488/p to either enable, or disable serial echo.

SYNTAX	EC;n n = 1, enable serial echo. n = 0, disable serial echo.
RESPONSE	None
BUS STATES	None
EXAMPLE	PRINT#1, "EC;1" Enable serial echo.

The ENTER command reads data from the IEEE bus. If a device address is specified, that device is addressed to talk. If no address is specified, the Micro488/p must already be configured to receive data as a result of an immediately preceding ENTER command. The Micro488/p hangs the bus if no device is present to provide the data. From either mode (addressed or unaddressed), the Micro488/p inputs data from the IEEE bus and sends it to serial port until one of the following conditions is met:

1. A terminator character is received from the IEEE device that is talking.
2. An EOI is received with the data from the IEEE device that is talking.
3. An Escape command is received from the host computer via the serial port.

SYNTAX	EN[;addr] addr is the IEEE bus device address.	
RESPONSE	Device-dependent data. The response ends when the IEEE bus input terminator is detected and the serial output terminators are appended to the returned data.	
BUS STATES	ATN,UNL,TAG,*ATN Micro488/p is in the listener active state, and IEEE device is in the talker active state.	
EXAMPLES	PRINT#1, "EN;16 " INPUT#1, A\$ PRINT#1, "EN;16 " LINE INPUT#1, A\$	Read data from device 16. Read an entire line of data from device 16 even if it contains commas or other punctuation.

<CTRL>A

ESCAPE

The system command ESCAPE unlocks the Micro488/p from an inappropriate command, such as a command requesting data from a nonexistent device.

When the ESCAPE command is received, the serial handshake line (RTS) is un-asserted. It is asserted when the Micro488/p is capable of buffering commands. If XON/XOFF handshake is selected, the software handshake state is not modified.

Issuing the ESCAPE command clears the serial input (pending commands) and causes the Micro488/p to wait for new commands.

SYNTAX <CTRL> A or CHR\$(1)

RESPONSE None

BUS STATES None

EXAMPLE PRINT #1, CHR\$(1)

H

HARDWARE HANDSHAKE

The system command HARDWARE HANDSHAKE enables or disables hardware (CTS/RTS) handshake.

SYNTAX H;n
 n = 0, disable hardware handshake.
 n = 1, enable hardware handshake.

RESPONSE None

BUS STATES None

EXAMPLE PRINT#1, "H;1" Enable hardware handshake.

TB

IEEE BUS TERMINATOR

The IEEE BUS TERMINATOR command is used to select the IEEE bus terminator for reads from the IEEE bus. The selected terminator signifies the end of an ENTER sequence. The available terminators are:

- 1 - LF
- 2 - CR
- 3 - LF-CR
- 4 - CR-LF

SYNTAX TB;n
 n is one of the available terminator types.

RESPONSE None

BUS STATES None

EXAMPLE PRINT #1, "TB;1" Select LF as an IEEE bus terminator.

I

INIT

The system command INIT provides a warm start of the interface. Issuing the INIT command clears the serial input (pending commands) and output (pending data) buffers and re-initializes the internal IEEE controller hardware.

SYNTAX	I
RESPONSE	None
BUS STATES	IFC, REN, *IFC, ATN, *REN, REN
EXAMPLE	PRINT#1, "I"

L

LOCAL

The LOCAL command, without optional address, causes the Micro488/p to un-assert the Remote Enable line causing devices on the bus to return to manual operation. With the address specified, the bus device is placed in the local mode by the Go To Local (GTL) bus command.

SYNTAX	L [;addr]
RESPONSE	None
BUS STATES	*REM unaddressed. ATN, UNL, UNT, LAG, GTL addressed.

EXAMPLES	PRINT#1, "L"	Un-assert the REN Line.
	PRINT #1, "L;16"	Cause device 16 to go to local.

LL

LOCAL LOCKOUT

The LOCAL LOCKOUT command causes the Micro488/p to issue a Local Lockout IEEE bus command which inhibits bus devices that support this command from being controlled manually from their front panels.

SYNTAX	LL	
RESPONSE	None	
BUS STATES	ATN, LLO	
EXAMPLES	PRINT#1, "LL"	Send Local Lockout command.

O

OUTPUT

The OUTPUT command sends data to the IEEE bus. The Remote Enable line is first asserted, then, if a device address is specified, that device is addressed to listen. If an address is not specified, the Micro488/p must already be configured to send data as a result of an immediately preceding OUTPUT command.

SYNTAX	O;cmd\$ unaddressed. OA;addr;cmd\$ addressed.	
	addr is a bus device address. cmd\$ is a string of characters to OUTPUT terminated by the serial terminator(s).	
RESPONSE	None	
BUS STATES	REN, *ATN, cmd\$ unaddressed. ATN, UNL, UNT, LAG, GTL, data addressed.	
EXAMPLES	PRINT#1, "OA;22;R0C0T1X" PRINT#1, "O;XYZ"	Send "R0C0T1X" to device 22. Send device 22 "XYZ".

RE

REMOTE

The REMOTE command asserts the Remote Enable (REN) bus management line. If the optional bus address is specified, then REMOTE also addresses the device to listen, placing it in the Remote addressed state.

SYNTAX	RE [;addr]	
RESPONSE	None	
BUS STATES	REN unaddressed. REN, ATN, UNL. UNT. LAG addressed.	
EXAMPLE	PRINT #1, "RE"	Assert Remote Enable.

RS

RESUME

The RESUME command un-asserts the Attention (ATN) bus signal removing the Micro488/p from the active controller state and allowing transfers to take place between two peripheral devices.

SYNTAX	RS	
RESPONSE	None	
BUS STATES	*ATN	
EXAMPLE	PRINT#1, "RS"	Un-assert ATTENTION line.

SP

SERIAL POLL

The SERIAL POLL command performs a Serial Poll of the bus device specified and responds with a number from 0 to 255 representing the decimal equivalent of the eight-bit device response. If rsv (DIO7, decimal value 64) is set, then that device is signaling that it requires service. Serial Polls are normally performed in response to assertion of the Service Request (SRQ) bus signal by some bus device.

SYNTAX	SP; addr	
RESPONSE	0 to 255	
BUS STATES	ATN, UNL, TAG, SPE, *ATN, data, ATN, SPD, UNT	
EXAMPLES	PRINT#1, "SP 16 " INPUT#1, SPSTAT	Serial Poll device 16. Receive the Spoll status.

TC

SERIAL TERMINATOR

The SERIAL TERMINATOR command sets the end-of-line terminators for input from the serial host. All input from the serial host must be terminated by the selected terminator.

During INPUT, the Micro488/p takes the data it receives from the bus device until it detects the LF of other optionally specified input terminating condition. It strips all CR and LF from the input data and appends the serial output terminator CR before sending it to the serial host. The available terminators are:

- 1 - LF
- 2 - CR
- 3 - LF-CR
- 4 - CR-LF

SYNTAX	TC;n	n is one of the available terminator types.
RESPONSE	None	
BUS STATES	None	
EXAMPLES	PRINT#1, "TC ; 2 "	Select CR as the serial output terminator.

SQ

SRQ CHECK

The system command SRQ CHECK inquires whether or not the SRQ line on the IEEE bus is currently being asserted.

SYNTAX	SQ	
RESPONSE	Y	SRQ is being asserted.
	N	SRQ is not being asserted.
BUS STATES	None	
EXAMPLES	PRINT #1, "SQ"	Issue SRQ CHECK command.
	INPUT#1, SRQSTAT	Receive SRQ status.

TR

TRIGGER

The TRIGGER command issues a Group Execute Trigger (GET) bus command to the specified device. If no address is specified, then GET only affects those devices that are already in the listen state as a result of a previous OUTPUT command.

SYNTAX	TR[;addr]	
RESPONSE	None	
BUS STATES	ATN, GET unaddressed.	
	ATN, UNL, UNT, LAG, GET addressed.	
EXAMPLES	PRINT#1, "TR;16"	Issue Group Execute Trigger to device 16.

X

XOFF/XON

The system command XOFF/XON enables or disables XON/XOFF handshaking.

SYNTAX	X;n n = 0, disable XON/XOFF handshaking. n = 1, enable XON/XOFF handshaking.	
RESPONSE	None	
BUS STATES	None	
EXAMPLE	PRINT #1, "X;1"	Enable XON/XOFF handshaking.

<CTRL>S

XOFF

The system command XOFF temporarily inhibits serial transmission from the Micro488/p.

SYNTAX	<CTRL> S or CHR\$(19)	
RESPONSE	None	
BUS STATES	None	
EXAMPLE	PRINT #1, CHR\$(19)	

The system command XON restarts serial transmission from the Micro488/p following reception of the XOFF command.

SYNTAX	<CTRL> Q CHR\$(17)
RESPONSE	None
BUS STATES	None
EXAMPLE	PRINT #1, CHR\$(17)

Command	Code	Description	Page
/A	/A	Asserts the attention line; leaves Micro488/p in the controller active state.	3-6
/L	/L	Sends the LAG command to the specified device; leaves Micro488/p in the controller active state.	3-6
/ML	/ML	Places the Micro488/p in the listen state on RESUME (RS).	3-7
/MT	/MT	Places the Micro488/p in the talk state on RESUME (RS).	3-7
/T	/T;addr	Issues the talk command to the specified IEEE device.	3-8
/UL	/UL	Sends the UNL command to the IEEE bus; instructs all devices on the IEEE bus to get off the IEEE bus.	3-8
/UT	/UT	Sends the UNT command to the IEEE bus; instructs all devices on the IEEE bus to get off the IEEE bus.	3-9
ABORT I/O	A	Pulses Interface Clear (IFC) bus management line to be pulsed; forces all IEEE bus device interfaces into a quiescent idle state.	3-9
DEVICE CLEAR	C[:addr]	Instructs Micro488/p to issue Device Clear (DCL) bus command; if optional addresses are included, issues the Selected Device Clear (SDC) command to the specified devices.	3-10
ECHO	EC;n	Instructs the Micro488/p to enable or disable serial echo.	3-10
ENTER	ENTER[:addr]	Reads data from the IEEE bus and sends it to serial port; a terminator character, an EOI, or an ESCAPE command terminates data input/output.	3-11
ESCAPE	<CTRL> A CHR\$(1)	Unlocks the Micro488/p from an inappropriate command; clears the serial input (pending commands) and instructs Micro488/p to wait for new commands.	3-12
HARDWARE HANDSHAKE	H;n	Enables or disables hardware (CTS/RTS) handshake.	3-12
IEEE BUS TERMINATOR	TB;n	Selects the IEEE bus terminator for reads from the IEEE bus; selected terminator signifies the end of an ENTER sequence.	3-13
INIT	I	Provides a warm start of the interface; clears the serial input (pending commands) and output (pending data) buffers and re-initializes the internal IEEE controller hardware.	3-14

Command	Code	Description	Page
LOCAL	L[;addr]	Without optional address, instructs the Micro488/p to un-assert the Remote Enable line causing devices on the bus to return to manual operation; with optional address, places bus device in the local mode by the Go To Local (GTL) bus command.	3-14
LOCAL LOCKOUT	LL	Instructs the Micro488/p to issue a Local Lockout IEEE bus command.	3-15
OUTPUT	O;cmd\$ O;addr;cmd\$	Sends data to the IEEE bus.	3-15
REMOTE	RE[;addr]	Asserts the Remote Enable (REN) bus management line.	3-16
RESUME	RS	Un-asserts the Attention (ATN) bus signal; removes the Micro488/p from the active controller state and allows transfers between two peripheral devices.	3-16
SERIAL POLL	SP;addr	Performs a serial poll of the bus device specified; responds with a number from 0 to 255 representing the decimal equivalent of the eight-bit device response.	3-17
SERIAL TERMINATOR	TC;n	Sets the end-of-line terminators for input from the serial host.	3-17
SRQ CHECK	SQ	Inquires whether or not the SRQ line on the IEEE bus is currently being asserted.	3-18
TRIGGER	TR[;addr]	Issues a Group Execute Trigger (GET) bus command to the specified device; if no address is specified, then GET affects those devices already in the listen state.	3-18
XOFF/XON	X;n	Enables or disables XON/XOFF handshaking.	3-19
XOFF	<CTRL>S CHR\$(9)	Temporarily inhibits serial transmission from the Micro488/p.	3-19
XON	<CTRL>Q CHR\$(17)	Restarts serial transmission from the Micro488/p.	3-20

Appendix B

Character Codes and IEEE Multiline Messages

\$00 0 NUL	\$10 16 DLE	\$20 32 SP	\$30 48 0	\$40 64 @	\$50 80 P	\$60 96 ,	\$70 112 p
\$01 1 SOH GTL	\$11 17 DCI LLO	\$21 33 !	\$31 49 1	\$41 65 A	\$51 81 Q	\$61 97 a	\$71 113 q
\$02 2 STX	\$12 18 DC2	\$22 34 "	\$32 50 2	\$42 66 B	\$52 82 R	\$62 98 b	\$72 114 r
\$03 3 ETX	\$13 19 DC3	\$23 35 #	\$33 51 3	\$43 67 C	\$53 83 S	\$63 99 c	\$73 115 s
\$04 4 EOT SDC	\$14 20 DC4 DCL	\$24 36 \$	\$34 52 4	\$44 68 D	\$54 84 T	\$64 100 d	\$74 116 t
\$05 5 ENQ PPC	\$15 21 NAK PPU	\$25 37 %	\$35 53 5	\$45 69 E	\$55 85 U	\$65 101 e	\$75 117 u
\$06 6 ACK	\$16 22 SYN GTL	\$26 38 &	\$36 54 6	\$46 70 F	\$56 86 V	\$66 102 f	\$76 118 v
\$07 7 BEL	\$17 23 ETB	\$27 39 ,	\$37 55 7	\$47 71 G	\$57 87 W	\$67 103 g	\$77 119 w
\$08 8 BS GET	\$18 24 CAN SPE	\$28 40 (\$38 56 8	\$48 72 H	\$58 88 X	\$68 104 h	\$78 120 x
\$09 9 HT TCT	\$19 25 EM SPD	\$29 41)	\$39 57 9	\$49 73 I	\$59 89 Y	\$69 105 i	\$79 121 y
\$0A 10 LF	\$1A 26 SUB	\$2A 42 *	\$3A 58 :	\$4A 74 J	\$5A 90 Z	\$6A 106 j	\$7A 122 z
\$0B 11 VT	\$1B 27 ESC	\$2B 43 +	\$3B 59 ;	\$4B 75 K	\$5B 91 [\$6B 107 k	\$7B 123 {
\$0C 12 FF	\$1C 28 FS	\$2C 44 ,	\$3C 60 <	\$4C 76 L	\$5C 92 \	\$6C 108 l	\$7C 124
\$0D 13 CR	\$1D 29 GS	\$2D 45 -	\$3D 61 =	\$4D 77 M	\$5D 93]	\$6D 109 m	\$7D 125 }
\$0E 14 SO	\$1E 30 RS	\$2E 46 .	\$3E 62 >	\$4E 78 N	\$5E 94 ^	\$6E 110 N	\$7E 126 ~
\$0F 15 SI	\$1F 31 US	\$2F 47 /	\$3F 63 ?	\$4F 79 O	\$5F 95 -	\$6F 111 o	\$7F 127 DEL
ACG	UCG	LAG		TAG		SCG	

ACG = Addressed Command Group
 UCG = Universal Command Group
 LAG = Listen Address Group

TAG = Talk Address Group
 SCG = Secondary Command Group

Notes:

Appendix C

Sample Initialization Program

```
'Sample Micro488/p initialization program
'Copyright 1992, IOtech Inc.
'
'This program demonstrates how to initialize the Micro488/p IEEE
'controller using Quick Basic. This program will initialize the
'Micro488/P, and establish IEEE communications.

CLS
CLOSE          'Close all files, this turns off DTR and DSR.

com$ = "COM1:19200,N,8,1,BIN"
IeeeOut = FREEFILE
IeeeIn = FREEFILE

OPEN com$ FOR RANDOM AS #IeeeOut      'Open the serial port on COM 1
t = TIMER
DO WHILE t + .1 > TIMER              'Wait for .1 Seconds
LOOP

FOR i = 1 TO 5                        'Send 5 carriage returns, with a .1
                                     'second delay seperation.
    PRINT #IeeeOut, CHR$(13);
    t = TIMER
    DO WHILE t + .1 > TIMER
    LOOP
NEXT i

PRINT #IeeeOut, "I"                  'Send Init command
PRINT #IeeeOut, "EC;0"               'Turn off serial echo
PRINT #IeeeOut, "H;1"               'Turn on hardware handshake
PRINT #IeeeOut, "X;0"               'Turn off XON/XOFF handshake
PRINT #IeeeOut, "TC;2"              'Set serial terminator to CR
PRINT #IeeeOut, "TB;4"              'Set IEEE bus terminator to CR
LF

t = TIMER
DO WHILE t + .5 > TIMER              'Wait .5 seconds
LOOP

a$ = INPUT$(LOC(1), #IeeeIn)        'Clear the serial input buffer.
```

Notes: