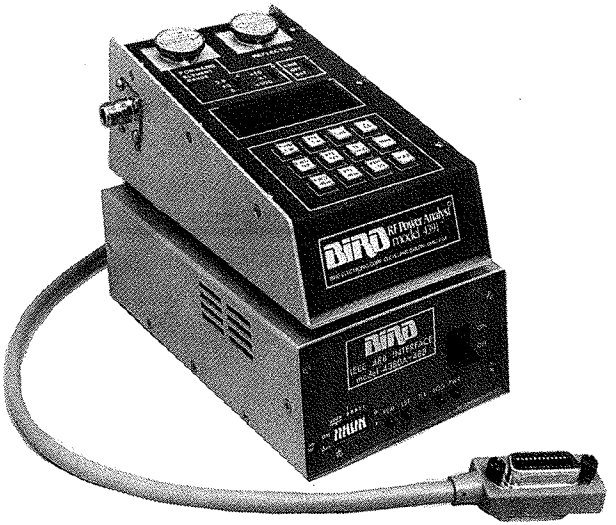
INSTRUCTION BOOK FOR MODEL 4380A - 488

IEEE - 488 BUS COMPATIBLE INTERFACE UNIT

FOR USE WITH BIRD RF POWER ANALYST® WATT METERS



Electronic Corporation

30303 Aurora Road, Cleveland, Ohio 44139-2794

LIMITED WARRANTY

We are proud of the high quality of our product and we warrant to the original purchaser that each new instrument of our manufacture will for a period of one year after original shipment be free from defects in material and workmanship under normal and proper operating conditions and that properly used during such period it will perform in accordance with our applicable specifications.

Our obligation and the purchaser's exclusive remedy for any defect or failure to meet specifications shall be limited, at our option, to repair or replacement, or if we determine said defect or failure to be so defective as to preclude remedying by repair or replacement, the purchaser's sole and exclusive remedy shall be limited to refund of the purchase price. We shall have no obligation if defects result from improper use, operation above rated capacities, repairs not made by us, or misapplication of the equipment. Our warranty does not extend to the failure of semiconductor devices and batteries, or to equipment and parts made by others except to the extent of the original manufacturer's warranty to us. No other warranty is expressed or implied. Bird Electronic Corporation is not liable for consequential damages.

Warranty returns must be first authorized by the factory office and are to be shipped prepaid.

SAFETY PRECAUTIONS

The following are general safety precautions that are not necessarily related to any specific part or procedure and do not necessarily appear elsewhere in this publication.

Keep away from live circuits.

Operating personnel must at all times observe normal safety regulations. Do not attempt to replace parts while power is applied. When working with high voltage always have someone present who is capable of rendering aid if necessary. Personnel working with or near high voltage should be familiar with modern methods of resuscitation.

The following will appear in the text of this publication and is shown here for emphasis.

WARNING

The potential of electrical shock exists. Unplug device when removing cover to avert accidental shock.

CAUTION

The 4380A-488 contains MOS integrated circuits which may be damaged by static electricity. Open the housing only when sure that there are no static producing materials such as carpeting or styrofoam where the work is to be done. Work on a conductive, grounded work surface touching it frequently to discharge static from your body. If a part is to be stored or shipped, wrap it in conductive packaging materials designed for static sensitive circuitry.

CAUTION

The Model 4380A-488 complies with FCC regulations as a Class A computing device under Part 15.J of the FCC rules. To maintain this compliance it is required to only use external cables supplied by Bird Electronic Corporation.

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INTRODUCTION

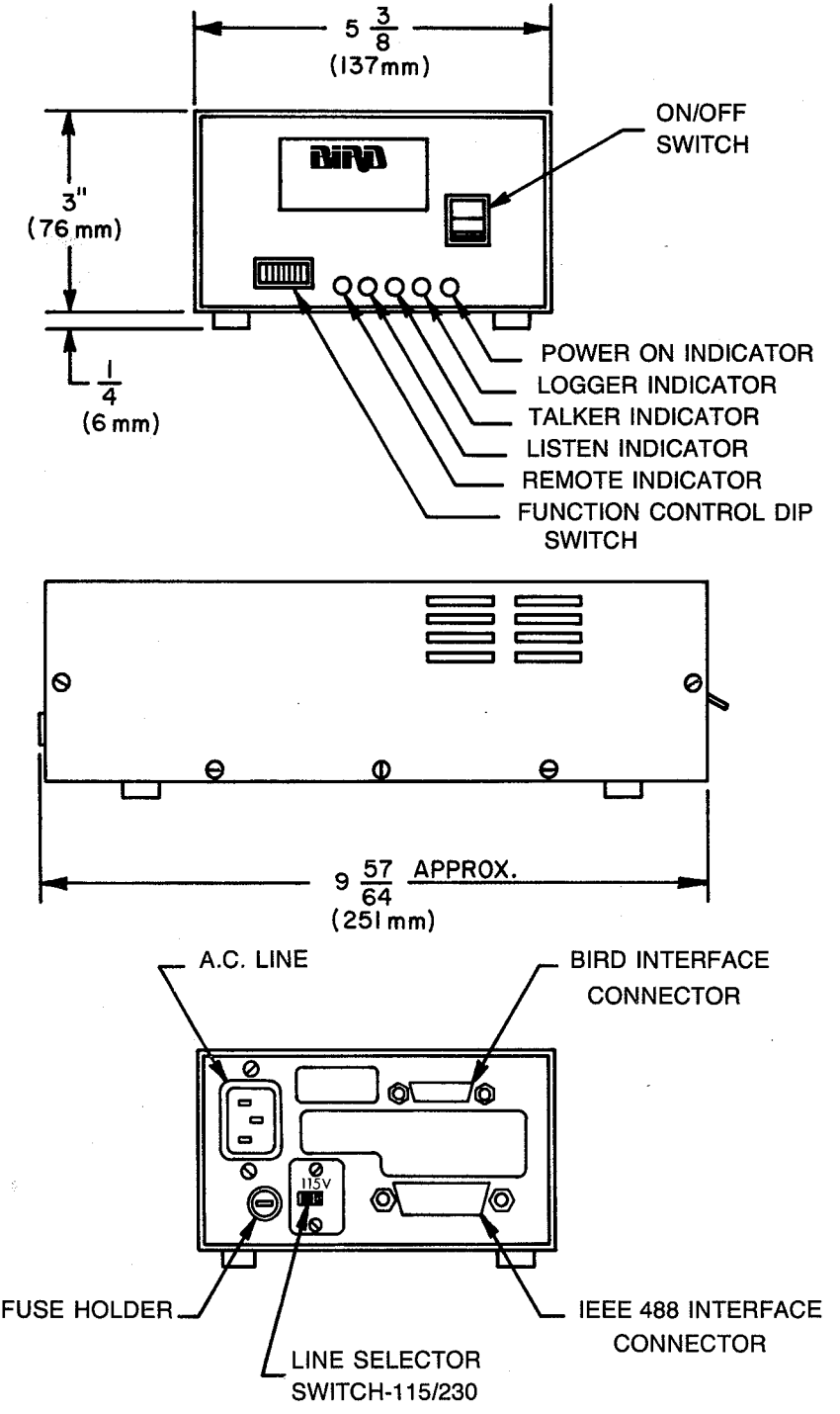
PREFACE

This publication refers to Bird power analysts as 4380 Series Wattmeters. This term includes the following wattmeters; 4381, 4382, 4383 and 4391 portable wattmeters 4385, 4386, 4387 and 4388 rack mount wattmeters. To be used with Model 4380A-488, the above wattmeters must be equipped with the 832 option.

SCOPE

The purpose of this manual is to provide the operator with an understanding of the Model 4380A-488 and its operation. It is not the intent of this manual to familarize the operator with the I.E.E.E. 488 Bus and its detailed protocol. It is therefore recommended the operator be familiar with the I.E.E.E. standard 488-1978 before configuring this instrument with the bus.

Figure I-1. Model 4380A-488 Outline.



SHORT FORM COMMAND SUMMARY

Measurement	FC	Forward Carrier Wave
	FP	Forward Peak Envelope Power
	FD	Forward Decibels
	RC	Reflected Carrier Wave
	RP	Reflected Peak Envelope Power
	RD	Reflected Decibels
	SW	Standing Wave Ratio
	AM	Percent of Modulation
	RL	Return Loss
	MN	Minimum Value
	MX	Maximum Value
	AD	Delta Function
Logger	LGxxHyym	Logger Every xx Hours yy Minutes
Terminators	YT	Two Terminators (CR) (LF)
	YO	One Terminator (CR)
	YN	No Terminator
Prefixes	PY	Prefixes Yes
	PN	No Prefixes
Triggers	T0	Continuous on Talk
	T1	One Shot on Talk
	T2	Continuous on Get
	T3	One Shot on Get
	T4	Continuous on Measurement Command
	T5	One Shot on Measurement Command
Serial Polling	M00	Do Not Generate SRQ
	M01	Generate SRQ on Error
	M02	Generate SRQ on Overrange
	M04	Generate SRQ on Underrange
	M08	Generate SRQ on Operation Complete
Status	U0	Send Back Current Machine State
	U1	Send Back Error Conditions
	U2	Send Back Last Reading
	U3	Send Back Revision Levels
Self-Test	J0	Run Self-Test
EOI Response	K0	Send EOI on Last Byte
	K1	Do Not Send EOI on Last Byte
Veritable Store	Wxxxxxx	Place xxxxxx in-Ram

DESCRIPTIONS

The Model 4380A-488 Interface provides the 4380 Series of Wattmeters access to the IEEE-488 General Purpose Interface Bus. The 488 Bus provides the capability for the 4380 Series Wattmeter to be commanded and read remotely via a 488 Bus controller or appropriate command source.

The Model 4380A-488 is an addressable talk and listen device which meets all requirements of the 488-1978 standard.

The Model 4380A-488 interface unit is contained within an aluminum enclosure. It's front and rear panel are recessed to avoid accidental damage to panel mounted hardware. Communication cable interconnections and main line power are provided via the rear panel. The front panel contains a power switch to apply main line power to unit, and eight position dip switch to configure operational conditions and interface address and five L.E.D.'s indicate instrument status.

Controls

ON/OFF Switch...	Applies ac line power to 4380A-488
Dip Switch.....	Selects device address and operational conditions
Power Select.....	Selects 115/230 Vac *Unit is shipped with line select in 115V position. To select 230V position remove two #2-56 pan head screws. This allows you to remove the line select plate and to push the switch button to the right (230V position). Now reverse the line select plate and re-install to lock in voltage selection.

Indicators

POWER.....	Indicates 5 volts supplied
REM	Indicates remote mode (on), local mode (off)
TLK.....	Indicates device is TALKER on Bus
LST.....	Indicates device is LISTENER on Bus
LOG	When flashing indicates Logger Function is enabled

SPECIFICATIONS FOR MODEL 4380A-488

Physical

Dimensions	Width 5.375 inches (137mm) Height 3.25 inches (82mm) Length 9.89 inches (215mm)
Weight	2 lbs 10 oz. (1.2 kg)
Connectors	Bird Interface - AMP-205205-1, 2 or equivalent I EEE-488 Bus - AMP 553811-3
Power	115/230 VAC + 10% 47-63Hz Fuse 1/4 AMP slow blow
Temperature	Operating Temp. Range: 0°C to 50°C Storage Temp. Range: -40°C to 100°C
Output	3-1/2 digit ASCII Format
Logic Levels	Meets all IEEE std. 488-1978 specifications
Modes of Operation	Switch and Bus selectable
Talk Only	Allows the Wattmeter to output its keyboard initiated measurements to the bus, this information can then be accepted by a listen only device.
Addressable	Allows the 4380A-488 to be addressed as a talker or listener under the command of a IEEE 488 bus controller.
Logger	A bus-selected operation that allows measurements to be made repeatably at time intervals chosen by the operator.

488 BUS INTERFACE SUBSET IMPLEMENTATION

The Model 4380A-488 provides the following 488 Bus interface and subsets as set forth in the 488-1978 standard.

Acceptor Handshake (AH1)	-	complete capability
Source Handshake (SH1)	-	complete capability
Function (T5)	-	unaddressed to talk on MLA
Listener Function (L4)	-	no listen only mode and unaddressed to listen on MTA
Service Request (SR1)	-	complete capability
Remote/Local (RL0)	-	no local lock out
Parallel Poll (PP0)	-	no capability
Device Clear (DC1)	-	complete capability
Device Trigger (DT1)	-	complete capability

IEEE INTERFACE CONNECTOR

On the rear of the Model 4380A-488 is a 24 pin connector with pin assignments, physical parameters, and electrical specifications which meet the 488-1978 standard. This connector provides the proper signal path to implement the 488 Bus.

The following is a list of the pin assignments:

Contact Number	IEEE-488 Designation	Type
1	D101	Data
2	D102	Data
3	D103	Data
4	D104	Data
5	EOI(24)*	Management
6	DAV	Handshake
7	NRFD	Handshake
8	NDAC	Handshake
9	IFC	Management
10	SRQ	Management
11	ATN	Management
12	SHIELD	Ground
13	D105	Data
14	D106	Data
15	D107	Data
16	D108	Data
17	REN(24)*	Management
18	Gnd, (6)*	Ground
19	Gnd, (7)*	Ground
20	Gnd, (8)*	Ground
21	Gnd, (9)*	Ground
22	Gnd, (10)*	Ground
23	Gnd, (11)*	Ground
24	Gnd, LOGIC	Ground

*Numbers in parentheses refer to signal ground return of referenced contact number. EOI and REN signal lines return on contact 24.

BIRD INTERFACE

On the rear of the Model 4380A-488 is a 15 pin connector which is for interfacing the 4380 Series Wattmeter to the Model 4380A-488. The connector provides a signal path which tells the Wattmeter to make a measurement, read back the measured value, and provide a ground reference to the Wattmeter. The following is the list of pin assignments and their functions:

Pin	Signal	Function
1	Ground	Shielding
2		Not Used
3	Row 3	Row 3 of Keyboard
4	Row 2	Row 2 of Keyboard
5	Row 1	Row 1 of Keyboard
6	Col 4	Fourth column of Keyboard
7	Col 3	Third column of Keyboard
8	Col 2	Second column of Keyboard
9	Col 1	First column of Keyboard
10	Dec Point	Decimal point location
11	BCD 8	Most significant digit
12	BCD 4	
13	BCD 2	
14	BCD 1	Least significant digit
15	Ground	Signal

SECTION I - GETTING STARTED

1-1. QUICK UP AND RUNNING GUIDE

1-2. The paragraphs below will take you through a step-by-step procedure to get your Model 4380A-488 on the bus as quickly as possible and program basic operating modes. Refer to Section III for detailed information on IEEE-488 operation and programming.

1-3. Step 1: Connect Your Model 4380A-488 to the Controller, see Figure 1-1.

1-4. With power off, connect the Model 4380A-488 to the IEEE-488 interface of the controller using a standard interface cable. Some controllers such as the HP-85 include an integral cable, while others require a separate cable. See Paragraph 1-21 for more detail.

1-5. Step 2: Connect Your 4380A-488 to the Desired Bird Wattmeter, see Figure 1-1.

1-6. With power off, connect the 4380A-488 to a Bird 4380 Series Wattmeter using the supplied shielded 15 pin cable. Be sure to secure the cable screws at both ends.

1-7. Step 3: Select the Primary Address and Addressable Mode.

1-8. Much like your home address, the primary address is a way for the controller to refer to each device on the bus individually. Consequently, the primary address of your Model 4380A-488 (and any other devices on the bus, for that matter), must be the same as the primary address specified in the controller's programming language, or you will not be able to program instrument operating modes and obtain data over the bus. Keep in mind that each device on the bus must have a different primary address. Also select ADDR positions since we desire remote control via a controller.

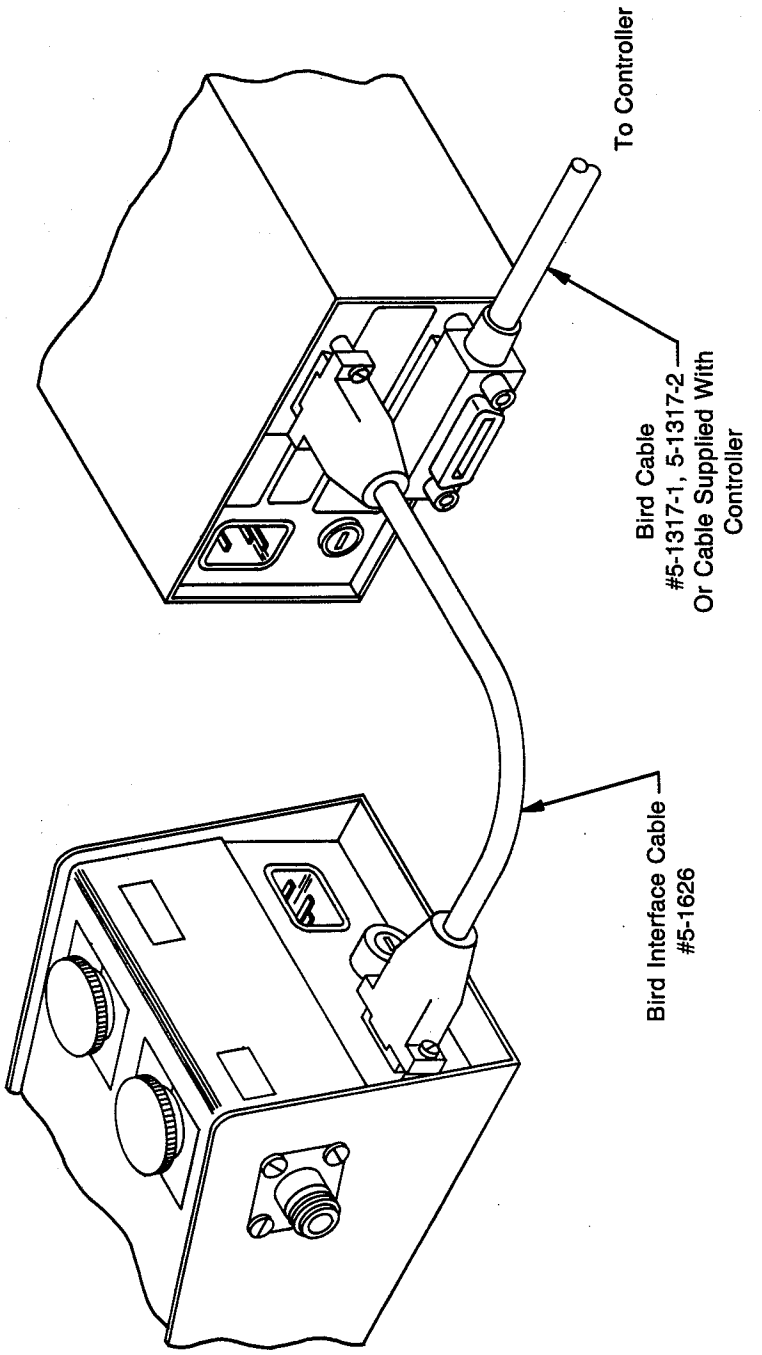
1-9. The primary address of your Model 4380A-488 is set to 6 at the factory, but you can program other values between 0 and 30.

ADDR	A16	A8	A4	A2	A1
0	0	0			0
X X					
			1	1	
TO					

ON = 0
X = DON'T CARE
OFF = 1

Arrangement shown above is Factory default address 6 with Talks only mode off (i.e. set to Addressable)

Figure 1-1. Hook-up of External Cables to 4380A-488 Interface Unit and 4380 Wattmeter. (4391 Shown).



1-10. Step 4: Write Your Program.

1-11. Even the most basic operations will require that you write a simple program to send commands and read back data from the instrument. The programming examples below allow such operations. The program will allow you to type in command strings to program the instrument and display data on the computer CRT.

1-12. HP-85 Programming Example - Use the simple program below to send programming commands to the Model 4380A-488 and display the data string on the computer CRT.

PROGRAM		COMMENTS
10	REMOTE 706	Send remote enable.
20	DISP "COMMAND";	Prompt for command string.
30	INPUT B$	Input the command string.
40	OUTPUT 706, B$	Send command string to 4380.
50	ENTER 706; A$	Get a reading from the instrument.
60	DISP A$	Display the reading.
70	GOTO 20	Repeat.
80	END	

1-13. Step 5: Turn the Power ON.

1-14. Step 6: Program Model 4380A-488 Operating Modes.

1-15. You can program instrument operating modes by sending the appropriate command, which is made up of ASCII letters and numbers. The Introduction summarizes the 4380A-488 commands.

1-16. A number of commands can be grouped together in one string, if desired.

1-17. If you are using the programming examples from Step 4 above, simply type in the command string when prompted to do so.

EXAMPLE: FC to select Forward Carrier Wave.

1-18. Step 7: Get Readings from the Model 4380A-488.

1-19. Usually, you will want to obtain one or more readings from the Model 4380A-488. In the example program above, a single reading is requested and displayed after each command. In other cases, you may wish to program the instrument configuration at the beginning of your program, and then obtain a whole series of measurements.

1-20. The basic reading string that the Model 4380A-488 sends over the bus is in ASCII characters of the form:

NFC 1.234

where: N indicates a normal reading (O would indicate an overflow, U would indicate underflow) FC shows the Forward Carrier Wave measurement function is in selected and 1.234 is the mantissa of the reading data. That is all that's required to get the unit working in your application.

1-21. DETAILED BUS CONNECTIONS

1-22. The Model 4380A-488 is intended to be connected to the IEEE-488 Bus through a cable equipped with standard IEEE-488 connectors. The connector is designed to be stacked to allow a number of parallel connections at one instrument. Two screws are located on each connector to ensure that connections remain secure. Current standards call for metric threads, which are identified with dark colored screws. Earlier versions had different screws, which were silver colored. Do not attempt to use these type of connectors on the Model 4380A-488 which is designed for metric threads.

1-23. Although any number of connectors can be stacked on one instrument, it is recommended that you stack no more than three connectors on any one unit to avoid possible mechanical damage.

Connect the Model 4380A-488 to the IEEE-488 Bus as follows:

a. Line up the cable connector with the connector located on the read panel of the instrument. The connector is designed so that it will fit only one way.

b. Tighten the screws securely, but do not overtighten them.

c. Add additional connectors from other instruments, as required.

d. Make certain that the other end of the cable is properly connected to the controller. Most controllers are equipped with an IEEE-488 style connector, but a few may require a different type of connecting cable. Consult the instruction book for your controller for the proper connecting method.

Note - The IEEE-488 Bus is limited to a maximum of 15 devices, including the controller. The maximum cable length is 20 meters, or 2 meters times the number of devices, which ever is less. Failure to observe these limits may result in erratic bus operation.

1-24. INTERFACE FUNCTION CODES

1-25. The interface function codes, which are part of the IEEE-488 standards, define an instrument's ability to support various interface functions, and they should not be confused with programming commands found elsewhere in this book. Interface function codes for the Model 4380A-488 are listed in Table 1-1 and are listed on the rear panel adjacent to the IEEE-488 connector. The codes define Model 4380A-488 capabilities as follows:

SH (Source Handshake) - SH1 defines the ability of the Model 4380A-488 to properly handshake data or command bytes when the unit is acting as a source.

AH (Acceptor Handshake) - AH1 defines the ability of the Model 4380A-488 to properly handshake the bus when it is acting as an acceptor of data or commands.

T (Talker) - The ability of the Model 4380A-488 to send data over the bus to other devices is defined by the T function. Model 4380A-488 talker capabilities exist only after the instrument has been addressed to talk, or after a reading on the Talker Only mode.

L (Listener) - The L function defines the ability of the Model 4380A-488 to receive device-dependent data over the bus. Listener capabilities exist only after the instrument has been addressed to listen.

SR (Service Request) - The SR function defines the ability of the Model 4380A-488 to request service from the controller.

RL (Remote-Local) - The RL function defines the capability of the Model 4380A-488 to be placed in the remote or local modes.

PP (Parallel Poll) - The Model 4380A-488 does not have parallel polling capabilities.

DC (Device Clear) - The DC function defines the ability of the Model 4380A-488 to be cleared to factory (power on conditions).

DT (Device Trigger) - The ability for the Model 4380A-488 to have its readings triggered is defined by the DT function.

C (Controller) - The Model 4380A-488 does not have controller capabilities.

TE (Extended Talker) - The Model 4380A-488 does not have extended talker capabilities.

LE (Extended Listener) - The Model 4380A-488 does not have extended listener capabilities.

E (Bus Driver Type) - The Model 4380A-488 has open-collector bus drivers.

Table 1-1. Model 4380A-488 Function Codes.

Code	Interface Function
SH1	Source Handshake Capability
AH1	Acceptor Handshake Capability
T5	Talker (Basic Talker, Serial Poll, Unaddressed To Talk On MLA)
L4	Listener (Basic Listener, Unaddressed To Listen On MTA)
SR1	Service Request Capability

Code	Interface Function
RL0	Remote/Local Capability (No LLO capabilities)
PP0	No Parallel Poll Capability
DC1	Device Clear Capability
DT1	Device Trigger Capability
C0	No Controller Capability
E1	Open Collector Bus Drivers
TE0	No Extended Talker Capabilities
LE0	No Extended Listener Capabilities

1-26. IEEE-488 STATUS INDICATORS

1-27. The REMOTE, TALK, and LISTEN indicators show the present IEEE-488 status of the instrument. The LOG indicator shows the status of the internal data logger. Each of these indicators is briefly described below.

TALK - This indicator will be on when the instrument is in the talker active state. The unit is placed in this state by addressing it to talk with the correct MTA (My Talk Address) command. TALK will be off when the unit is in the talker idle state. The instrument is placed in the talker idle state by sending it an UNT (Untalk) command, addressing it to listen, or with the IFC (Interface Clear) command. When in the Talker Only mode this indicator will always be on.

LISTEN - This indicator will be on when the instrument is in the listener active state, which is activated by addressing the instrument to listen with the correct MLA (My Listen Address) command. LISTEN will be off when the unit is in the listener idle state. The unit can be placed in the listener idle state by sending UNL (unlisten), addressing it to talk, or by sending IFC (Interface Clear) over the bus.

REMOTE - As the name implies, this indicator shows when the instrument is in the remote mode. Note that REMOTE does not indicate the state of the REN line, as the instrument must be addressed to listen with REN true before the REMOTE indicator will turn on. When REMOTE is turned off, the instrument is in the local mode. Since the Bird 4380 Series wattmeters have no provisions for locking out Key hits Remote/Local has no effect on operation.

LOG - This indicator shows when the logger mode is enabled by flashing at a 1/2 second rate.

SECTION II - GENERAL BUS COMMAND PROGRAMMING

2-1. GENERAL

2-2. This section contains information on programming the Bird Model 4380A-488 with the Bird 4380 Series Wattmeter over the IEEE-488 Bus.

2-3. General bus commands are those commands such as Device Clear (DCL) that have the same general purpose regardless of the instrument. Commands supported by the Model Bird 4380A-488 are summarized in Table 2-1, which also lists HP-85 statements necessary to send each command. Note that commands requiring a primary address assume that the Model 4380 primary address is set to 6 (its factory default address).

Table 2-1. Bus Commands.

Command	HP-85 Statement	Affect on Model 4380A-488
REN	REMOTE 7	Goes into affect when next addressed.
IFC	ABORTIO 7	Goes into talker and listener idle states.
GTL	LOCAL 706	Cancel remote, restore LOCAL.
DCL	CLEAR 7	Returns to default conditions.
SDC	CLEAR 706	Returns to default conditions.
GET	TRIGGER 706	Triggers reading in T2 and T3 modes.

2-4. REN (REMOTE ENABLE)

2-5. REN is a uniline command that must be asserted by the controller to place the Model 4380A-488 in the remote mode. Simply setting REN true will not actually place the instrument in Remote; instead, the unit must be addressed to listen after REN is set true. In the Remote state the REM LED will be on.

2-6. Generally, remote enable should be asserted before attempting to program the instrument over the bus. However, for the 4380A-488 the Remote state has no effect on operation.

2-7. To place the Model 4380A-488 in the remote mode, the controller must perform the following sequence:

a. Set the REN line true.

b. Address the Model 4380A-488 to listen.

2-8. HP-85 Programming Example - Place the Model 4380A-488 in remote with the following statement:

REMOTE 706

2-9. When the END LINE key is pressed, the Model 4380A-488 should be in the remote mode as indicated by the REMOTE annunciator light (note - the Listen LED will also go on). If not, check to see that proper bus connections are made, and that the instrument is programmed for the correct primary address (6).

2-10. **IFC (INTERFACE CLEAR)**

2-11. The IFC command is sent by the controller to place the Model 4380A-488 in the talker and listener idle states. The unit will respond to the IFC command by cancelling front panel REM, TALK or LISTEN lights, if the instrument was previously placed in one of those modes.

2-12. To send the IFC command, the controller need only set the IFC line true for a minimum of 100 usec.

2-13. HP-85 Programming Example - Before demonstrating the IFC command, place the instrument in the Remote state with the following statements:

REMOTE 706

At this point, the REMOTE indicator and LISTEN should be on. The IFC command can be sent by depressing the following keys:

SHIFT RESET

The REMOTE and LISTEN LED's should go off.

2-14. **DCL (DEVICE CLEAR)**

2-15. The DCL command may be used to clear the Model 4380A-488 and return the unit to the factory default conditions. The Table 2-2 lists factory default conditions for the instrument after it receives a DCL.

Table 2-2. Default Conditions.

FC	= Forward Carrier Wave
LGOOHOOM	= Logger Off.
YT	= Two Terminators (CR) (LF)
PY	= Prefixes Yes
T1	= Trigger One Shot being addressed to talk
M00	= All SRQ's Off
K0	= Send EOI with Last Byte of Message

To send the DCL command, the controller must perform the following steps:

a. Set ATN true.

b. Place the DCL command byte on the data bus.

2-16. HP-85 Programming Example - Using a front panel button on the 4380 Series Wattmeter alter instrument configuration from the factory default value and enter the following statement into the keyboard:

CLEAR 7

When the above statement is executed, the instrument returns to default conditions (i.e.; forward carrier wave is selected).

2-17. **SDC (SELECTIVE DEVICE CLEAR)**

2-18. SDC is an addressed command that performs the same function as the DCL command. However, since each device must be individually addressed, SDC provides a method for clearing only a single, selected instrument instead of clearing all devices simultaneously, as is the case with DCL. When the Model 4380A-488 receives the SDC command, it will return to the default configuration.

2-19. To transmit the SDC command, the controller must perform the following steps:

a. Set ATN true.

b. Address the Model 4380A-488 to listen.

c. Place the SDC command byte on the data bus.

2-20. HP-85 Programming Example - Using a front panel button on the 4380 Series Wattmeter alter instrument modes from the factory default configuration. Send SDC with the following statement:

CLEAR 706

When the above statement is executed, the instrument returns to the default configuration.

2-21. **GET (GROUP EXECUTE TRIGGER)**

2-22. GET may be used to initiate a Model 4380A-488 measurement if the instrument is placed in the appropriate trigger mode (see Section V). Once triggered, the instrument will perform the measurement sequence in accordance with previously selected parameters.

2-23. To send GET, the controller must perform the following sequence.

a. Set ATN low.

b. Address the Model 4380A-488 to listen.

c. Place the GET command byte on the data bus.

2-24. HP-85 Programming Example - Type in the following statements to place the instrument in the correct trigger mode for purposes of this demonstration:

```
REMOTE 706
OUTPUT 706; "T3"
```

Now trigger the measurement sequence by sending GET with the following statement:

```
TRIGGER 706
```

When the END LINE key is pressed, the measurement sequence will be triggered, and a reading will be taken for the bus to use.

2-25. **SPE, SPD (SERIAL POLLING)**

2-26. The serial polling sequence is used to obtain the Model 4380A-488 status byte. The status byte contains important information about internal functions, as described in Section III. The serial polling sequence can also be used by the controller to determine which instrument on the bus has asserted SRQ (Service Request).

2-27. The serial polling sequence is generally conducted as follows:

a. The controller sets ATN true.

b. The controller then places the SPE (Serial Poll Enable) command byte on the data bus. At this point, all active devices are in the serial poll enabled mode and waiting to be addressed.

c. The Model 4380A-488 is then addressed to talk.

d. The controller sets ATN false.

e. The instrument places its status byte on the data bus to be read by the controller.

f. The controller then sets ATN true and places the SPD (Serial Poll Disable) command byte on the data bus to end the serial polling sequence.

2-28. Once instruments are in the serial poll mode, steps c. through e. above can be repeated by sending the correct talk address for each instrument.

2-29. HP-85 Programming Example - The HP-85 SPOLL statement automatically performs the sequence just described. To demonstrate serial polling, type in the following statements:

```
REMOTE 706
S = SPOLL (706)
DISP S
```

When the above statements are executed, the Model 4380A-488 is serial polled, and the decimal value of the status byte is displayed on the computer CRT.

SECTION III - DEVICE-DEPENDENT COMMAND PROGRAMMING

3-1. GENERAL

3-2. IEEE-488 Device-Dependent commands are the most important commands associated with the instrument because they control all of the 4380A-488 operating modes.

a. Command Syntax

1. Each 4380A-488 command is made up of an ASCII letter followed by an ASCII Integer number of 0 to 9 or an ASCII letter followed by another ASCII letter. ASCII letters can be upper or lower case.

2. Some valid examples are:

FC or fc
T2 or t2

3. If an invalid command is sent as a command string the instrument will place an error condition into the serial poll byte and the offending command will not be executed. Commands will continue not executing until the 4380A-488 recognizes another valid command. At that time it will execute the valid command.

4. The two invalid errors are IDDC and IDDCO. IDDC indicates that the command received was invalid (Invalid Device-Dependent Command). For example: V2. The IDDCO indicates that the command option received was invalid (Invalid Device Dependent Command Option). For example: FQ.

b. Device-Dependent Command Summary

Device-dependent commands that control the Model 4380A-488 are summarized on the following page.

Table 3-1. Device Dependent Commands.

Measurement	FC	Forward Carrier Wave
	FP	Forward Peak Envelope Power
	FD	Forward Decibels
	RC	Reflected Carrier Wave
	RP	Reflected Peak Envelope Power
	RD	Reflected Decibels
	SW	Standing Wave Ratio
	AM	Percent of Modulation
	RL	Return Loss
	MN	Minimum Value
	MX	Maximum Value
	AD	Delta Function
Logger	LGxx HyyM	Take Measurement Every xxH yym
Terminators	YT	Two Terminators (CR) (LF)
	YO	One Terminator (CR)
	YN	No Terminator
Prefixes	PY	Yes, Send Proper Prefix
	PN	No, Do Not Send Prefix
Triggers	T0	Continuous on Talk
	T1	One Shot on Talk
	T2	Continuous on GET
	T3	One Shot on GET
	T4	Continuous on Measurement Command
	T5	One Shot on Measurement Command
Serial Polling	M00	Do Not Generate SRQ
	M01	Generate SRQ on Error (IDDC, IDDCO, Buffer Overflow)
	M02	Generate SRQ on Measurement over Range
	M04	Generate SRQ on Measurement under Range
	M08	Generate SRQ on Operation Complete
Status	U0	Send Back Current Machine State
	U1	Send Back Error Conditions
	U2	Send Back Last Reading
	U3	Send Back Revision Levels
Self-Test	J0	Run Self-Test and Report Results in SRQ
EOI Response	K0	Send EOI with Last Byte
	K1	Do Not Send EOI with Last Byte
Writable Store	WXXXXXX	Receive 6 Bytes for Internal Storage

3-3. PROGRAMMING EXAMPLES

3-4. Throughout the following paragraphs, numerous programming examples show how to send the various commands using a typical IEEE-488 controller: the Hewlett-Packard Model 85 computer. Note that all these examples assume that the instrument's primary address is at its factory setting of 6. If you change the primary address of the instrument, you must modify the various programming examples accordingly.

In order to send a device-dependent command, the controller must perform the following sequence:

a. Set ATN true.

b. Address the Model 4380A-488 to listen. The actual listen command byte is derived by ORing the primary address with Hexadecimal 20.

c. Set ATN false.

d. Send the command string over the bus one byte at a time.

3-5. General HP-85 Programming Example - Device-dependent commands may be sent from the HP-85 with the following statement:

```
OUTPUT 706; A$
```

A$ in this case contains the command letters representing the command string.

3-6. MEASUREMENT FUNCTION

3-7. The measurement function allows you to select the type of measurement to be performed by the 4380 Series Wattmeter mated to the 4380A-488. The measurement function acts just like a key press on the Wattmeter in the manual mode. Consult the 4380 Series Wattmeter manual for detailed function operation.

3-8. It should be noted that based on the function selected a delay of 1 second or 15 second will be initiated on certain function changes (thus, for one shot triggers 15 second delays may be encountered). These delays will allow the analog front end to settle. The following table will show delays which can be encountered:

Table 3-2. Delays.

The functions on the Model 4380 Series Wattmeters fall into two major groups - Group 1 and Group 2. Group 2 has three subgroups.

GROUP 1	**GROUP 2**		
DELTA	Sub1	Sub2	Sub3
MINIMUM			
MAXIMUM	FWD CW	RFL CW	%MODULATION
SWR	FWD PEP	RFL PEP	
RTN LSS	FWD DBM	RFL DBM	

A long delay will be defined as 15 seconds. A short delay will be defined as 1 second.

Changes in command are marked by ——► with it's appropriate delay above it.

Group 2 —Short►— Group 1

SubX —Short►— SubX ; Subgroup to same Subgroup

SubX —Long►— SubY ; Subgroup to different Subgroup

SubX —Short►— Group 1 —Short►— SubX ; Return to same Subgroup after fast command

SubX —Short►— Group 1 —Long►— SubY ; Return to different Subgroup after fast command

3-9. Upon power up or after a DCL or SDC command the 4380A-488 will be in the FC mode (forward carrier wave).

Table 3-3. List of Measurement Functions.

Measurement		
	FC	Forward Carrier Wave
	FP	Forward Peak Envelope Power
	FD	Forward Decibels
	RC	Reflected Carrier Wave
	RP	Reflected Peak Envelope Power
	RD	Reflected Decibels
	SW	Standing Wave Ratio
	AM	Percent of Modulation
	RL	Return Loss
	MN	Minimum Value
	MX	Maximum Value
	AD	Delta Function

3-10. HP Programming Example - Type in the following lines to program the instrument to select the Forward Decibels measurement:

```
REMOTE 706
OUTPUT 706; "FD"
```

When the End Line key is pressed the instrument goes to the Forward Decibels Function.

3-11. **LOGGER FUNCTION (LG)**

3-12. The Logger Function (LG) command allows data to be taken at predetermined intervals by the 4380A-488. The value must be read out before the next interval or the data will be overwritten (only 1 value saved).

3-13. The LG function allows the user to specify the interval in hours and minutes (1 minute is the smallest interval and 19 hours 59 minutes is the maximum interval).

3-14. The format for the LG command is given below:

LGXXHYYM

XX = hours 01-19
YY = minutes 01-59

Note - XX = 00 and YY = 00 have special significance. It turns the logger off (disables it).

3-15. When the LG function is enabled (i.e.; XX and YY different from 00). The Logger LED will blink at a 1/2 second rate to indicate that the Logger function is enabled.

3-16. Upon power up, or after a DCL or SDC command, the 4380A-488 will be in the LG00H00M mode (Logger disabled).

3-17. HP-85 Programming Example - To enable the Logger function type in the following statements:

```
REMOTE 706
OUTPUT 706; "LG00H02M"
```

Note - The Logger function is enabled on 2 minute intervals when the second statement above is executed.

3-18. TERMINATOR (Y)

3-19. The terminator that marks the end of the instrument's data string or status words can be programmed by sending the Y command followed by an appropriate ASCII character. The default terminator sequence in the commonly-used carriage return, line feed (CR) (LF) sequence (ASCII (CR) = DEC 13; ASCII (LF) = DEC 10). The terminator will assume this default value upon power up, or after the instrument receives a DCL or SDC command (default is YT).

YT = Two terminators, append on message output a (CR) and a (LF)
YO = One terminator, append on message output a (CR)
YN = No terminator, append no terminator on the output message. Message can still be terminated by EOI if its enabled.

NOTES:

a. Many controllers use the default terminator sequence to end their input sequences. Modifying the terminator may cause the input sequence to hang unless a different terminating method (such as EOI) is used.

b. The terminator sequence is sent only at the end of the complete transmission sequence regardless of the data format.

3-20. HP-85 Programming Example - Use the following statements to suppress the terminator entirely:

```
REMOTE 706
OUTPUT 706;  "YN"
```

a. The terminator sequence will be suppressed when the second statement above is executed. The absence of a terminator can be verified by requesting data with the following statement:

```
ENTER 706; A$
```

b. Note that the computer ceases to operate because it is waiting for the terminator sequence. Computer operation at this point can be restored by pressing SHIFT RESET.

c. To return the instrument to its default conditions, type in the following:

```
CLEAR 7
```

3-21. **PREFIXES (P)**

3-22. The P command gives control over the format of the data that is transmitted by the 4380A-488 over the IEEE-488 Bus.

The Prefix command has two options shown below:

PY - (Prefix yes) append message with prefix
PN - (Prefix no) append no prefix on the message

3-23. Upon power up, or after a DCL or SDC command, the 4380A-488 will be in the PY mode (append prefix).

The list of prefixes used, which correspond to the measurement function selected are given as:

FC	SW
FP	AM
FD	RL
RC	MN
RP	MX
RD	AD

U = underflow (when underflow indicated given value sent will be .0000)
O = overflow (when overflow indicated value sent will be 9999.)
N = normal on scale reading
BRD = numeric for BIRD Electronic

Data formats for the P mode are given in Table 3-4.

Table 3-4. Data Format (P) Mode Examples.

a. Normal forward carrier wave with Prefixes on:

N	F	C		0	.	1	2	3	(CR)	(LF)

b. Overflowed forward carrier wave with Prefixes on:

O	F	C		9	9	9	9	.	(CR)	(LF)

c. Underflowed forward carrier wave with Prefixes on:

U	F	C		.	0	0	0	0	(CR)	(LF)

d. Overflowed forward carrier wave with no Prefixes:

	9	9	9	9	.	(CR)	(LF)

3-24. OBTAINING DATA

3-25. Before the instrument will transmit its data string, it must be properly addressed to talk by the controller. The basic controller sequence for requesting data is as follows:

a. The controller sets the ATN line true.

b. The Model 4380A-488 is addressed to talk by placing the appropriate talk command byte on the data lines. For the default primary address (6), the correct talk command byte is Hexadecimal 46.

c. The controller places the ATN line false.

d. The controller then begins its input sequence and inputs data bytes in succession until all are taken. Generally, the sequence will cease when the terminator is detected.

3-26. Generally, data is placed into a string or numeric variable as the bytes are received. For example, a typical sequence for the HP-85 computer is:

```
ENTER 706; A$
```

3-27. In this instance the complete reading string is placed in the A$ variable. In cases where numeric input is required, the instrument should be operated in a mode without a prefix. Under these conditions, readings can be placed directly into a numeric variable as in the example below:

```
ENTER 706; A
```

3-28. A is the variable into which the numeric value is placed. If the prefix is not eliminated with the correct P command, an incorrect value may be placed into the numeric variable A.

3-29. HP-85 Programming Example - Use the following program to obtain and display an instrument data string.

PROGRAM		COMMENTS
10	REMOTE 706	Place instrument in remote.
20	OUTPUT 706; "PYFC"	Select prefix format, forward carrier measurement.
30	ENTER 706; A$	Get reading from instrument.
40	DISP A$	Display the reading.
50	END	

3-30. In this program, the instrument is first placed in remote (line 10), and an operating mode is then programmed. The instrument is placed in the PY format, (line 20), and data is then requested (line 30) and displayed (line 40). Note that data with prefix, is displayed because the instrument is in the PY mode.

3-31. **TRIGGER MODE (T)**

3-32. The trigger mode command programs the type of trigger stimulus to be used to initiate a measurement. Triggering may be done in two basic ways: single or continuous. In a single trigger mode, a trigger stimulus initiates a single measurement sequence, while in a continuous mode, the instrument will continuously repeat the measurement sequence once triggered (much like a Digital Multimeter in bench mode). At its own internal trigger rate (approximately 1 rdg/sec). A number of different methods can be used to trigger the instrument, as summarized below:

Triggers	T0	Continuous on Talk
	T1	One Shot on Talk
	T2	Continuous on Get
	T3	One Shot on Get
	T4	Continuous on Measurement command
	T5	One Shot on Measurement command

3-33. Upon power up, or after a DCL or SDC command, the instrument will be in the T1, one shot measurement function mode.

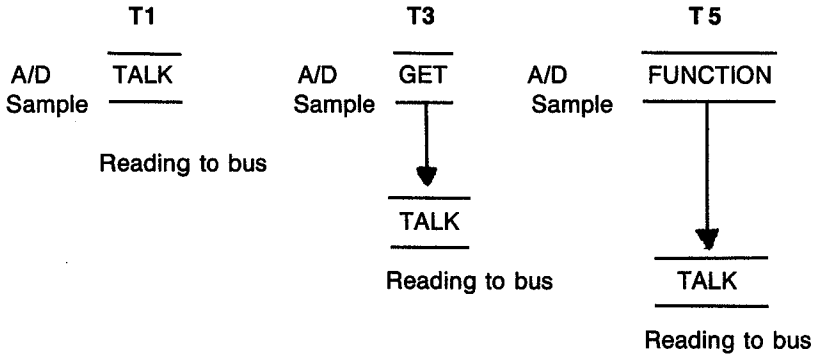
3-34. The trigger modes are paired according to the type of trigger stimulus as follows:

3-35. Talk (T0 and T1): The measurement will be triggered when it is addressed to talk over the bus.

3-36. GET (T2 and T3): The IEEE-488 multiline GET command provides the trigger in these two modes.

3-37. Measurement Function (T4 and T5): The measurement function triggers the instrument.

3-38. Description of Triggers - One shot triggers will be used most of the time. The three types can be viewed in time as follows:



3-39. Talk (T1) holds the bus while waiting for a reading - could be 1 to 15 seconds. If you want better bus throughput use T3 or T5 which would allow you to SRQ on measurement complete and then take the reading. Function trigger (T5) needs a function given in the programming string (i.e., "FC"). If in T5 (or T4) and no function is given the 4380A-488 will wait until you supply one. If you do not supply one and ask for a reading over the bus you will hold the bus.

3-40. Continuous triggers can be used to speed up certain bus tranfers (15 seconds - 1 second) since the internal readings are being computed at the internal rate. This will be noticeable in column function changes (i.e., "FC" - "RC") if you change the function and then do some other bus action.

3-41. Additional Triggering Notes - Fastest reading rate is 1 rdg/sec, slowest is 1 rdg every 15 seconds (function column changes).

T0 1. If was in continuous and you program continuous again 4380A-488 will give next valid reading to the bus. (It's waiting for next continuous conversion from the previous continuous mode.)

2. If was in one-shot and you program continuous the 4380A-488 will initiate a reading and make it available to the bus and perform continuous reading.

3. In either case measurement complete will not be given to the bus. In these trigger modes the bus is waiting for the 4380A-488, and the instant a measurement is complete, the bus gets it.

T1 1. Initiate a reading and make it available to the bus and wait for next trigger.

2. Measurement complete will not be given to the bus.

T2,T4 1. Same as T0 above except measurement complete will be given to the bus.

T3,T5 1. Same as T1 above except measurement complete will be given to the bus.

3-42. HP-85 Programming Example - Place the instrument in the single, talk trigger mode with the following statements:

```
REMOTE 706
OUTPUT 706; "T1"
```

The instrument can now be triggered by addressing it to talk with the following statement:

```
SEND 7; TALK 6
```

When the above statement is executed, the instrument will perform a single measurement sequence.

3-43. **STATUS (U)**

3-44. The status command allows access to information concerning instrument operating modes that are controlled by other device-dependent commands such as T (trigger). Additional options of the status command allow access of unit data and error conditions.

3-45. The status command has four options, as summarized below. These command options are discussed in the following paragraphs.

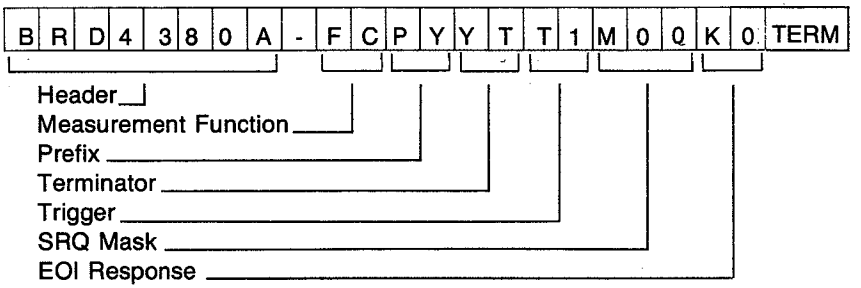
Status	U0	Send back current machine state
	U1	Send back error conditions
	U2	Send back last reading
	U3	Send back revision levels

3-46. **MACHINE STATUS (U0)**

3.47 When the command sequence U0 is transmitted to the Model 4380-A-488, the instrument will send its machine status word the next time it is addressed to talk instead of its normal data string. The status word will be transmitted only once each time the U0 command is given. To make sure that correct status is transmitted, this status word should be requested as soon as possible after the command is sent.

3-48. The format of the U0 machine status word is shown in Table 3-5. The default values in the status word (upon power up or after a DCL or SDC command) are also shown in the table.

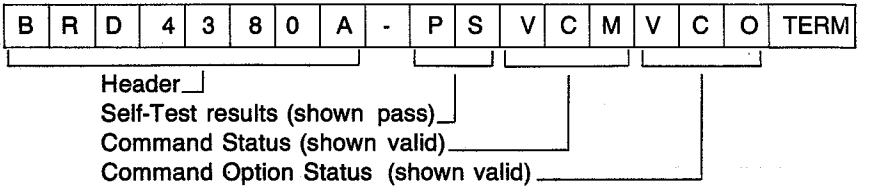
Table 3-5. Machine Status Word.



3-49. **ERROR STATUS (U1)**

3-50. The U1 command allows access to Model 4380A-488 error conditions in a similar manner. Once the sequence U1 is sent, the instrument will transmit the error conditions with the format shown in Table 3-6 the next time it is addressed to talk in the normal manner. The error condition word will be transmitted only once each time the U1 command is given. Note that the error word is actually a string of ASCII characters.

Table 3-6. Error Status Word.



3-51. An error condition is also flagged in the status (serial poll) byte, and the Model 4380A-488 can be programmed to generate an SRQ when one of these errors occurs. These aspects of Model 4380A-488 operation are covered in paragraph 3-60.

3-52. The various characters in the error condition word are described as follows:

PS - (Self-test pass) occurs when a self-test has been commanded via the "J" command and the test was okay.

FL - (Self-test fail) occurs when a self-test has been commanded via the "J" command and the test has failed.

ICM - (Invalid command) occurs when an illegal device-dependent command (IDDC) such as V2 is received (V is illegal).

VCM - (Valid command) occurs when no illegal device-dependent command is received.

ICO - (Invalid command option) occurs when an illegal device-dependent command option (IDDCO) such as T6 is received (6 is illegal).

VCO - (Valid command option) occurs when no illegal device-dependent command option has been received.

All messages above will revert to their non-error conditions after the reading of the U1 work.

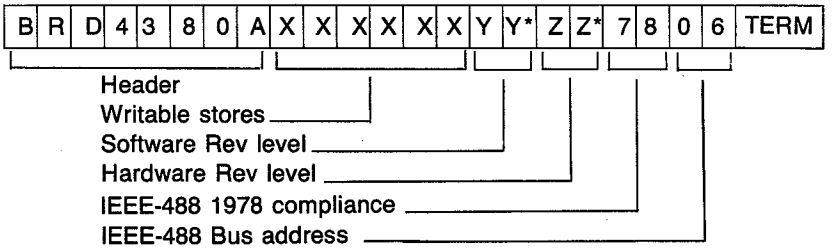
3-53. **LAST READING (U2)**

3-54. In a similar manner the U2 command allows access to the previous message (or reading) sent back on the bus. Note that if the previous message was the result of a "U" (status) request; it will be repeated. The format for the U2 command depends on what the last bus message (or reading) happened to be.

3-55. **REVISION HISTORY (U3)**

3-56. In a similar manner the U3 command allows access to the writable store, software revision level, Hardware revision level, IEEE-488 address, and 488 compliance level. The format for the U3 command is shown in Table 3-7 below:

Table 3-7. Revision History.



* YY is replaced with current software revision level. ZZ is replaced with current hardware revision level.

3-57. HP-85 Programming Example - Enter and run the program below to obtain and display all 4 status words.

PROGRAM		COMMENTS
10	DIM A$[50]	Dimension string.
20	REMOTE 706	Place unit in remote.
30	FOR I = 0 TO 3	Loop 4 times.
40	OUTPUT 706; "U"&VAL$(I)	Program to obtain status word.
50	ENTER 706;A$	Get status from instrument.
60	DISP A$	Display status.
70	NEXT I	Go back and get next status word.
80	END	

3-58. In the example program, the instrument is placed in remote (line 20), and a loop is set up to request all 4 status words (line 30). The status word command is then sent to the instrument (line 40), and status is then requested and displayed (lines 50 and 60).

3-59. **SRQ MODE (M) AND STATUS BYTE FORMAT**

3-60. The SRQ command controls which of a number of conditions within the Model 4380A-488 will cause the instrument to assert SRQ (Service Request). Once an SRQ has been generated, the status byte can be checked to determine if the Model 4380A-488 was the instrument that asserted SRQ, and, if so, what conditions caused it to do so. Note that error conditions can be checked by using the U1 status command, as discussed in paragraph 3-50.

3-61. The Model 4380A-488 can be programmed to generate an SRQ under any of the following conditions:

a. If an overflowed reading has occurred.

b. If an underflowed reading has occurred.

c. When a measurement is completed.

d. If an error has occurred. The nature of the error can be determined with the U1 command, as described in paragraph 3-50. Possible errors include: an illegal device-dependent command or command option received or the instrument failed the self-test.

Upon power up, or after a DCL or SDC command, SRQ is disabled.

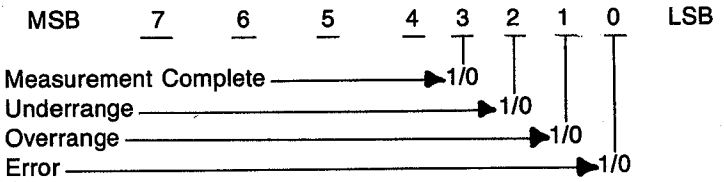
3-62. **SRQ MASK**

3-63. The Model 4380A-488 uses an internal mask to determine when to assert SRQ. Table 3-8. shows the general format of the SRQ mask, which is made up of eight bits. The SRQ mask has the same general format as the status byte (discussed below) except for bit 6 which is not used in the SRQ mask. A 0 indicates not to SRQ and a 1 indicates to generate the SRQ.

3-64. SRQ can be programmed by sending the ASCII letter "M" following by two ASCII numbers to set the appropriate bit or bits in the mask. SRQ commands are summarized below. Note that you can program the unit for more than one set of conditions simultaneously. For example, the command sequence M12 would be sent to program SRQ under both measurement complete and underflow (M08 and M04).

Serial Polling	M00	Do not generate SRQ.
	M01	Generate SRQ on error (IDDC, IDDCO, Self-test fail).
	M02	Generate SRQ on measurement over range.
	M04	Generate SRQ on measurement under range.
	M08	Generate SRQ on operation complete.

Table 3-8. SRQ Mask.



3-65. STATUS BYTE FORMAT

3-66. The status byte contains information relating to data and error conditions within the instrument. The status byte is obtained from the instrument by using the following serial polling sequence.

a. The controller places the ATN line true.
b. The SPE (Serial Poll Enable) command byte is then placed on the bus by the controller.
c. The Model 4380A-488 is then addressed to talk.
d. The controller sets ATN false.
e. The Model 4380A-488 places the status byte on the data lines to be read by the controller.
f. The controller sets ATN true.
g. The SPD (Serial Poll Disable) command byte is then placed on the bus by the controller to end the serial polling sequence.

3-67. The general format of the status byte is shown in Table 3-8. Note that bits correspond to the bits in the SRQ mask, as described above. These bits flag the following conditions:

SRQ (bit 6) - This bit will be set if the service request was generated by the Model 4380A-488. If bit 6 is cleared, other instruments on the bus should be checked to determine where the SRQ occurred.

Measurement Complete (bit 3) - Set when the instrument has completed a reading. Cleared by requesting a reading over the bus.

Reading Underflow (bit 2) - Set when an underrange input is applied to the instrument. Cleared by requesting a reading over the bus.

Reading Overflow (bit 1) - Set when an overrange input is applied to the instrument. Cleared by requesting a reading over the bus.

Error (bit 0) - This bit will be set if one of the following errors has occurred:

a. An illegal device-dependent command (IDDC) or illegal device-dependent command option (IDDCO) was received.
b. The unit failed the self-test.

3-68. The exact nature of the error can be determined by using the U1 status command, as described in paragraph 3-50. The reading of the U1 status clears the error bit.

NOTES:

a. The status byte should be read once the instrument has generated an SRQ in order to clear the SRQ line.

b. All bits in the status byte will be latched when an SRQ is generated.

c. The status byte can be read to determine current instrument conditions even if SRQ is disabled. In this case, bits 0 through 3 will be updated to reflect current conditions.

d. If an error occurs, it will remain latched until the U1 status word (paragraph 3-50) is requested.

3-69. HP-85 Programming Example - Enter and run the program below to demonstrate SRQ and status byte programming.

```
PROGRAM                                    COMMENTS

10    DIM A$ [50]                          Dimension string.
20    REMOTE 706                           Place instrument in remote.
30    OUTPUT 706; "M01"                    Program for SRQ on error.
40    OUTPUT 706; "Q9"                     Attempt to program illegal option.
50    STATUS 7,2;S                         Get bus status
60    IF NOT BIT (S,5) THEN 50             If no SRQ, go back and wait.
70    S-SPOLL(706)                         Serial poll the 4380.
80    DISP"B7 B6 B5 B4 B2 B1 B0"           Identify the bits.
90    FOR I = 7 TO 0 STEP -1               Loop eight times.
100   DISP BIT(S,I);                       Display the status byte bits.
110   NEXT I
120   DISP
130   OUTPUT 706; "U1"                     Program for U1 status.
140   ENTER 706;A$                         Get U1 status to clear error.
150   DISP A$                              Display U1 status.
160   END
```

3-70. In this example program, the computer first places the instrument in remote (line 20), and then programs the instrument to generate an SRQ on error. The statement at line 40 then attempts to program an illegal command option. The program then waits for an SRQ to occur on the bus (lines 50 and 60), and then serial polls the instrument (line 70) and displays the status byte bits (lines 80-110). The error (U1) status word is then requested and displayed in order to clear the error bit in the status byte (lines 130-140).

3-71. **SELF TEST (J)**

3-72. The self test command, allows you to test much of the internal circuitry of the Model 4380A-488.

3-73. The self test is run by sending the following command over the bus: J0

3-74. The instrument will then run the test and set the self test bytes in the U1 status word. A complete description of the U1 (error) status word may be found in paragraph 3-50. J0 must be given each time you wish to have the self test run. Note: the default condition in the status is "FL". You must send J0 to get "PS".

3-75. Refer to Section IV for troubleshooting procedures if the self test should indicate a failure. Upon power up or after a DCL or SDC command the 4380A-488 will be in the J0 mode (no self test).

3-76. HP-85 Programming Example - Use the program below to run the self test and obtain and display the U1 status word.

PROGRAM		COMMENTS
10	REMOTE 706	Place 4380A-488 in remote.
20	OUTPUT 706; "J0"	Start self test.
30	WAIT 10000	Wait 10 seconds.
40	OUTPUT 706;"U1"	Program for error status.
50	ENTER 706; A$	Get error status.
60	DISP A$	Display error status.
70	END	

In this program, the instrument is placed in remote (line 10) and then programmed to perform the self test (line 20). The program waits 10 seconds for the instrument to perform the self test (line 30), and then obtains and displays the error status word (lines 40-70). PS will indicate PASS and FL will indicate failure in the U1 status word.

3-77. **EOI MODES (K)**

3-78. The K command allows control over whether or not the instrument sends the EOI command at the end of its data string. K command options are summarized below:

EOI Response	K0	Send EOI with last byte.
	K1	Do not send EOI with last byte

Upon power up, or after a DCL or SDC command, the K0 mode will be enabled.

3-79. **EOI (END OR IDENTIFY)**

3-80. The EOI line on the IEEE-488 Bus provide some method to positively identify the last byte in a multi-byte transfer sequence. Thus, EOI can be used to determine when the Model 4380A-488 is transmitting the last byte in its reading string.

3-81. Keep in mind that some controllers rely on EOI to mark the end of their input sequences. Thus, suppressing EOI may cause the controller input sequence to hang unless another termination method is used.

3-82. HP-85 Programming Example - Enter the following statements to program the instrument for the K1 mode:

```
REMOTE 706
OUTPUT 706, "K1"
```

3-83. **WRITABLE STORE (W)**

3-84. The W command gives control of six (6) bytes on RAM memory on the 4380A-488. The six bytes could represent the configuration of Bird equipment the 4380A-488 is controlling or the six bytes could be used to store any 6 bytes of ASCII the system designer desires.

3-85. The six (6) bytes are sent back in the U3 status response. The format to send the command is as follows:

WXXXXXX where XXXXXX are the six bytes

Note - The 6 bytes are taken no matter what they are - no error checking is done for 6 bytes.

3-86. Upon power up, the six bytes will contain ASCII nulls (Hexadecimal 00).

3-87. HP-85 Programming Example - Enter the following statements to program the instrument for a W response.

PROGRAM		COMMENTS
10	REMOTE 706	
20	OUTPUT 706, "W4391 U3"	Send 4391 bytes and U3.
30	ENTER 706, A$	Get U3 status.
40	DISP A$	Display U3 status on CRT.
50	END	

In this program the instrument receives its 6 bytes and U3 response request (in line 20) and gives that request to the controller (line 30). For the example above the response would be.

BRD4380A-4391 YYZZ* 78 06

*YY is replaced with the current software revision level. ZZ is replaced with the current hardware revision level.

3-88. **TALKER ONLY**

3-89. With the TO switch selected on the front panel cycle the power on the 4380A-488. This places the unit into the Talker Only Mode, and the TLK LED will be on continuously. The power up default conditions are in effect for all other parameters.

3-90. The operator is now able to press any key on the wattmeter (with exception of the DELTA key) and generate a measurement to be written to the bus. Upon completion of the measurement the 4380A-488 will output the information to the bus and a listen only device, such as a printer, will read the value. The Log LED will go on momentarily indicating the 4380A-488 is ready and another key can be depressed.

SECTION IV - MAINTENANCE

4-1. GENERAL

4-2. The Model 4380A-488 requires no internal adjustments or periodic calibration. The connectors should be cleaned frequently with alcohol to insure good contact.

4-3. TROUBLESHOOTING

4-4. Due to its complexity, repair of the 4380A-488 in the field is recommended only for certain malfunctions. The following is a list of these malfunctions and corrective action.

PROBLEM	POSSIBLE CAUSE	REMEDY
Power supply or no power indicator	Blown fuse	Replace fuse.
	115/230 switch	Check for correct setting.
	AC power cord	Check for shorted cord.
	Broken LED	Replace LED (DS2).
No device response	GPIB cable	Clean contacts and check for good connection
	Dip switch	Verify proper address and function selection Replace dip switch if broken.
	Command format	Verify 488 interface command(s) sent in right order.
	Inoperative Device	Contact factory.
Incorrect Measurement	Interface cable	Clean contacts and check for good connection. Replace cable if suspect Verify operation of wattmeter.

For problems more complex than those listed, it may be necessary to return the unit to Bird for analysis and repair. A call or telegram to the Bird Customer Service Department will help determine the best solution for the problem.

CAUTION

The 4380A-488 contains MOS integrated circuits which may be damaged by static electricity. Open the housing only when sure that there are no static producing materials such as carpeting or styrofoam where the work is to be done. Work on a conductive, grounded work surface touching it frequently to discharge static from your body. If a part is to be stored or shipped, wrap it in conductive packaging materials designed for static sensitive circuitry.

WARNING

The potential of electrical shock exists. Unplug device when removing cover to avert accidental shock.

4-5. DISASSEMBLY

4-6. To remove top cover, remove the 10 button head machine screws. Disassemble beyond this point is not recommended since complete disassembly is required to remove PC board.

SECTION V - REPLACEMENT PARTS LIST

5-1. **MODEL 4380A-488**

ITEM	QUANTITY	DESCRIPTION	PART NUMBER
1	1	Assembly, P.C. Board	4380-006
2	1	Assembly, Wiring, A.C.	4380-004
3	1	Switch, Power	5-1301
4	1	Switch, Dip	5-1264-2
5	1	Fuse	5-721-14
6	2	Stand-off, Stud Mount	5-1639
7	2	Stand-off, Stud Mount	5-1312
8	1	Cable Assembly	5-1624
9	1	Cable Assembly I/O	5-1626
10	1	Cable IEEE 488 Bus (2M)	5-1317-2
11		Cable IEEE 488 Bus (1M)	5-1317-1
12	1	Cord, Power	5-1286
13		Cord, Power	5-1287

SECTION VI - 488 BUS PRIMER

6-1. GENERAL

6-2. The IEEE-488 Bus is a communication channel used primarily for automated test applications. The bus provides a communication link for all types of hardware devices that are equipped with the 488 interface capability. Under the direction of a 488 controller, devices can be commanded to provide their functional capabilities and responses.

6-3. A controller may be in the form of a complete computer with the 488 capability being one of the numerous functions. It may also be a stand alone device with functions structured only for the bus.

6-4. A controller will establish and maintain communications by using a set of unique messages which are sent over the bus at different times.

6-5. The bus is designed to operate primarily in laboratory and production test environments under the following constraints:

a. Data communication along the bus is digital.

b. No more than 15 devices are connected on the bus.

c. Total length of the bus must not exceed 20 meters or 2 times the number of devices, whichever is less.

d. The data rate on the bus must not exceed 1 mega byte/sec.

e. The environment should be electrically quiet as possible.

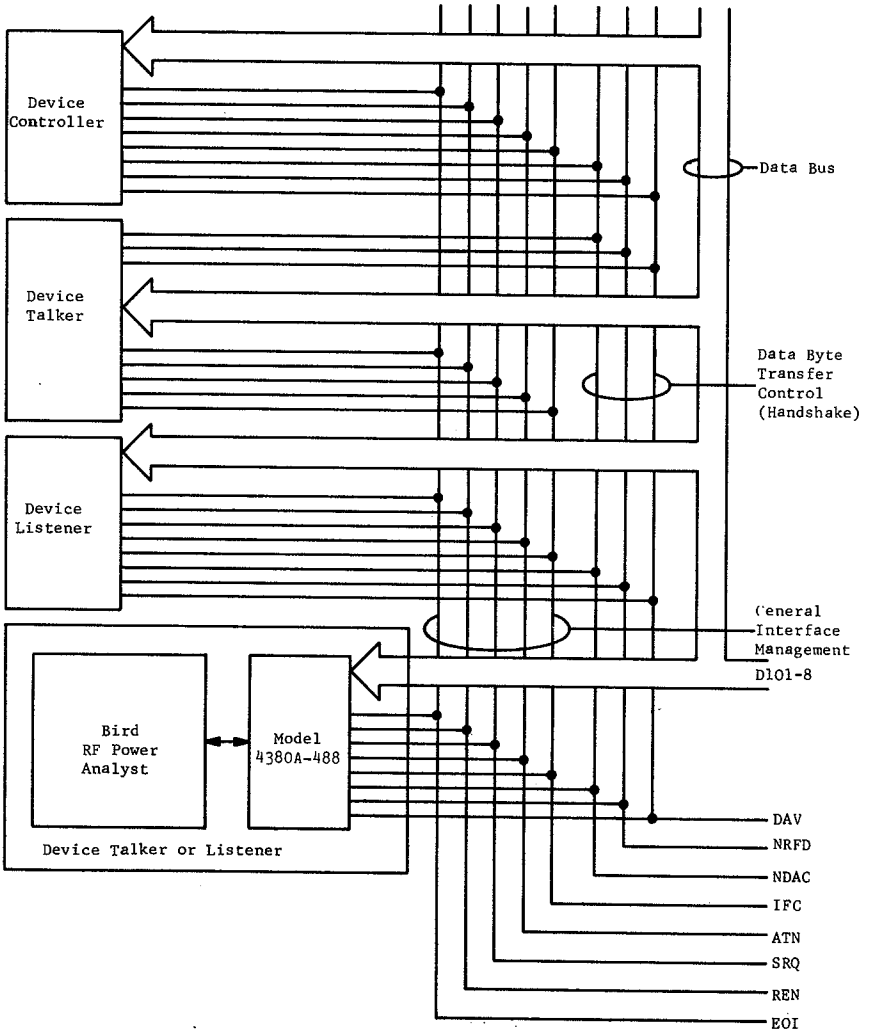
6-6. BUS LINES

6-7. The signal lines on the IEEE-488 Bus (Figure 6-1) are grouped into three categories: data lines (8), management lines (5), and handshake lines (3). The eight data lines handle bus data and many commands, while the management and handshake lines ensure orderly bus operation. Each bus line is active low with approximately zero volts representing logic 1 (true). The following paragraphs briefly describe the operation of these lines.

6-8. DATA LINES

6-9. The bus uses eight data lines to transmit and receive data in bit-parallel, byte serial fashion. These lines use the convention DI01-DI08 instead of the more common D0-D7. DI01 is the least significant bit, while DI08 is the most significant bit. The data lines are bidirectional (with most devices), and, as with the remaining bus lines, low is considered to be true.

Figure 6-1. IEEE-488 Signal Lines.



6-10. BUS MANAGEMENT LINES

6-11. The five bus management lines ensure proper interface control and management. These lines are used to send uniline commands.

ATN (Attention) - The state of ATN determines how information on the data lines is to be interpreted.

IFC (Interface Clear) - IFC allows the clearing of active talkers or listeners from the bus.

REN (Remote Enable) - REN is used to place devices in the remote mode. Usually, devices must be in remote before they can be programmed over the bus.

EOI (End Or Identify) - EOI is used to mark the end of a multi-byte data transfer sequence.

SRQ (Service Request) - SRQ is used by devices to request service from the controller.

6-12. HANDSHAKE LINES

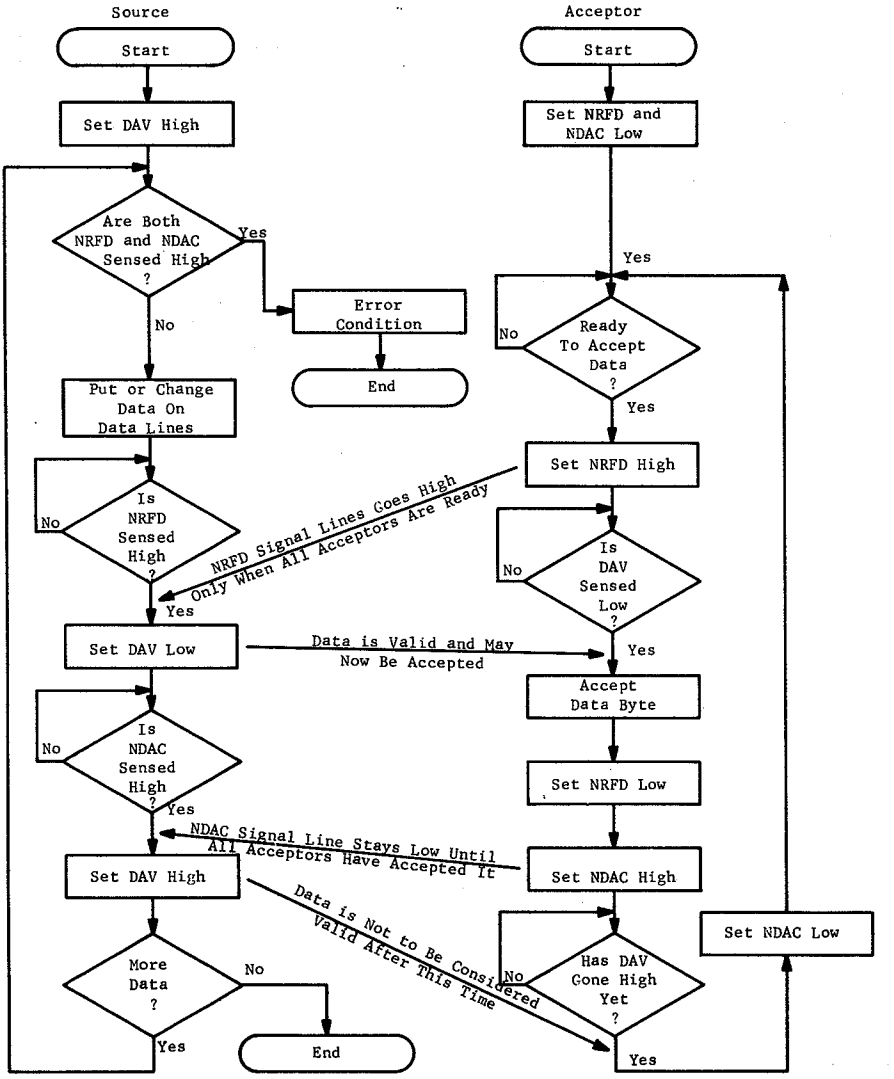
6-13. Three handshake lines that operate in an interlocked sequence are used to ensure reliable data transmission regardless of the transfer rate. Generally, data transfer will occur at a rate determined by the slowest active device on the bus. Figure 6-2 shows how the basic handshake process that takes place on the bus and provides for asynchronous transfer of data between devices with slower input or output speeds. The transfer of data on the bus occurs at the rate the slowest device can handle it.

DAV (Data Valid) - The source (talker) controls the state of DAV to indicate to any listeners when data is valid.

NRFD (Not Ready For Data) - The acceptor (listener) controls the state of NRFD. It is used to signal the transmitting device to hold off the byte transfer sequence until the accepting device is ready.

NDAC (Not Data Accepted) - NDAC is also controlled by the accepting device. The state of NDAC tells the source whether or not the device has accepted the data byte.

Figure 6-2. Basic Handshake Process.



6-14. BUS COMMANDS

6-15. Commands associated with the IEEE-488 Bus can be grouped into the following three general categories.

a. Uniline Commands - These commands are asserted by setting the associated bus line true. For example, to assert REN (Remote Enable), the REN line would be set low (true).

b. Multiline Commands - General bus commands which are sent over the data lines with the ATN line true.

c. Device-Dependent Commands - Commands whose meanings depend on the device in question. These commands are transmitted via the data lines while ATN is false.

These bus commands are summarized in Table 6-1 below:

Table 6-1. IEEE-488 Bus Command Summary.

Command Type	Command	State of ATN Line*	Comments
Uniline	REN (Remote Enable)	X	Sets up devices for remote operation.
	EOI	X	Marks end of transmission.
	IFC (Interface Clear)	X	Clears interface.
	ATN (Attention)	Low	Defines data bus contents.
	SRQ	X	Controlled by external device.
Multiline			
Universal	LLO (Local Lockout)	Low	Locks out local operation.
	DCL (Device Clear)	Low	Returns device to default conditions.
	SPE (Serial Enable)	Low	Enables serial polling.
	SPD (Serial Poll Disable)	Low	Disables serial polling.
Addressed	SDC (Selective Device Clear)	Low	Returns unit to default conditions.
	GTL (Go To Local)	Low	Returns device to Local.
	GET (Group Execute Trigger)	Low	Triggers device for reading.
Unaddressed	UNL (Unlisten)	Low	Removes all listener from bus

UNT (Untalk)	Low	Removes any talkers from bus.
Device-dependent	High	Programs Model 194 for various modes.

6-16. UNILINE COMMANDS

6-17. The five uniline commands include REN, EOI, IFC, ATN, and SRQ. Each command is associated with a dedicated bus line, which is set low to assert the command in question.

REN (Remote Enable) - REN is asserted by the controller to set up instruments on the bus for remote operation. When REN is true, devices will be removed from the local mode. Depending on device configuration, all front panel controls except the LOCAL button (if the device is so equipped) may be locked out when REN is true. Generally, REN should be asserted before attempting to program instruments over the bus.

EOI (End or Identify) - EOI may be asserted either by the controller or by external devices to identify the last byte in a multi-byte transfer se- quence, allowing data words of various lengths to be transmitted.

IFC (Interface Clear) - IFC is asserted by the controller to clear the interface and return all devices to the talker and listener idle states.

ATN (Attention) - The controller asserts ATN while sending addressed or multiline commands.

SRQ (Service Request) - SRQ is asserted by a device on the bus when it requires service from the controller.

6-18. UNIVERSAL MULTILINE COMMANDS

6-19. Universal multiline commands are those commands that required no addressing as part of the command sequence. All devices equipped to implement these commands will do so simultaneously when the commands are transmitted. As with all multiline commands, these commands are transmitted with ATN true.

LLO (Local Lockout) - LLO is sent to instruments to lock out front panel or local operation of the instrument.

DCL (Device Clear) - DCL is used to return instruments to some default state. Usually, devices return to their power-up conditions.

SPE (Serial Poll Enable) - SPE is the first step in the serial polling sequence, which is used to determine which device on the bus is requesting service.

SPD (Serial Poll Disable) - SPD is used by the controller to remove all devices on the bus from the serial poll mode and is generally the last command in the serial polling sequence.

6-20. ADDRESSED MULTILINE COMMANDS

6-21. Addressed multiline commands are those commands that must be preceded by an appropriate listen address before the instrument will respond to the command in question. Note that only the addressed device will respond to the command. Both the command and the address preceding it are sent with ATN true.

SDC (Selective Device Clear) - The SDC command performs essentially the same function as DCL except that only the addressed device responds. Generally, instruments return to their power-up default conditions when responding to SDC.

GTL (Go To Local) - GTL is used to remove instruments from the remote mode and place them in local. With many instruments, GTL may also restore operation of front panel controls if previously locked out.

GET (Group Execute Trigger) - GET is used to trigger devices to perform a specific action that will depend on device configuration (for example, perform a measurement sequence). Although GET is an addressed command, many devices may respond to GET without addressing.

6-22. ADDRESS COMMANDS

6-23. Addressed commands include two primary command groups, and a secondary address group. ATN is true when these commands are asserted. These commands include:

LAG (Listen Address Group) - These listen commands are derived from an instrument's primary address and are used to address devices to listen. The actual command byte is obtained by ORing and primary address with hexadecimal 20.

TAG (Talk Address Group) - The talk commands are derived from the primary address by ORing the address with hexadecimal 40. Talk commands are used to address devices to talk.

SCG (Secondary Command Group) - Commands in this group provide additional addressing capabilities.

6-24. UNADDRESS COMMANDS

6-25. The two unaddress commands are used by the controller to remove any talkers or listeners from the bus. ATN is true when these commands are asserted.

UNL (Unlisten) - Listeners are placed in the listener idle state by UNL.

UNT (Untalk) - Any previously commanded talkers will be placed in the talker idle state by UNT.

6-26. DEVICE-DEPENDENT COMMANDS

6-27. The purpose of device-dependent commands will depend on instrument configuration. Generally, these commands are sent as one or more ASCII characters that command the device to perform a specific action.

6-28. The IEEE-488 Bus treats these commands as data in that ATN is false when commands are transmitted.

6-29. COMMAND CODES

6-30. Command codes for the various commands that use the data lines are summarized below:

Table 6-2. Hexadecimal and Decimal Command Codes.

Command	Hex Value	Decimal Value
GTL	01	1
SDC	04	4
GET	08	8
LLO	11	17
DCL	14	20
SPE	18	24
SPD	19	25
LAG	20-3F	32-63
TAG	40-5F	64-95
SGG	60-7F	96-127
UNL	3F	63
UNT	5F	95

6-31. IEEE COMMAND GROUPS

6-32. Command groups supported by the Model 4380A-488 are listed in device-dependent command are not included in this list.

Table 6-3. IEEE Command Group.

HANDSHAKE COMMAND GROUP
- DAC = DATA ACCEPTED
- RFD = READY FOR DATA
- DAV = DATA VALID

UNIVERSAL
- ATN = ATTENTION
- DCL = DEVICE CLEAR
- IFC = INTERFACE CLEAR
- REN = REMOTE ENABLE
- SPD = SERIAL POLL DISABLE
- SPE = SERIAL POLL ENABLE

ADDRESS COMMAND GROUP
LISTEN: LAG = LISTEN ADDRESS GROUP
MLA = MY LISTEN ADDRESS
UNL = UNLISTEN
TALK: TAG = TALK ADDRESS GROUP
MTA = MT TALK ADDRESS
UNT = UNTALK
OTA = OTHER TALK ADDRESS
ADDRESSED COMMAND GROUP
ACG = ADDRESSED COMMAND GROUP
GET = GROUP EXECUTE TRIGGER
GTL = GO TO LOCAL
SDC = SELECTIVE CLEAR
STATUS COMMAND GROUP
RQS = REQUEST SERVICE
SRQ = SERIAL POLL REQUEST
STB = STATUS BYTE
EOI = END

6-33. COMPLETE IEEE-488 CODES

6-34. Table 6-4 gives the total IEEE-488 Bus definition. This chart is taken from the IEEE-488 1978 standard.

6-35. NOTES ON TABLE 6-4

The logical state a bus signal line may have is specified in the table as a 0, 1, Y, or X. These represent the logic states as follows:

0 - logical zero
1 - logical one
X - don't care (for the coding of a received message)
X - must not drive unless directed by another message (for the coding of a transmitted message)
Y - don't care (for the coding of a transmitted message)

Signal Level Assignment:
0 - High state signal level
1 - Low state signal level

Symbols:
Type U - Uniline message
M - Multiline message
Class AC - Addressed command
AD - Address (talk or listen)
DD - Device dependent
HS - Handshake
UC - Universal command
ST - Status

Table 6-4. Complete IEEE-488 Codes.

Mnemonic	Message Name	Type	C1 s	D IO 8	7	6	5	4	3	2	1	D IO VDC	NN DRD AFA	A T N	E O I	S R Q	I F C	E N
ACG	addressed command group	M	AC	Y	0	0	0	X	X	X	X	X	XXX	1	X	X	X	X
ATN	attention	U	AC	X	X	X	X	X	X	X	X	X	XXX	1	X	X	X	X
DAB	data byte (Notes 1, 6)	M	DD	D	D	D	D	D	D	D	D	D	XXX	0	X	X	X	X
DAC	data accepted	U	HS	X	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	X	1XX	X	X	X	X	X
DCL	device clear	M	UC	Y	0	0	1	0	1	0	0	0	XXX	1	X	X	X	X
END	end	U	ST	X	X	X	X	X	X	X	X	X	XXX	0	1	X	X	X
EOS	end of string (Notes 2, 6)	M	DD	E	E	E	E	E	E	E	E	E	XXX	0	X	X	X	X
				8	7	6	5	4	3	2	1							
GTL	go to local	M	AC	Y	0	0	0	0	0	0	1	X	XXX	1	X	X	X	X
IDY	identify	u	UC	X	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	X	XXX	X	X	X	1	X
LAG	listen address group	M	AD	Y	0	L	X	X	X	X	X	X	XXX	1	X	X	X	X
MLA	my listen address (Note 3)	M	AD	Y	0	1	L	L	L	L	L	L	XXX	1	X	X	X	X
							5	4	3	2	1							
MTA	my talk address (Note 4)	M	AD	Y	1	0	T	T	T	T	T	T	XXX	1	X	X	X	X
							5	4	3	2	1							
PPR1	parallel poll response 1)	U	ST	X	X	X	X	X	X	X	1	X	XXX	1	1	X	X	X
PPR2	parallel poll response 2)	U	ST	X	X	X	X	X	X	1	X	X	XXX	1	1	X	X	X
PPR3	parallel poll response 3)	U	ST	X	X	X	X	X	1	X	X	X	XXX	1	1	X	X	X
PPR4	parallel poll response 4) (Nt.7)	U	ST	X	X	X	X	1	X	X	X	X	XXX	1	1	X	X	X
PPR5	parallel poll response 5)	U	ST	X	X	X	1	X	X	X	X	X	XXX	1	1	X	X	X
PPR6	parallel poll response 6)	U	ST	X	X	1	X	X	X	X	X	X	XXX	1	1	X	X	X
PPR7	parallel poll response 7)	U	ST	X	L	X	X	X	X	X	X	X	XXX	1	1	X	X	X
PPR8	parallel poll response 8)	U	ST	1	X	X	X	X	X	X	X	X	XXX	1	1	X	X	X
PPU	parallel poll unconfigure	M	UC	Y	0	0	1	0	1	0	1	X	XXX	1	X	X	X	X
REN	remote enable	U	UC	X	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	X	XOX	X	X	X	X	X
RQS	request service (Note 6)	U	ST	X	1	X	X	X	X	X	X	X	XXX	0	X	X	X	X
SDC	selected device clear	M	AC	Y	0	0	0	0	1	0	0	0	XXX	1	X	X	X	X
SPD	serial poll disable	M	UC	Y	0	0	1	1	0	0	1	X	XXX	1	X	X	X	X
SPE	serial poll enable	M	UC	Y	0	0	1	1	0	0	0	X	XXX	1	X	X	X	X
SRQ	service request	U	ST	X	X	X	X	X	X	X	X	X	XXX	X	X	1	X	X
STB	status byte (Notes 5, 6)	M	ST	S	X	S	S	S	S	S	S	S	XXX	0	X	X	X	X
TAG	talk address group	M	AD	Y	1	0	X	X	X	X	X	X	XXX	1	X	X	X	X
UCG	universal command group	M	UC	Y	0	0	1	X	X	X	X	X	XXX	1	X	X	X	X
UNL	unlisten	M	AD	Y	0	1	1	1	1	1	1	X	XXX	1	X	X	X	X
UNT	untalk	M	AD	Y	1	0	1	1	1	1	1	X	XXX	1	X	X	X	X

Notes:

a. D1-D8 specify the 4380A-488 dependent data bits, e.g.; FC, RC, FD etc.

b. E1-E8 specify the 4380A-488 code used to indicate the EOS message, e.g.; carriage return, line feed, EOI.

c. L1-L5 specify the 4380A-488 dependent bits of its listen address.

d. T1-T5 specify the 4380A-488 dependent bits of its talk address.

e. S1-S6, S8 specify the 4380A-488 dependent status. DI07 is used for the RQS message. (S) is used for the devices address identifier.

f. The source of the message on the ATN line is always the controller function, whereas the messages on the DIO and EOI lines are enabled by the talker function.

g. The source of the messages on the ATN and EOI lines is always the controller function, whereas the source of the messages on the DIO lines is always the parallel poll function.

6-36. DEFINITIONS FOR TABLE 6-4

6.37. The following definitions describe the messages in Table 6-4 in relation to the 4380A-488. A complete definition listing can be found in the 488-1978 IEEE Standard.

ATTENTION - Directs the 4380A-488 to interpret the information in the form of an address or data.

DATA BYTE - Used by the 4380A-488 to transmit or receive data in ASCII format.

DEVICE CLEAR - Resets the 4380A-488 at which point the device will reinitialize and wait for another command string to be sent. Also resets all other devices on the bus.

END - Used by the 4380A-488 to establish the end of an information transfer to or from another device.

END OF STRING - The 4380A-488 will terminate its output message with a carriage return, line feed, or end or identify, e.g.; "FC 66.6 (CR) (LF)".

GO TO LOCAL - Directs the 4380A-488 to allow keyboard initiated measurements without interference from the bus.

IDENTIFY - In conjunction with the attention line directs the 4380A-488 to output its parallel poll response bit onto the bus.

INTERFACE CLEAR - Used by a controller to place the 4380A-488 into a quiescent state.

MY LISTEN ADDRESS - Directs the 4380A-488 to a listen state, capable of receiving information over the bus, e.g.; "FC; RC; MX."

MY TALK ADDRESS - Directs the 4380A-488 to a talker state capable of writing its measurement to the bus, e.g.; "66.6(CR)."

REMOTE ENABLE - Enables the 4380A-488 to accept information over the bus.

SERVICE REQUEST - The 4380A-488 will use this line to indicate a need for service due to a completed measurement.

REQUEST SERVICE - Directs the 4380A-488 to output a status byte to tell the controller if it generated the service request.

STATUS BYTE - The message the 4380A-488 sends to the bus when a request service message is sent.

SELECTED DEVICE CLEAR - Does the same function as the device clear message but only resets the 4380A-488.

SECTION VII - CONTROLLER PROGRAMS

7-1. GENERAL

7-2. The following programs have been supplied as a simple aid to the user. Each program allows you to send a device-dependent command string to the instrument and obtain and display an instrument reading string.

7-3. Programs for the following controllers are included:

* IBM PC or XT (with National Instruments IEEE-488 Interface)
* Apple II (equipped with the Apple II IEEE-488 Interface)
* Hewlett-Packard Model 85
* Hewlett-Packard Model 9816
* Hewlett-Packard Model 9825A

7-4. IBM PC OR XT (NATIONAL INSTRUMENTS INTERFACE)

7-5. The following program sends a command string to the Model 4380A-488 from an IBM PC or XT computer and displays the instrument reading string on the CRT. The computer must be equipped with the National Instruments IEEE-488 Interface and the DOS 2.00 operating system. The software must be installed and configured as described in the National instruction manual.

7-6. DIRECTIONS

a. Set the primary address of the Model 4380A-488 to 6.

b. With the power off, connect the Model 4380A-488 to the IEEE-488 interface installed in the IBM computer.

c. Type in BASICA on the computer keyboard to get into the IBM interpretive BASIC language.

d. Add the lines below to lines 1-6 which National shows in it's manual. Modify the address in lines 1 and 2, as described in the Manual.

e. Run the program and type in the desired command string. For example, to place the instrument in the forward carrier wave mode type in FC and press the return key.

f. The instrument reading string will then appear on the display. For example, the display might show NFC 1.234.

g. To exit the program, type in EXIT at the command prompt and press the return key.

PROGRAM	COMMENTS
10 CLS	Clear screen.
20 NA$ = "GPIBO":CALL IBFIND(NA$,BRD0%)	Find board descriptor.

```
30 NA$ = "DEVI":CALL IBFIND(NA$,BRD%)      Find instrument descriptor.
40 V% = 6:CALL IBPAD(BRD%,V%)              Set primary address to 9.
50 V% = &H102:CALL IBPOKE(BRD0%,V%)        Set timeouts.
60 V% = 1:CALL IBSRE(BRD0%,V%)             Set REN true
70 INPUT"COMMAND STRING";CMD$              Prompt for command.
80 IF CMD$ = "EXIT"THEN 150                See if program is to be halted.
90 IF CMD$ = ""THEN 70                     Check for null input.
110 CALL IBWRT(BRD%,CMD$)                  Address 4380A-488 to listen,
                                           send string.
110 RD$=SPACES$(100)                       Define reading input buffer.
120 CALL IBRD(BRD%,RD$)                    Address 4380A-488 to talk,
                                           get reading.
130 PRINT RD$                              Display the string.
140 GOTO 70                                Repeat.
150 V% = 0:CALLIBONL(BRD%,V%)              Close the instrument file.
160 CALL IBONL(BRD%,V%)                    Close the board file.
```

Note - For conversion to numberic variable, make the following changes:

```
130 RD = VAL(MID$(RD$,5,14))
135 PRINT RD
```

7-7. APPLE II (APPLE II IEEE-488 INTERFACE)

7-8. The following program sends a command string to the Model 4380A-488 from an Apple II computer and displays the instrument reading string on the computer DRT.

7-9. The computer must be equipped with the Apple II IEEE-488 Interface.

7-10. DIRECTIONS

a. Using the front panel program feature, set the primary address of the Model 4380A-488 to 6.

b. With the power off, connect the Model 4380A-488 to the IEEE-488 interface installed in the Apple II computer.

c. Enter the lines in the program below, using the RETURN key after each line.

d. Run the program and type in the desired command string at the command prompt. For example, to place the instrument in the forward carrier wave mode type in FC and press the return key.

e. The instrument reading string will then appear on the CRT. A typical display is: NFC 1.234.

PROGRAM	COMMENTS
10 Z$ = CHR$(26)	Terminator.
20 INPUT"COMMAND STRING";B$	Prompt for and enter command string.
30 PR#3	Set output to IEEE-488 Bus.
40 IN#3	Define input from IEEE-488 Bus.
50 PRINT "RA"	Enable remote.
60 PRINT "&";B$	Address 4380A-488 to listen, send string.
70 PRINT "LF1"	Line feed on.
80 PRINT "RDI";"F";:INPUT";A$	Address 4380A-488 to talk, input data.
90 PRINT "UT"	Untalk the 4380A-488.
100 PR#0	Define output to CRT.
110 IN#0	Define input from keyboard.
120 PRINT A$	Display reading string.
130 GOTO 20	Repeat.

Note - If conversion to numeric variable is required, make the following changes:

```
120 A = VAL(MID$(A$,5,14)
125 PRINT A
```

7-11. HEWLETT-PACKARD MODEL 85

7-12. The following program sends a command string to the Model 4380A-488 from an HP-85 computer and displays the instrument reading string on the computer CRT. The computer must be equipped with the HP82937 GPIB Interface and an I/O ROM.

7-12. DIRECTIONS

a. Using the front panel program feature, set the primary address of the Model 4380A-488 to 6.

b. With the power off, connect the Model 4380A-488 to the HP82937A GPIB interface installed in the HP-85 computer.

c. Enter the lines in the program below, using the END LINE key after each line.

d. Press the HP-85 RUN key and type in the desired command string at the command prompt. For example, to place the instrument in the forward carrier wave mode type in FC and press the END LINE key.

e. The instrument reading string will then appear on the CRT. A typical display is: NFC 1.234.

PROGRAM	COMMENTS
10 DIM A$[25],B$[25]	Dimension strings.
20 REMOTE 706	Place 4380A-488 in remote.
30 DISP"COMMAND STRING";	Prompt for command.
40 INPUT A$	Input command string.
50 OUTPUT 706; A$	Address 4380A-488 to listen, send string.
60 ENTER 706; B$	Address 4380A-488 to talk, input reading.
70 DISP B$	Display reading string.
80 GOTO 30	Repeat
90 END	

Note - For conversion to numeric variable, change line 70 as follows:

70 DISP VAL(B$[5])

7-14. **HEWLETT-PACKARD MODEL 9816**

7-15. The following program sends a command string to the Model 4380A-488 from a Hewlett-Packard Model 9816 computer and displays the instrument reading string on the computer CRT. The computer must be equipped with the HP82937 GPIB Interface and BASICA 2.0.

7-16. **DIRECTIONS**

a. Using the front panel program feature, set the primary address of the Model 4380A-488 to 6.

b. With the power off, connect the Model 4380A-488 to the HP82937A GPIB interface installed in the 9816 computer.

c. Type EDIT and press the EXEC key.

d. Enter the lines in the program below, using the ENTER key after each line.

e. Press the 9816 RUN key and type in the desired command string at the command prompt. For example, to place the instrument in the forward carrier wave mode type in FC and press the ENTER key.

f. The instrument reading string will then appear on the CRT. A typical display is: NFC 1.234.

PROGRAM	COMMENTS
10 REMOTE 706	Place 4380A-488 in remote.
20 INPUT"COMMAND STRING";A$	Prompt for and input command.
30 OUTPUT 706; A$	Address 4380A-488 to listen, send string.
40 ENTER 706; B$	Address 4380A-488 to talk, input reading.

```
50 PRINT B$                    Display reading string.
60 GOTO 20                     Repeat.
70 END
```

Note - For conversion to a numeric variable, change the program as follows:

```
40 ENTER 706:B
50 PRINT B
```

7-17. HEWLETT-PACKARD MODEL 9825A

7-18 Use the following program to send a command string to the Model 4380A-488 from a Hewlett-Packard Model 9825A and display the instrument reading string on the computer printer. The computer must be equipped with the HP98034A HPIB Interface and a 9872A extended I/O ROM.

7-19. DIRECTIONS

a. From the front panel, set the primary address of the Model 4380A-488 to 6.

b. With the power off, connect the Model 4380A-488 to the 98034A HPIB interface installed in the 9825A.

c. Enter the lines in the program below, using the STORE key after each line. Line numbers are automatically assigned by the 9825A.

d. Press the 9825A RUN key and type in the desired command string at the command prompt. For example, to place the instrument in the forward carrier wave mode type in FC and press the CONT key.

e. The instrument reading string will then appear on the computer print out. A typical display is: NFC 1.234.

PROGRAM	COMMENTS
0 dim A$[20],B$[20]	Dimension data strings.
1 dev"BRD",706	Define 4380A-488 at address 6.
2 rem"BRD"	Place 4380A-488 in remote.
3 ent"COMMAND STRING",B$	Prompt for command string.
4 wrt"BRD",B$	Address 4380A-488 to listen, send string.
5 red"BRD",A$	Address 4380A-488 to talk, input data.
6 prt A$	Print data string on printer.
7 gto3	Repeat.

Note - For conversion to numeric variable, modify the program as follows:

```
6 prt val(A$[5])
```

SECTION VIII - HEWLETT-PACKARD BASIC STATEMENTS (HP-85. 9816)

8-1. GENERAL

PROGRAM STATEMENT	COMMENT
OUTPUT 706;A$	Transmit string to device 6.
ENTER 706; A$	Obtain string from device 6.
LOCAL 706	Send GTL to device 6.
CLEAR 706	Send SDC to device 6.
CLEAR 7	Send DCL to all devices.
REMOTE 7	Send remote enable.
LOCAL 7	Cancel remote enable.
SPOLL (706)	Serial poll device 6.
LOCAL LOCKOUT 7	Send local lockout.
TRIGGER 706	Send GET to device.
ABORTIO 7	Send IFC.