Model 3388-D1A/G1A

GPIB Interface

INSTRUCTION MANUAL

August, 1987

**** SPECIAL OPTION ****

Model 3388-S001

September 1981

**** SPECIAL OPTION ****

Model 3388-S001

The Model 3388-S001 is a single wide 3388 with I/O connections on the rear edge connector.

1 1R

18 18R

FACE VIEW

Pin/Wire List

18/36 POSITION P.C. EDGE CONNECTOR

PIN NO.			PIN NO.		
1	Ground	(23)	1R	Ground	(24)
2	DIO 1	(1)	2R	DIO 5	(13)
3	DIO 2	(2)	3R	DIO 6	(14)
4	DIO 3	(3)	4R	DIO 7	(15)
5	DIO 4	(4)	5R	DIO 8	(16)
6	EOI	(5)	6R	REN	(17)
7	DAV	(6)	7R	Ground	(12)
8	NRFD	(7)	8R	Ground	(18)
9	NDAC	(8)	9R	Ground	(19)
10	IFC	(9)	10R	Ground	(20)
11	SRQ	(10)	11R	Ground	(21)
12	ATN	(11)	12R	Ground	(22)
13			13R		
14			14R		
15			15R		
16			16R		
17			17R		
18			18R		

CONTENTS

GPIB Interface

Allows IEEE-488 instruments to be driven from a CAMAC crate

3388

Features

- **Provides the interface between a CAMAC system and GPIB-interfaced instruments**
- **Meets IEEE-488 and -583 requirements**
- **Provides GPIB T8, L4, C1-C4, C25, SH1, AH1, SR0, RL0, PP0, DC0, DT0 interface functions**
- **GPIB T6, SR1, DC1, C5-C24 interface functions can be implemented by additional user software**
- **Switch-selectable talk/listen address**

Typical Applications

- **Interfacing GPIB (IEEE-488) instruments to CAMAC (IEEE-583)**
- **Connecting instruments such as DVMs and counters to a computer**
- **Data loggers**

General Description *(Product specifications and descriptions subject to change without notice.)*

The 3388 is a double-width CAMAC module providing the interface between a CAMAC system (IEEE Standard 583 - 1982) and the General Purpose Interface Bus (also called "GPIB" or "ASCII Bus," IEEE Standard 488). This module allows digital multimeters, counters, printers, calculators, display terminals, and other devices meeting the GPIB standard to be connected to a CAMAC system. In the past, interfacing such instruments to CAMAC often required special modules and engineering effort on a case-by-case basis. With the 3388, up to 14 other GPIB-interfaced instruments can be connected via standard GPIB cables.

The 3388 GPIB Interface module functions as a CONTROLLER, TALKER, and LISTENER as described in IEEE Standard 488. For example, while in the LISTEN mode itself, the 3388 can cause a digital multimeter to be in the TALK mode. The DMM then transmits data to the 3388 to be processed by the computer associated with the CAMAC system. The computer can then cause the 3388 to be in the TALK mode and a GPIB-interfaced printer to be in the LISTEN mode. Processed data from the computer can then be printed.

The 3388 can be set to the CONTROLLER IDLE state so that it can be a TALKER or LISTENER in a system containing another CONTROLLER (such as an intelligent terminal or a desk-top calculator).

GPIB Specification Summary

Item	Description
Interconnected Devices:	Up to 15 maximum on one contiguous bus
Interconnection Path:	Star or linear bus network up to 20 meters total transmission path length
Active Signal Lines:	Sixteen total: eight data lines, three data transfer control lines, and five bus management message lines
Message Transfer Scheme:	Byte-serial, bit-parallel, asynchronous data transfer using interlocked three-wire handshake technique
Data Rate	Depends upon host computer program and external devices
Address Capability:	Primary addresses, 31 TALK and 31 LISTEN

 Phone: (815) 838-0005 • FAX: (815) 838-4424 • E-mail: mkt-info@kscorp.com • Web: http://www.kscorp.com

Function Codes

Command		Q	Action
F(0)·A(0)	RD1	IRDY	Reads the Input register and clears the Input LAM status bit. (See Note 1.)
F(1)·A(0)	RD2	1	Reads the Status register.
F(1)·A(12)	RD2	1	Reads the LAM Status register.
F(1)·A(14)	RD2	1	Reads the LAM Request register.
F(8)·A(15)	TLM	LR	Tests whether a LAM request is present.
F(16)·A(0)	WT1	ORDY	Writes the Output register and clears the Output LAM status bit. (See Note 2.)
F(17)·A(13)	WT2	1	Writes the LAM Mask register.
F(23)·A(12)	SC2	1	Selectively clears the LAM Status register.
F(24)·A(0)	DIS	1	Disables the Attention control signal.
F(24)·A(1)	DIS	1	Disables the Remote Enable control signal and clears LAM 4.
F(24)·A(2)	DIS	1	Disable the End or Identify control signal.
F(24)·A(3)	DIS	1	Disables the Service Request control signal.
F(24)·A(4)	DIS	1	Disables the Universal and Addressed command inhibit.
F(25)·A(0)	XEQ	1	Executes the Interface Clear control signal. (See Note 5.)
F(26)·A(0)	ENB	1	Enables the Attention control signal.
F(26)·A(1)	ENB	1	Enables the Remote Enable control signal.
F(26)·A(2)	ENB	1	Enables the End or Identify control signal.
F(26)·A(3)	ENB	1	Enables the Service Request control signal.
F(26)·A(4)	ENB	1	Enables the Universal and Addressed command inhibit.
F(27)·A(0)	TST	IRDY	Tests whether the Input LAM status bit is set.
F(27)·A(1)	TST	ORDY	Tests whether the Output LAM status bit is set.
Z	CZ	0	Clears the Input register, the LAM Status and LAM Mask registers, and puts the interface in a known state.

Notes:
1. Q = 1 for Input data ready, Q = 0 otherwise.
2. Q = 1 for Output data ready, Q = 0 otherwise.
3. F(24)·A(5 - 15) and F(26)·A(5 - 15) reserved for future use (Q = 1, X = 1 response given).
4. X = 1 for all valid addressed commands.
5. READY (or LAM 4) is false during IFC and is set true on completion of IFC.

Power Requirements

+6 volts: 610 mA

Ordering Information

Model 3388-D1A GPIB Interface with IEC (Europe) standard connector (25-contact "D" connector)

Model 3388-G1A GPIB Interface with IEEE-488 - 1975 (USA) standard connector (25-contact ribbon connector with metric hardware)

Related Products

For Model	I/O Cable
3388-D1A	Model 5852-Axyz, Cxyz, or Exyz-Series Cable Assemblies
3388-G1A	Model 5864-Series Cable Assemblies

STATUS REGISTER (READ ONLY)

BIT	LABEL	DESCRIPTION
7	ATN	The Attention signal is being received true.
6	HS ERR	The Handshake Error condition true.*
5	SRQ	The Service Request control signal is true.
4	Ready	The module is ready to output data to the GPIB bus.
3	EOI	The End or Identify control signal is true.
2	MTA	The module is in the talker addressed state.
1	MLA	The module is in the listener addressed state.

*HS ERR = NRFD and NDAC control signals false when the DAV control signal is true.

REGISTERS

9	8	7	6	5	4	3	2	1	
* ATN	GPIB INPUT DATA								F(0)·A(0)

INPUT DATA REG

8	7	6	5	4	3	2	1	
GPIB OUTPUT DATA								F(16)·A(0)

OUTPUT DATA REG

ATN	HS ERR	SRQ	RDY	EOI	MTA	MLA	F(1)·A(0)

STATUS REG

READ	ATN	HS ERR	SRQ	RDY	EOI	MTA	MLA	F(1)·A(12) F(1)·A(14) F(17)·A(13) F(23)·A(12)

LAM STATUS REG

* Strap selectable

BIT**	LABEL	DESCRIPTION
8	Read	The interface is waiting to complete the handshake until a CAMAC data read is done.
7	ATN	Attention control signal detected.
6	HS ERR	Handshake error condition detected.*
5	SRQ	Service Request control signal detected.
4	Ready	Action due to previous commands completed and the Bus is not busy.
3	EOI	End or identify control signal detected.
2	MTA	My Talk Address detected.
1	MLA	My Listen Address detected.

*HS ERR = NRFD and NDAC handshake control signals false when the DAV control signal is true.

**These bits represent edge triggered latches and thus indicate that the condition occurred at least once since the last time that bit was cleared.

LED INDICATORS

N	Flashes when the module is addressed.
L	On when the L signal is true.
SRQ	On when the Service Request control signal is true.
HS ERR	On when the Handshake Error condition is true.
IFC	Flashes when the Interface Clear signal is true.
C ACT	On when the Attention control signal is asserted by the module.
TALK	On when the module is in the Talker Addressed state.
Listen	On when the module is in the Listener Addressed state.
NRFD	On when the Not Ready for Data handshake signal is true.
NDAC	On when the No Data Accepted handshake signal is true.
DAV	On when the Data Available handshake signal is true.

OPERATION

In most applications the Model 3388 will be the system controller and instruments such as DVM's, counters, printers, etc. will be controlled via the GPIB. An extensive LAM status register and status register are included to simplify programming. Eleven front-panel LED's provide the programmer or user with valuable information about the current state of the interface. The read and write data are each packed in the lower eight bits of the CAMAC data words. This allows for easy ASCII representation in high level languages.

Since all GPIB data and command transfer operations use the three-wire handshake, the data transfer waits until the associated devices are ready for that byte transfer. Therefore the 3388 LAM status register can be used to minimize the software overhead.

When the 3388 is used in a system where it is the system controller, it can assert the "controller" GPIB control signals. In this application the F(26)·A(3) command (enabling the Service Request control signal) would not be used. This is used by the other devices on the bus to "signal" the controller. If the 3388 is not used as the system controller, it can request service, but it would not use the F(25)·A(0), F(26)·A(0) or F(26)·A(1) commands.

The GPIB control signals are available to the CAMAC system via enable/disable and Execute commands and bus status is monitored by LAM and Status registers.

For GPIB command or data byte transfers, the CAMAC write command Q response is determined by the completion of GPIB action previously initiated. When the module is acting as the system controller or is the current talker, it is available to send GPIB command or data bytes, respectively. When a command or data byte is accepted by the module (Q = 1 to the write command) the Ready LAM is cleared. Until all of the listeners on the bus have accepted the byte, there will be a Q = 0 response to any data write commands. Upon completion of the handshake cycle, the Ready LAM will be set and a Q = 1 response will result on the next write command. The Ready LAM and Q response are affected by certain control signals. An example is the Interface Clear (IFC) signal, which is asserted by an Execute command. When the module accepts the Execute command, the Ready LAM is cleared and Q to the write command is blocked. The IFC signal is asserted for 150 s. At the end of this time, the Ready LAM is set and Q = 1 response will result in the next write command.

The Read LAM is set when the module is an active listener and a valid data byte is available to it or when the Universal and Addressed Command Inhibit is disabled and a universal or addressed command is being sent to it. The Read LAM being true indicates that a valid byte is waiting to be accepted by the module. The handshake is held until the next CAMAC data read. The Read LAM is cleared by the CAMAC read and a Q = 0 response to future data read commands will result until a new byte is available.

GPIB ADDRESS

The 5-bit GPIB address for TALK and LISTEN on the 3388 is set by the switch on the 3388 PC card. See the STRAP AND SWITCH OPTIONS sheet for details.

THE GPIB THREE WIRE HANDSHAKE

The GPIB handshake operate automatically between the 3388 and other devices on the GPIB bus. A discussion is presented here to provide the user with a better understanding of its operation.

The three wire handshake consists of three low true signals, DAV (data available), NRFD (not ready for data) and NDAC (no data accepted). A typical handshake sequence is shown below. During Period 1, DAV is false and NRFD and NDAC are true. The device which is an active talker at this time must wait until all devices on the bus stop asserting NRFD true. Period 2 shows NRFD false, indicating that all devices on the bus are ready for data. The currently active talker can now set DAV true and send another data byte. This occurs during Period 2. All of the handshake signals are true during Period 3. At this point, the active talker is waiting for all of the listeners to stop asserting NDAC. At the beginning of Period 4, all active listeners have stopped asserting NDAC, indication that they have all accepted the data byte. The active talker senses this and releases DAV. When the active listeners sense DAV false, they again assert NDAC true. The handshake sequence is now completed and another cycle can begin as soon as all of the active listeners stop asserting NRFD.

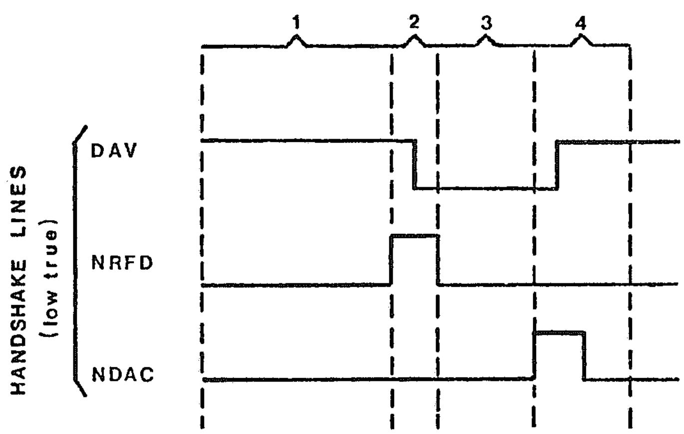


FIG. 1 Handshake Sequence

INTERACTION OF THE MODEL 3388 WITH THE THREE WIRE HANDSHAKE

When the 3388 is an active listener (MLA true), the Read LAM status bit will be set when DAV is sensed true. The handshake sequence is held in Period 3 until the next CAMAC read. The Read LAM is cleared by the CAMAC read and the module will stop asserting NDAC. When all other active listeners have stopped asserting NDAC, the handshake will move to completion.

TAKE CONTROL AND DATA ACQUISITION EXAMPLE (See Figure 2).

Command

#1 F(25)·A(0) Execute IFC. Q Response = 1.

Interface Clear (IFC) is pulsed low (true) for approximately 150 microseconds. This initializes all instruments on the bus.

#2 F(26)·A(0) Enable ATN. Q Response = 1.

Attention (ATN) is set to its low (true) state. This prepares all instruments to receive command instructions from the controller.

#3 F(26)·A(1) Enable REN. Q Response = 1.

Remote Enable (REN) is set to its low (true) state. This prepares all instruments with remote-local capability to enter the remote state upon receiving their listen addresses.

#4 F(26·A(4) Enables the Universal and Addressed command inhibit. Q Response = 1

This allows the 3388 to send or receive Universal or Addressed commands with no special treatment. Since the 3388 is the system controller, the Universal and Addressed commands are already handled by software. This command should be sent as part of the "start-up" sequence whenever the 3388 is the system controller.

#5 F(16)·A(0) Send command data. Q Response =1.

Send the instrument's listen address to put it in the remote mode and ready for data when ATN is false.

#6 F(16)·A(0) Send command data. Q Response = 0.

The data was not transmitted on the bus because the last transmission had not been accepted by all instruments yet. (Q Response = 0.) Note that the Ready Status bit was not true when the command was executed.

#7 F(16)·A(0) Send command data. Q Response = 1.

Send the 3388's talk address. It can now send data when ATN is false.

#8 F(27)·A(1) Check the state of output ready. Q Response = 1.

The last command data transmission has been completed.

#9 F(24)·A(0) Disable ATN. Q Response = 1

Attention (ATN) is set to its high (false) state. Now the bus is ready for data exchange between the presently active Talker and Listener.

Command

#10 F(16)·A(0) Send data. Q Response = 1.

Send data to instrument. For example, send range setting to voltmeter.

#11 F(16)·A(0) Send data. Q Response = 0.

Last transmission not completed. (Q Response = 0.)

#12 F(16)·A(0) Send data. Q Response =1.

Repeat command #11 until Q Response = 1 received. The data has now been transmitted.

#13 F(27)·A(1) Check the state of output ready. Q Response =1.

The last data transmission has been completed.

#14 F(26)·A(0) Enable ATN. Q Response = 1.

Attention (ATN) is set to its low (true) state. All instruments are now ready to receive command data.

#15 F(16)·A(0) Send command data. Q Response = 1

Send instrument Talk address. This enables the instrument to send data and causes the 3388 to leave the Talk Addressed state.

#16 F(16)·A(0) Send command data. Q Response = 1.

Send the 3388's Listen address. The 3388 will be ready to accept data sent out by the instrument.

#17 F(27)·A(1) Check the state of output ready. Q Response = 0.

The last command data transmission has not been completed. Note that the Ready status bit was not true when this command was executed.

#18 F(27)·A(1) Check the state of output ready. Q Response = 1.

The last command data transmission has been completed so ATN can be disabled.

#19 F(24)·A(0) Disable ATN. Q Response = 1.

Attention (ATN) is set to its high (false) state. Now the bus is ready for data exchange between the presently addressed Talker and Listener. As soon as DAV becomes true, the Read LAM Status bit is set.

Command

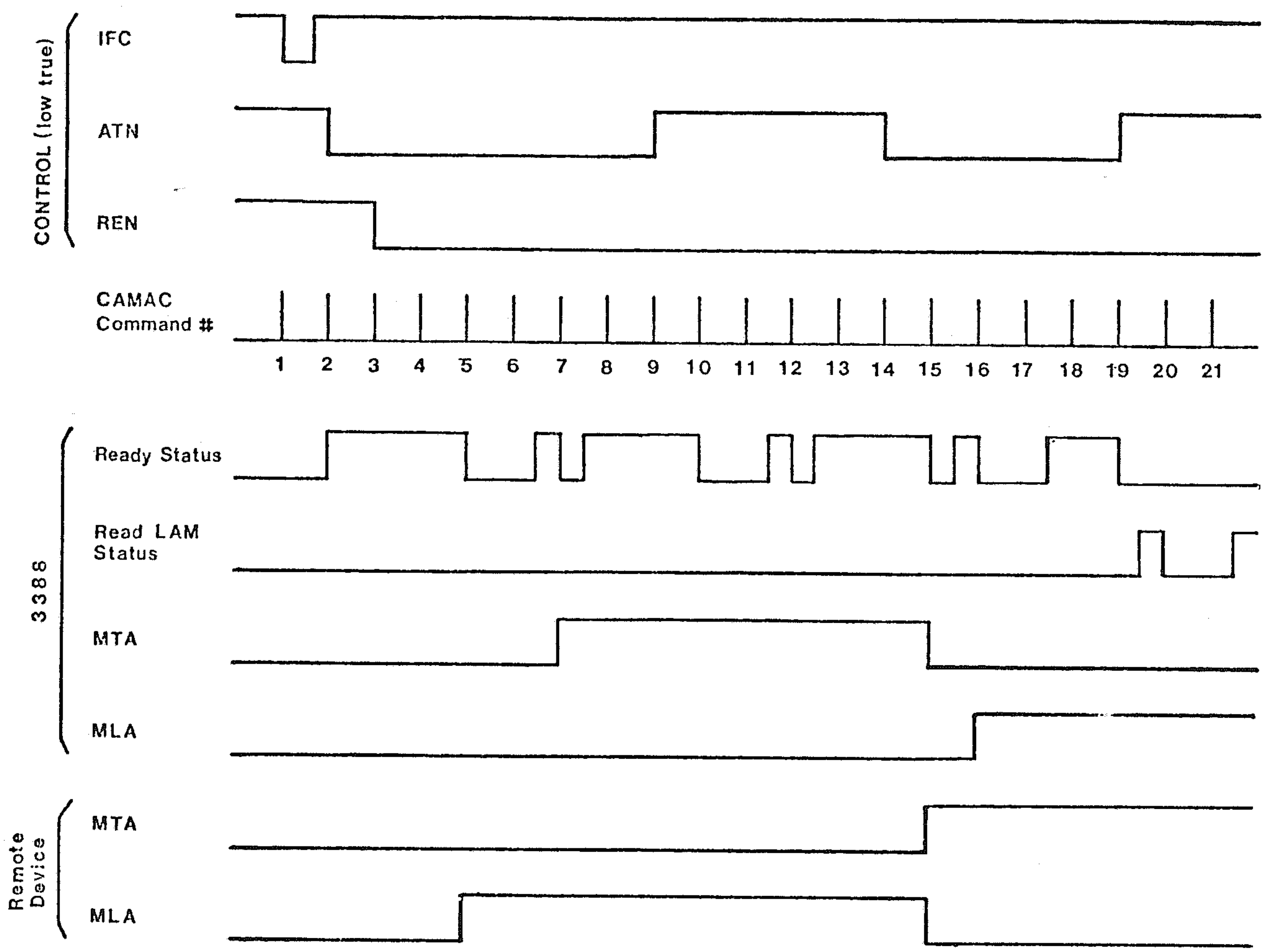
#20 F(0)·A(0) Read the input register. Q Response = 1.

This allows completion of the bus handshake sequence and clears the Read LAM Status bit. Data sent from the instrument is read.

#21 F(0)·A(0) Read the input register. Q Response = 0

A new data byte is not available. Note that the Read LAM Status bit was false when the command was executed.

In the preceeding example the sequence was controlled by Q test (Q = 0 until the handshake indicated a ready condition). If an interrupt driven system is used, the appropriate LAM status bits can be used to generate LAM's when an operation is completed.



Note: All signals are shown HIGH true, except Control.

Fig. 2 Take Contcol and Data Acquisition Sequence

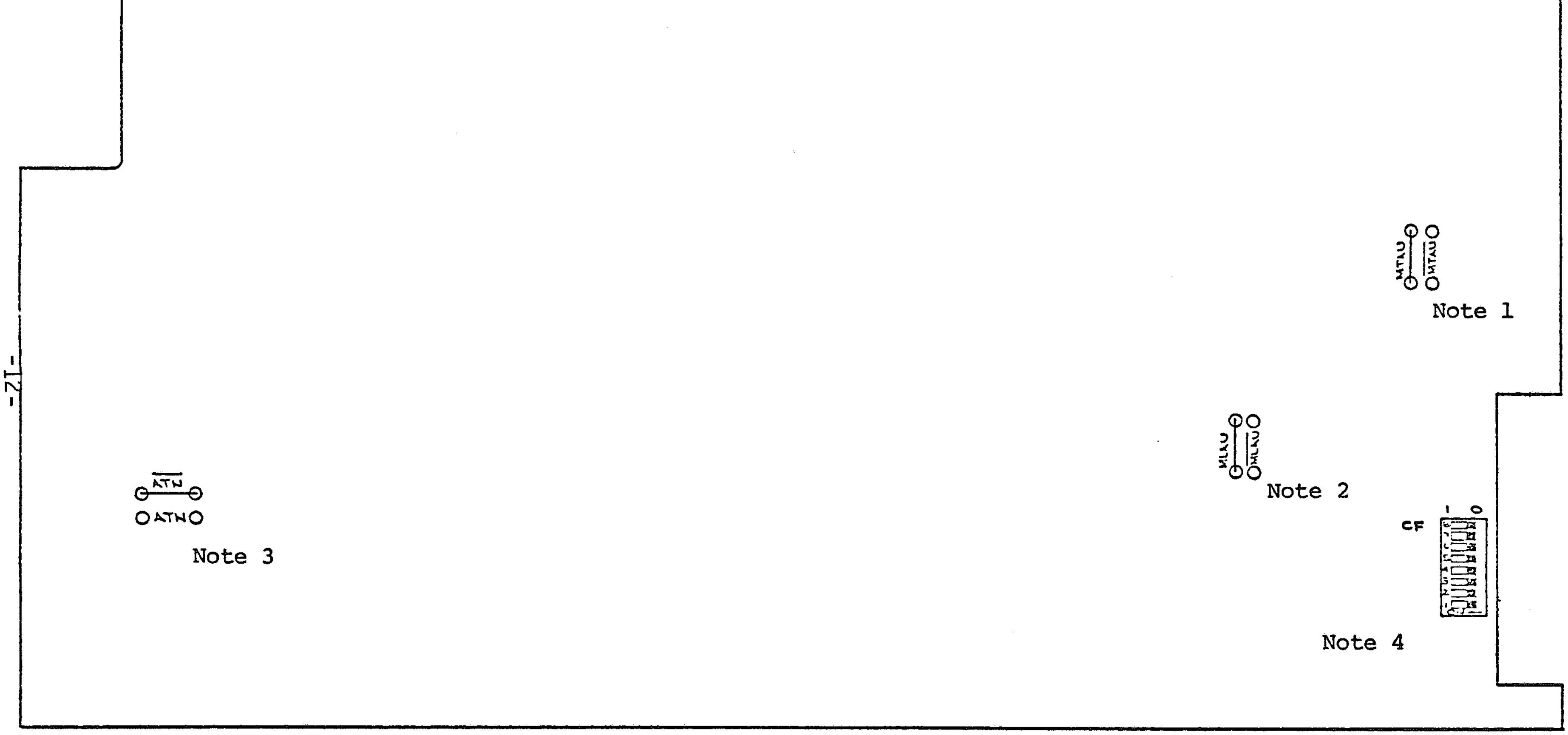
THE UNIVERSAL AND ADDRESSED COMMAND INHIBIT

The GPIB Addressed command group consists of all command bytes (bytes sent with ATN true) which have bits five, six and seven in the logical zero state. An example is the TCT (Take Control) command byte. The GPIB Universal command group consists of all command bytes which have bits six and seven in the logical zero state and bit five in the logical one state. The SPE (Serial Poll Enable) command is a Universal command.

The 3388's Universal and Addressed command inhibit is meant for use in systems where GPIB functions not implemented by the module hardware can be handled by software (generally set [F(26)·A(4)] whenever the 3388 is the system controller). When the Universal and Addressed command inhibit is disabled (state at power up), the handshake sequence will be held until the next CAMAC data read whenever a Universal or Addressed command is received or sent by the 3388. If the Universal and Addressed command inhibit is enabled [F(26)·A(4)] the handshake will be completed normally for all command bytes.

STRAP AND SWITCH OPTIONS

Notes:
1. MTAU - My Talk Address will cause the module to exit the listener addressed state.
2. MLAU - My Listen Address will cause the module to exit the talker addressed state.
3. ATN - Make the Attention status bit the ninth bit of the F(0) A(0) read field.
4. Talk/Listen Address switch - Switches one to five correspond to address bits one to five. The ON position corresponds to a logical one.
5. Factory straps are shown with solid lines.



INPUT/OUTPUT CONNECTORS

IEEE 488-1975 Connector
(socket: type AMP 57-20240

Contact	Signal Line	Contact	Signal Line
1	DIO 1	13	DIO 5
2	DIO 2	14	DIO 6
3	DIO 3	15	DIO 7
4	DIO 4	16	DIO 8
5	EOI	17	REN
6	DAV	18	Gnd, (6)
7	NRFD	19	Gnd, (7)
8	NDAC	20	Gnd, (8)
9	IFC	21	Gnd, (9)
10	SRQ	22	Gnd, (10)
11	ATN	23	Gnd, (11)
12	SHIELD	24	Gnd, LOGIC

IEC Proposed Connector
(socket: Cannon DB25S)

Contact	Signal Line	Contact	Signal Line
1	DIO 1	14	DIO 5
2	DIO 2	15	DIO 6
3	DIO 3	16	DIO 7
4	DIO 4	17	DIO 8
5	REN	18	GND
6	EOI	19	GND
7	DAV	20	GND
8	NRFD	21	GND
9	NDAC	22	GND
10	IFC	23	GND
11	SRQ	24	GND
12	ATN	25	GND
13	SHIELD		

Remote Message Coding

Mnemonic	Message Name		Type	Class	DIO 8	7	6	5	4	3	2	DIO 1	DAV NRFD NDAC	ATN	EOI	SRQ	IFC	REN
													Bus Signal Line(s) and Coding That Asserts the True Value of the Message					
ACG	addressed command group		M	AC	Y	0	0	0	X	X	X	X	XXX	1	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	(Notes 1, 9)	M	DD	D8	D7	D6	D5	D4	D3	D2	D1	XXX	0	X	X	X	X
DAC	data accepted		U	HS	X	X	X	X	X	X	X	X	XX0	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		M	UC	Y	0	0	1	0	1	0	0	XXX	1	X	X	X	X
END	end		U	ST	X	X	X	X	X	X	X	X	XXX	0	1	X	X	X
EOS	end of string	(Notes 2, 9)	M	DD	E8	E7	E6	E5	E4	E3	E2	E1	XXX	0	X	X	X	X
GET	group execute trigger		M	AC	Y	0	0	0	1	0	0	0	XXX	1	X	X	X	X
GTL	go to local		M	AC	Y	0	0	0	0	0	0	1	XXX	1	X	X	X	X
IDY	identify		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		M	AD	Y	0	1	X	X	X	X	X	XXX	1	X	X	X	X
LLO	local lock out		M	UC	Y	0	0	1	0	0	0	1	XXX	1	X	X	X	X
MLA	my listen address	(Note 3)	M	AD	Y	0	1	L5	L4	L3	L2	L1	XXX	1	X	X	X	X
MTA	my talk address	(Note 4)	M	AD	Y	1	0	T5	T4	T3	T2	T1	XXX	1	X	X	X	X
MSA	my secondary address	(Note 5)	M	SE	Y	1	1	S5	S4	S3	S2	S1	XXX	1	X	X	X	X
NUL	null byte		M	DD	0	0	0	0	0	0	0	0	XXX	X	X	X	X	X
OSA	other secondary address		M	SE	$(OSA = SCG \wedge \overline{MSA})$													
OTA	other talk address		M	AD	$(OTA = TAG \wedge \overline{MTA})$													
PCG	primary command group		M	—	$(PCG = ACG \vee UCG \vee LAG \vee TAG)$													
PPC	parallel poll configure		M	AC	Y	0	0	0	0	1	0	1	XXX	1	X	X	X	X
PPE	parallel poll enable	(Note 6)	M	SE	Y	1	1	0	S	P3	P2	P1	XXX	1	X	X	X	X
PPD	parallel poll disable	(Note 7)	M	SE	Y	1	1	1	D4	D3	D2	D1	XXX	1	X	X	X	X
PPR1	parallel poll response 1		U	ST	X	X	X	X	X	X	X	1	XXX	1	1	X	X	X
PPR2	parallel poll response 2		U	ST	X	X	X	X	X	X	1	X	XXX	1	1	X	X	X
PPR3	parallel poll response 3	(Note 10)	U	ST	X	X	X	X	X	1	X	X	XXX	1	1	X	X	X
PPR4	parallel poll response 4		U	ST	X	X	X	X	1	X	X	X	XXX	1	1	X	X	X
PPR5	parallel poll response 5		U	ST	X	X	X	1	X	X	X	X	XXX	1	1	X	X	X

Mnemonic	Message Name		Type	Class	DIO 8	7	6	5	4	3	2	DIO 1	DAV	NRFD	NDAC	ATN	EOI	SRQ	IFC	REN
					Bus Signal Line(s) and Coding That Asserts the True Value of the Message															
PPR6	parallel poll response 6	(Note 10)	U	ST	X	X	1	X	X	X	X	X	X	X	X	1	1	X	X	X
PPR7	parallel poll response 7	(Note 10)	U	ST	X	1	X	X	X	X	X	X	X	X	X	1	1	X	X	X
PPR8	parallel poll response 8	(Note 10)	U	ST	1	X	X	X	X	X	X	X	X	X	X	1	1	X	X	X
PPU	parallel poll unconfigure		M	UC	Y	Ø	Ø	1	Ø	1	Ø	1	X	X	X	1	X	X	X	X
REN	remote enable		U	UC	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1
RFD	ready for data		U	HS	X	X	X	X	X	X	X	X	X	Ø	X	X	X	X	X	X
RQS	request service	(Note 9)	U	ST	X	1	X	X	X	X	X	X	X	X	X	Ø	X	X	X	X
SCG	secondary command group		M	SE	Y	1	1	X	X	X	X	X	X	X	X	1	X	X	X	X
SDC	selected device clear		M	AC	Y	Ø	Ø	Ø	Ø	1	Ø	Ø	X	X	X	1	X	X	X	X
SPD	serial poll disable		M	UC	Y	Ø	Ø	1	1	Ø	Ø	1	X	X	X	1	X	X	X	X
SPE	serial poll enable		M	UC	Y	Ø	Ø	1	1	Ø	Ø	Ø	X	X	X	1	X	X	X	X
SRQ	service request		U	ST	X	X	X	X	X	X	X	X	X	X	X	X	X	1	X	X
STB	status byte	(Notes 8, 9)	M	ST	S8	X	S6	S5	S4	S3	S2	S1	X	X	X	Ø	X	X	X	X
TCT	take control		M	AC	Y	Ø	Ø	Ø	1	Ø	Ø	1	X	X	X	1	X	X	X	X
TAG	talk address group		M	AD	Y	1	Ø	X	X	X	X	X	X	X	X	1	X	X	X	X
UCG	universal command group		M	UC	Y	Ø	Ø	1	X	X	X	X	X	X	X	1	X	X	X	X
UNL	unlisten		M	AD	Y	Ø	1	1	1	1	1	1	X	X	X	1	X	X	X	X
UNT	untalk	(Note 11)	M	AD	Y	1	Ø	1	1	1	1	1	X	X	X	1	X	X	X	X

The 1/Ø coding on ATN when sent concurrent with multiline messages has been added to this revision for interpretive convenience.

NOTES:

(1) D1-D8 specify the device dependent data bits.

(2) E1-E8 specify the device dependent code used to indicate the EOS message.

(3) L1-L5 specify the device dependent bits of the device's listen address.

(4) T1-T5 specify the device dependent bits of the device's talk address.

(5) S1-S5 specify the device dependent bits of the device's secondary address.

(6) S specifies the sense of the PPR.

S	Response
Ø	Ø
1	1

P1-P3 specify the PPR message to be sent when a parallel poll is executed.

P3	P2	P1	PPR Message
Ø	Ø	Ø	PPR1
.	.	.	.
.	.	.	.
1	1	1	PPR8

(7) D1-D4 specify don't-care bits that shall not be decoded by the receiving device. It is recommended that all zeroes be sent.

(8) S1-S6, S8 specify the device dependent status. (DIO7 is used for the RQS message.)

(9) The source of the message on the ATN line is always the C function, whereas the messages on the DIO and EOI lines are enabled by the T function.

(10) The source of the messages on the ATN and EOI lines is always the C function, whereas the source of the messages on the DIO lines is always the PP function.

(11) This code is provided for system use, see 6.3.

APPENDIX A

3388 - General Purpose Interface Bus (GPIB)

The 3388 provides a simple way to interface CAMAC with devices using the GPIB bus. The 3388 simulates the IEEE-488 bus and allows devices such as DVMs, counters, printers, and display terminals to be controlled by a CAMAC system.

Signal Standards of the GPIB

The GPIB bus structure is organized into three sets of signal lines:

1. Data bus, eight signal lines.

   (a) DIO 1 through DIO 8.

2. Data byte transfer control bus, three signal lines.

   (a) DAV (Data Valid)
   (b) NRFD (Not Ready For Data)
   (c) NDAC (No Data Accepted)

3. General Interface Management Bus, five signal lines.

   (a) ATN (Attention) used by the controller to specify how data on the DIO lines are to be interpreted and which device must respond to the data.

   (b) IFC (Interface Clear) is used by the controller to place the device in a known or initialize state.

   (c) SRQ (Service Request) is used by devices to indicate the need for attention.

   (d) REN (Remote Enable) is used by the controller along with other messages to select between two alternate sources of device programming data.

   (e) EOI (End Or Identify) is used by a talker to indicate the end of a multiple byte transfer sequence or in conjunction with ATN (by a controller) to execute a polling sequence.

Addressing Devices on the Bus

The way devices are addressed on the bus is by assigning a talker and a listener, or group of listeners. This is done so that data is sent in one direction in a controlled fashion. Assigning the talker and listener is the job of the controller. Each device on the bus has what is commonly called an address. This address can range from 0 to 31. This address, placed in a sequence of messages, will allow devices to be assigned talker and listener. The first thing to establish is what the talker and listener addresses would be for the devices on the bus. This is done using the following formula:

BA + 64 = TALKER ADDRESS
BA + 32 = LISTENER ADDRESS

For example, if there are two devices on the bus, one having a base address of zero and the other having a base address of one, the talker and listener addresses would be calculated as follows:

0 + 64 = TALKER ADDRESS OF 64
0 + 32 = LISTENER ADDRESS OF 32

1 + 64 = TALKER ADDRESS OF 65
1 + 32 = LISTENER ADDRESS OF 33

This method would be used to find the talk and listen addresses for any device on the bus.

One of the management bus lines mentioned above will be used to output the address on the data lines. The signal line is ATN (Attention).

This line tells the devices on the bus to receive this byte regardless of their present talk/listen status. After all the information on the bus has been transmitted, the attention line is removed.

The sequence of events using the 3388 would be as follows:

```
C 3388      BASE ADDRESS = 0.
C 3388      TALK ADDRESS 64=BA+64.
C           LISTEN ADDRESS 32=BA+32.

C HP        BASE ADDRESS = 1.
C HP        TALK ADDRESS 65=BA+64.
C HP        LISTEN ADDRESS 33=BA+32.

C     INTERFACE CLEAR. SETS THE BUS TO KNOWN STATE.
      CALL CAMAC(0,N3388,0,25,0,0)

C     RAISE ATTENTION.
C     TELLS ALL DEVICES TO ACCEPT THE NEXT BYTE(S).
      CALL CAMAC(0,N3388,0,26,0,0)
```

```
C       REMOTE ENABLE.
C       ALLOWS DEVICES TO ENTER REMOTE PROGRAMMING MODE.
        CALL CAMAC(0,N3388,1,26,0,0)

C       HP LISTEN ADDRESS.  OUTPUT HP METER LISTEN ADDRESS.
        CALL CAMAC(0,N3388,0,16,0,33)

C       3388 TALK ADDRESS.  OUTPUT 3388 TALK ADDRESS.
        CALL CAMAC(0,N3388,0,16,0,64)

C       LOWER ATTENTION.  END COMMAND MODE ENTER ADDRESS MODE.
        CALL CAMAC(0,N3388,0,24,0,0)
```

The above sequence of events will put the HP meter in the listen mode and the 3388 in the talk mode. Bytes can now be transmitted to the HP meter.

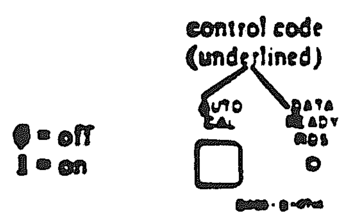
The HP meter requires a number of parameters to be set such as mode (i.e., AC volt, DC volt, OHMs), resolution (i.e., 1, 10, 100, auto), and trigger (i.e., internal, external, hold/manual). This information can be found in Figure 3-4 of the HP manual on the next page. Once these parameters are established, the HP meter will be ready to take data.

Table 3-4. HP-IB Program Codes.

	Control	Program Code
FUNCTION	DC Volts AC Volts Fast AC Volts 2 Wire kΩ 4 Wire kΩ Test	F1 F2 F3 F4 F5 F6
RANGE	.1 1 10 100 1 K 10 K AUTO	R1 R2 R3 R4 R5 R6 R7
TRIGGER	Internal External Hold/Manual	T1 T2 T3
MATH	Scale Error Off	M1 M2 M3
ENTER	Y Z	EY EZ
STORE	Y Z	SY SZ
AUTO CAL	Off On	AØ A1
HIGH RESOLUTION	Off On	HØ H1
DATA READY RQS	Off On	DØ D1
BINARY PROGRAM		B

3-47. The program code for single control features which can only be programmed on or off (AUTO CAL and HIGH RESOLUTION) consist of the letter underlined in the control heading and the number "Ø" for off or the number "1" for on. This also applies to the DATA READY Request feature which is Bus programmable only.

Example:

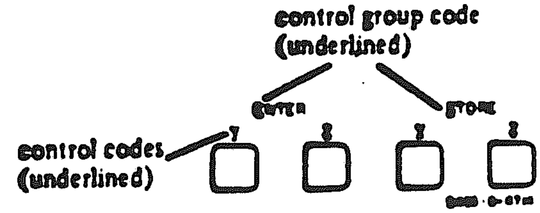


Program Code

(off)	AØ	DØ
(on)	A1	D1

3-48. Program codes for the ENTER and STORE features consist of the letter underlined in the control heading and the underlined letter of the particular control.

Example:



program code EY EZ SY SZ

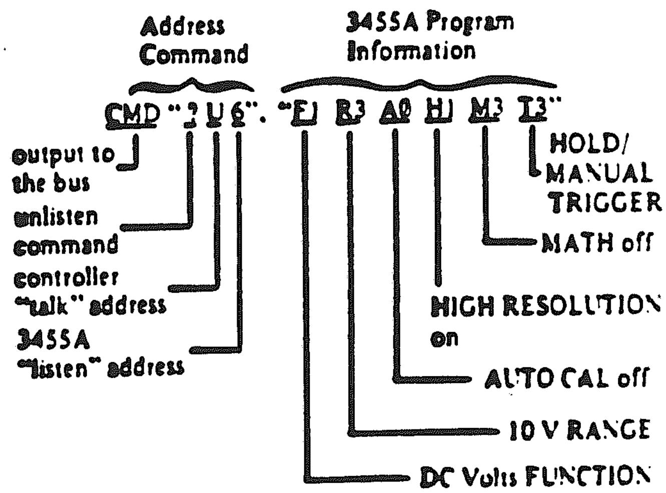
3-49. The program code for the BINARY PROGRAM feature consists of only the underlined character in the control heading (B).

3-50. Data Messages.

3-51. The major portion of communications transmitted over the Bus is accomplished by data messages. Data messages are used by the controller to program the Model 3455A and are used by the 3455A to transmit measurement data. These functions are explained in the following paragraphs.

3-52. Programming. The 3455A is programmed by means of data messages sent over the Bus from the controller. These messages are composed of two parts – the address command and the program information. The address command contains the "talk" and "listen" addresses of the devices involved; in this case, the talk address of the controller and the listen address of the 3455A. The program information contains the codes of the 3455A controls to be programmed. Syntax of the address command portion of the data message is dependent upon the controller being used. For the proper syntax refer to the controller manual. Syntax for the program information portion consists of the program codes listed in Table 3-4.

Example program data messages:



Program data message using the 9830A Calculator.

Note that the bytes transmitted are ASCII characters. This is common for HP devices. The meter will send back data in ASCII as well. The data sent from the HP will be sent in exponential format, starting with sign and ending the power of 10.

(For example, -0.0000000E00.)

A few of the parameters needed by the meter are:

1. Function = DC volts
2. Range = Auto
3. Trigger = Hold/Manual
4. High Resolution = On

The following section of a program will send over the proper sequence of bytes to place the meter in the proper state.

```
C      SEND PROGRAMMING INFORMATION TO HP METER

C      THE NEXT TWO BYTES OUTPUT F1 TO SELECT DC VOLT
       CALL CAMAC(0,N3388,0,16,0,70) ; send ASCII F
       CALL CAMAC(0,N3388,0,16,0,49) ; send ASCII 1

C      THE NEXT TWO TYPES OUTPUT R7 TO SELECT AUTO RANGE
       CALL CAMAC(0,N3388,0,16,0,82) ; send ASCII R
       CALL CAMAC(0,N3388,0,16,0,55) ; send ASCII 7

C      THE NEXT TWO BYTES OUTPUT A0 TO SELECT AUTO CALIBRATION OFF
       CALL CAMAC(0,N3388,0,16,0,65) ; send ASCII A
       CALL CAMAC(0,N3388,0,16,0,48) ; send ASCII 0

C      THE NEXT TWO BYTES OUTPUT H1 TO SELECT HIGH RESOLUTION
       CALL CAMAC(0,N3388,0,16,0,72) ; send ASCII H
       CALL CAMAC(0,N3388, 0,16,0,49) ; send ASCII 1

C      THE NEXT TWO BYPES OUTPUT M3 TO SELECT MATH OFF
       CALL CAMAC(0,N3388,0,16,0,77) ; send ASCII M
       CALL CAMAC(0,N3388,0,16,0,51) ; send ASCII 3

C      THE NEXT TWO BYTES OUTPUT T3 TO SELECT MANUAL TRIGGER
       CALL CAMAC(0,N3388,0,16,0,84) ; send ASCII T
       CALL CAMAC(0,N3388,0,16,0,51) ; send ASCII 3

C      THE FOLLOWING COMMANDS SET TRIGGER
       CALL CAMAC(0,N3388,0,16,0,84)
       CALL CAMAC(0,N3388,0,16,0,51)
```

Now that the meter has been programmed, it can transmit the voltage it is monitoring. The meter will only send data if it is the talker. The following program section will demonstrate how this is accomplished.

```
C       RAISE ATTENTION
        CALL CAMAC (0,N3388,0,26,0,0)
C       HP TALK ADDRESS
        CALL CAMAC(0,N3388,0,16,0,65)
C       3388 LISTEN ADDRESS
        CALL CAMAC(0,N3388,0,16,0,32)
C       LOWER ATTENTION
        CALL CAMAC(0,N3388,0,24,0,0)
```

With the HP device in the talker state, it will now place data on the bus. Since there is no buffer on the 3388, the handshake will not be completed until the data is readout of the 3388. The following program section demonstrates how this is accomplished.

```
C       GET DATA FROM 3388
C
        D0 30 I=1,15
11      CALL CAMAC(0,N3388,0,D2,D1)   ; command to read data from 3388
        IF(Q(IDMY).EQ.0) GOTO 11      ; check Q to see if valid data
C       CHECK FOR CR
        IF(D1.EQ.13) GOTO 50          ; check to see if last character
C       CHECK FOR LF
        IF(D1.EQ.10) GOTO 50          ; check to see if last character
C       ADD DATA TO STRING
        DATA(I)=(D1)                  ; add character to string
30      CONTINUE
C
```

The above program section will receive characters and add them to the string until a carriage return or line feed is received. Once received, we know all bytes needed for the string have been received and that a new string is being sent.

The above sections give the general idea of how to access devices on the GPIB bus. This is not the total extent of the bus, but it will allow you to get started.