Allen-Bradley

1771–DB Basic Module

User Manual

Table of Contents

Using This Manual

1.1 Chapter Objectives

Read this chapter before you use the BASIC Module. It tells you how to use this manual properly and efficiently.

1.2 What this manual contains

This manual shows you how to install and operate your module. It gives you information about:

- hardware specifications.
- installing the module.
- the BASIC instruction set.
- programming the module.

This manual is not a BASIC tutorial document. We assume that you are familiar with BASIC programming.

1.3 Audience

Before you read this manual or try to use the BASIC Module, you should be familiar with the operation of the 1771 I/O structure as it relates to your particular processor. Refer to our Publication Index (publication number SD499) for the appropriate Programming and Operations manual.

1.4 Definitions of major terms

To make this manual easier for you to read and understand, we avoid repeating product names where possible. We refer to the:

- BASIC Language Module (Cat. No. 1771-DB) as the BASIC Module.
- Industrial Terminal System (Cat. No. 1770-T3/T4) as the industrial terminal.
- Data Recorder (Cat. No. 1770-SA/SB) as the 1770-SA/SB Recorder.
- RS-232-C compatible devices which communicate with the BASIC Module, such as the Industrial Terminal, SA/SB Recorder, computers, robots, barcode readers, or data terminals, as RS-423A/RS-232C devices.

1.5 Important information

There are three different types of precautionary statements in this manual: Important, CAUTION and WARNING.

- Important: used to point out specific areas of concern when operating your BASIC Module.
- CAUTION: used to make you aware of instances where damage to your equipment could occur.
- WARNING: used to make you aware of instances where personal injury could occur.

1.6 Conventions

In this manual, we use certain notational conventions to indicate keystrokes and items displayed on a CRT or printer. A keystroke is shown in parentheses:

(ENTER)

Introducing the BASIC Module

2.1 Chapter Objectives

This chapter discusses the functions and features of the BASIC Module. When you finish reading this chapter, you should:

- understand and be able to identify the hardware components of the BASIC Module.
- understand the basic features and functions of the BASIC Module.

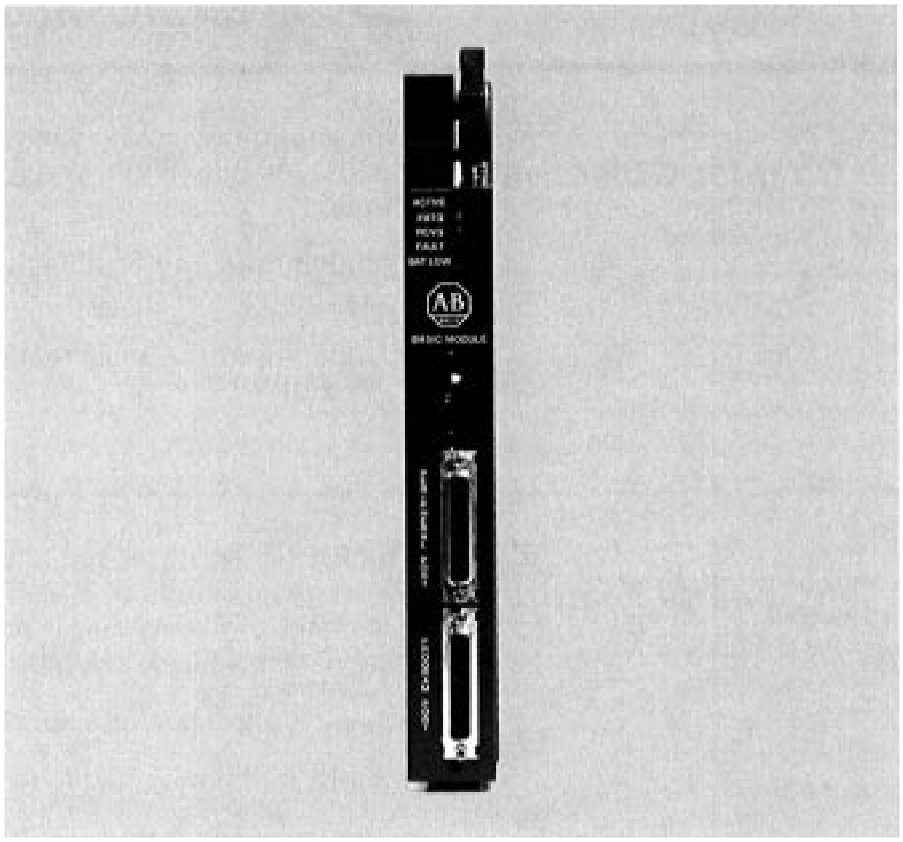
2.2 General Features

The BASIC Module (figure 2.1) provides math functions, report generation and BASIC language capabilities for any Allen-Bradley processor that communicates with the 1771 I/O system using block-transfer. It provides:

- basic programming using the Intel BASIC-52 language.
- math functions consistent with the BASIC-52 definition.
- two independently configurable serial ports capable of connecting to various user devices.
- user accessible real-time clock with 5 ms resolution.
- user accessible “wall” clock/calendar with 1 second resolution.
- program generation and editing using a dumb ASCII terminal or a T3/T4 Industrial Terminal in alphanumeric mode.
- program storage and retrieval using the 1770-SA/SB Recorder.
- block-transfer communication capability from a PLC-2, PLC-3 or PLC-5 family processor.
- on board program PROM burning.

2.2 General Features (continued)

Figure 2.1
BASIC Module Front Edge



2.3 Hardware Features

Your module is a one-slot module with the following functions and features:

- 13 K bytes of battery backed RAM for user programs.
- 32 K bytes of EPROM storage for user software routines.
- One RS-423A/232C compatible serial communications port(PROGRAM port) which works with ASCII terminals providing operator program interaction, command level input printer output, etc. The program port baud rate defaults to 1200 baud. Initially you must set your terminal for 1200 baud. Use CALL 78 to change the program port baud rate. The program port is fixed at no parity, 1 start bit, 1 stop bit and 8 data bits.

  It also supports XON/XOFF for interruption of LISTing or to suspend data output from the program port.

2.3 Hardware Features (continued)

- One RS-423A/232C/RS-422 compatible serial communications port (PERIPHERAL port), supporting bi-directional XON/XOFF software handshaking and RTS/CTS, DTR, DSR, DCD hardware handshaking for interfacing to printers and commercial asynchronous modems. You can change the peripheral port configuration using a CALL 30. (Refer to Section 5.8.1). Default values are: 1 start bit, 1 stop bit, 8 bits/character, no parity, handshaking off and 1200 baud. The baud rate is jumper selectable (300 to 19.2 K bps). (Refer to Section 3.2.4 titled, “Configuration Plugs”).
- Interface to the 1771 I/O rack backplane to support block-transfer.
- Wall clock/calendar with battery back-up available for program access.
- Battery replacement without removing the module from the I/O rack.
- All power derived from the backplane (1.5 A).
- Multiple BASIC modules can reside in the same I/O rack and function independently of each other.

2.4 Software Features

Your module runs BASIC language programs in an interactive mode through the dumb terminal/programming port interface, or on power-up. The execution of these programs allows a direct interface with programmable controller ladder programs.

Your module uses the following devices and features:

- terminal for programming, editing, system commands, displaying data and interactive program dialog
- serial port for report generation output, upload/download to 1770-SA/SB Recorder
- PLC-2, PLC-3 and PLC-5 data table reads and writes using block-transfer

We provide routines to use both the real-time clock and the wall-clock/calendar. The wall-clock time base is seconds.

2.4 Software Features (continued)

You can start program execution:

- by entering commands at the interactive terminal.
- at power-up initialization.

You can store and execute programs in RAM or EPROM. You can store one user-program in RAM and up to 255 (depending on program size) independent user-programs simultaneously in EPROM memory.

The programs run single-task mode only. You can generate the following data types with the BASIC Module:

- 16-bit binary (4 hex digits)
- 3-digit, signed, fixed decimal BCD
- 4-digit, unsigned, fixed decimal BCD
- 4-digit, signed, octal
- 6-digit, signed, fixed decimal BCD
- 3.3 digit, signed, fixed decimal BCD

Refer to Chapter 7, "Data Types" for more information.

2.5 Specifications

Isolation

- Formats: integer, decimal, hexadecimal and exponential
- The Programming Port is isolated from the 1771 I/O backplane. (+500 V)
- The Peripheral Port is isolated from the 1771 I/O backplane. (+500 V)
- The Programming Port is isolated from the Peripheral Port. (+500 V)

Communication Rates

- 300, 600, 1200, 2400, 4800, 9600, 19.2 K bits
- Communication rates/distances

Communication Rate (bps)	Maximum Distance Allowed		
	RS-232-C	RS-423	RS-422
300	50	4000	4000
600	50	3000	4000
1200	50	2500	4000
4800	50	800	4000
9600	50	400	4000
19,200	50	200	4000

Wall-clock accuracy

- Formats: integer, decimal, hexadecimal and exponential
- Absolute: ≤ ± 5 min/month @ 25° C

@@@@ Drive output +3.6 V minimum

- Drift ≤ ± 50 ppm/°C
- Drift ≤ ± 50 ppm/year @ 25°C

@@@@

Port driver and receiver

- Drive output +3.6 V minimum

@@@@

- Receiver sensitivity 200 mV minimum

@@@@

Math

- Precision: 8 significant digits
- Range: ±1E-127 to ±99999999E+127

- Formats: integer, decimal, hexadecimal and exponential

Module location

- One 1771 I/O chassis module slot

Backplane power supply load

- 1.5 A

Environmental Conditions

- Operational temperature: 0°C to 60°C (32°F to 140°F)
- Storage temperature: -40°C to 85°C (-40°F to 185°F)
- Relative humidity: 5% to 95% (non-condensing)

Keying (top backplane connector)

- Between 8 and 10
- Between 32 and 34

Installing the BASIC Module

3.1 Chapter Objectives

This chapter describes how to install your BASIC module in a 1771 I/O rack. After reading this chapter you should be able to:

- configure the module using the configuration plugs.
- insert the module into a 1771 I/O backplane.
- understand module status indicators.
- install additional EPROM's.

3.2 Installing the BASIC module

WARNING: Disconnect and lockout all AC power from the programmable controller and system power supplies before installing modules to avoid injury to personnel and damage to equipment.

Read this installation section completely before beginning. Re-check all option selections and connections before you begin programming.

Before installing your module in the I/O chassis you must:

1. calculate the power requirements of all the modules in each chassis. (Refer to Section 3.2.1 below).

2. determine the location of the module in the I/O chassis. (Refer to Section 3.2.2 below).

3. key the backplane connectors in the I/O chassis. (Refer to Section 3.2.3 below).

4. set the module configuration plugs. (Refer to Section 3.2.4 below).

3.2.1 Power Requirements

Your module receives its power through the 1771 I/O chassis backplane from the chassis power supply. It does not require any other external power supply to function. When planning your system you must consider the power usage of all modules in the I/O chassis to prevent overloading the chassis backplane and/or power supply. Each BASIC module requires 1.5 A at +5V DC. Add this to the requirements of all other modules in the I/O chassis.

CAUTION: Do not insert or remove modules from the I/O chassis while system power is on. Failure to observe this rule may result in damage to module circuitry.

3.2.2 Module Location in the I/O Chassis

You can place your module in any I/O slot of the I/O chassis except for the extreme left slot. This slot is reserved for processors or adapter modules. You can place your module in the same module group as a discrete high density module if you are using processors or adapters with single-slot addressing capabilities.

Important: Certain processors restrict the placement of block-transfer output modules. Refer to the user manual for your particular processor for more information.

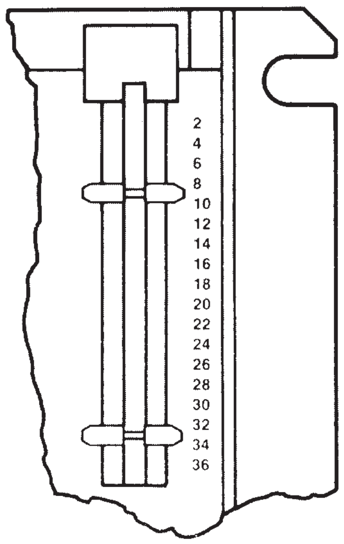
3.2.3 Module Keying

Initially you can insert your module into any I/O module slot in the I/O chassis. However, once you designate a slot for a module you must not insert other modules into these slots. We strongly recommend that you use the plastic keying bands shipped with each I/O chassis, to key I/O slots to accept only one type of module. Your module is slotted in two places on the rear edge of the board. The position of the keying bands on the backplane connector must correspond to these slots to allow insertion of the module. You may key any I/O rack connector to receive the module assembly. Snap the keying bands onto the upper backplane connectors between the numbers printed on the backplane (figure 3.1).

- Between 8 and 10
- Between 32 and 34

3.2.3 Module Keying (continued)

Figure 3.1
Keying Diagram for Placement of Module Keying Bands



You may change the position of these bands if subsequent system design and rewiring makes insertion of a different type of module necessary. Use needle-nose pliers to insert or remove keying bands.

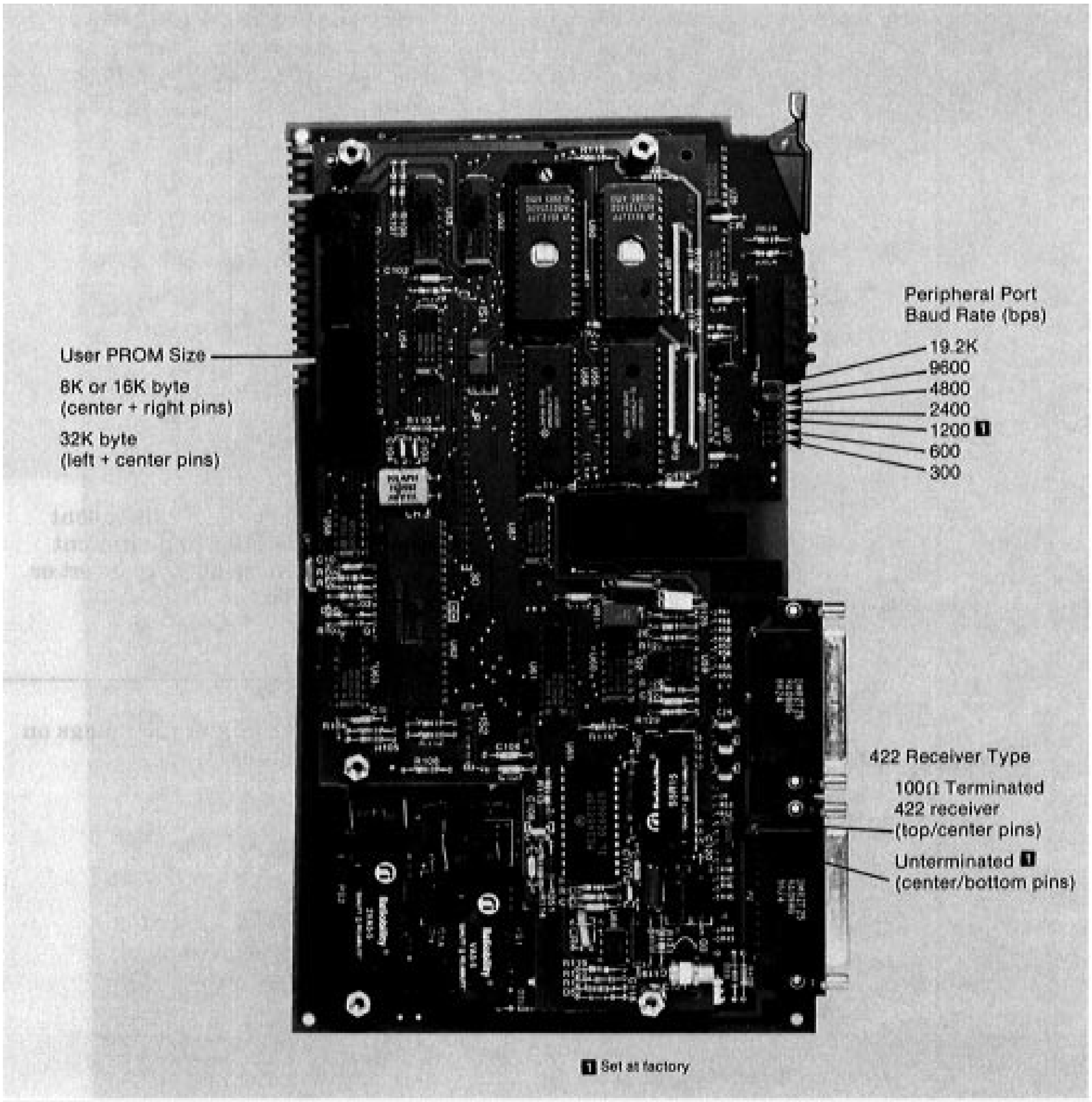
3.2.4 Configuration Plugs

There are three sets of user selectable configuration plugs on the BASIC Module (figure 3.2). You can use these configuration plugs to select:

- PROM size.
- peripheral port baud rate (bps).
- 422 receiver termination.

3.2.4 Configuration Plugs (continued)

Figure 3.2
The Configuration Plugs



All other configuration plugs are factory set. Do not reset these factory set configuration plugs.

3.2.5 Module Installation

Now that you have determined the configuration, power requirements, location, keying and wiring for your module, you are ready to install it in the I/O chassis.

1. Turn off power to the I/O chassis.

2. Insert your module in the I/O rack. Plastic tracks on the top and bottom of the slots guide the module into position. Do not force the module into its backplane connector. Apply firm, even pressure on the module to seat it properly. Note the rack, module group and slot numbers and enter them in the module address section of the block-transfer instructions.

3. Snap the I/O chassis latch over the module. This secures the module in place.

3.2.6 Initial Start-up Procedure

You must use the following procedure when powering up the module for the first time. This procedure is a continuation of the installation procedure presented above.

4. Connect the cable from your program terminal to the BASIC Module program port.

CAUTION: Be sure you properly ground the system be fore turning on power. A difference in ground potential between the BASIC Module serial connectors and your program terminal or other serial device can cause damage to the equipment or loss of module programs.

5. Turn on your program terminal. Select 1200 baud. If you are using an industrial terminal, select the Alpha Numeric mode, baud rate and press [RETURN].

6. Turn on power to the rack. The following sequence takes place:

- Fault (FLT) and ACTIVE LED’s go on.
- FLT and ACTIVE LED’s go out until power-up diagnostics is complete. Ignore any other LED activity during power-up.
- ACTIVE LED goes on.

3.2.6 Initial Start-up Procedure (continued)

When the ACTIVE LED comes on observe the sign-on message displayed on the terminal followed by <READY.

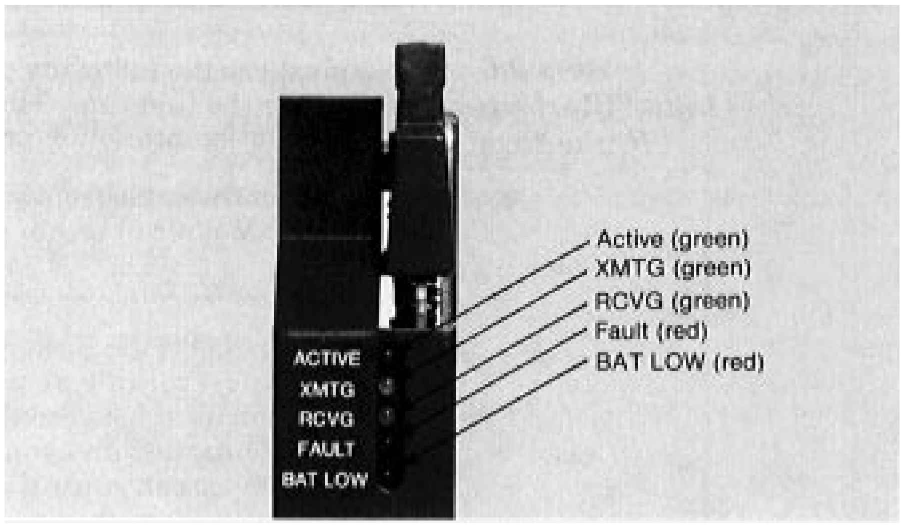
You are now ready to begin BASIC programming. Refer to Chapter 6 for an example program to help you get your processor and BASIC Module communicating properly.

Important: If you break communications with the module check that the terminal is set at the proper baud rate.

3.3 Module Status LED's

There are five LED's (figure 3.3) on the front panel of the module which indicate the status of the module.

Figure 3.3
Module Status Indicators



LED	Description
ACTIVE (green)	Indicates the module has passed power-up diagnostics. You can program using CALL 79 to: ▪ remain on (default). ▪ remain on in RUN mode and blink every second when in COMMAND mode. Refer to Chapter 5 for an explanation of CALL 79.
XMTG (green)	ON when data is transmitting on the peripheral port. Lights for either RS-422 or RS-423/RS-232C output.
RCVG (green)	ON when data is transmitting on the **peripheral** port. Lights for either RS-422 or RS-423/RS-232C input. This LED does not indicate whether or not valid data was received.
FAULT (red)	When LED is on, indicates either a hardware problem or block-transfer problem. See below.
BAT LOW (red)	Lights when the battery voltage drops below about 3.0V DC.

3.3 Module Status LED's (continued)

If the FLT LED lights after the module has been operating properly check the following troubleshooting chart.

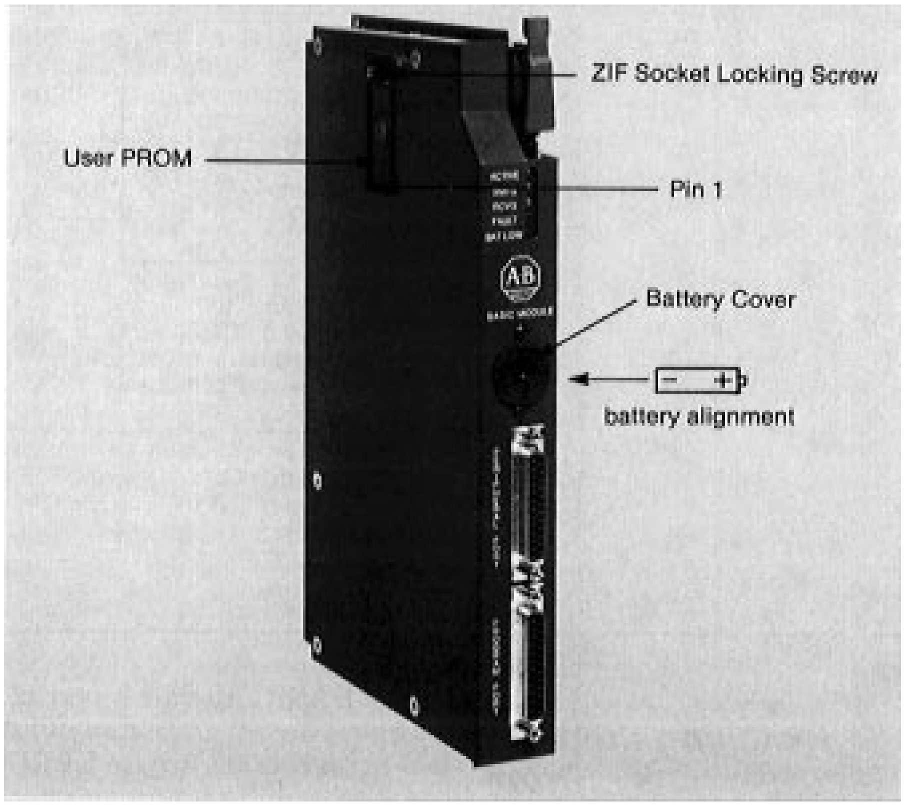
Problem	Probable Cause	Recommended Action
Module's programming port does not respond	Hardware failure	Send module for repair
Module's programming port continues to function but FLT LED goes on and off	Problem with block-transfers between processor and BASIC module	Verify ladder logic
Module's programming port continues to function and FLT LED goes out when processor is switched to program mode		
Module's programming port continues to function and FLT LED remains on	Problem with block-transfer circuitry on the BASIC Module	Send module for repair

3.4 Installing the User Prom

The BASIC Module has a 32 K byte EPROM installed (figure 3.4). We recommend that you keep JEDEC standard 8 K, 16 K or 32 K byte EPROMs which use 12.5V DC programming voltage as spares. You can buy 32 K byte EPROMs from Allen-Bradley (part numbers 940654-02 or 9406454-03).

Installing the User Prom (continued)

Figure 3.4
User PROM and Battery Holder



To replace the EPROM:

1. Turn the small screw in the socket just above the chip (figure 3.4) 1/4 turn counterclockwise.

2. Remove the old chip.

3. Insert the new chip with pin one down and the center notch down as shown in the socket diagram.

4. Turn the small screw in the socket above the chip 1/4 turn clockwise.

5. Refer to the above section titled, “Configuration Plugs” for the proper setting of the corresponding configuration plug.

3.4.1 Electrostatic Discharge

Electrostatic discharge can damage integrated circuits or semiconductors in this module if you touch backplane connector pins. It can also damage the module when you set configuration plugs and/or switches inside the module. Avoid electrostatic damage by observing the following precautions:

- Touch a grounded object to rid yourself of charge before handling the module.
- Do not touch the backplane connector or connector pins.
- If you configure or replace internal components, do not touch other circuit components inside the module. If available, use a static-safe work station.
- When not in use, keep the module in its static-shield bag.

CAUTION: Electrostatic discharge can degrade performance or damage the module. Handle as stated above.

3.5 Battery

The 13 K bytes of user RAM and the clock/calendar are battery backed. Drain on the battery should be less than 0.5 mA DC during battery back-up (no power) and less than 50 uA while the module is powered. Battery life during no-power conditions is about 2000 hours. Battery shelf life is about 20,000 hours. When the BAT LOW indicator comes on the battery should maintain the clock and program data for about three days. We recommend immediate replacement.

To replace the battery (figure 3.4):

1. Place a screwdriver in the battery cover slot.
2. Press inwards slightly.
3. Rotate the screwdriver and battery cover counterclockwise 1/4 turn.
4. Release the pressure and remove the battery cover.
5. Replace the battery with the positive (+) terminal out.
6. Replace the battery cover.

3.5 Battery (continued)

The BAT LOW indicator should go out.

You can monitor the battery low condition in revision A and revision B modules using a XBY(77B4H) statement. Bit 2 high indicates the battery low condition.

With revision C modules use CALL 80 to monitor battery status.

Using the Serial Ports

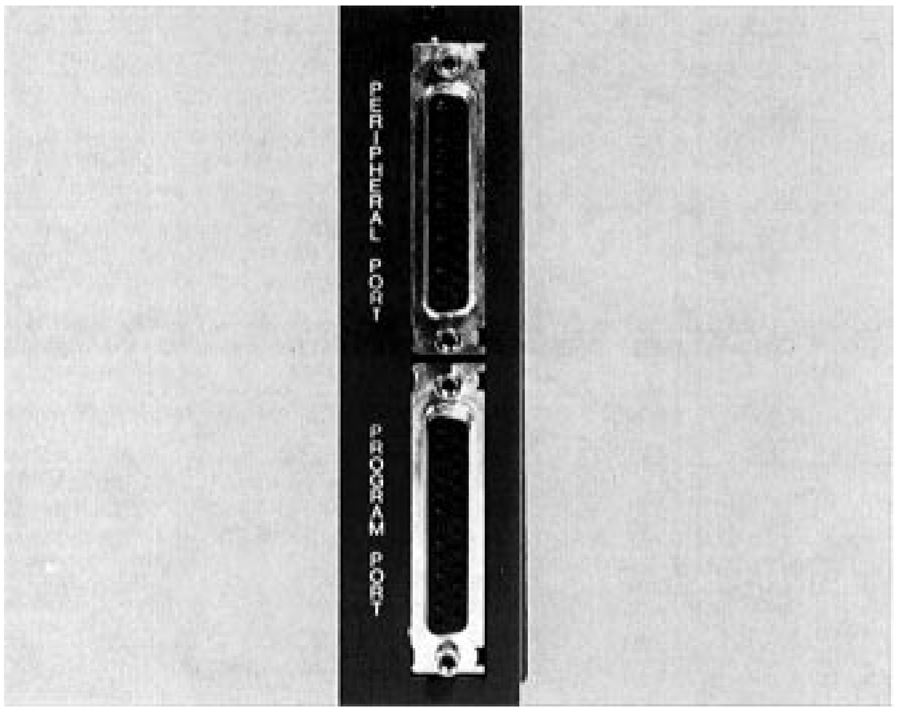
4.1 Chapter Objectives

This chapter describes how to use the program serial port and the peripheral serial port to connect terminals, Data Cartridge Recorders, Digital Cassette Recorders, printers and other compatible devices.

4.2 Using the BASIC Module Program and Peripheral Communication Ports

The BASIC Module has a program serial port and a peripheral serial port capable of connecting to various user devices (figure 4.1). You can configure each port independently. Both ports are electrically isolated from each other and from the backplane up to 500 V with no external power needed. Both ports operate from 300 baud to 19.2K baud and default to 1200 baud.

Figure 4.1
Program/Peripheral Port Locations



If you use an RS-423/RS-232 device or an Allen-Bradley Industrial Terminal you can use up to a 50 foot maximum cable length for connections from either the program or peripheral ports. Refer to the specifications section in Chapter 2 for cable length recommendations.

4.2 Using the BASIC Module Program and Peripheral Communication Ports (continued)

CAUTION: Be sure you properly ground the system before turning on power. A difference in ground potential between the BASIC Module serial connectors and your program terminal or other serial device can cause damage to the equipment or loss of module programs.

4.2.1 Pin Descriptions

Use the following pins for connections made to the program or peripheral ports. Refer to figure 4.2 for pin descriptions. Not all signals are available on both ports.

Signal states are:

mark = logical 1 = – voltage
space = logical 0 = + voltage

Pin	Name	Description
1[1]	Chassis/ Shield	Connect this pin to chassis ground for shielding purposes.
2[1]	TXD	TXD is an RS-423A compatible serial output port.
3[1]	RXD	RXD is an RS-423A compatible serial input data port.
4	RTS	RTS is an RS-423 compatible hardware handshaking output line. This line changes to a mark (1) state when the BASIC Module has data in the output queue and is requesting permission to transmit to the data communications equipment.
5	CTS	CTS is an RS-423A compatible hardware handshaking input line. This line must be in a mark (1) state for the BASIC Module to transmit on the peripheral port. If no corresponding signal exists on the data communications equipment, connect CTS to RTS.
6	DSR	DSR is a general purpose RS-423A compatible input line. The BASIC Module transmits or receives in the mark (1) or space (0) state. Use this line for data recorder interface.
7[1],9,10	Signal Common	Use the signal common pins to reference all RS-423A/RS-422 compatible signals.
8	DCD	If DCD is enabled using CALL 30, the BASIC Module does not transmit or receive characters until the DCD line is in the mark (1) state. When disabled, the module ignores the state of this line.
11,12,13,15 17,19,21,22 23,24	NC	No connection
14,25	422 TXD	RS-422A compatible equivalent of the RS-423A TXD line. Differential serial output lines.
16, 18	422 RXD	Differential RS-422A compatible serial input lines.
20	DTR	DTR is an RS-423A compatible hardware handshaking output line. This line changes to a space (0) state when the BASIC Module input queue has accumulated more than 223 characters. The DTR line changes to a mark (1) state when the input queue contains less than 127 characters.
[1]program port pins		

4.3 Program Port

The program port is an RS-423A/232C compatible serial port that provides minimum signal line connection to terminals, printers and other serial devices for operator-program interaction, command level input, printer output etc. Figure 4.2 shows the signals available on both the program port and the peripheral port described later.

Figure 4.2
Program Port and Peripheral Port Wiring Connections

Program Port	Peripheral Port	Description
1[1]	1[1]	Chassis/Shield
2[1]	2[1]	TXD-Output
3[1]	3[1]	RXD-Input
4	4[1]	RTS-Output
5	5[1]	CTS-Input
6	6[1]	DSR-Input
7[1]	7[1]	Signal Common
8	8[1]	DCD-Input
9	9[1]	Signal Common
10	10[1]	Signal Common
11	11	NC
12	12	NC
13	13	NC
14	14[1]	RS-422 TXD
15	15	NC
16	16[1]	RS-422 RXD
17	17	NC
18	18[1]	RS-422 RXD’
19	19	NC
20	20	DTR-Output
21	21	NC
22	22	NC
23	23	NC
24	24	NC
25	25[1]	RS-422 TXD’

[1]Signal is provided on this pin

The baud rate is initially set at 1200 baud. You can use CALL 78 to change the baud rate from 300 to 19.2K bps.

The program port has the following fixed format:

- parity: none
- start bits: 1
- stop bits: 1
- data bits: 8
- receiver threshold: 200 mV
- driver output (loaded): +3.6V

4.3 Program Port (continued)

Important: The program port always resets the most significant bit of all its data inputs. The range of each byte of data is 0 to 127 ($7F_H$). On output, the module transmits all bits as specified when using the PRINT CHR() command except for the XOFF (13H) character. The range of each byte of data is 0 to 255 (OFF_H).

Important: The program port automatically inserts a CR, LF sequence after the 79th character column. Use CALL 99 to reset the column counter to zero to allow PRINT page width's in excess of 79 characters.

You enter BASIC programs through a dumb ASCII terminal, such as an industrial terminal in alphanumeric mode. Refer to section 4.3.2, "Connecting a T3/T4 Industrial Terminal to the Program Port".

4.3.1 Using the XOFF/XON Commands for the Program Port

Use the XOFF/XON commands to disable outputs from the program port in the following way.

1. Use XOFF only on PRINT statements.

2. When XOFF is received during a PRINT, data output and program execution are suspended immediately.

3. When XOFF is received at any other time, program execution continues until a PRINT is encountered. When a PRINT is encountered program execution is suspended.

4. Use XON to resume program execution.

The program port accepts uppercase or lowercase input, however, the input receiver changes all commands, keywords or variables to upper case before storing in memory, thus:

>10 print "hello"(CR)

appears as

10 PRINT "hello"

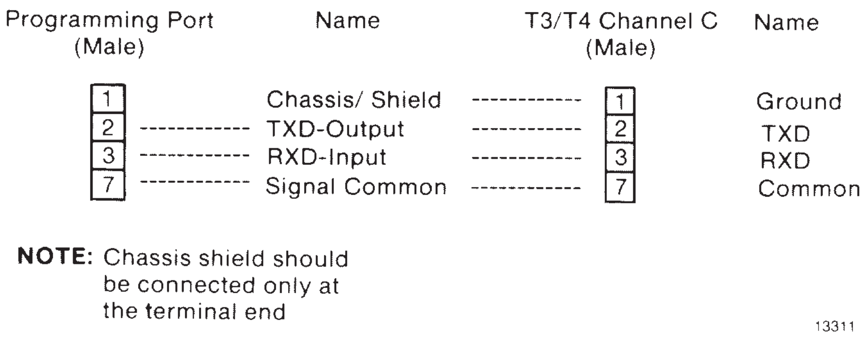
when listed.

4.3.2 Connecting a T3/T4 Industrial Terminal to the Program Port

You can use an Industrial Terminal System as the programming system for the BASIC Module. Connect the module to CHANNEL C only. You can construct cable for distances up to 50 feet. Figure 4.3 shows cable connections to a T3/T4 Industrial Terminal from the program port.

Important: You may continue to use CHANNEL B in existing installations.

Figure 4.3
Cable Connection to T3/T4 Terminal from the Program Port



You can use a T3 or T4 Industrial Terminal with the following keyboard revisions:

- T3 Series A, Revision H or later
- T3 Series B, Revision H or later
- T3 Series C, Revision A or later
- T4 Series A, Revision F or later

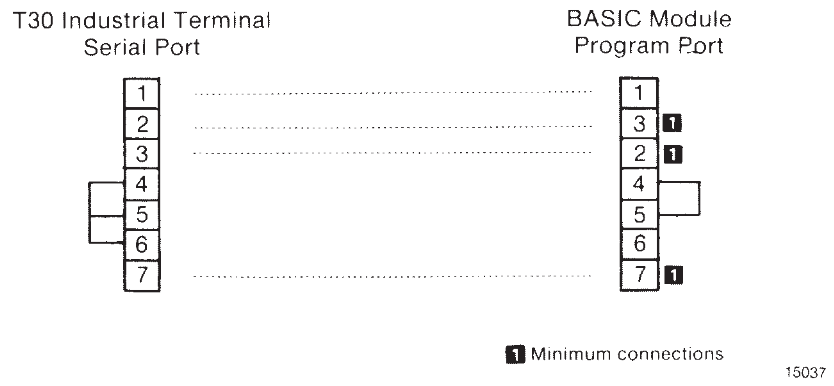
Refer to the Industrial Terminal Systems User's Manual (Cat. No. 1770-T1, T2, T3), publication number 1770-6.5.3, and PLC-3 Industrial Terminal User's Manual (Cat. No. 1770-T4), publication number 1770-6.5.15 for additional information.

4.3.3 Connecting a T30 Industrial Terminal (Cat. No. 1784-T30) to the Program Port

You can connect a T30 Industrial Terminal to the BASIC Module program port to act as a dumb terminal.

Refer to the following figure 4.4 for BASIC Module/T30 connections.

Figure 4.4
Connecting a T30 Industrial Terminal to a BASIC Module


T30 Industrial Terminal Serial Port
BASIC Module Program Port
1
2
3
4
5
6
7
1
3
2
4
5
6
7
Minimum connections
15037

Important: Jumper T30 Industrial Terminal pin 4,5 and 6; and BASIC Module pins 4 and 5 if you do not use them.

4.3.4 Connecting a T50 Industrial Terminal (Cat. No. 1784-T50) to the Program Port

You can use your T50 Industrial Terminal as a BASIC Module programming device. You must use a terminal driver package to configure the industrial terminal serial port and communications protocol to match the BASIC Module.

These packages include the ability to upload to and download from the hard or floppy disk drives in the industrial terminal.

To upload and download you must:

1. configure the software.
2. construct a cable with the pin connections shown in figure 4.5 under, “Wiring”.
3. use the upload and download commands of the driver package.

4.3.4 Connecting a T50 Industrial Terminal (Cat. No. 1784-T50) to the Program Port (continued)

4.3.4.1 Configuring the Software

Configure the driver package for compatibility with the BASIC Module by setting:

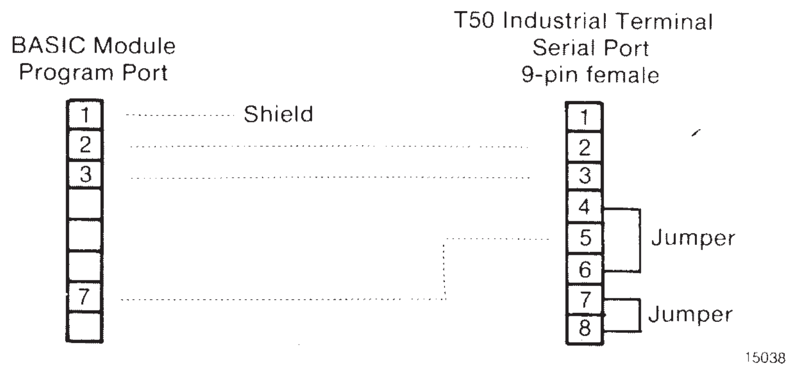
- baud rate – 9600 baud recommended
- parity – none
- data bits – 8
- start bits – 1
- stop bits – 1

To download to the BASIC Module, you must use a line wait function. The industrial terminal waits for the " > " BASIC Module prompt before sending the next line to the module. You must enter a line delay of 1.5 seconds for terminal drivers that do not have the "wait for character" function, so that you do not lose subsequent lines. Most drivers allow storage of the complete set of parameters in a file for later recall.

The industrial terminal stores the BASIC Module program in a text file on the hard or floppy disc depending on where you store the terminal driver package. We recommend you store the driver package on the hard drive to increase execution speed. Most driver packages have upload and download capability. Refer to the driver documentation for these commands.

4.3.4.2 Wiring

Figure 4.5
Connecting a T50 Industrial Terminal to a BASIC Module



4.4 Peripheral Port

The peripheral port is an asynchronous serial communication channel compatible with RS-423A/232C or RS-422 interfaces. It uses bi-directional XON/XOFF software handshaking and RTS/CTS, DTR, DSR, DCD hardware handshaking for interfacing with printers, terminals and commercial asynchronous modems. Use a CALL routine to change peripheral port configuration. Configure the baud rate (300 to 19.2K bps) by setting a configuration plug. Refer to figure 3.2 for configuration plug locations.

In addition, the peripheral port has the following format requirements:

- configurable parity: odd, even or none
- fixed start bits: 1
- configurable stop bits: 1, 1.5 or 2
- configurable data bits: 5,6,7 or 8
- receiver threshold: 200 mV
- driver output (loaded): +3.6V

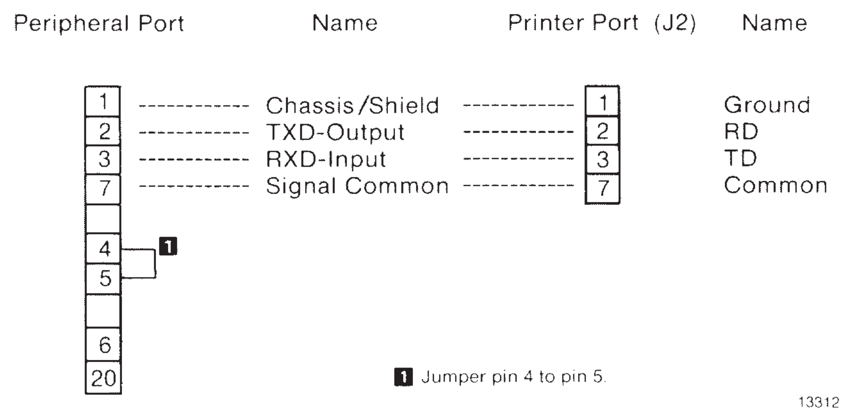
Defaults are 1 start bit, 1 stop bit, 8 bits/character, no parity, handshaking off and 1200 baud.

When you select 8 bits/character you have full access to all 8 bits of each character on both input and output data bytes.

Refer to figure 4.2 for peripheral port wiring connections.

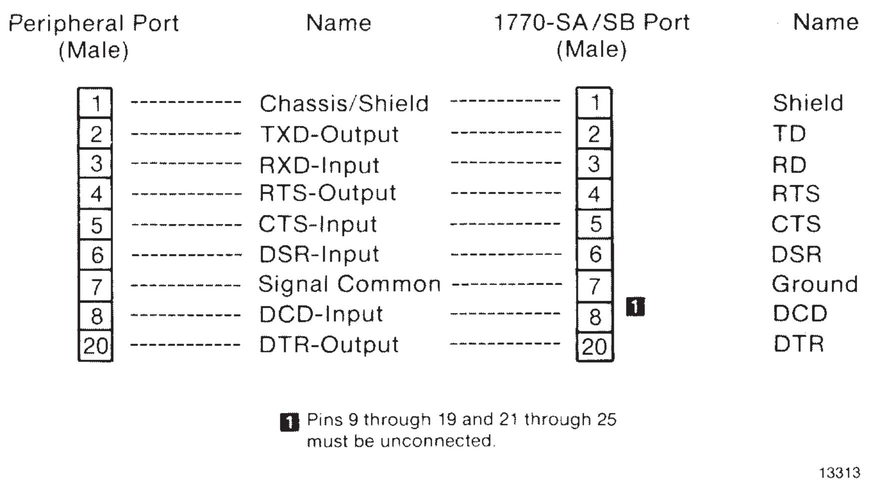
The peripheral port can connect to printers (figure 4.6), asynchronous modems and to SA/SB recorders for program storage and retrieval (figure 4.7).

Figure 4.6
Cable Connection to 1771-HC Printer



4.4 Peripheral Port (continued)

Figure 4.7
Cable Connection to SA/SB Recorder



Peripheral Port (Male)	Name	1770-SA/SB Port (Male)	Name
1	Chassis/Shield	1	Shield
2	TXD-Output	2	TD
3	RXD-Input	3	RD
4	RTS-Output	4	RTS
5	CTS-Input	5	CTS
6	DSR-Input	6	DSR
7	Signal Common	7	Ground
8	DCD-Input	8 [1]	DCD
20	DTR-Output	20	DTR

[1] Pins 9 through 19 and 21 through 25 must be unconnected.

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4.4.1 Using the XON/XOFF Commands for the Peripheral Port

Output Data – The BASIC Module stops sending characters within 2 character times after receiving an XOFF. Transmission resumes when XON is received.

Input Data – The BASIC Module sends XOFF when the input buffer reaches 224 characters. The module sends XON when the buffer contains less than 127 characters.

The BASIC Module requires CTS (pin 5) to be true before data can be output. If hardware handshaking is not used with your device then RTS (pin 4) may be connected to CTS to satisfy this requirement. Jumper pin 4 to pin 5.

4.4.2 Connecting A T30 Industrial Terminal (1784-T30) to the Peripheral Port

Communication between a programmable controller and the T30 Industrial Terminal using the BASIC Module requires two data transfers. We use block-transfer-read and write instructions for bi-directional data transfer between the programmable controller data table and the BASIC Module. We use an RS-423/RS-232 communication link for bi-directional data transfer between the BASIC Module and the industrial terminal. Refer to the Plant Floor Terminal Application Data (publication number 1784-4.1) for more information.

4.4.2 Connecting A T30 Industrial Terminal (1784-T30) to the Peripheral Port (continued)

4.4.2.1 Hardware Configuration

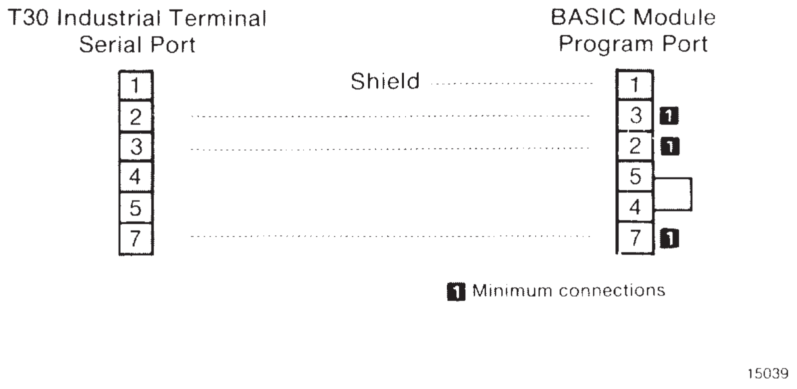
You must configure the BASIC Module peripheral port and the T30 Industrial Terminal serial port in the same way for proper communications to occur. We configure the peripheral port on the BASIC Module as follows:

Baud rate	1200 bps
Parity	disabled
Duplex	full (default setting)
Bits per character	8
Stop bits	1
Handshaking	disabled

Configure the T30 Industrial Terminal serial port the same way.

Refer to the following figure 4.8 for T30 Serial Port/BASIC Module Peripheral Port connections.

Figure 4.8
T30 Serial Port/BASIC Module Peripheral Port Connections


T30 Industrial Terminal Serial Port
BASIC Module Program Port
Shield
1
2
3
4
5
7
1
3
2
5
4
7
Minimum connections
15039

Important: Jumper the T30 Industrial Terminal and BASIC Module pins 4 and 5 if you do not use them.

4.4.3 Connecting a 1770-SA/SB Recorder to the Peripheral Port

You can use a 1770-SB Data Cartridge Recorder or 1770-SA Digital Cassette Recorder to save and load BASIC programs to the BASIC Module. Figure 4.6 shows cable pin connections. Use the connections shown in figure 4.6 otherwise improper operation could occur. Note that the standard cable does not connect properly with the BASIC Module. Refer to the user manuals for the 1770-SB (publication number 1770-6.5.4) and 1770-SA (publication number 1770-6.5.1) for more information on these recorders.

It is not necessary to set the peripheral port parameters (except baud rate) before CALLing the recorder interface routines. This is done automatically by the software. The parameters are returned to their original state when the routine is complete.

You can find more information on saving and loading programs in Chapter 6 of this manual.

Important: STR LINK II and III Recorders do not function like SA/SB recorders. Do not use them with the BASIC Module.

4.4.4 Connecting a 1770-HC Printer to the Peripheral Port

You can connect a 1770-HC Printer to the peripheral port for program listing, report generation etc. Figure 4.7 shows cable pin connections. Refer to your printer product manual for more information.

We recommend enabling XON/XOFF on the peripheral port (see Chapter 5 section titled, “Peripheral Port Support – Parameter Set”) and selecting XON/XOFF(DEC) protocol on the 1770-HC Printer (switch selectable). Refer to your printer manual. You can find more information on printing reports and listing programs in Chapter 5 of this manual.

4.4.5 Connecting RS-422 Devices

The BASIC Module can communicate with various RS-422 devices. RS-422 signals for both sending and receiving data are located on the module’s peripheral port. Figure 4.9 shows point-to-point signal connections. The RS-422 port floats (i.e no voltages are applied to the output) when it is not sending characters. This allows you to connect two transmitting devices on the same line. Also, you can connect more than one device in a multi-drop configuration (figure 4.10).

4.4.5 Connecting RS-422 Devices (continued)

Figure 4.9
Point-to-Point RS-422 Connections

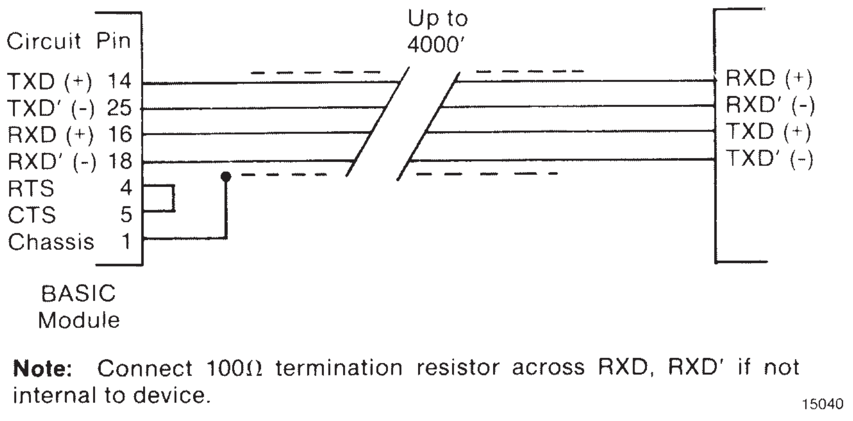
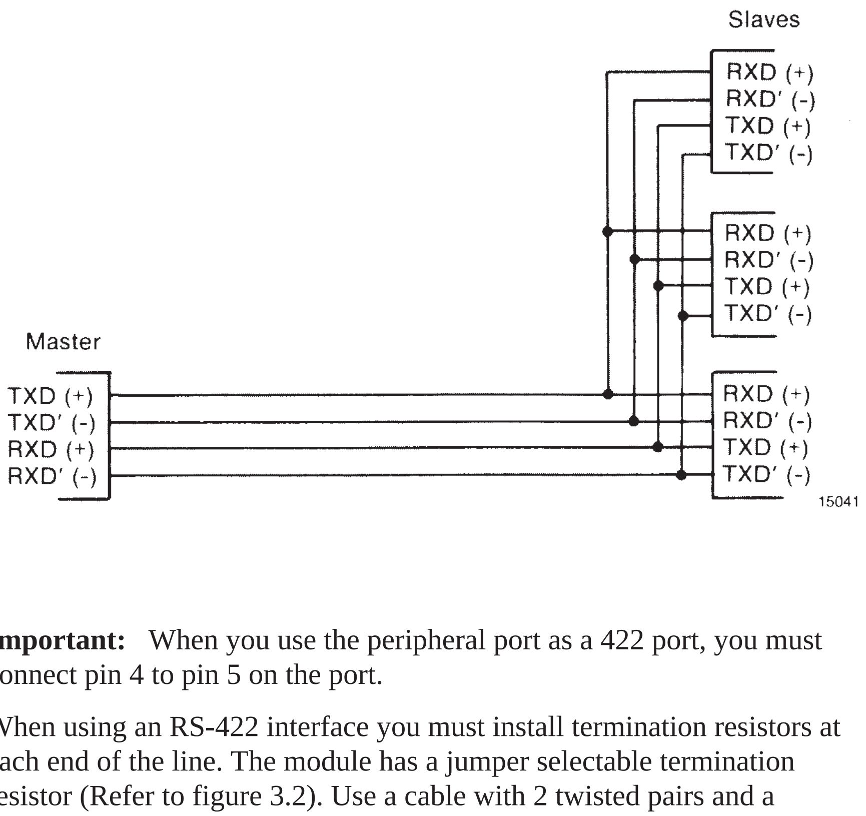


Figure 4.10
Multi-drop configuration with master and multiple slaves



Important: When you use the peripheral port as a 422 port, you must connect pin 4 to pin 5 on the port.

When using an RS-422 interface you must install termination resistors at each end of the line. The module has a jumper selectable termination resistor (Refer to figure 3.2). Use a cable with 2 twisted pairs and a nominal impedance of 100 ohms.

Important: Use terminating resistors only at the ends of the link if using multiple RS-422 devices, and at both ends if using point-to-point connections.

4.5 Cable Assembly Parts

You must supply cables for connecting devices to the program and peripheral ports. You can construct the cables with the parts listed in Table 4–1.

Table 4–1
Cable assembly parts for connection to the program and peripheral ports

Part	Manufacturer's Part Number
25 pin female connector	Cannon type DB-25S, or equivalent
25 pin male connector	Cannon type DB-25P, or equivalent
Plastic Hood	Amp type 205718-1
2 twisted pair 22 gauge, individually shielded cable	Cat. No. 1778-CR, Belden 8723 or equivalent (Do not use for cable RS-422 connections)

Chapter 5

Operating Functions

5.1 Chapter Objectives

After reading this chapter you should be familiar with the BASIC instruction set and be ready to begin BASIC programming.×This chapter is a reference section×to help you with module programming. You should×already×be familiar with BASIC programming.

5.2 Definition of Terms

The following sections define the following terms: commands, statements, format×statements,×data format,×integers, constants, operators, variables, expressions, relational expressions,×system control×values, argument stack and control stack.

5.2.1 Commands

The BASIC module operates×in two modes, the×command or direct mode×and the interpreter×or run mode. You can only enter commands when the×processor is in the command or direct×mode. This×document uses×the terms run mode and command mode×to refer×to the two different×operation×modes.

5.2.2 Statements

A BASIC program consists×of statements. Every statement begins×with a line×number, followed×by a statement body, and terminated×with×a carriage×return (cr), or a colon (:) in the case of multiple×statements per line.×There are three types of statements: assignments, input/output×and control.

- Every line in a program must have×a statement line×number ranging between×0 and 65535×inclusive.×BASIC uses×this to order the program statements in sequence.
- You can use a statement number only×once in a program.
- BASIC automatically×orders×statements in ascending order.
- A statement×may not contain more than×79 characters.
- BASIC ignores×blanks (spaces) and automatically inserts them during a LIST command.

5.2.2 Statements (continued)

- You may put more than × one statement on a line, if separated by a colon × (:). You can use only one statement number per × line.
- You can enter lower case characters × in the COMMAND mode. Any keywords, commands, variable and array names entered in lower case change to upper case when stored × in memory.

5.2.3 Format Statements

You can use format × statements within the print × statement. The format statements × include × TAB((|expr|), × SPC([expr]), USING(special symbols), and CR (carriage return with no line feed).

5.2.4 Data Format

You can represent the following range of numbers in × the BASIC module: +1E–127 × to +.99999999E+127

There are eight × significant × digits. × Numbers are × internally rounded to × fit this precision. You can × enter and display numbers in × four formats: integer, × decimal, hexadecimal and exponential.

Example: × 129, 34.98, 0A6EH, 1.23456E+3

5.2.5 Integers

In the BASIC module, × integers × are numbers that × range from 0 to 65 535 or OFFFFH. You × can × enter all integers in either decimal or hexadecimal × format. You indicate × a hexadecimal number by placing the character × “H” after the number (e.g. 170H). If the hexadecimal number begins × with A – F, then it must be preceded by a zero (i.e. You must enter A567H as OA567H). When an × operator, such as .AND. requires an integer, the BASIC module truncates × the fraction × portion of the number so it fits the integer format. We refer × to integers and line numbers as:

[integer] – [ln-num]

5.2.6 Constants

A constant is a real × number that ranges from +1E–127 to +.9999999 9E+127. A constant × can be an integer. × We refer to constants as: [const]

5.2.7 Operators

An operator performs a predefined × operation on variables and/or constants. Operators × require × either one or two operands. Typical two operand or dyadic operators include ADD (+), × SUBTRACT (–), MULTIPLY (*) × and DIVIDE(/). × We call × operators that require × only one operand, unary operators. Some typical × unary operators are SIN, COS and ABS.

5.2.8 Variables

A variable can be:

- a letter (e.g. A, X,I)
- a letter followed by a one dimensioned × expression, (e.g. J(4), GA(A + 6), I(10*SIN(X))
- a letter followed by a number followed by a one dimensioned expression × (e.g. × A1(8), P7(10*SIN(X)), W8(A + B).
- a letter followed by a number or letter × (e.g. AA, AC, XX, × A1, X3, G8) except × for the following × combinations: × CR, DO, lE, IF, IP, ON, PI, SP, TO, UI and UO.

We refer to variables that include × a one dimensioned expression [expr] as dimensioned or arrayed variables. × We refer × to variables × that contain a letter × or a letter and a number as scalar variables. Any variables entered in lower case are changed × to × upper case. We refer × to variables as:

[var].

The BASIC module × allocates variables × in a “static” manner. This means that × the first time a variable × is used, BASIC allocates a portion of memory (8 bytes) × specifically × for that variable. This memory cannot be de-allocated × on a variable to variable basis. This means that × if you execute × a statement (e.g. × Q 3), you cannot × tell BASIC × that the variable Q no longer exists to “free up” the 8 bytes of memory that belong to Q. You can × clear × the memory allocated × to variables by executing a CLEAR statement. × The CLEAR statement “frees” all memory allocated × to variables.

5.2.8 Variables (continued)

Important: The BASIC Module requires less time to find a scalar variable because there is no expression × to evaluate. If you want to × run a program as × fast as possible, × use dimensioned × variables only when necessary. Use scalars × for intermediate variables and assign the final result to a dimensioned × variable. Also, put the most frequently × used variables × first. Variables defined first × require the least amount of time to locate.

5.2.9 Expressions

An expression × is a logical × mathematical × expression that involves operators (both unary and dyadic), × constants and variables. × Expressions are simple or complex, (e.g. 12*EXP(A)/100, H(1) × + 55, or (SIN(A)*SIN(A)+COS(A)* COS(A)/2). × A “stand alone” × variable [var] or constant [const] is also considered an expression. We refer × to expressions as:

[expr].

5.2.10 Relational Expressions

Relational × expressions involve × the operators × EQUAL (=), × NOT EQUAL (< >), GREATER THAN × OR × EQUAL TO × (>=), and LESS THAN OR × EQUAL TO (<=). You use them in control statements to test a condition × (i.e. IF A <100 THEN...). Relational × expressions always require two operands. × We refer to relational expressions × as:

[rel expr].

5.2.11 System Control Values

The system control values include × the following:

- LEN (returns the length of your program).
- MTOP (the last memory location assigned to BASIC).

See the following × Section × 5.6.2 × titled, “System Control Values” for more information.

5.2.12 Argument Stack

The argument stack (A-stack) stores all constants that the BASIC Module is currently using. Operations such as add, subtract, × multiply × and divide always operate × on the first two numbers on × the argument × stack × and return × the result to the stack. × The argument × stack × is 203 bytes long. Each floating point × number placed on the stack requires × 6 bytes of storage. The argument stack can hold up to 33 floating × point numbers before × overflowing.

5.2.13 Control Stack

The control stack (C-stack) × stores all information × associated with loop control (i.e. DO-WHILE, DO-UNTIL, × FOR-NEXT, BASIC subroutines and “PUSHed” or “POPed” values). The control × stack is 157 bytes long. DO-WHILE and × DO-UNTIL loops × use 3 bytes of control × stack. FOR-NEXT loops × use 17 bytes. × The control × stack contains × enough space × for up to 9 nestings × of control × loops.

5.3 Description of Commands

The × following × sections list and describe × the commands × you can use with the BASIC Module.

5.3.1 Command: RUN

Action Taken: × After you type RUN, all variables × are set equal to zero, × all BASIC × evoked × interrupts × are cleared and program execution begins with the first line number of the selected program. The RUN command and the × GOTO statement are the only way you can place the BASIC Module × interpreter × into the RUN mode × from the COMMAND mode. You can terminate program execution × at any time by typing a Control C on × the × console device.

Variations: × Some BASIC interpreters allow a line number to follow the RUN command × (i.e. × RUN 100). The BASIC × Module does not permit this variation on the RUN command. Execution begins with the first line number. To obtain a function similar to the RUN[ln num] command, × use the GOTO[ln × num] statement × in the direct mode. See statement GOTO.

Example:

```
>10 FOR I=1 TO 3
>20 PRINT I
>30 NEXT × I
>40 END
>RUN

 1
 2
 3

READY
>
```

5.3.2 Command: CONT

Action × Taken: If × you stop a program by × typing a Control C on the console × device or by execution × of a STOP statement, × you can resume execution of the program by typing × CONT. If × you enter × a Control × C during the execution × of a CALL routine × you cannot × CONTinue. Between × the stopping and the re-starting of the program you × may display the values of variables × or change the × values of variables. However, you cannot CONTinue if × the program is × modified × during the STOP or after × an error.

Example:

```
>10 FOR I=1 TO 10000
>20 PRINT × I
>30 PRINT × I
>40 END
>RUN

  1
  2
  3
  4
  5– (TYPE CONTROL × C × ON CONSOLE)

STOP – IN LINE 20

READY
>PRINT I
  6

>I=10

>CONT
  10
  11
  12
```

5.3.3 Command: LIST

Action × taken: The LIST command prints the program to × the console device. Spaces are inserted after the line number, and before × and after statements. × This helps in the debugging of BASIC Module programs. You can × terminate the “listing” × of a program at anytime × by typing a Control × C on the console device. You can interrupt and continue × the listing using Control S and Control Q.

5.3.3 Command: LIST (continued)

Variations: Two variations of the LIST command are possible with the BASIC Module.

They are:

1. LIST [ln num] (cr)×and
2. LIST [ln num] – [ln num] (cr)

The first×variation×causes the program to print×from the designated line×number (integer) to the end of the program. The second variation causes the program to print from the first line number (integer)×to the second line×number (integer).

Important: You must×separate×the two line×numbers with×a dash (–).

Example:

```
READY
>LIST
>10 PRINT “LOOP PROGRAM”
>20 FOR I=1 TO 3
>30 PRINT I
>40 NEXT I
>50 END
READY
>LIST 30
>30 PRINT I
>40 NEXT I
>50 END
READY
>LIST 20–40
>20 FOR I=1 TO 3
>30 PRINT I
>40 NEXT I
```

5.3.4 Command: LIST# or LIST®

Action×taken: The LIST#×or LIST@ command lists the program to the device attached to the peripheral port (LIST device).×All comments that×apply to the LIST command apply to the LIST# or×LIST@ commands. We×include these commands to×permit you to make “hard copy×printouts” of a×program.×A configuration×plug sets the baud rate and must match your list×device (see section 3.2.4 titled, “Configuration Plugs”).×Also, you must configure×the peripheral×port parameters to×match your×particular×list device (see section 5.8.1 titled,×“Peripheral Port×Support×– Parameter Set×– CALL 30”).

5.3.5 Command: NEW

Action taken: When you enter NEW(cr), × the × BASIC Module deletes the program that × is currently stored in RAM memory. In addition, all variables are set equal to ZERO, all strings and all BASIC evoked interrupts × are cleared. The REAL TIME CLOCK, × string allocation, and the internal stack pointer values are not affected. × In general, NEW (cr) is used to erase a program and × all × variables.

5.3.6 Command: NULL [integer]

Action taken: The NULL[integer] command × determines × how many NULL characters × (00H) the BASIC Module outputs after a carriage return. After initialization NULL 0. × Most printers × contain × a RAM buffer that eliminates the need to output NULL characters × after a carriage return.

5.3.7 Command: Control C

Action taken: This command stops × execution of the current program and returns the BASIC Module × to the COMMAND mode. In some cases you can continue × execution using a CONTinue. See × the explanation for CONTinue for more information.

5.3.7.1 Command: Disabling Control C

Action taken: This command disables × the Control C break × function. You can × do this × by setting × bit 48 (30H) to 1. Bit 48 is located in internal memory location 38 (26H). Set bit 48 by executing the following statement in a BASIC Module program or from the × command mode:

```
DBY(38) × DBY(38).OR.01H
```

When bit × 48 is set to 1, the Control C break × function for both LIST and RUN operations × is disabled. Cycling power returns Control C to normal operation × if it is disabled × from the command mode.

To re-enable the Control × C function, execute the following statement in a BASIC Module × program or × from the × command mode.

```
DBY(38) × DBY(38).AND.0FEH
```

CALL routines × do not check for this feature. If you enter a Control C while × using a CALL routine, the program stops if Control C is enabled or disabled.

5.3.8 Command: Control S

Action × taken: This command interrupts × the scrolling × of a BASIC program × during the execution of a LIST command. × It also × stops output from the receiving × port if you are running a program. × In this case XOFF (Control S) operates as follows:

1. XOFF only operates on PRINT statements.
2. When received during a PRINT, × data × output × and program execution are suspended immediately.
3. When received at any other time, × program execution continues until a PRINT is × encountered. × At this time program execution × is suspended.
4. XON (Control × Q) is required × to resume program operation.

5.3.9 Command: Control Q

Action × taken: This command restarts a LIST command or PRINT output that × is interrupted by a Control S.

5.3.10 Overview of EPROM File Commands

Your BASIC Module × can × execute and SAVE up to 255 programs × in an EPROM. The × module × generates × all of the timing × signals needed to program most × EPROM devices. The programs × are × stored in sequence in the EPROM for × retrieval and execution. This sequential storing of programs is × called the EPROM FILE. The following commands allow × you to generate × and manipulate × the × EPROM FILE.

5.3.11 Commands: RAM and ROM [integer]

Action × taken: These two commands tell × the the BASIC Module interpreter whether to select the current program out of RAM or EPROM. The × current program is × displayed × during a LIST command and executed × when RUN is typed.

5.3.11 Commands: RAM and ROM [integer] (continued)

5.3.11.1 RAM

When you enter RAM(cr), the BASIC Module × selects × the current program from × RAM MEMORY.

Important: RAM × space × is limited to 13 K bytes. × Use the following formula × to calculate the available × user RAM space:

LEN system × control × value which contains × current × RAM program length

+# bytes allocated × for strings × (first × value in the STRING instruction)

+6 * each array × size × + 1 × (asterisk = × multiply)

+8 * each variable × used (including × each array name)

+1024 – number of × bytes reserved × for BASIC
V

Available × user × RAM= MTOP–V

5.3.11.2 ROM

When you enter ROM [integer], × the BASIC Module × selects the current program out × of EPROM memory. If × no integer × is typed after the ROM command (i.e. × ROM) the module defaults × to ROM 1. × Since the programs are × stored × in sequence × in EPROM, the integer × following the ROM command × selects × which program the user wants to × run or list. If you attempt × to select a program that does not exist × (e.g. you type in ROM 8 and only × 6 programs are stored × in the EPROM) the message ERROR: PROM MODE is × displayed.

The module × does not transfer × the program from EPROM to RAM when the × ROM mode × is × selected. × If you attempt to alter a program in the ROM mode, by typing in a line × number, the message ERROR: PROM MODE displays. × The XFER command allows × you to transfer a program from × EPROM to RAM for × editing × purposes. × You get no error message if × you attempt to edit a line of ROM program.

Important: When × you transfer programs from × EPROM to RAM you lose × the previous × RAM contents.

Since the ROM command does NOT transfer a program to RAM, it × is possible to have different × programs in × ROM and RAM simultaneously. You can × move back × and forth between the two modes when in command mode. If you are in run mode you can change × back × and forth using CALLS 70, 71 and 72. You can also use all of the RAM memory for variable storage if the program is stored in EPROM. The × system control value – MTOP always refers × to RAM. The system control value, LEN, refers × to the currently × selected program in RAM or × ROM.

5.3.12 Command: XFER

Action × taken: The XFER (transfer) × command transfers the current selected × program in × EPROM to × RAM and × then selects the RAM mode. If × you type × XFER while × the BASIC Module × is in the RAM mode, × the × program stored in RAM is × transferred back into × RAM and × the RAM mode × is × selected. After the XFER command executes, you can edit × the program in the same way you edit any RAM program.

Important: The XFER command × clears existing RAM programs.

5.3.13 Command: PROG

Important: Before × you attempt to program a × PROM, read the PROG, PROG1 × and × PROG2 sections of this chapter. Some PROG options exclude × the use of others.

Action × taken: The PROG command × programs × the resident EPROM with the current × program. × The current selected program may reside × in either RAM or EPROM. See Section 3.4, titled "Installing × the User Prom", for × additional information × concerning EPROM's.

Important: Be × sure × you have selected the program you want to save before × using the PROG command. Your × module does not automatically copy the RAM program to × ROM. You must also disable interrupts prior to the PROG, PROG1 × or PROG2 commands using × CALL 8 × and enable interrupts × after the PROM is × burned using × CALL 9. × If an error × occurs during EPROM programming, the × message ERROR PROGRAMMING is × displayed. When this × error occurs:

- previously × stored programs may or × may not × be accessible.
- you cannot × store × additional programs on this PROM.

After you type × PROG(cr), the BASIC Module displays × the number in the EPROM FILE × the × program occupies. Programming × can × take up to 12 minutes × to complete depending × on the length × of the program (51 seconds per K bytes of program).

5.3.13 Command: PROG (continued)

Example:

```
>LIST
10 FOR I=1 TO 10
20 PRINT×I
30 NEXT I
40 END
READY
>CALL 8 :REM DISABLE INTERRUPTS
>PROG
12
>READY CALL 9 :REM ENABLE×INTERRUPTS
>ROM 12
READY
>LIST 10 FOR I=1 TO 10
20 PRINT×I
30 NEXT×I
40 END
READY
>
```

In this×example, the program just placed in the EPROM is×the 12th program stored.

Important: If you exceed×the available PROM space,×you cannot continue×programming until it is erased. In some cases you can alter×the previously stored programs.×Be sure×to use CALL 81×to determine memory space prior to burning. See section×5.3.13.1×below.

5.3.13.1 User PROM Check×and×Description – CALL 81

Use CALL 81×in command mode before burning a program into PROM×memory. This×CALL:

- determines×the number of×PROM programs.
- determines×the number of×bytes left×in PROM.
- determines×the number of×bytes in the×RAM program.
- prints×a message telling if enough space is available in×PROM for the RAM program.
- checks×for×a valid PROM if×it contains×no×program.
- prints×a good or×bad PROM message. A bad PROM message with an address of 00xx×indicates an incomplete program.

No×PUSHes or POPs are×needed.

5.3.14 Command: PROG1

Action taken: × You can use the PROG1 × command to program the resident EPROM with × baud rate information. × When the module is “powered-up” × the module reads this information and × initializes × the program port with the stored baud rate. The × “sign-on” message is sent to the × console immediately after × the module × completes its reset sequence. × If the baud rate on × the console device is changed you must program × a new EPROM to make × the module compatible with the new console.

If × you have × already used a PROG2 command, you cannot × use the PROG 1 command.

5.3.15 Command: PROG2

Action taken: × The PROG2 × command functions the same as the PROG1 command × except for the following. Instead of “signing-on” and entering the command × mode, the module immediately × begins executing the first program stored in the resident EPROM, if no program × is stored in RAM. Otherwise it × executes the RAM program. × You can use the PROG2 command to RUN a program on power-up without × connecting to a console. × Saving PROG2 information is the same as typing a ROM 1, RUN command sequence. This feature × also allows you to write a special initialization × sequence in BASIC and × generate a custom “sign-on” message for specific applications.

If × you have × already used a PROG1 command, × you cannot × use the PROG 2 command.

5.3.15 Command: PROG2 (continued)

Figure 5.1
Flow Chart of Power-up Operation

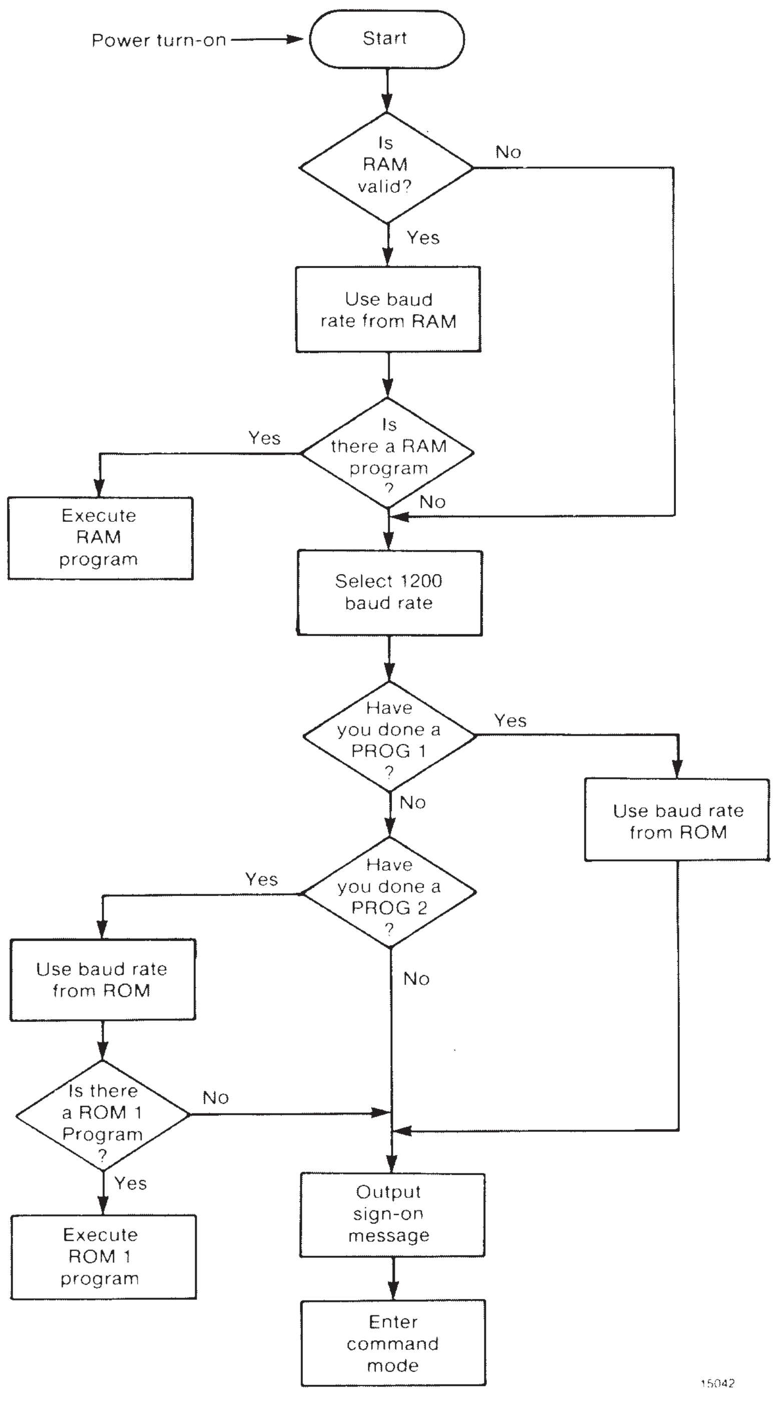


Figure 5.1 shows BASIC Module operation from a power-up condition using PROG1 or PROG2; or battery backed RAM.

5.4 Description of Statements

The × following sections list and describe the statements × you can × use with the BASIC Module.

5.4.1 Statement: CALL [integer]

Mode: × COMMAND AND/ OR RUN
Type: × CONTROL

You × use the CALL [integer] statement to call specially × written BASIC Module application programs. Specific × call numbers are × defined later in this chapter.

5.4.2 Statement: CLEAR

Mode: × COMMAND AND/OR RUN
Type: × CONTROL

The × CLEAR statement × sets all variables equal to 0 and resets all BASIC × evoked interrupts and stacks. This means that after × the CLEAR statement is executed an ONTIME statement × must be executed before the module acknowledges the × internal timer interrupts. ERROR trapping using the ONE × RR statement also does not occur × until an ONERR[integer] × statement is executed. The CLEAR statement × does not affect × the real time clock × that is enabled by × the × CLOCK1 statement. × CLEAR also does not reset the memory that has been allocated × for strings, × so it is not necessary × to enter × the STRING [expr], × [expr] statement × to re-allocate × memory for strings after the CLEAR × statement × is executed. In general, × CLEAR is used × to “erase” × all variables.

5.4.3 Statement: CLEARI (clear interrupts)

Mode: × COMMAND AND/OR RUN
Type: × CONTROL

The × CLEARI statement clears all of the BASIC evoked interrupts. × The ONTIME interrupt × disables after the CLEARI statement × executes. CLEARI does not affect × the real time clock × enabled × by the CLOCK1 statement. You can use this statement × to selectively × DISABLE ONTIME interrupts during specific × sections of your BASIC × program. You must × execute the × ONTIME statement again before the specific interrupts enable.

Important: When the CLEARI × statement is LISTED it appears × as CLEAR × I.

5.4.4 Statement: CLEARS

Mode: × COMMAND/RUN
Type: CONTROL

The CLEARS statement resets × all of the module’s × stacks. × The control, × argument and internal × stacks all reset to their initialization values. You can use this × command to reset the stack if an error × occurs in a subroutine.

Important: When the × CLEARS statement is LISTed it appears as CLEAR S.

5.4.5 Statements: CLOCK1 and CLOCK0

Mode: COMMAND AND/OR × RUN
Type: CONTROL

CLOCK1

The CLOCK1 statement enables the real time clock × feature × resident on the BASIC Module. × The special × function operator TIME is incremented × once every × 5 milliseconds after the CLOCK1 statement is executed. The CLOCK1 STATEMENT uses an internal TIMER to generate an interrupt once every 5 milliseconds. × Because of this, the special × function operator TIME has a resolution × of 5 milliseconds. The special × function operator × TIME counts × from 0 to 65535.995 seconds. × After reaching × a count of 65535.995 seconds × TIME overflows × back to a count of zero. The interrupts associated × with the CLOCK1 statement × cause the module programs to × run at about 99.6% of normal speed. × That means that the interrupt handling for × the REAL TIME × CLOCK feature uses about .4% of × the total CPU time.

CLOCK0

The CLOCK0 (zero) × statement × disables × or “turns × off” the real time clock feature. After CLOCK0 is executed, × the special function operator TIME no longer × increments. CLOCK0 is × the only × module statement that can disable the real time clock. CLEAR and × CLEARI do NOT disable the real time clock, only × its associated ONTIME interrupt.

Important: CLOCK1 and CLOCK0 are independent of the × wall clock.

5.4.6 Statements: DATA – READ – RESTORE

Mode: RUN
Type: Assignment

DATA

DATA specifies expressions that you can retrieve using a READ statement. If multiple expressions per line are used, you MUST separate them with a comma.

Example:

```
>10×DATA    10,ASC(A), ASC(B), 35.627
```

Important: You cannot×use the CHR() operator×in a DATA statement.

READ

READ retrieves the expressions×that are specified in the DATA statement and assigns×the value of the expression to the variable in the READ statement.×The READ statement is×always followed×by one or more variables. If more than one variable×follows×a READ statement, they are separated by a comma.

RESTORE

RESTORE "resets"×the internal read pointer×to the beginning of the data so that it may be read again.

Example:

```
>10 FOR I=1 TO 3
>20 READ A,B
>30 PRINT A,B
>40 NEXT I
>50 RESTORE
>60 READ A,B
>70 PRINT A,B
>80 DATA 10,20,×10/2,20/2,SIN(PI),COS(PI)
>RUN

    10    20
     5    10
     0    –1
    10    20
```

Every time×a READ statement×is encountered the next consecutive expression×in the DATA statement×is evaluated and assigned×to the variable in the READ statement.×You can place DATA statements anywhere within a program.×They are not executed×and do not cause an error. DATA statements are considered to be chained×together and appear to be one large DATA statement. If at anytime all the data is read and another READ statement is executed,×the program terminates and the message ERROR: NO×DATA×– IN LINE XX×prints to the console device.

5.4.7 Statement: DIM

Mode:×COMMAND×AND/OR RUN
Type:×Assignment

DIM reserves storage for matrices. The storage×area is first assumed×to be zero.×Matrices×in the BASIC Module×may have only×one dimension and the size×of the dimensioned×array may not×exceed 254 elements. Once a variable is dimensioned in×a program it may not be re-dimensioned.×An attempt to re-dimension×an array causes an ARRAY SIZE×ERROR. If an arrayed×variable is used that is not dimensioned by the DIM statement,×BASIC assigns a default×value of 10 to the array size. All arrays are set equal×to zero×when the RUN command, NEW command×or the×CLEAR×statement is executed. The number of bytes allocated×for an array is 6 times×the array size×plus 1. The array×A(100) requires×606 bytes of storage. Memory×size usually limits the size of a dimensioned×array.

Variations: More than one variable×can be dimensioned×by a single DIM statement.

Example:

```
>10 DIM A(25), B(15), A1(20)
```

Example: Default error on attempt to re-dimension×array

```
>10 A(5)10 –BASIC ASSIGNS DEFAULT OF 10 TO ARRAY SIZE HERE
>20 DIM A(5) –ARRAY CANNOT BE RE–DIMENSIONED
>RUN

ERROR: ARRAY SIZE – IN LINE×20

20      DIM×A(5)
------  X
```

5.4.8 Statements: DO – UNTIL [rel expr]

Mode:×RUN
Type:×CONTROL

The DO – UNTIL×[rel expr] instruction provides a means of "loop control"×within a module×program.×All statements between×the DO and×the UNTIL [rel expr]×are executed until the relational×expression following the UNTIL statement is TRUE.×You may nest×DO – UNTIL loops.

5.4.8 Statements: DO – UNTIL [rel expr] (continued)

Examples:

SIMPLE DO-UNTIL

```
>10 A=0
>20 DO
>30 A=A+1

>40 PRINT A
>50 UNTIL A=4
>60 PRINT "DONE"
>70 END
>RUN

 1
 2
 3
 4

DONE

READY
>
```

NESTED DO-UNTIL

```
>10 DO
>20 A=A+1
>30 DO
>40 B=B+1
>50 PRINT A,B,A,*B
>60 UNTIL B=3
>70 B=0
>80 UNTIL A=3
>90 END
>RUN

 1 1 1
 1 2 2
 1 3 3
 2 1 2
 2 2 4
 2 3 6
 3 1 3
 3 2 6
 3 3 9

 READY
 >
```

5.4.9 Statements: DO – WHILE [rel expr] (continued)

Mode: RUN
Type: CONTROL

The × DO – WHILE [rel expr] instruction × provides a means of “loop control” within a module program. The operation of this statement is similar to the DO – × UNTIL [rel expr] except that all × statements between × the DO and the × WHILE [rel expr] are executed as long as the relational × expression following the WHILE statement × is true. You can nest × DO – WHILE and DO – × UNTIL statements.

Examples:

SIMPLE DO-WHILE

```
>10 DO
>20 A=A+1
>30 PRINT A
>40 WHILE At4
>50 PRINT “DONE”
>60 END
>RUN



1
2
3
4
DONE

READY
>
```

NESTED
DO-WHILE - DO-UNTIL

```
>10 DO
>20 PRINT A=A+1
>25 DO
>30 B=B+1
>40 A,B,A*B
>50 WHILE B< >3
>60 B=0
>70 UNTIL A=3
>80 END
>RUN
1 1 1
1 2 2
1 3 3
2 1 2
2 2 4
2 3 6
3 1 3
3 2 6
3 3 9

READY
>
```

5.4.10 Statement: END

Mode: RUN
Type: CONTROL

The END statement × terminates program execution. × The continue comm and, CONT does × not operate × if the END statement × is used to terminate execution. A CAN’T CONTINUE ERROR prints to the console. The last statement in a module program × automatically terminates program execution × if you do not use an end statement. × You should always × use an END statement × to terminate a program.

Examples:

END STATEMENT TERMINATION

```
>10 FOR I=1 TO 4
>20 GOSUB 100
>30 NEXT I
>40 END
>100 PRINT × I
>110 RETURN
>RUN

1
2
3
4

READY
>
```

Variations: × None

5.4.11 Statements: FOR – TO – (STEP) – NEXT

Mode: RUN
Type: CONTROL

Use the × FOR – TO – (STEP) – NEXT statements × to set up and control loops.

Example:

```
>5 B=0: × C=10 : D=2
>10 FOR A= × B TO C STEP D
>20 PRINT × A
>30 NEXT A
>40 END
```

5.4.11 Statements: FOR – TO – (STEP) – NEXT (continued)

Since B=0, C=10 and D=2, × the PRINT statement × at line × 20 executes 6 times. The values of “A” printed are 0, 2, 4, 6, 8 and 10. “A” represents the name of × the index or loop counter. The value of “B” is the starting value of the index. The value × of “C” is the limit × value of the index and the × value of “D” is the increment × to the index. If the STEP statement and the value “D” are omitted, × the increment × value × defaults × to 1, therefore, STEP is an optional statement. × The NEXT statement × adds the value of “D” to the index. × The index is then compared to the value of “C”, the limit. × If the index is less than or equal to the limit, control transfers × back to the statement × after × the FOR statement. × Stepping “backwards” × (FOR × I= 100 TO 1 STEP–1) is × permitted in the BASIC Module. You may not × omit the index from the × NEXT statement in the module (The NEXT statement × is always followed by the appropriate variable). You may nest FOR-NEXT loops up to 9 times.

Examples:

```
>10 FOR I=1 TO 4            >10 FOR I=O TO 8 STEP 2
>20 PRINT I,                >20 PRINT I
>30 NEXT I                  >30 NEXT I
>40 END                     >40 END
>RUN                        >RUN

  1 2 3 4                   0
                            2
                            4
                            6
                            8

READY
>                           READY
                            >
```

5.4.12 Statements: GOSUB [ln num] – RETURN

Mode: RUN
Type: CONTROL

GOSUB

The GO SUB [ln × num] statement × causes × the BASIC Module × to transfer × control of the program directly to the line number ([ln num]) following the GOSUB statement. × In addition, × the GOSUB statement saves the location × of the statement following × GOSUB on the control stack so that you can perform a RETURN statement to return × control × to the statement × following × the most recently × executed GO SUB STATEMENT.

5.4.12 Statements: GOSUB [ln num] – RETURN (continued)

RETURN

Use this statement × to “return” × control to the statement following × the most recently executed GO SUB STATEMENT. Use one return for each GOSUB to × avoid overflowing × the C-STACK. This × means that × a subroutine × called × by the GO SUB statement × can call another subroutine with another GOSUB statement.

Examples:

```
SIMPLE SUBROUTINE NESTED SUBROUTINES

>10 FOR I=1 TO 5        >10 FOR I=1 TO 3
>20 GOSUB 100           >20 GOSUB 100
>30 NEXT I              >30 NEXT I
>40 END                 >40 END
>100 PRINT I            >100 REM USER SUBROUTINE HERE
>110 RETURN             >105 PRINT I,
>RUN                    >110 GOSUB 200
 1                      >200 PRINT I,I*I
 2                      >210 RETURN
 3                      >RUN
 4
 5                         1  1
                           2  4
READY                      3  9
>
                        READY
                        >
```

5.4.13 Statement: GOTO [ln num]

Mode: COMMAND AND/OR × RUN
Type: CONTROL

The GOTO [ln num] statement × causes BASIC to transfer control directly to the line number ([ln × num]) following the GOTO statement.

Example:

```
>50 GOTO 100
```

If × line 100 exists, × this statement causes × execution × of the program to resume at line 100. If line number 100 does not exist the message ERROR: INVALID × LINE × NUMBER × is printed to the console device.

5.4.13 Statement: GOTO [ln num] (continued)

Unlike the RUN command the GOTO statement, if executed in the COMMAND mode, does × not clear the variable storage space or interrupts. × However, if × the GOTO statement is executed in the COMMAND mode after a line × is edited the module clears × the variable storage × space and all BASIC evoked interrupts. This is necessary because × the variable storage and the BASIC program reside in the same RAM memory. Because × of this editing a program can destroy variables.

5.4.14 Statements: ON [expr] GOTO [ln num], [ln num],...[ln num], ON [expr] GOSUB[ln num], [ln num],...[ln num]

Mode: RUN
Type: × CONTROL

The value × of the expression × following × the ON statement × is the number in the line list that control is transferred to.

Example:

```
>10 ON Q GOTO 100,200,300
```

If Q is equal to 0, control × is transferred × to line number 100. × If Q is equal to 1, control is transferred to line number 200. If Q is equal to 2, GOTO line 300, etc. All comments that apply to GOTO and × GOSUB apply × to the ON statement. If Q is less than × ZERO a BAD ARGUMENT ERROR × is × generated. × If Q is greater than the line number list × following × the GOTO or GOSUB statement, a BAD SYNTAX × ERROR × is generated. The ON statement × provides "conditional branching" × options within the constructs of a BASIC Module × program.

5.4.15 Statements: IF – THEN – ELSE

Mode: RUN
Type: × CONTROL

The IF statement sets up a conditional test. The general form of the IF – THEN – × ELSE statement follows:

> [ln num] IF [rel expr] THEN valid × statement × ELSE valid statement

Example:

```
>10 IF × A=100 THEN A=0 ELSE A=A+1
```

5.4.15 Statements: IF – THEN – ELSE (continued)

Upon execution × of line 10 IF A is × equal to 100, THEN A is assigned a value of 0. IF A does not equal 100, A is × assigned a value of A+1. If you want to × transfer × control to different line numbers using the IF statement, you may omit × the GOTO statement. × The following examples give × the same results:

```
>20 IF × INT(A) × <10 THEN GOTO × 100 × ELSE GOTO 200
                          or
>20 IF × INT(A) × <10 THEN 100 ELSE 200
```

You can replace × the THEN statement × with any valid × BASIC Module statement, as shown below:

```
>30 IF × A<> 10 THEN PRINT × A × ELSE 10

>30 IF × A<> 10 PRINT × A × ELSE 10
```

You may execute × multiple × statements following × the THEN or ELSE if × you use a colon to separate them.

Example:

```
>30 IF × A<> 10 THEN PRINT × A:GOTO × 150 × ELSE 10

>30 IF × A<> 10 PRINT × A:GOTO 150 ELSE 10
```

In these examples, × if × A does not equal 10 then both PRINT A and GOTO 150 × are executed. × If A10, then control passes to 10.

You may omit the ELSE statement. If you omit the ELSE statement control passes to the next statement.

Example:

```
>20 IF × A10 THEN 40

>30 PRINT × A
```

In this example, if A equals × 10 then control × passes to line number 40. If A does not equal 10 line × number 30 × is executed.

5.4.16 Statement: INPUT

Mode: RUN
Type: × INPUT/OUTPUT

The INPUT statement allows you to enter data from the console during program × execution. You may assign data to one or more variables with a single × input statement. × You must separate the variables × with a comma.

Example:

```
>INPUT A,B
```

5.4.16 Statement: INPUT (continued)

Causes a question × mark (?) × to print on the console device. × This prompts × you to input × two numbers separated × by a comma. If you do not enter × enough data, the module prints × TRY AGAIN on the console device.

Example:

```
>10 INPUT A,B
>20 PRINT A,B
>RUN

?1

TRY AGAIN

?1,2
1    2

READY
```

You can × write the INPUT statement × so that × a descriptive prompt tells you what to × enter. The message to be printed × is placed in quotes after the INPUT statement. × If a comma appears × before the first variable on the input list, × the question mark prompt × character is not displayed.

Examples:

```
>10 INPUT“ENTER A NUMBER” A
>20 PRINT SQR(A)
>30 END
>RUN

ENTER A NUMBER
?100
10
```

```
>10 INPUT”ENTER A NUMBER–”,A
>20 PRINT SQR(A)
>30 END
>RUN

ENTER A NUMBER–100
10
```

You can × also assign strings with an INPUT statement. Strings × are always terminated with a carriage × return (cr). If more than one string input is requested × with a single INPUT statement, the module prompts you × with × a question mark.

5.4.16 Statement: INPUT (continued)

Examples:

```
>10 STRING 110,10
>20 INPUT “NAME:”,$(1)
>30 PRINT “HI”,$(1)
>40 END
>RUN

NAME: SUSAN
HI SUSAN

READY
```

```
>10 STRING 110,10
>20 INPUT “NAMES:”,$(1),$(2)
>30 PRINT “HI”,$(1),“ AND “,$(2)
>40 END
>RUN

NAMES: BILL
?ANN
HI BILL AND ANN

READY
```

You can assign × strings and variables with a single × INPUT statement.

Example:

```
>10 STRING 100,10
>20 INPUT“NAME(CR), × AGE – ”,$(1),A
>30 PRINT “HELLO ”,$(1),“, × YOU ARE ”,A,“YEARS × OLD”
>40 END
>RUN

NAME(CR), AGE – × FRED
?15
HELLO FRED, × YOU × ARE × 15 × YEARS OLD

READY
>
```

5.4.17 Statement: LD@ [expr]

Mode: COMMAND AND/OR × RUN

This statement, along with CALL 77, allows you to save/retrieve variables × to/from a protected × area of memory. This protected × area is not zeroed on power-up × or when the RUN command is issued. The LD@ statement takes × the variable stored at address × [expr] and moves it × to the top of the argument stack. × For more information on protecting variables, × see section 5.11.6, “Protected Variable Storage × – CALL 77”.

5.4.18 Statement: LET

Mode: COMMAND AND/OR × RUN
Type: × ASSIGNMENT

Use the × LET statement × to assign a variable to the value of an expression. × The general × form of × LET is:

LET [var] = [expr]

Examples:

LET A =10*SIN(B)/100 × or

LET A = A+1

Note that × the = sign × used in the LET statement × is not an equality operator. It is a “replacement” operator. The statement × should × be read A is × replaced by A plus one. The word LET is always optional, × (i.e. LET A =2 is the same as A × =2).

When LET is × omitted × the LET statement is called × an IMPLIED LET. We use × the word LET to refer × to both the LET statement × and the × IMPLIED LET statement.

Also use the LET statement to assign the string × variables:

LET $(1)=“THIS × IS A STRING” or

LET $(2)=$(1)

Before × you can assign strings you must execute the STRING [expr], [expr] statement or else a MEMORY ALLOCATION ERROR occurs. See the following × section × 5.4.31 titled, “STRING”.

5.4.19 Statement: ONERR [ln num)

Mode: RUN
Type:×CONTROL

The ONERR[ln num]×statement lets you handle×arithmetic errors, if they occur, during program execution.×Only ARITH. OVERFLOW, ARITH. UNDERFLOW,×DIVIDE BY ZERO and BAD ARGUMENT errors×are “trapped”×by the ONE RR×statement.×All other errors are not “trapped”.×If an arithmetic error×occurs after×the ONE RR statement×is executed,×the module interpreter passes control to the line number following the ONERR[ln num] statement. You handle the error condition in a manner suitable to the particular×application. The ONERR command×does not trap×bad data×entered during an input instruction.×This yields×a “TRY AGAIN”×message×or “EXTRA IGNORED”×message.×See Chapter×9 for an explanation of errors.

With the×ONERR[ln num] statement,×you have the option of determining what×type of error×occurred. Do this×by examining external×memory location 257 (101H)×after the error×condition×is trapped.

The error codes are:

ERROR×CODE =10×– DIVIDE BY ZERO

ERROR×CODE =20×– ARITH. OVERFLOW

ERROR×CODE×=30 – ARITH. UNDERFLOW

ERROR CODE =40 – BAD ARGUMENT

You can examine this location×by using an XBY(257) statement.

Example:

```
PRINT XBY(257)

     or

E XBY(257)
```

5.4.20 Statement: ONTIME [expr],[ln num]

Mode: RUN
Type: CONTROL

Your BASIC Module can process a line in milliseconds while the timer/counters on the microprocessor operate in microseconds. You must use the ONTIME [expr], [In num] statement because of this incompatibility between the timer/counters on the microprocessor and the BASIC Module. The ONTIME statement generates an interrupt every time the special function operator, TIME, is equal to or greater than the expression following the ON TIME statement. Only the integer portion of TIME is compared to the integer portion of the expression. This comparison is performed at the end (CR or:) of each line of BASIC. The interrupt forces a GOSUB to the line number [ln num]) following the expression ([expr]) in the ONTIME statement.

Important: The ONTIME statement does not interrupt an input command or a CALL routine. Since the ONTIME statement uses the special function operator, TIME, you must execute the CLOCK1 statement for ONTIME to operate. If CLOCK1 is not executed the special function operator, TIME, does not increment.

You can generate periodic interrupts by executing the ONTIME statement again in the interrupt routine:

Example:

```
>10 TIME=0 : CLOCK1 : ONTIME 2,100: DO
>20 WHILE TIME<10 : END
>100 PRINT “TIMER INTERRUPT AT –”,TIME,“SECONDS”
>110 ONTIME TIME+2,100 : RETI
 >RUN

TIMER INTERRUPT AT – 2.045 SECONDS
TIMER INTERRUPT AT – 4.045 SECONDS
TIMER INTERRUPT AT – 6.045 SECONDS
TIMER INTERRUPT AT – 8.045 SECONDS
TIMER INTERRUPT AT – 10.045 SECONDS

READY
```

The terminal used in this example runs at 4800 baud. This baud rate allows about 45 milliseconds to print the message TIMER INTERRUPT AT –“ ”. The resulting printed time is 45 milliseconds greater than the planned time.

5.4.20 Statement: ONTIME [expr], [ln num] (continued)

If you do not want this delay, you should assign a variable to the special function operator, TIME, at the beginning of the interrupt routine.

Example:

```
>10 TIME=0 : CLOCK1 : ONTIME 2,100: DO
>20 WHILE TIME <10: END
>100 A=TIME
>110 PRINT “TIMER INTERRUPT AT –”,A,“SECONDS”
>120 ONTIME A+2,100 : RETI
>RUN

TIMER INTERRUPT AT – 2 SECONDS
TIMER INTERRUPT AT – 4 SECONDS
TIMER INTERRUPT AT – 6 SECONDS
TIMER INTERRUPT AT –8 SECONDS
TIMER INTERRUPT AT – 10 SECONDS

READY
```

Important: You must exit the ONTIME interrupt routine with a RET I statement. Failure to do this “locks-out” all future interrupts.

The ONTIME statement eliminates the need for you to “test” the value of the TIME operator periodically throughout the BASIC program.

5.4.21 Statement: PRINT or P.

Mode: COMMAND and/or RUN
Type: INPUT/OUTPUT

The PRINT statement directs the BASIC Module to output to the console device. You may print the value of expressions, strings, literal values, variables or text strings. You may combine the various forms in the print list by separating them with commas. If the list is terminated with a comma, the carriage return/line feed is suppressed. P. is a “shorthand” notation for PRINT.

Examples:

```
>PRINT 10*10,3*3 > PRINT “MCS–51” > PRINT 5,1E3
  100   9             MCS–51              5  1000
```

Important: Values are printed next to one another with two intervening blanks. A PRINT statement with no arguments sends a carriage return/line feed sequence to the console device.

5.4.22 Special Print Formatting Statements

The following sections list and describe the special print formatting statements.

5.4.22.1 PRINT TAB([expr])

Use the TAB([expr]) function in the PRINT statement to cause data to print out in exact locations on the output device. TAB([expr]) tells the BASIC Module which position to begin printing the next value in the print list. If the printhead or cursor is on or beyond the specified TAB position, the module ignores the TAB function.

Example:

```
>PRINT TAB(5),“X”,TAB(10),“Y”
     X    Y
```

5.4.22.2 PRINT SPC([expr])

Use the SPC([expr]) function in the PRINT statement to cause the BASIC Module to output the number of spaces in the SPC argument.

Example:

```
> PRINT A,SPC(5),B
```

Use the above statement to place an additional 5 spaces between the A and B in addition to the two that would normally print.

5.4.22.3 PRINT CR

Use CR in a PRINT statement to force a carriage return, but no line feed. You can use CR to create one line on a CRT device that is repeatedly updated.

Example:

```
> 10 FOR I=1 TO 1000
>20 PRINT I,CR,
>30 NEXT I
```

The above example causes the output to remain on one line only. No line feed is ever sent to the console device.

5.4.22 Special Print Formatting Statements (continued)

5.4.22.4 PRINT USING (special characters)

Use the USING function to tell the BASIC Module what format to use when displaying printed values. The module "stores" the desired format after the USING statement is executed. All outputs following a USING statement are in the format evoked by the last USING statement executed. You do not need to execute the USING statement within every PRINT statement unless you want to change the format. U. is a "shorthand" notation for USING.

Important: The USING statement applies to numbers following it until another USING statement is encountered.

5.4.22.5 PRINT USING(Fx)

This forces the BASIC Module to output all numbers using the floating point format. The value of x determines how many significant digits are printed. If x equals 0, the module does not output any trailing zeros, so the number of digits varies depending upon the number. The module always outputs at least 3 significant digits even if x is 1 or 2. The maximum value for x is 8.

Example:

```
>10 PRINT USING(F3),1,2,3
>20 PRINT USING(F4),1,2,3
>30 PRINT USING(F5),1,2,3
>40 FOR I=10 TO 40 STEP 10
>50 PRINT I
>60 NEXT I
>RUN

 1.00 E 0    2.00 E 0    3.00 E 0
 1.000 E 0    2.000 E 0    3.000 E 0
 1.0000 E 0    2.0000 E 0   3.0000 E 0
 1.0000 E+1
 2.0000 E+1
 3.0000 E+1
 4.0000 E+1
 READY
```

5.4.22 Special Print Formatting Statements (continued)

5.4.22.6 PRINT USING(#.#)

This forces the module to output all numbers using an integer and/or fraction format. The number of "#"'s before the decimal point represents the number of significant integer digits that are printed and the number of "#"'s after the decimal point represents the number of digits that are printed in the fraction. Omit the decimal point to print integers only. You may use the abbreviation U for USING. USING(###.###), USING(######) and USING(######.##) are all valid in the BASIC Module. The maximum number of "#" characters is 8. If the module cannot output the value in the desired format (usually because the value is too large) a question mark (?) is printed to the console device. BASIC then outputs the number in the FREE FORMAT described below (refer to section 5.4.22.7).

Example:

```
>10 PRINT USING(##.##),1,2,3
>20 FOR I=1 TO 120 STEP 20
>30 PRINT I
>40 NEXT I
>50 END
>RUN
  1.00     2.00     3.00
  1.00
  21.00
  41.00
  61.00
  81.00
? 101

READY
```

Important: The USING(Fx) and the USING(#.#) formats always "align" the decimal points when printing a number. This makes displayed columns of numbers easy to read.

5.4.22.7 PRINT USING(0)

This argument lets the BASIC Module determine what format to use. If the number is between +/–99999999 and +/–.1, BASIC displays integers and fractions. If it is out of this range, BASIC uses the USING (F0) format. Leading and trailing zeros are always suppressed. After reset, the module is placed in the USING(0) format.

5.4.22 Special Print Formatting Statements (continued)

5.4.22.8 Reset Print Head Pointer – CALL 99

You can use CALL 99 when printing out wide forms to reset the internal print read/character counter and prevent the automatic CR/LF at character 79. You must keep track of the characters in each line.

You can solve this problem in revision A or B modules using DBY(1 6H) 0

Example:

```
>10 REM THIS PRINTS TIME BEYOND 80TH COLUMN
>20 PRINT TAB (79),
>30 CALL 99 40 PRINT TAB (41), “TIME –”,
>50 PRINT H , “:” , M , “:” ,S
>60 GOTO 20
>70 END
```

5.4.23 Statement: PRINT# or P.#

Mode: COMMAND and/or RUN
Type: INPUT/OUTPUT

The PRINT# (PRINT @) or P.# statement functions the same as the PRINT or P. statement except that the output is directed to the list device instead of the console device. The baud rate and peripheral port parameters must match your device. See Chapter 3 Section 3.2.4 titled, “Configuration Plugs” and Chapter 5 Section 5.8.1 titled, “Peripheral Port Support – Parameter Set – CALL 30″.

All comments that apply to the PRINT or P. statement apply to the PRINT# or P.# statement. P.# is a “shorthand” notation for PRINT#.

5.4.24 Statements: PH0., PH1., PH0.#, PH1.#

Mode: COMMAND and/or RUN
Type: INPUT/OUTPUT

The PH0. and PH1. statements function the same as the PRINT statement except that the values are printed out in a hexadecimal format. The PH0. statement suppresses two leading zeros if the number printed is less than 255 (0FFH). The PH1. statement always prints out four hexadecimal digits. The character "H" is always printed after the number when PH0. or PH1. is used to direct an output. The values printed are always truncated integers. If the number printed is not within the range of valid integer (i.e. between 0 and 65535 (0FFFFH) inclusive), the BASIC Module defaults to the normal mode of print. If this happens no "H" prints out after the value. Since integers are entered in either decimal or hexadecimal form the statements PRINT, PH0., and PH1. are used to perform decimal to hexadecimal and hexadecimal to decimal conversion. All comments that apply to the PRINT statement apply to the PH0. and PH1. statements. PH0.# and PH 1.# function the same as PH0. and PH1. respectively, except that the output is directed to the list device instead of the console device. The baud rate and peripheral port parameters must match your device. See Chapter 3 Section 3.2.4 titled, "Configuration Plugs" and Chapter 5 Section 5.8.1 titled, "Peripheral Port Support – Parameter Set – CALL 30".

Examples:

```
>PH0.2*2      >PH1.2*2      >PRINT 99 H  >PH0.100
 04H           0004H         153          64H
>PH0. 1000    >PH1. 1000    >P. 3E8H     >PH0.PI
 3E8H          03E8H         1000         03H
```

5.4.25 Statement: PUSH[expr]

Mode: COMMAND AND/OR RUN
Type: ASSIGNMENT

The arithmetic expression, or expressions, following the PUSH statement are evaluated and then placed in sequence on the BASIC Module's ARGUMENT STACK. This statement, in conjunction with the POP statement, provides a simple means of passing parameters to assembly language routines. In addition, the PUSH and POP statements are used to pass parameters to BASIC subroutines and to "SWAP" variables. The last value PUSHed onto the ARGUMENT STACK is the first value POPed off the ARGUMENT STACK.

Variations: You can push more than one expression onto the ARGUMENT stack with a single PUSH statement. The expressions are followed by a comma: PUSH[expr],[expr],......... [expr]. The last value PUSHed onto the ARGUMENT STACK is the last expression [expr] encountered in the PUSH STATEMENT.

Examples:

```
SWAPPING         CALL
VARIABLES        ROUTINE
>10 A=10         >10 PUSH 3
>20 B=20         >20 CALL 10
>30 PRINT A,B    >30 POP W
>40 PUSH A,B     >40 REM PUSH VALUE ON STACK, CALL
>50 POP A,B      >50 REM CONVERSION, POP RESULT IN W
>60 PRINT A,B    >60 END
>70 END
>RUN

10      20
20      10
READY
>
```

5.4.26 Statement: POP[var]

Mode: COMMAND AND/OR RUN
TYPE: ASSIGNMENT

The value on top of the ARGUMENT STACK is assigned to the variable following the POP statement and the ARGUMENT STACK is "POPed" (i.e. incremented by 6). You can place values on the stack using either the PUSH statement or assembly language CALLS.

Important: If a POP statement executes and no number is on the ARGUMENT STACK, an A-STACK ERROR occurs.

Variations: You can pop more than one variable off the ARGUMENT stack with a single POP statement. The variables are followed by a comma (i.e. POP [var],[var], ... [var]).

Examples:

See PUSH statement above (section 5.4.25).

You can use the PUSH and POP statements to minimize GLOBAL variable problems. These are caused by the "main" program and all subroutines used by the main program using the same variable names (i.e. GLOBAL VARIABLES). If you cannot use the same variables in a subroutine as in the main program you can re–assign a number of variables (i.e. A=Q) before a GOSUB statement is executed. If you reserve some variable names just for subroutines (S1, S2) and pass variables on the stack as shown in the previous example, you can avoid any GLOBAL variable problems in the BASIC Module.

The PUSH and POP statements accept dimensioned variables A(4) and S1(12) as well as scalar variables. This is useful when large amounts of data must be PUSHed or POPed when using CALL routines.

Example:

```
>40 FOR I=1 TO 64
>50 PUSH I
>60 CALL 10
>70 POP A(I)
>80 NEXT I
```

5.4.27 Statement: REM

Mode: COMMAND and/or RUN
Type: CONTROL – Performs no operation

REM is short for REMark. REM allows you to add comments to a program to make it easier to understand. If a REM statement appears on a line the entire line is used for the REM statement. You cannot terminate a REM statement using a colon (:), however, you can place a REM statement after a colon. This allows you to place a comment on each line.

Example:

```
>10 REM INPUT ONE VARIABLE
>20 INPUT A
>30 REM INPUT ANOTHER VARIABLE
>40 INPUT B
>50 REM MULTIPLY THE TWO
>60 Z=A*B
>70 REM PRINT THE ANSWER
>80 PRINT Z
>90 END
>10 INPUT A: REM INPUT ONE VARIABLE
>20 INPUT B : REM INPUT ANOTHER VARIABLE
>30 Z=A*B : REM MULTIPLY THE TWO
>40 PRINT Z :REM PRINT THE ANSWER
>50 END
```

The following example does NOT work because the entire line is interpreted as a REMark. The PRINT statement is not executed:

Example:

```
>10 REM PRINT THE NUMBER: PRINT A
```

Important: REMark statements add time to program execution. Use them selectively or place them at the end of the program where they do not affect program execution speed. Do not use REMark statements in frequently called loops or subroutines.

5.4.28 Statement: RETI

Mode: RUN
Type: CONTROL

Use the RETI statement to exit from the ONTIME interrupts that are handled by a BASIC Module program. The RETI statement functions the same as the RETURN statement except that it also clears a software interrupt flag so interrupts can again be acknowledged. If you fail to execute the RETI statement in the interrupt procedure, all future interrupts are ignored.

5.4.19 Statement: ST@ [expr]

Mode: COMMAND AND/OR RUN

This statement, along with CALL 77, allows you to save/retrieve variables to/from a protected area of memory. This protected area is not zeroed on power-up or when the RUN command is issued. The ST@ statement takes the argument on top of the argument stack and moves it to the address location specified by [expr]. For more information on protecting variables, see section 5.11.6, “Protected Variable Storage – CALL 77”.

5.4.30 Statement: STOP

Mode: RUN
Type: CONTROL

The STOP statement allows you to break program execution at specific points in a program. After a program is STOPped you can display or modify variables. You can resume program execution with a CONTinue command. The purpose of the STOP statement is to allow for easy program “debugging” More details of the STOP-CONT sequence are covered in Section 5.3.2 titled, “Command: CONT”.

Example:

```
>10 FOR I=1 TO 100
>20 PRINT I
>30 STOP
>40 NEXT I
>RUN

 1
 STOP – IN LINE 40

 READY
>CONT

 2
```

5.4.30 Statement: STOP (continued)

Note that the line number printed out after execution of the STOP statement, is the line number following the STOP statement, not the line number that contains the STOP statement.

5.4.31 Statement: STRING

Mode: COMMAND and/or RUN
Type: CONTROL

The STRING [expr], [expr] statement allocates memory for strings. Initially, no memory is allocated for strings. If you attempt to define a string with a statement such as LET $(1)“HELLO” before memory is allocated for strings, a MEMORY ALLOCATION ERROR is generated. The first expression in the STRING [expr],[expr] statement is the total number of bytes you want to allocate for string storage. The second expression gives the maximum number of bytes in each string. These two numbers determine the total number of defined string variables.

The BASIC Module requires one additional byte for each string, plus one additional byte overall. The additional character for each string is allocated for the carriage return character that terminates the string. This means that the statement STRING 100,10 allocates enough memory for 9 string variables, ranging from $(0) to $(8) and all of the 100 allocated bytes are used. Note that $(0) is a valid string in the BASIC Module. Refer to the following Section 5.10 titled, “Description of String Operators” for further discussion of strings and example programs for string memory allocation.

Important: After memory is allocated for string storage, commands (e.g. NEW) and statements (e.g. CLEAR) cannot “de-allocate” this memory. Cycling power also cannot de-allocate this memory unless battery backup is disabled. You can de-allocate memory by executing a STRING 0,0 statement. STRING 0,0 allocates no memory to string variables.

Important: The BASIC Module executes the equivalent of a CLEAR statement every time the STRING [expr],[expr] statement executes. This is necessary because string variables and numeric variables occupy the same external memory space. After the STRING statement executes, all variables are “wiped-out”. Because of this, you should perform string memory allocation early in a program (during the first statement if possible). If you re-allocate string memory you destroy all defined variables.

5.5 Description of Arithmetic, and Logical Operators and Expressions

The BASIC Module contains a complete set of arithmetic and logical operators. We divide the operators into two groups, dual operand (dyadic) operators and single operand (unary) operators.

5.5.1 Dual Operand (dyadic) Operators

The general form of all dual operand instructions is:

(expr) OP (expr), where OP is one of the following operators.

- + Addition Operator

  Example: PRINT 3+2
  ```
  5
  ```

- / Division Operator

  Example: PRINT 100/5
  ```
  20
  ```

- ** Exponentiation Operator

  The Exponentiation Operator raises the first expression to the power of the second expression. The maximum power to which you raise a number is 255.

  Example: PRINT 2**3
  ```
  8
  ```

- * Multiplication Operator

  Example: PRINT 3*3
  ```
  9
  ```

- – Subtraction Operator

  Example: PRINT 9–6
  ```
  3
  ```

- .AND. Logical AND Operator

  Example: PRINT 3.AND.2
  ```
  2
  ```

- .OR. Logical OR Operator

  Example: PRINT 1.OR.4
  ```
  5.
  ```

- .XOR. Logical EXCLUSIVE OR operator

  Example: PRINT 7.XOR.6
  ```
  1
  ```

5.5.1 Dual Operand (dyadic) Operators (continued)

5.5.1.1 Comments on logical operators .AND.,.OR. and .XOR.

These operators perform a BIT-WISE logical function on valid INTEGERS. This means both arguments for these operators are between 0 and 65535 (0FFFFH) inclusive. If they are not, the BASIC Module generates a BAD ARGUMENT ERROR. All non-integer values are truncated, not rounded. Use the following chart for bit manipulations on 16 bit values.

			Hex	Decimal
To set bit	0	.OR. VARIABLE WITH	0001H	1
	1		0002H	2
	2		0004H	4
	3		0008H	8
	4		0010H	16
	5		0020H	32
	6		0040H	64
	7		0080H	128
	10		0100H	256
	11		0200H	512
	12		0400H	1024
	13		0800H	2048
	14		1000H	4096
	15		2000H	8192
	16		4000H	16384
	17		8000H	32768
	Example: 10 A= A .OR. 0100H:REM SET BIT 10			
To clear bit	0	.AND. VARIABLE WITH	0FFFEH	65534
	1		0FFFDH	65533
	2		0FFFBH	65531
	3		0FFF7H	65527
	4		0FFEFH	65519
	5		0FFDFH	65503
	6		0FFBFH	65471
	7		0FF7FH	65407
	10		0FEFFH	65279
	11		0FDFFH	65023
	12		0FBFFH	64511
	13		0F7FFH	63487
	14		0EFFFH	61439
	15		0DFFFH	57343
	16		0BFFFH	49151
	17		7FFFH	32767
	Example: 10 A= A .AND. 0F7FFH: REM CLR BIT 13			
To clear all bits		.XOR. VARIABLE WITH ITSELF		
	Example: 10 A = A.XOR.A : REM CLR A			

5.5.2 Unary Operators

We divide the unary operators into three groups; general purpose, log functions and trig functions.

5.5.2.1 General Purpose Operators

Following are the general purpose operators.

5.5.2.1.1 **ABS**([expr])

Returns the absolute value of the expression.

Examples:

```
>PRINT ABS(5)             >PRINT ABS(–5)
5                          5
```

5.5.2.1.2 **NOT**([expr])

Returns a 16 bit one’s complement of the expression. The expression must be a valid integer (i.e. between 0 and 65535 (0FFFFH) inclusive). Non-integers are truncated, not rounded.

Examples:

```
>PRINT NOT(65000)         >PRINT NOT(0)
535                        65535
```

5.5.2.1.3 **INT**([expr])

Returns the integer portion of the expression.

Examples:

```
>PRINT INT(3.7)           >PRINT INT(100.876)
3              100
```

5.5.2.1.4 **SGN**([expr])

Returns a value of +1 if the argument is greater than zero, zero if the argument is equal to zero and –1 if the argument is less than zero.

Examples:

```
>PRINT SGN(52)   >PRINT SGN(0)      >PRINT SGN(–8)

1                0                  –1
```

5.5.2.1.5 **SQR**([expr])

Returns the square root of the argument. The argument may not be less than zero. The result returned is accurate to within +/–a value of 5 on the least significant digit.

Examples:

```
>PRINT SQR(9)    >PRINT SQR(45)     >PRINT SQR(100)

3          6.7082035                10
```

5.5.2 Unary Operators (continued)

5.5.2.1.6 **RND**

Returns a pseudo-random number in the range between 0 and 1 inclusive. The RND operator uses a 16-bit binary seed and generates 65536 pseudo-random numbers before repeating the sequence. The numbers generated are specifically between 0/65535 and 65535/65535 inclusive. Unlike most BASICS, the RND operator in the BASIC Module does not require an argument or a dummy argument. If an argument is placed after the RND operator, a BAD SYNTAX error occurs.

Examples:

```
>PRINT Rnd
.30278477
```

5.5.2.1.7 **PI**
PI is a stored constant. In the BASIC Module PI is stored as 3.1415926.

5.5.2.2 Log Functions

Following are the log functions.

5.5.2.2.1 **LOG**([expr])

Returns the natural logarithm of the argument. The argument must be greater than 0. This calculation is carried out to 7 significant digits.

Examples:

```
>PRINT LOG(12)            >PRINT LOG(EXP(1))
2.484906                  1
```

5.5.2.2.2 **EXP**([expr])
This function raises the number "e" (2.7182818) to the power of the argument.

Examples:

```
>PRINT EXP(1)             >PRINT EXP(LOG(2))
2.7182818                 2
```

5.5.2.3 Trig Functions

5.5.2.3.1 **SIN**([expr]

Returns the sine of the argument. The argument is expressed in radians. Calculations are carried out to 7 significant digits. The argument must be between ±200000.

Examples:

```
>PRINT SIN(PI/4)          >PRINT SIN(0)
.7071067      0
```

5.5.2 Unary Operators (continued)

5.5.2.3.2 **COS**([expr])

Returns the cosine of the argument. The argument is expressed in radians. Calculations are carried out to 7 significant digits. The argument must be between ± 200000.

Examples:

```
>PRINT COS(PI/4)            >PRINT COS(0)
.7071067                    1
```

5.5.2.3.3 TAN([expr])

Returns the tangent of the argument. The argument is expressed in radians. The argument must be between ±200000.

Examples:

```
>PRINT TAN(PI/4)            >PRINT TAN(0)
1                           0
```

5.5.2.3.4 ATN([expr])

Returns the arctangent of the argument. The result is in radians. Calculations are carried out to 7 significant digits. The ATN operator returns a result between –PI/2 (3.1415926/2) and PI/2.

Examples:

```
>PRINT ATN(PI)              >PRINT ATN(1)
1.2626272                   .78539804
```

5.5.2.4 Comments on Trig Functions

The SIN, COS and TAN operators use a Taylor series to calculate the function. These operators first reduce the argument to a value between 0 and PI/2. This reduction is accomplished by the following equation:

reduced argument = (user arg/PI – INT(user arg/PI)) * PI

The reduced argument, from the above equation, is between 0 and PI. The reduced argument is then tested to see if it is greater than PI/2. If it is, then it is subtracted from PI to yield the final value. If it is not, then the reduced argument is the final value.

5.5.2 Unary Operators (continued)

Although this method of angle reduction provides a simple and economical means of generating the appropriate arguments for a Taylor series, there is an accuracy problem associated with this technique. The accuracy problem is noticed when the user argument is large (i.e. greater than 1000). This is because significant digits, in the decimal (fraction) portion of reduced argument are lost in the (user arg/PI – INT(user arg/PI)) expression. As a general rule, keep the arguments for the trigonometric functions as small as possible.

5.5.3 Understanding Precedence of Operators

You can write complex expressions using only a small number of parenthesis. To illustrate the precedence of operators examine the following equation:

4+3*2 =?

In this equation multiplication has precedence over addition.

Therefore, multiply (3*2) and then add 4.

4+3*2 = 10

When an expression is scanned from left to right an operation is not performed until an operator of lower or equal precedence is encountered. In the example you cannot perform addition because multiplication has higher precedence. Use parentheses if you are in doubt about the order of precedence. The precedence of operators from highest to lowest in the BASIC Module is:

1) Operators that use parenthesis ()
2) Exponentiation (**)
3) Negation (–)
4) Multiplication (*) and division (/)
5) Addition (+) and subtraction (–)
6) Relational expressions (=, < > , >, >=, <, <=).
7) Logical and (.AND.)
8) Logical or (.OR.)
9) Logical XOR (.XOR.)

5.5.4 How Relational Expressions Work

Relational expressions involve the operators =, < >, >, >=, <, and <=. These operators are typically used to "test" a condition. In the BASIC Module relational operations are typically used to "test" a condition. In the BASIC Module relational operators return a result of 665535 (OFFFFH) if the relational expression is true, and a result of 0, if the relation expression is false. The result is returned to the argument stack. Because of this, it is possible to display the result of a relational expression.

Examples:

```
PRINT 1=0 PRINT 1>0 PRINT A < > A PRINT A=A

0 65535 0 65535
```

You can "chain" relational expressions together using the logical operators .AND., .OR., and .XOR.. This makes it possible to test a complex condition with ONE statement.

Example:

```
>10 IF ([A>B].AND. [A>C]) .OR.[A>D] THEN
```

Additionally, you can use the NOT([expr]) operator.

Example:

```
>10 IF NOT(A>B).AND.(A>C) THEN
```

By "chaining" together relational expressions with logical operators, you can test particular conditions with one statement.

Important: When using logical operators to link together relational expressions, you must be sure operations are performed in the proper sequence.

5.6 Special Operators

Special operators include special function operators and system control values.

5.6.1 Special Function Operators

Special function operators directly manipulate the I/O hardware and the memory addresses on the processor.

5.6.1.1 GET

Use the GET operator in the RUN mode. It returns a result of zero in the command mode. The GET operator reads the console input device. If a character is available from the console device, the value of the character is assigned to GET. After GET is read in the program, it is assigned the value of zero until another character is sent from the console device. The following example prints the decimal representation of any character sent from the console:

Example:

```
>10 A=GET
>20 IF A <> 0 THEN PRINT A :REM ZERO MEANS NO ENTRY
>30 GOTO 10
>RUN

  65    (TYPE “A” ON CONSOLE)
  49    (TYPE “1” ON CONSOLE)
  24    (TYPE “CONTROL–X” ON CONSOLE)
  50    (TYPE “2” ON CONSOLE)
```

The GET operator is read only once before it is assigned a value of zero. This guarantees that the first character entered is always read, independent of where the GET operator is placed in the program. There is no buffering of characters on the program port.

5.6.1.2 TIME

Use the TIME operator to retrieve and/or assign a value to the real time clock resident in the BASIC Module. After reset, time is equal to 0. The CLOCK1 statement enables the real time clock. When the real time clock is enabled, the special function operator, TIME, increments once every 5 milliseconds. The units of time are in seconds.

5.6.1 Special Function Operators (continued)

When TIME is assigned a value with a LET statement (i.e. TIME > 100), only the integer portion of TIME is changed.

Example:

```
>CLOCK1      (enable REAL TIME CLOCK)

>CLOCK0      (disable REAL TIME CLOCK)

>PRINT TIME (display TIME)
 3.315

>TIME = 0    (set TIME = 0)

>PRINT TIME (display TIME)
 .315        (only the integer is changed)
```

You can change the “fraction” portion of TIME by manipulating the contents of internal memory location 71 (47H). You can do this by using a DBY(71) statement. Note that each count in internal memory location 71 (47H) represents 5 milliseconds of TIME.

Continuing with the example:

```
>DBY(71) = 0                (fraction of TIME = 0)

>PRINT TIME
 0

>DBY(71) = 3                (fraction of TIME = 3, 15 ms)

>PRINT TIME
 1.5 E–2
```

Only the integer portion of TIME changes when a value is assigned. This allows you to generate accurate time intervals. For example, if you want to create an accurate 12 hour clock: There are 43200 seconds in a 12 hour period, so an ONTIME 43200, (ln num) statement is used. When the TIME interrupt occurs, the statement TIME 0 is executed, but the millisecond counter is not re-assigned a value. If interrupt latency exceeds 5 milliseconds, the clock remains accurate.

5.6.2 System Control Values

The system control values determine how memory is allocated by the BASIC Module.

5.6.2.1 MTOP

After reset, the BASIC Module sizes the external memory and assigns the last valid memory address to the system control value, MTOP. The module does not use any external RAM memory beyond the value assigned to MTOP.

Examples:

```
 >PRINT MTOP          or     PH0. MTOP
 14335                       37FFH
```

5.6.2.2 LEN

The system control value, LEN, tells you how many bytes of memory the currently selected program occupies. This is the length of the program and does not include the size of string memory, variables and array memory usage. You cannot assign LEN a value, it can only be read. A NULL program (i.e. no program) returns a LEN of 1. The 1 represents the end of program file character.

Important: The BASIC Module does not require any “dummy” arguments for the system control values.

5.7 Data Transfer Support Routines

The BASIC Module communicates with the host processor using block-transfer communications. The host processor sends variable length blocks of data to the module. You can transfer a maximum of 64 words in and 64 words out per scan. The module responds with the requested block length of data. The module has an auxiliary processor dedicated to servicing of the block-transfers to and from the host processor. These support routines provide the communications link between the host processor and the BASIC processor. The block-transfer-read (BTR) buffer resides at address 7800H and is 128 bytes long. You can examine the values in the buffer using the XBY command, i.e. PRINT XBY(7800H).

The block-transfer-write (BTW) buffer resides at one of two starting addresses; 7B00H or 7C00H . Examine addresses 7D0 AH and 7D0BH which point to the proper starting address. 7D0AH contains the high byte of the address and 7D0BH contains the low byte of the address. The BTW buffer is also 128 bytes long. You can also examine these values in the buffer using the XBY command.

5.7 Data Transfer Support Routines (continued)

Example:

```
>10 REM PRINT CONTENTS OF BTW BUFFER
>20 C=(XBY(7D0AH)*100H)+XBY(7D0BH)
>30 FOR I=0 TO 128
>40 PH0. XBY(C+I),
>50 NEXT I
>60 END
```

5.7.1 Update Block-Transfer-Read Buffer (timed) – CALL 2

This routine transfers the block-transfer-read (BTR) buffer to the auxiliary processor on the BASIC Module for use in the next BTR request from the host processor. If no data transfer occurs within 2 seconds the routine returns to BASIC without transferring data. This routine has no input arguments and one output argument (the status of the transfer). A non-zero returned means that no transfer occurred and the CALL timed out. A zero returned means a successful transfer.

Example:

```
    >10 CALL 2
    >20 POP X
    >30 IF X < > 0 PRINT “TRANSFER UNSUCCESSFUL”
```

5.7.2 Update Block-Transfer-Write Buffer (timed) – CALL 3

This routine transfers the block-transfer-write (BTW) buffer of the auxiliary processor on the BASIC Module to the BASIC BTW buffer. If no data transfer occurs within 2 seconds the routine returns to BASIC with no new data. This routine has no input arguments and one output argument (the status of the transfer). A non-zero returned means that no transfer occurred and the CALL timed out. A zero returned means a successful transfer.

Example:

```
>10 CALL 3
>20 POP X
>30 IF X < > 0 PRINT “TRANSFER UNSUCCESSFUL”
```

5.7.3 Set Block-Transfer-Write Length – CALL 4

This routine sets the number of words (1–64) to transfer between the BASIC Module and the host processor. The processor program block-transfer length must match the set value. Only one argument is input (the number of words to BTW) and none returned. If not used, the default length is 5 words.

Example:

```
>10 PUSH 10:
>20 CALL 4
```

5.7.4 Set Block-Transfer-Read Length – CALL 5

This routine sets the number of words (1–64) to transfer between the BASIC Module and the host processor. The processor program block-transfer length must match the set value. Only one argument is input (the number of words to BTR) and none returned. If not used, the default length is 5 words.

Example:

```
>10 PUSH 10
>20 CALL 5
```

5.7.5 Update Block-Transfer-Write Buffer – CALL 6

This routine transfers the block-transfer-write (BTW) buffer of the auxiliary processor on the BASIC Module to the BASIC BTW buffer. This routine waits until a block-transfer occurs if one has not previously occurred.

5.7.6 Update Block-Transfer-Read Buffer – CALL 7

This routine transfers the block-transfer-read (BTR) buffer to the auxiliary processor on the BASIC Module for use in the next BTR request from the host processor. This routine waits until a block-transfer occurs.

5.7.7 Disable Interrupts – CALL 8

Important: You must use an Interrupt Control CALL 8 before a PROG command to disable interrupts.

This routine disables system interrupts. It is mandatory for PROM programming. The wall clock cannot be accessed and the peripheral port is disabled by this call. Some call routines enable interrupts automatically upon completion.

5.7.8 Enable Interrupts – CALL 9

Important: You must use an Interrupt Control CALL 9 after a PROG command to re-enable interrupts.

This routine enables system interrupts. It is mandatory after programming a PROM. The wall clock is accessible and the peripheral port is enabled.

5.7.9 Input Call Conversion Routines

All of the input call conversion routines require the same sequence of commands. These are:

PUSH – the word position of the processor block-transfer-file to be converted (1–64)

CALL – the appropriate input conversion

POP – the input argument into a variable

The data format of the output arguments from each of the input conversion routines is described in more detail in Chapter 7.

5.7.9.1 3-Digit Signed, Fixed Decimal BCD to Internal Floating Point ±XXX – CALL 10

The input argument is the number (1 to 64) of the word in the write-block-transfer buffer that is to be converted from 3-digit BCD to internal format. The output argument is the converted value in internal floating point format. The sign bit is bit number 16.

5.7.9.2 16-Bit Binary (4-digit hex) to Internal Floating Point – CALL 11

The input argument is the number (1 to 64) of the word in the write-data-transfer buffer to be converted from 16-bit binary to internal format. The output argument is the converted value in internal floating point format. There are no sign or error bits decoded.

5.7.9.3 4-Digit Signed Octal to Internal Floating Point ±XXXX – CALL 12

The input argument is the number (1 to 64) of the word in the processor block-transfer buffer to be converted from 4-digit signed octal to internal format. This 12-bit format has a maximum value of ±7777 octal. The output argument is the converted value in internal floating point format. The sign bit is bit number 16.

5.7.9 Input Call Conversion Routines (continued)

5.7.9.4 6-Digit, Signed, Fixed Decimal BCD to Internal Floating Point ± XXXXXX – CALL 13

The input argument is the number (1–64) of the first word (6-digit BCD is sent to the BASIC module in two processor words) of the write-block-transfer buffer to be converted from 6-digit, signed, fixed decimal BCD to internal format. The maximum values allowed are ± 999999. The output argument is the converted value in internal floating point format. The sign bit is bit number 16.

5.7.9.5 4-Digit BCD to Internal Floating Point XXXX – CALL 17

The input argument is the number (1–64) of the word in the write-block-transfer buffer to be converted from 4-digit BCD to internal format. The maximum value allowed is 0–9999. The output argument is the converted value in internal floating point format.

Sample input conversions:

```
>20 PUSH 3 :REM CONVERT 3rd WORD OF PLC DATA
>30 CALL 10 :REM DO 3 DIGIT BCD TO F.P. CONVERSION
>40 POP W :REM GET CONVERTED VALUE – STORE IN VARIABLE W
>20 PUSH 9 :REM CONVERT STARTING WITH 9th WORD OF PLC DATA
>30 CALL 13 :REM DO 6 DIGIT BCD TO F.P. CONVERSION
>40 POP L(9) :REM GET CONVERTED VALUE – STORE IN ARRAY L (9)
```

5.7.10 Output Call Conversion Routines

All of the output call conversion routines require the same sequence of commands. These are:

PUSH – the value to be converted

PUSH – the word position of the processor block-transfer-file to be converted (1–64)

CALL – the appropriate output conversion

The data format of the converted value of each of the output conversion routines is described in more detail in Chapter 7. Use these output call conversion routines to load the BTR buffer before executing a CALL 7 or CALL 2.

5.7.10 Output Call Conversion Routines (continued)

5.7.10.1 Internal Floating Point to 3-Digit, Signed, Fixed Decimal BCD ±XXX – CALL 20

This routine has two input arguments and no output arguments. The first argument is the variable with a value in the range of –999 to +999 that is converted to a signed 3-digit binary coded decimal format used by the processor. The second input argument is the number of the word to receive the value in the read-block-transfer buffer. The sign bit is bit number 16.

Example:

```
>20 PUSH W  :REM DATA TO BE CONVERTED
>30 PUSH 6  :REM WORD LOCATION TO GET DATA
>40 CALL 20
```

5.7.10.2 Internal Floating Point to 16-Bit Unsigned Binary (4 digit hex) – CALL 21

This routine takes a value between 0 and 65535 and converts it to its binary representative and stores this in the read-block-transfer buffer in one word. Two arguments are PUSHed and none POPed. The first value PUSHed is the data or variable. This is followed by the number of the word to receive the value in the read-block-transfer buffer.

Example:

```
>50 PUSH T   :REM THE VALUE TO CONVERTED TO 16 BINARY
>60 PUSH 3   :REM WORD 3 IN THE BTR BUFFER GETS THE VALUE T
>70 CALL 21  :REM DO THE CONVERSION
```

5.7.10.3 Internal Floating Point to 4-Digit, Signed Octal ±XXXX–Call 22

This routine converts a value from internal format to a four digit signed octal value. Two arguments ar PUSHed and non POPed. The first value PUSHed is the data ($\pm 7777_8$) or variable. This is followed by the number of the word to receive the value in the read-block-transfer buffer. The sign bit is bit number 16.

Example:

```
>50 PUSH H   :REM THE VALUE TO CONVERTED TO 4-DIGIT SIGNED OCTAL
>60 PUSH 3   :REM WORD 3 IN THE BTR BUFFER GETS THE VALUE H
>70 CALL 22  :REM DO THE CONVERSION
```

5.7.10 Output Call Conversion Routines (continued)

5.7.10.4 Internal Floating Point to 6-Digit, Signed, Fixed Decimal BCD ±XXXXXX – CALL 23

This routine converts an internal 6-digit, signed, integer to a 2 word format and places the converted value in the read-block-transfer buffer. Two arguments are PUSHed and none POPed. The first value PUSHed is the data or variable. This is followed by the number of the word to receive the value in the read-block-transfer buffer. The sign bit is bit number 16.

Example:

```
>20 PUSH 654321. OR          >20 PUSH B(I)
>30 PUSH 3                   >30 PUSH 3
>40 CALL 23                  >40 CALL 23
```

5.7.10.5 Internal Floating Point to 3.3-digit, Signed, Fixed Decimal BCD ±XXX.XXX – CALL 26

This routine converts a variable in internal format to a signed, 6-digit, fixed decimal point number which is stored in 2 words in the block-transfer-read buffer. Two arguments are PUSHed and none POPed. The first value PUSHed is the data (±999.999) or variable. This is followed by the number of the first word to receive the value in the block-transfer-read buffer. The sign bit number is 16.

Example:

```
>50 PUSH S     :REM THE VALUE TO BE CONVERTED TO 3.3-DIGIT FIXED POINT
>60 PUSH 3     :REM WORD 3 IN THE BTR BUFFER GETS THE VALUES
>70 CALL 26    :REM DO THE CONVERSION
```

5.7.10.6 Internal Floating Point to 4-digit BCD XXXX – CALL 27

This routine converts a value in internal floating point format to a 4-digit, unsigned BCD value and places it in the read-block-transfer buffer. Two arguments are PUSHed and none POPed. The first value PUSHed is the data (0–9999) or variable. This is followed by the number of the word to receive the value in the read-block-transfer buffer.

Example:

```
>20 PUSH B     REM THE VALUE TO BE CONVERTED TO 4-DIGIT BCD
>30 PUSH 7     :REM WORD 7 IN THE BTR BUFFER GETS THE VALUE B
>40 CALL 27    :REM DO THE CONVERSION
```

5.8 Peripheral Port Support

The peripheral port is used for:

1. exchanging data with an external device with user written protocol.
2. listing programs with the LIST# or LIST @ statement.
3. loading/saving programs using the 1771–SA/SB data recorders.

For these functions to operate properly and to allow flexibility for talking to many different devices we provide parameter setup routines.

To make best use of the port, a 256 character buffer is provided on both input and output. This means that the module may receive up to 256 characters without error from a device before the module must service the data. The module can store an entire response to a command in the input buffer. This is useful when the data arrives in a high speed burst that is too fast for the BASIC program to handle character by character.

The 256 character output buffer allows the module to assemble an entire message leaving your user program free to perform other operations while the message is sent character by character by the device driver.

5.8.1 Peripheral Port Support – Parameter Set – CALL 30

This routine sets up the parameters for the peripheral port. The parameters set are the number of bits/word, parity enable or disable, even or odd parity, number of stop bits, software handshaking and hardware handshaking. Default values are:

- 1 stop bit
- no parity
- 8 bits/character
- DCD off
- XON/XOFF disabled
- 1200 baud (jumper selected)
- 1 start bit (fixed)

5.8.1 Peripheral Port Support – Parameter Set – CALL 30 (continued)

The five values PUSHed on the stack before executing the CALL are in the following order:

Parameter	Selections
Number of bits/word	5,6,7,8
Parity Enable	0=None,2=Even 1=Odd
Number of Stop Bits	1=1 Stop Bit, 2=2 Stop Bits, 3=1.5 Stop Bits
Software Handshaking	0=None, 1=XON–XOF
Hardware Handshaking	0=Disable DCD 1=enable DCD

```
Example:     100 PUSH 8 : REM 8 BITS/WORD
             120 PUSH 0 : REM NO PARITY
             140 PUSH 1 : REM 1 STOP BIT
             160 PUSH 0 : REM NO SOFTWARE HANDSHAKING
             180 PUSH 0 : REM DISABLE DCD
             200 CALL 30 : REM SET UP PERIPHERAL PORT
or
Example:     100 PUSH 8,0,1,0,0:CALL 30
```

Important: Hardware and software handshaking is disabled and both I/O buffers are cleared on power-up.

5.8.2 Peripheral Port Support – Display Peripheral Port Parameters –CALL 31

This routine displays the current peripheral port configuration on the terminal. No argument is PUSHed or POPed.

Enter CALL 31 [return] from the command mode.

Example:

```
CALL 31 [RETURN]

DCD OFF
1 STOP BIT
NO PARITY
8 BITS/CHAR
```

Important: XON/XOFF status is shown only if enabled.

5.8.3 Save Program to Data Recorder – CALL 32

Important: Maximum baud rate is 2400 bps for all data recorder CALL routines. The Peripheral Port is set up in these routines and does not need setting in BASIC.

This routine saves the current RAM program on a 1770–SA/SB recorder. The program in RAM is not modified. The message ERROR—IN ROM displays if ROM is selected instead of RAM.

To use this routine:

- insert the cassette/cartridge into the recorder and rewind.
- enter CALL 32. The terminal responds with "POSITION TAPE AND PRESS WRITE/RECORD ON TAPE".
- Press RECORD. The module begins sending data to the recorder. An asterisk is displayed on the terminal as each program line is sent to the recorder.

During this time the "DATA IN" LED on the data recorder and the XMIT LED on the front of the module illuminate. When the last line of program is sent to the recorder, a final asterisk is displayed on the terminal indicating that the save operation is complete. Finally, tape motion ceases and the BASIC prompt (>) is displayed.

- Press STOP if you are using a 1770–SA Recorder.

Important: If there is no program in RAM, the module displays the message ERROR–NO BASIC PROGRAM EXISTS.

5.8.4 Verify Program with Data Recorder – CALL 33

Important: Maximum baud rate is 2400 bps for all data recorder CALL routines. The Peripheral Port is set up in these routines and does not need setting in BASIC. See section 4.2.2.2 for required cable connections.

This routine is used to verify the current RAM program with a previously stored program on the data recorder. To use this routine:

- insert the cassette cartridge into the recorder and rewind.
- enter CALL 33. The terminal responds with "POSITION TAPE AND PRESS READ FROM TAPE".

5.8.4 Verify Program with Data Recorder – CALL 33 (continued)

- Press PLAY. Tape movement begins and the recorder searches for the beginning of the next program. As each line of the program verifies, an asterisk displays.

  During this time the "DATA OUT" LED on the recorder and the "RECV" LED on the module illuminate. When the last line of program is verified a final asterisk is displayed on the terminal followed by the "VERIFICATION COMPLETE" message and the BASIC (>) prompt. If any differences between programs are encountered, the routine displays an "ERROR–VERIFICATION FAILURE" message and the BASIC (>) prompt is immediately displayed.

5.8.5 Load Program from Data Recorder – CALL 34

Important: Maximum baud rate is 2400 bps for all data recorder CALL routines. The UART is set up in these routines and does not need setting in BASIC. See section 4.2.2.2 for required cable connections.

This routine loads a program stored on a 1770–SA/SB recorder into user RAM, destroying the previous contents of RAM. To use this routine:

- enter CALL 34. The terminal responds with "POSITION TAPE AND PRESS READ FROM TAPE".
- Press PLAY. Tape movement begins and the routine searches for the beginning of the next program. When the program is found an asterisk is printed for each line read from the recorder.

During this time the "DATA OUT" LED of the recorder and the "RECV" LED on the front of the module illuminate. When the recorder sends the last line of program, a final asterisk appears on the terminal indicating that the load operation is complete. Tape motion ceases and the BASIC prompt (>) appears.

If you are using a 1770–SA Recorder, press STOP.

Important: This routine loads the first program encountered and does not distinguish between labelled programs. See section 5.8.10 below titled, "Load Labeled Program from Data Recorder (1770–SB only) CALL 39″ for an explanation of labelled programs.

5.8.6 Get Numeric Input Character from Peripheral Port – CALL 35

This routine gets the current character in the 255 character, peripheral port input buffer. It returns the decimal representation of the characters received as its output argument. The peripheral port receives data transmitted by your device and stores it in this buffer. If there is no character, the output argument is a 0 (null). If there is a character, the output argument is the ASCII representation of that character. There is no input argument for this routine.

Example:

```
>10 CALL 35
>20 POP X
>30 IF X =0 THEN GOTO 10
>40 PRINT CHR(X)
```

Important: A 0 (null) is a valid character in some communications protocols. You should use CALL 36 to determine the actual number of characters in the buffer.

Important: Purge the buffer before storing data to ensure data validity.

5.8.6 Get Numeric Input Character from Peripheral Port – CALL 35 (continued)

Example:

```
>10 REM PERIPHERAL PORT INPUT USING CALL 35
>20 STRING 200,20
>30 DIM D(254)
>40 CALL 35: POP X
>50 IF X <>2 GOTO 40
>55 REM WAIT FOR DEVICE TO SEND START OF TEXT
>60 REM
>70 DO
>80 I=I+1
>90 CALL 35: POP D(I) : REM STORE DATA IN ARRAY
>100 UNTIL D(I)=3 : REM WAIT FOR DEVICE TO SEND END OF TEXT
>120 REM
>130 REM FORMAT AND PRINT DATA TYPES
>140 PRINT “RAW DATA=”
>150 FOR J=1 TO I : PRINT D(J), : NEXT J
>155 REM PRINT RAW DECIMAL DATA
>160 PRINT: PRINT: PRINT
>170 PRINT “ASCII DATA=”
>180 FOR J=1 TO I : PRINT CHR(D(J)), : NEXT J
>185 REM PRINT ASCII DATA
>190 PRINT: PRINT: PRINT
>200 PRINT “$(1)=”
>210 FOR J=1 TO I : ASC($(1),J)=D(J) : NEXT J
>215 REM STORE DATA IN STRING
>220 PRINT $(1)
>230 PRINT: PRINT: PRINT
>240 I=0
>250 REM
>260 GOTO 40

READY
>RUN

RAW DATA=
   65 66 67 68 69 70 71 49 50 51 52 53 54 55 56 57 3

ASCII DATA=
ABCDEFG123456789

$(1)=
ABCDEFG123456789

READY
>
```

5.8.7 Get the Number of Characters in the Peripheral Port Buffers – CALL 36

Use this routine to retrieve the number of characters in the chosen buffer as its output argument. You must PUSH which buffer is to be examined.

- PUSH 1 for the input buffer.
- PUSH 0 for the output buffer.

One POP is required to get the number of characters.

Example:

```
>10 PUSH 0: REM examines the output buffer
>20 CALL 36
>30 POP X: REM get the number of characters
>40 PRINT “Number of characters in the Output Buffer is”,X
>50 END
```

5.8.8 Clear the Peripheral Ports Input or Output Buffer – CALL 37

This routine clears either the peripheral ports input or output buffer.

- PUSH 0 to clear the output buffer.
- PUSH 1 to clear the input buffer.
- PUSH 2 to clear both buffers.

Example:

```
>10 PUSH 0: REM clears the output buffer
>20 CALL 37
>30 END
```

5.8.9 Save Labeled Program to Data Recorder (1770-SB only) – CALL 38

Important: Maximum baud rate is 2400 bps for all data recorder CALL routines. The Peripheral Port is set up in these routines and does not need setting in BASIC. See section 4.4.3 for required cable connections. Tape verification failures result if you use a cable with different pin connections

This routine is identical to the CALL 32 routine except the program is assigned an ID number (0-255) before storing it on tape. This allows you to search for a specific program on a tape that contains many different programs. To do this:

- PUSH the ID number.
- enter CALL 38. From this point on operation is identical to the CALL 32 routine. See section 5.8.3 above titled, “Save Program to Data Recorder – Call 32” for an explanation.

5.8.9 Save Labeled Program to Data Recorder (1770-SB only) – CALL 38 (continued)

This routine has one input argument and no output arguments. If no ID number is pushed prior to CALL 38, an error occurs and the routine aborts without saving.

An unlabeled save (CALL 32) has an ID of 0.

Important: Do not press rewind between programs saved. If you press rewind only the last program is saved.

5.8.10 Load Labeled Program from Data Recorder (1770-SB only) – CALL 39

Important: Maximum baud rate is 2400 bps for all data recorder CALL routines. The Peripheral Port is set up in these routines and does not need setting in BASIC. The Peripheral Port parameters restore when the call is complete. See section 4.4.3 for required cable connections. Tape verification failures result if you use a cable with different pin connections.

This routine is identical to the CALL 34 routine except that labeled programs are organized according to an ID number (0-255) assigned to the stored program using a CALL 38. To use this routine:

- PUSH the ID number.
- Enter CALL 39. From this point on, operation is identical to the CALL 34 routine. See Section 5.8.4 above titled, “Verify Program with Data Recorder – CALL 33” for explanation.

This routine has one input argument and no output arguments. If no ID number is pushed prior to CALL 38, an error occurs and the routine aborts without saving.

While searching for the correct program, one asterisk prints for each program encountered. When the correct program is found one asterisk per line prints. You must press the READ FROM TAPE button twice on the SB Recorder at the end of each program encountered to continue the search. Press the READ FROM TAPE button when the DATA OUT light on the SB Recorder goes out. This indicates the end of file. If the BASIC Module starts loading from the middle of a file, the DATA OUT light is on but no asterisk is printed on the console. Follow the above procedure to continue the search.

An unlabeled save (CALL 32) has an ID of 0.

5.8.11 Print the Peripheral Port Output Buffer and Pointer – CALL 110

CALL 110 prints the complete buffer with addresses, front pointer and the number of characters in the buffer to the console. No PUSHes or POPs are needed. Use this information as a troubleshooting aid. It does not affect the contents of the buffer.

5.8.12 Print the Peripheral Port Input Buffer and Pointer – CALL 111

CALL 111 prints the complete buffer with addresses, front pointer and the number of characters in the buffer to the console. No PUSHes or POPs are needed.

Use this information as a troubleshooting aid. It does not affect the contents of the buffer.

5.8.13 Reset the Peripheral Port to Default Settings – CALL 119

CALL 119 resets the peripheral port to the following default settings:

- 8 bits/character
- 1 stop bit
- No parity
- DCD off
- XON-XOFF off

No PUSHes or POPs are needed.

5.9 Wall Clock Support Calls

The battery backed wall time clock provides year, month, day of month, day of week, hours, minutes and seconds. The clock operates in 24 hour military time format. The support routines allow the setting of the clock and retrieval of clock values in numeric form.

The wall clock support routines use the argument stack to pass data between the BASIC program and the routines. Data is passed in both directions and consists of the actual clock data.

The wall clock or time of day clock is separate from the real time clock also provided on the module. The real time clock is accessed by CLOCK 1, CLOCK0, ONTIME and other statements, and has a resolution of 5 milliseconds. It should be used for all short time interval measurements because the greater resolution results in more accurate timing. The two clocks are not synchronized and comparison of times is not recommended. Also, the real time clock is not battery backed.

5.9.1 Setting the Wall Clock Time (Hour, Minute, Second) – CALL 40

Use this routine to set the following wall clock time functions:

- H = hours (0 to 23)
- M = minutes (0 to 59)
- S = seconds(0-59)

Example:

Program the wall clock for 1:35 pm (13:35 on a 24 hour clock).

```
>10 H=13: M=35: S=00        :REM HOURS=13; MINUTES=35; SECONDS=00
>20 PUSH H,M,S              :REM PUSH HOURS, MINUTES, SECONDS
>30 CALL 40                 :REM CALL THE ROUTINE TO SET THE WALL CLOCK TIME
```

5.9.2 Setting the Wall Clock Date (Day, Month, Year) – CALL 41

Use this routine to set the following wall clock functions:

- D = day
- M = month
- Y = year

Three values are PUSHed and none POPed.

Example:

Program the wall clock for the 16th day of June, 1985

```
>10 D=16: M=06: Y=85        :REM DAY OF MONTH = 16, MONTH = 6, YEAR = 85
>20 PUSH D,M,Y              :REM PUSH DAY OF MONTH, MONTH, YEAR
>30 CALL 41                 :REM CALL THE ROUTINE TO SET THE WALL CLOCK DATE
```

5.9.3 Set Wall Clock – Day of Week – CALL 42

CALL 42 sets the day of the week. Sunday is day 1. Saturday is day 7.

Example:

```
>PUSH 3 : CALL 42 REM DAY IS TUESDAY.
```

5.9.4 Date/Time Retrieve String – CALL 43

CALL 43 returns the current date and time as a string. PUSH the number of the string to receive the date/time (dd/mmm/yy HH:MM:SS). You must allocate a minimum of 18 characters for the string. This requires you to set the maximum length for all strings to at least 18 characters.

Example:

```
>10 STRING 100,20
>20 PUSH 1: CALL 43: REM put date/time in string 1
>30 PRINT $(1)
>40 END
```

5.9.5 Date Retrieve Numeric (Day, Month, Year) – CALL 44 (2)

CALL 44 returns the current date on the argument stack as three numbers. There is no input argument to this routine and three variables are returned. The date is POPed in day, month and year order.

Example:

```
>10 REM DATE RETRIEVE – NUMERIC EXAMPLE
>20 CALL 44: REM INVOKE THE UTILITY ROUTINE
>30 POP D,M1,Y : REM GET THE DATA FROM THE 30 STACK
>40 PRINT “CURRENT DATE IS”, Y,M1,D
>50 END
>RUN

 CURRENT DATE IS 84 12 25

 READY
```

5.9.6 Time Retrieve String – CALL 45

CALL 45 returns the current time in a string (HH:MM:SS). PUSH the number of the string to receive the time. You must allocate a minimum of 8 characters for the string.

Example:

```
>10 STRING 100,20
>20 PUSH 1, CALL 45: REM put time in string 1
>30 PRINT $(1)
>40 END
```

5.9.7 Time Retrieve Number – Call 46

The time of day is available in numeric form by executing a CALL 46 and POPing the three variables off of the argument stack on return. There are no input arguments. The time is POPed in hour, minute and second order.

Example:

```
>10 REM TIME IN VARIABLES EXAMPLE : REM GET THE WALL CLOCK TIME
>20 CALL 46
>30 POP H,M,S
>40 PRINT “CURRENT TIME IS”, H,M,S 50 END

>RUN

CURRENT TIME IS 13 44 54

READY
```

5.9.8 Retrieve Day of Week String – CALL 47

CALL 47 returns the current day of week as a three character string. PUSH the number of the string to receive the day of week. You must allocate a minimum of 3 characters/string. Strings returned are SUN, MON, TUE, WED, THUR, FRI, SAT.

Example:

```
>10 PUSH 0: CALL 47
>20 PRINT “TODAY IS”,$(0)
```

5.9.9 Retrieve Day of Week Numeric – CALL 48

CALL 48 returns the current day of week on the argument stack as a number (i.e. Sunday = 1, Saturday = 7). This can be POPed into a variable.

Example:

```
>10 REM DAY OF WEEK RETRIEVE – NUMERIC EX
>20 CALL 44: REM INVOKE UTILITY TO GET D.O.W.
>30 POP D
```

5.9.10 Date Retrieve String – CALL 52

CALL 52 returns the current date in a string (dd/mmm/yy). PUSH the number of the string to receive the date. You must allocate a minimum of 9 characters for the string.

Example:

```
>10 STRING 100,20
>20 PUSH 1: CALL 52: REM put date in string 1
>30 PRINT $(1)
>40 END
>RUN

30/JAN/87
```

5.10 Description of String Operators

A string is a character or group of characters stored in memory. Usually, the characters stored in a string make up a word or a sentence. Strings allow you to deal with words instead of numbers. This allows you to refer to individuals by name instead of by number.

The BASIC Module contains one dimensioned string variable, $([expr]). The dimension of the string variable (the [expr] value) ranges from 0 to 254. This means that you can define and manipulate 255 different strings in the BASIC Module. Initially, no memory is allocated for strings. Memory is allocated by the STRING [expr], [expr] STATEMENT. See Section 5.4.31 for more information on this statement.

In the BASIC Module you can define strings with the LET statement, the INPUT statement and with the ASC () operator.

Example:

```
>10 STRING 100,20
>20 $(1)=“THIS IS A STRING,”
>30 INPUT “WHAT’S YOUR NAME? – ”,$(2)
>40 PRINT $(1),$(2)
>50 END
>RUN
```

```
WHAT’S YOUR NAME? – FRED

THIS IS A STRING, FRED
```

You can also assign strings to each other with a LET statement.

Example:

```
LET $(2)=$(1)
```

Assigns the string value in $(1) to the STRING $(2).

5.10.1 The ASC Operator

Two operators in the BASIC Module can manipulate STRINGS. These operators are ASC() and CHR(). The ASC() operator returns the integer value of the ASCII character placed in the parentheses.

Example:

```
>PRINT ASC(A)
 65
```

The decimal representation for the ASCII character “A” is 65. In addition, you can evaluate individual characters in a pre-defined ASCII string with the ASC() operator.

Example:

```
>5 STRING 1000,40
>10 $(1)=“THIS IS A STRING”
>20 PRINT $(1)
>30 PRINT ASC($(1),1)
>40 END
>RUN

 THIS IS A STRING
 84
```

When you use the ASC() operator as shown above, the $([expr]) denotes what string is accessed. The expression after the comma selects an individual character in the string. In the above example, the first character in the string is selected. The decimal representation for the ASCII character “T” is 84. String character position 0 is invalid.

Example:

```
>5 STRING 1000,40
>10 $(1)=“ABCDEFGHIJKL”
>20 FOR X=1 TO 12
>30 PRINT ASC($(1),X),
>40 NEXT X
>50 END
>RUN

 65 66 67 68 69 70 71 72 73 74 75 76
```

The numbers printed in the previous example represent the ASCII characters A through L.

5.10.1 The ASC Operator (continued)

You can also use the ASC() operator to change individual characters in a defined string.

Example:

```
>5 STRING 1000,40
>10 $(1)="ABCDEFGHIJKL"
>20 PRINT $(1)
>30 ASC($(1),1)=75 REM: DECIMAL EQUIVALENT OF K
>40 PRINT $(1)
>50 ASC($(1),2)=ASC($(1),3)
>60 PRINT $(1)
>RUN

ABCDEFGHIJKL
KBCDEFGHIJKL
KCCDEFGHIJKL
```

In general, the ASC() operator lets you manipulate individual characters in a string. A simple program can determine if two strings are identical.

Example:

```
>5 STRING 1000,40
>10 $(1)="SECRET" : REM SECRET IS THE PASSWORD
>20 INPUT "WHAT'S THE PASSWORD – ",$(2)
>30 FOR I=1 TO 6
>40 IF ASC($(1),I)=ASC($(2),I) THEN NEXT I ELSE 70
>50 PRINT "YOU GUESSED IT!"
>60 END
>70 PRINT "WRONG, TRY AGAIN" : GOTO 20
>RUN

WHAT'S THE PASSWORD – SECURE
WRONG, TRY AGAIN WHAT'S THE
PASSWORD – SECRET
YOU GUESSED IT
```

5.10.2 The CHR Operator

The CHR() operator converts a numeric expression to an ASCII character.

Example:

```
>PRINT CHR(65)
 A
```

Like the ASC() operator, the CHR() operator also selects individual characters in a defined ASCII string.

Example:

```
>5 STRING 1000,40
>10 $(1)="The BASIC Module"
>20 FOR I=1 TO 16 : PRINT CHR($(1),I), : NEXT I
>30 PRINT: FOR I=16 TO 1 STEP -1
>40 PRINT CHR($(1),I), : NEXT I
>RUN

The BASIC Module

eludoM CISAB ehT
```

In the above example, the expressions contained within the parenthesis, following the CHR operator have the same meaning as the expressions in the ASC() operator.

Unlike the ASC() operator, you CANNOT assign the CHR() operator a value. A statement such as CHR($(1),1) = H, is INVALID and generates a BAD SYNTAX ERROR. Use the ASC() operator to change a value in a string, or use the string support call routine – replace string in a string. See Section 5.10.3 below titled, "String Support Calls" for more information.

Important: Use the CHR() function only in a print statement.

5.10.2.1 Clearing the Screen on an Allen-Bradley Industrial Terminal

Refer to Appendix B at the rear of this manual. In "Column 1" under "DEC", you find that 12 equals ASCII FF (form feed). Type PRINT CHR(12) to clear the industrial terminal screen with a form feed.

5.10.2 The CHR Operator (continued)

5.10.2.2 Cursor Positioning on an Industrial Terminal

Allen-Bradley Industrial Terminal – Refer to the Industrial Terminal User's Manual (publication number 1770-6.5.3), Table 6-3. You can control cursor positioning by typing:

```
(CTRL)(P)(COLUMN#)(;)(ROW#)(A).
```

The ASCII equivalent of (CTRL)(P) is DLE. Using Appendix B, the DEC equivalent of ASCII DLE is 16.

```
PRINT CHR(16), "40;10ATEST"
```

This prints "TEST" at column 40 row 10 on your Allen-Bradley Industrial Terminal.

5.10.3 String Support Calls

To enhance the BASIC Module we have added several string manipulation routines that make programming easier. Strings in the BASIC Module are declared by the STRING statement. You must execute the STRING statement before you can access or call any strings or string routines. The STRING statement has two arguments or numbers that follow it. They are:

- the total amount of space to allocate to string storage and,
- the maximum size in characters of each string.

Since you terminate strings using a carriage return character, each string is given an extra byte of storage for its carriage return if it is the maximum length. You can determine the number of strings allowed by taking the first number and dividing it by one plus the second number. Note that you must use the strings consecutively starting with string 0 through the allowed number of strings. All strings are allocated the maximum number of characters regardless of the actual number used.

All of these routines use or modify strings as part of their operation. The mechanism for passing a string to the support routine is to PUSH its number or subscript onto the stack. The support routine can then get the string number from the module's argument stack, and locate it in string memory.

Many of these routines also require the length of a string as an input. This number must normally be inclusively between zero and the second number used in the last STRING statement which specifies the maximum size of a string. However, in all cases, if a string length argument of minus one (-1) is given, it is interpreted as the maximum allowable string length.

5.10.3 String Support Calls (continued)

It is important to note that since the carriage return character is the string terminator, you cannot use it within a string as one of its characters. If the high bit is set in a carriage return character (use 141 instead of 13 as the decimal value of the carriage return character) the BASIC Module does not recognize it as the end of string character and passes it to the output device. Most devices use a seven bit ASCII code, ignore the top bit and treat the 141 as a normal carriage return.

Important: All undefined characters of a string (i.e. characters following CR) are nulls. If data is input to a string using the ASC($(X),I) command, you must be sure the string is (CR) terminated properly. You can initialize the string or add a (CR) to terminate the string.

Example:

```
>10 STRING 100,10
>20 FOR I=1 TO 5
>30 ASC($(0),I)=65
>40 NEXT I
>50 PRINT $(0)
>RUN
AAAAA
```

The string is stored in memory without a (CR) terminator. Be sure to insert a (CR) (0DH) into the last position of the string if using the above method.

Example:

```
>10 STRING 100,10
>20 FOR I=1 TO 5
>30 ASC ($(0),I) = 65
>40 NEXT I
>45 ASC($(0),6)=0DH
>50 PRINT $(0)
or

>10 STRING 100,10
>15 $(0))=“ -----”
>20 FOR 1 TO 5
>30 ASC ($(0),I) = 65
>40 NEXT I
>50 PRINT $(0)
```

The following three programs allow you to determine how much string space to allocate when you know two of three variables associated with the strings:

- number of characters in the longest string.
- number of string variables.
- amount of memory to allocate for strings.

5.10.3 String Support Calls (continued)

Example program 1:

```
>LIST
10      REM STRING ALLOCATION COMPUTATION KNOWING:
20      REM 1)# CHARACTERS IN LONGEST STRING 2)# OF STRING VARIABLES
30      PRINT : PRINT
40      INPUT “HOW MANY CHARACTERS IN YOUR LONGEST STRING”C
50      INPUT “HOW MANY STRING VARIABLES WILL YOU NEED”V
60      PRINT
70      N=(((C+1)*V)+1) : REM COMPUTE THE # OF BYTES OF MEMORY NEEDED
80      PRINT: PRINT
90      PRINT “YOU NEED TO ALLOCATE”,N,“BYTES OF MEMORY FOR”,V,“VARIABLES
100     PRINT ”CONTAINING”,C,“CHARACTERS EACH”
110     PRINT : PRINT
120     PRINT“                    STRING”,N“,”,C
130     END
>RUN

HOW MANY CHARACTERS IN YOUR LONGEST STRING
?21
HOW MANY VARIABLES WILL YOU NEED
?15

YOU NEED TO ALLOCATE 331 BYTES OF MEMORY FOR 15 VARIABLES CONTAINING
21 CHARACTERS EACH

        STRING 331, 21
READY
```

5.10.3 String Support Calls (continued)

Example program 2:

```
>LIST
10      REM STRING ALLOCATION COMPUTATION KNOWING:
20      REM 1)# CHARACTERS IN LONGEST STRING 2) AMOUNT OF STRING MEMORY
30      PRINT : PRINT
40      INPUT “HOW MANY CHARACTERS IN YOUR LONGEST STRING”C
50      INPUT “# OF BYTES OF MEMORY CAN YOU ALLOCATE FOR STRINGS”N
60      PRINT
70      V=INT((N-1)/(C+1)) : REM COMPUTE THE # OF POSSIBLE VARIABLES
80      N=(V*(C+1))+1 : REM COMPUTE HOW MUCH MEMORY IS ACTUALLY NEEDED
90      PRINT: PRINT
100     PRINT “YOU NEED TO ALLOCATE”,N,“BYTES OF MEMORY FOR”,V,“VARIABLES
110     PRINT “CONTAINING”,C,“CHARACTERS EACH
120     PRINT: PRINT
130     PRINT“                  STRING”,N,“,“C
140     END
>RUN

HOW MANY CHARACTERS IN YOUR LONGEST STRING
?20
# OF BYTES OF MEMORY CAN YOU ALLOCATE FOR STRINGS
?500

YOU NEED TO ALLOCATE 485 BYTES OF MEMORY FOR 22 VARIABLES
CONTAINING 21 CHARACTERS EACH

        STRING 485 , 21
READY
>
```

5.10.3 String Support Calls (continued)

Example program 3:

```
10     REM STRING ALLOCATION COMPUTATION KNOWING:
20     REM 1) AMOUNT OF STRING MEMORY 2) #OF STRING VARIABLES
30     PRINT: PRINT
40     INPUT “ENTER # OF BYTES OF MEMORY YOU CAN ALLOCATE FOR STRINGS”N
50     INPUT “HOW MANY STRING VARIABLES WILL YOU NEED”V
60     PRINT
70     C=INT(((N-1)/V)-1) : REM COMPUTE THE # OF CHARACTERS/STRING
80     N=(V*(C+1))+1 : REM COMPUTE THE # OF BYTES OF MEMORY NEEDED
90     PRINT: PRINT
100    PRINT “YOU NEED TO ALLOCATE”,N,“BYTES OF MEMORY FOR”, V,“VARIABLES”
110    PRINT “CONTAINING”,“C,CHARACTERS EACH”
120    PRINT: PRINT
130    PRINT“                STRING”,N,“,”,C
140    END
>RUN

ENTER # OF BYTES OF MEMORY YOU CAN ALLOCATE FOR STRINGS 500
HOW MANY STRING VARIABLES WILL YOU NEED ? 15

YOU NEED TO ALLOCATE 496 BYTES OF MEMORY FOR 15 VARIABLES CONTAINING 32
CHARACTERS EACH

                                STRING 496 , 32

READY
>
```

5.10.3 String Support Calls (continued)

5.10.3.1 String Repeat – CALL 60

This routine allows you to repeat a character and place it in a string. You can use the String Repeat when designing output formats. First PUSH the number of times to repeat the character, then PUSH the number of the string containing the character to be repeated. No arguments are POPed. You cannot repeat more characters than the string’s maximum length.

```
>10 REM STRING REPEAT EXAMPLE PROGRAM
>20 STRING 1000,50
>30 $(1)=“*”
>40 PUSH 40 :REM THE NUMBER OF TIMES TO REPEAT CHARACTER
>50 PUSH 1 :REM WHICH STRING CONTAINS CHARACTER
>60 CALL 60
>70 PRINT $(1)
>80 END
>RUN
****************************************
READY
```

5.10.3 String Support Calls (continued)

5.10.3.2 String Append (Concatenation) – CALL 61

This routine allows you to append one string to the end of another string. The CALL expects two string arguments. The first is the string number of the string to be appended and the second is the string number of the base string. If the resulting string is longer than the maximum string length, the append characters are lost. There are no output arguments. This is a string concatenation assignment. (Example: $(1)=$(1)+$(2)).

```
>10 STRING 200,20
>20 $(1)="How are"
>30 $(2)="you?"
>40 PRINT "BEFORE:",
>50 PRINT "$1=",$(1)," $2=",$(2)
>60 PUSH 2 :REM STRING NUMBER OF STRING TO BE APPENDED
>70 PUSH 1 :REM BASE STRING NUMBER
>80 CALL 61 :REM INVOKE STRING CONCATENATION ROUTINE
>90 PRINT "AFTER:",
>100 PRINT "$1=",$(1)," $2=",$(2)
>110 END

>RUN

BEFORE:     $1=How are        $2=you?
AFTER:      $1=How are you?   $2=you?

READY
```

5.10.3.3 Number to String Conversion – CALL 62

This routine converts a number or numeric variable into a string. You must allocate a minimum of 14 characters for the string. If the exponent of the value to be converted is anticipated to be 100 or greater, you must allocate 15 characters. Error checking traps string allocation of less than 14 characters only.

- PUSH the value to be converted
- PUSH the number of the string to receive the value.

Example:

```
>10 STRING 100,14
>20 INPUT "ENTER A NUMBER TO CONVERT TO A STRING ",N >30 PUSH N
>40 PUSH 1: REM CONVERT NUMBER TO STRING 1
>50 CALL 62: REM DO THE CONVERSION
>60 PRINT $(1)
>70 END
```

5.10.3 String Support Calls (continued)

5.10.3.4 String to Number Conversion – CALL 63

This routine converts the first decimal number found in the specified string to a number on the argument stack. Valid numbers and associated characters are: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, ., E, +, -. The comma (,) is not a valid number character and terminates the conversion. Two bytes are POPed after the CALL:

- validity of the value
- actual value

If the string does not contain a legal value a 0 (zero) is returned. A valid value is between 1 and 255. PUSH the number of the string to convert. Two POPs are required. First POP the validity value, then POP the value. If a string contains a number followed by an E followed by a letter or non-numeric character, it is assumed that no number was found since the letter is not a valid exponent (UAB701EA returns a zero in the first argument popped indicating that no valid number was in the string).

Example:

```
>10 STRING 100,14
>20 INPUT “ENTER A STRING TO CONVERT”,$(1)
>30 PUSH 1: REM CONVERT STRING 1
>40 CALL 63: REM DO THE CONVERSION
>50 POP V,N
>60 IF V <> 0 THEN PRINT $(1),“ ”,N: GO TO 80
>70 PRINT “INVALID OR NO VALUE FOUND” 80 END
```

5.10.3 String Support Calls (continued)

5.10.3.5 Find a String in a String – CALL 64

This routine finds a string within a string. It locates the first occurrence (position) of this string. This call expects two input arguments . The first is the string to be found, the second is the string to be searched for a match. One return argument is required. If the number is not zero then a match was located at the position indicated by the value of the return argument. This routine is similar to the BASIC INSTR$(findstr$,str$). (Example: L=INSTR$($(1),$(2))

```
>10    REM SAMPLE FIND STRING IN STRING ROUTINE
>20    STRING 1000,20
>30    $(1)="456"
>40    $(2)="12345678"
>50    PUSH 1 :REM STRING NUMBER OF STRING TO BE FOUND
>60    PUSH 2 :REM BASE STRING NUMBER
>70    CALL 64 :REM GET LOCATION OF FIRST CHARACTER
>80    POP L
>90    IF L=0 THEN PRINT "NOT FOUND"
>100   IF L>0 THEN PRINT "FOUND AT LOCATION ",L
>110   END

>RUN

FOUND AT LOCATION 4

READY
```

5.10.3 String Support Calls (continued)

5.10.3.6 Replace a String in a String – CALL 65

This routine replaces a string within a string. Three arguments are expected. The first argument is the string number of the string which replaces the string identified by the second argument string number. The third argument is the base string's string number. There are no return arguments.

```
>10    REM SAMPLE OF REPLACE STRING IN STRING
>20    STRING 1000,20
>30    $(0)="RED-LINES"
>40    $(1)="RED"
>50    $(2)="BLUE"  >60 PRINT "BEFORE: $0=",$(0)
>70    PUSH 2 :REM STRING NUMBER OF THE STRING TO REPLACE WITH
>80    PUSH 1 :REM STRING NUMBER OF THE STRING TO BE REPLACED
>90    PUSH 0 :REM BASE STRING NUMBER
>100   CALL 65 :REM INVOKE REPLACE STRING IN STRING ROUTINE
>110   PRINT "AFTER: $0=",$(0)
>120   END
RUN
BEFORE: $=RED-LINES
AFTER: $0=BLUE-LINES
READY
```

5.10.3 String Support Calls (continued)

5.10.3.7 Insert String in a String – CALL 66

This routine inserts a string within another string. The call expects three arguments. The first argument is the position at which to begin the insert. The second argument is the string number of the characters inserted into the base string. The third argument is the string number of the base string. This routine has no return arguments.

```
>10    REM SAMPLE ROUTINE TO INSERT A STRING IN A STRING
>20    STRING 500,15
>30    $(0)=“1234590”
>40    $(1)=“67890”
>50    PRINT “BEFORE: 0$=”,$(0)
>60    PUSH 6 :REM POSITION TO START THE INSERT
>70    PUSH 1 :REM STRING NUMBER OF THE STRING TO BE INSERTED
>80    PUSH 0 :REM BASE STRING NUMBER
>90    CALL 66 :REM INVOKE INSERT A STRING IN A STRING
>91    REM :REM ROUTINE
>100   PRINT “AFTER: 0$=”,$(0)
>110   END

>RUN

BEFORE: 0$=1234590
AFTER: 0$=1234567890
READY
```

5.10.3 String Support Calls (continued)

5.10.3.8 Delete String from a String – CALL 67

This routine deletes a string from within another string. The call expects two arguments. The first argument is the base string number. The second is the string number of the string to be deleted from the base string. This routine has no return arguments.

Important: This routine deletes only the first occurrence of the string.

```
>10   REM ROUTINE TO DELETE A STRING IN A STRING
>20   STRING 200,14
>30   $(1)="123456789012"
>40   $(2)="12"
>50   PRINT "BEFORE: $1=",$(1)
>60   PUSH 1 :REM BASE STRING NUMBER
>70   PUSH 2 :REM STRING NUMBER OF THE STRING TO BE DELETED
>80   CALL 67 :REM INVOKE STRING DELETE ROUTINE
>90   PRINT "AFTER: $1=",$(1)
>100  END

>RUN

BEFORE: $1=123456789012
AFTER: $1=3456789012

READY
```

5.10.3 String Support Calls (continued)

5.10.3.9 Determine Length of a String – CALL 68

This routine determines the length of a string. One input argument is expected. This is the string number on which the routine acts. One output argument is required. It is the actual number of non-carriage return (CR) characters in this string. This is similar to the BASIC command LEN(str$). (Example: L=LEN($1)).

```
>10    REM SAMPLE OF STRING LENGTH
>20    STRING 100,10
>30    $(1)="1234567"
>40    PUSH 1 :REM BASE STRING
>50    CALL 68 :REM INVOKE STRING LENGTH ROUTINE
>60    POP L :REM GET LENGTH OF BASE STRING
>70    PRINT "THE LENGTH OF ",$(1)," IS ",L
>80    END

>RUN

THE LENGTH OF 1234567 IS 7

READY
```

5.11 Memory Support Calls

The following sections list and describe the memory support calls you can use with the BASIC Module. All strings, arrays and variables are shared.

5.11.1 ROM to RAM Program Transfer – CALL 70

This routine shifts program execution from a running ROM program to the beginning of the RAM program. No arguments are PUSHed or POPed.

Important: The first line of the RAM program is not executed. We recommend that you make it a remark.

Example:

ROM #5

```
>10 REM SAMPLE ROM PROG FOR CALL 70
>20 PRINT “NOW EXECUTING ROM #5”
>30 CALL 70 :REM GO EXECUTE RAM
>40 END
```

RAM

```
>10 REM SAMPLE RAM PROGRAM FOR CALL 70
>20 PRINT “NOW EXECUTING RAM”
>30 END

>RUN

NOW EXECUTING ROM #5
NOW EXECUTING RAM
```

5.11.2 ROM/RAM to ROM Program Transfer – CALL 71

This routine transfers from a running ROM or RAM program to the beginning of any available ROM program. One argument is PUSHed (which ROM program). None are POPed. An invalid program error displays and you enter the command mode if the ROM number does not exist.

Important: The first line of the ROM program is not executed. We recommend that you make it a remark.

Example:

```
>10    REM THIS ROUTINE WILL CALL AND EXECUTE A ROM ROUTINE
>20    INPUT “ENTER ROM ROUTINE TO EXECUTE ”,N
>30    PUSH N
>40    CALL 71
>50    END

>RUN

ENTER ROM ROUTINE TO EXECUTE 4
```

5.11.2 ROM/RAM to ROM Program Transfer – CALL 71 (continued)

The user is now executing ROM 4 if it exists. If the ROM routine requested does not exist the result is:

```
PROGRAM NOT FOUND.
READY
>
```

5.11.3 RAM/ROM Return – CALL 72

This routine allows you to return to the ROM or RAM routine that called this ROM or RAM routine. Execution begins on the line following the line that CALLed the routine. No arguments are PUSHed or POPed. This routine works one layer deep. You may go back to the last CALLing program's next line.

Important: There must be a next line in the ROM or RAM routine, otherwise unpredictable events could occur which may destroy the contents of RAM. For this reason always be sure that at least one END statement exists following a Call 70 or 71.

Example:

```
>ROM #1

>10    REM SAMPLE PROG FOR CALL 72
>20    PRINT “NOW EXECUTING ROM #1
>30    PUSH 3
>40    CALL 71 :REM EXECUTE ROM #3 THEN RETURN
>50    PRINT “EXECUTING ROM #1 AGAIN”
>60    END
```

ROM #3

```
>10    REM THIS LINE WONT BE EXECUTED
>20    PRINT “NOW EXECUTING ROM #3”
>30    CALL 72
>40    END
```

With ROM #1 selected:

```
>RUN

NOW EXECUTING ROM #1
NOW EXECUTING ROM #3
EXECUTING ROM #1 AGAIN

READY
>
```

5.11.4 Battery-backed RAM Disable – CALL 73

CALL 73 disables the battery-backed RAM, prints “Battery Backup Disabled” when executed and allows a purging reset. The next power loss destroys the contents of RAM. When power is reapplied, RAM is cleared and battery back-up is reenabled automatically.

5.11.5 Battery-backed RAM Enable – CALL 74

CALL 74 enables the battery-backed RAM and prints “Battery Backup Enabled” when executed. It is enabled on power-up and remains enabled until you execute a CALL 73 or until the battery fails.

5.11.6 Protected Variable Storage – CALL 77

Important: Change MTOP from command mode only to ensure proper operation

CALL 77 reserves the top of RAM memory for protected variable storage. Values are saved if BATTERY-BACKUP is invoked. You store values with the ST @ command and retrieve them with the LD @ command. Each variable stored requires 6 bytes of storage space.

You must subtract 6 times the number of variables to be stored from MTOP reducing available RAM memory. This value is PUSHed onto the stack as the new MTOP address. All appropriate variable pointers are reconfigured. Do this only in command mode.

Important: Do not let the ST @ address write over the MTOP address. This could alter the value of a variable or string.

Example: For saving 2 variables.

```
>PRINT MTOP
14335
>PRINT MTOP-12
14323
>PUSH 14323:REM NEW MTOP ADDRESS
>CALL 77

>10 K = 678 * PI
>15 L =520 PUSH K
>30 ST @ 14335:REM STORE K IN PROTECTED AREA
>40 PUSH L
>50 ST @ 14329
>55 REM TO RETRIEVE PROTECTED VARIABLES
>60 LD@ 14335:REM REMOVE K FROM PROTECTED AREA
>70 POP K
>80 LD@ 14329
>90 POP L
>100 REM USE LD@ AFTER POWER LOSS AND BATTERY BACK-UP IS USED
```

5.11.6 Protected Variable Storage – CALL 77 (continued)

Example:

For using protected variable storage area.

A. Scalar Variables

Push all variables in one line:

```
>PRINT MTOP
14335
>PRINT MTOP-24
14311
>PUSH 14311:REM NEW MTOP ADDRESS
CALL 77

90 M1=14335 : REM BEGIN STORING HERE
100 PUSH A, B, C, D
```

Use the ST @ and LD @ commands in a DO loop:

```
>200 DO
>210 ST @ M1
>220 M1=M1-6 : REM EACH VARIABLE =6 BYTES
>230 UNTIL M1=MTOP: REM YOU DEFINED THE NEW MTOP W/CALL 77
>290 M1=14335
>300 DO
>310 LD @ M1
>320 M1 = M1-6
>330 UNTIL M1 = MTOP
>360 POP A, B, C, D
>370 PRINT A, B, C, D
```

5.11.6 Protected Variable Storage – CALL 77 (continued)

B. Arrays

Use an array to set up the data

```
>PRINT MTOP 14335
>PRINT MTOP-24 14311
>PUSH 14311:REM NEW MTOP ADDRESS
CALL 77
```

```
100 DIM A(4)
110 DATA 10, 20, 30, 40
120 FOR I=1 TO 4: READ A(I) : NEXT I
```

Use ST@ and LD @ commands in a DO loop:

```
>190 M1=14335
>200 DO
>210 PUSH A(I) : ST @ M1
>220 I = I+1 : M1 = M1-6
>230 UNTIL I = 4
>290 M1=14335
>300 DO
>310 LD @ M1 : POP A(I)
>320 PRINT A(I)
>330 I = I+1 : M1 = M1-6
>340 UNTIL I 10
```

5.12 Miscellaneous Calls

The following sections list and describe the miscellaneous calls you can use with the BASIC Module.

5.12.1 Program Port Baud Rate – CALL 78

CALL 78 allows you to change the program port baud rate from its default value (1200 baud) to one of the following: 300, 600,1200, 2400, 4800, 9600 or 19.2 K baud. PUSH the desired baud rate and CALL 78. The program port remains at this baud rate unless CALL 73 is invoked or the battery is removed and power is cycled. If this happens the baud rate defaults to 1200 baud.

Example:

```
>10 PUSH 4800
>20 CALL 78
```

5.12.2 Blink the Active LED by Default – CALL 79

The Active LED is on constantly during program execution or command mode. When you issue a CALL 79 the Active LED remains on while a program executes and blinks every second when the module is in the command mode. Issue CALL 79 again to cancel the blinking LED.

5.12.3 Check Battery Condition – CALL 80

CALL 80 checks the module’s battery condition. If a 0 is POPed after a CALL 80, battery is okay. If a 1 is POPed a low battery condition exists.

Example:

```
>10   CALL 80
>20   POP C
>30   IF C <>0 THEN PRINT “BATTERY LOW”
>40   END
```

5.12.4 User PROM Check and Description – CALL 81

Use CALL 81 before burning a program into PROM memory. This routine:

- determines the number of PROM programs.
- determines the number of bytes left in PROM.
- determines the number of bytes in the RAM program.
- prints a message telling if enough space is available in PROM for the RAM program.
- checks PROM validity if no program is found.
- prints a good or bad PROM message. A bad PROM message with an address of 00xx indicates an incomplete program.
- cannot detect a defective PROM.

No PUSHes or POPs are needed.

5.12.5 Reset Print Head Pointer – CALL 99

You can use CALL 99 when printing out wide forms to reset the internal print head character counter and prevent the automatic CR/LF at character 79. You must keep track of the characters in each line.

You can solve this problem in revision A or B modules using DBY(1 6H) = 0

Example:

```
>10    REM THIS PRINTS TIME BEYOND 80TH COLUMN
>20    PRINT TAB (79),
>30    CALL 99
>40    PRINT TAB (41), “TIME —”,
>50    PRINT H, “:”, M ,“:”,S
>60    END
```

5.12.6 Print the Argument Stack – CALL 109

CALL 109 prints the top 9 values on the argument stack to the console. No PUSHes or POPs are needed. Use this information as a troubleshooting aid. It does not affect the contents of, or pointer to the stack.

5.12.7 Print the Peripheral Port Output Buffer and Pointer – CALL 110

CALL 110 prints the complete buffer with addresses, front pointer and the number of characters in the buffer to the console. No PUSHes or POPs are needed.

Use this information as a troubleshooting aid. It does not affect the contents of the buffer.

5.12.8 Print the Peripheral Port Input Buffer and Pointer – CALL 111

CALL 111 prints the complete buffer with addresses, front pointer and the number of characters in the buffer to the console. No PUSHes or POPs are needed.

Use this information as a troubleshooting aid. It does not affect the contents of the buffer.

5.12.9 Reset the Peripheral Port to Default Settings – CALL 119

CALL 119 resets the peripheral port to the following default settings:

- 8 bits/character
- 1 stop bit
- No parity
- DCD off
- XON-XOFF off

No PUSHes or POPs are needed.

Chapter 6

Programming

6.1 Chapter Objectives

After reading this chapter you should be able to:

- program your BASIC Module for use with a programmable controller.
- use block-transfer to communicate with a programmable controller.

This chapter shows the BASIC programming and ladder logic needed for use with your processor. It also gives you sample programs.

6.2 Block-Transfer with the BASIC Module

Your BASIC Module communicates with any processor that has block-transfer capability. Your ladder logic program and BASIC program work together to enable proper communications between the module and processor.

The BASIC Module is a bi-directional block-transfer module. Bi-directional means that the module performs both read and write block-transfer operations. You transfer data (1 to 64, 16 bit words) from your module to the processor's data table with a block-transfer-read (BTR) instruction. You transfer data (1 to 64, 16 bit words) to your module from the processor's data table with a block-transfer-write (BTW) instruction.

Important: The module's read and write instruction enable bits must not set at the same time. Your program must toggle requests for the read and write instructions as shown in the sample programs.

6.2.1 Block-Transfer-Write and Block-Transfer-Read Buffers

The BASIC Module processor maintains a block-transfer-write (BTW) buffer containing the values of the last BTW sent by the host processor. You initialize this buffer using a CALL 4. You transfer data to the BASIC Module's buffer using CALL 6 or CALL 3. This buffer freezes and does not change when CALL 6 or CALL 3 completes. This double buffering and freezing ensures that the data does not change during processing by the BASIC Module. The BTW buffer remains unchanged and is accessed repeatedly by any of the data access routines provided. An additional CALL 6 or CALL 3 changes the BTW buffer contents.

6.2.1 Block-Transfer-Write and Block-Transfer-Read Buffers (continued)

The BASIC Module also maintains a block-transfer-read (BTR) buffer that is the value of the next block, read by the host processor. The BASIC program initializes this buffer using CALL 5 and transfers the data to the BASIC Module processor (for subsequent transfer to the host processor) when CALL 7 or CALL 2 executes. You should complete the building of the read buffer before initiating its transfer.

6.3 Block-Transfer with PLC-2 Family Processors

The following sample programs use block-transfer instructions. The Mini-PLC-2 (cat. no. 1772-LN3) and PLC 2/20 (cat. no. 1772-LP1,-LP2) processors use multiple GET instructions to perform block-transfers. Refer to the processor user's manual for an explanation of multiple GET block-transfers.

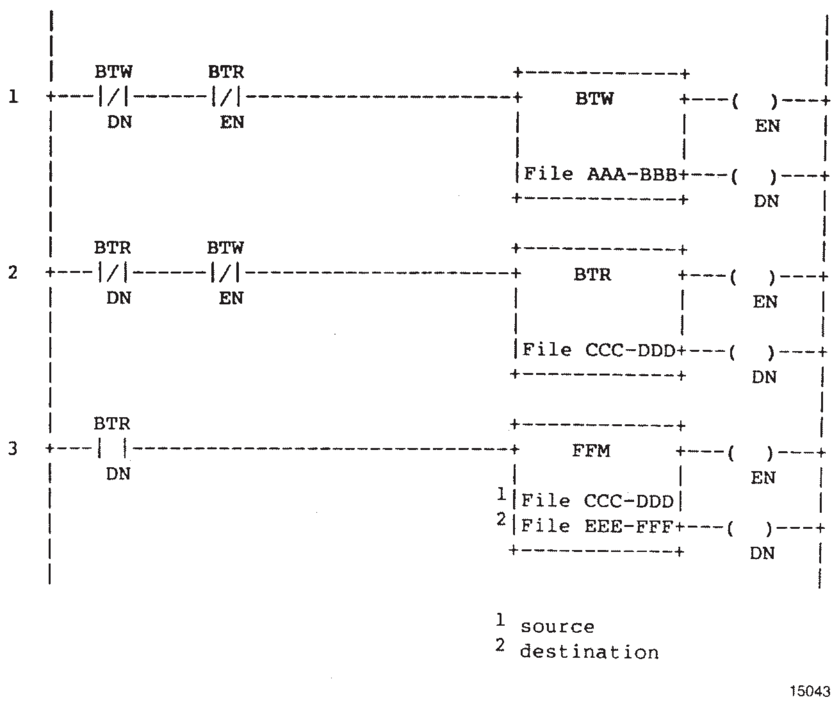
6.3.1 PLC-2 Processor Program

This sample program (figure 6.1 and 6.3) assumes that the application requires a single block-transfer-read (BTR) and a single block-transfer-write (BTW) to pass data between the processor and the BASIC Module (i.e. transfer of 64 words or less). If the transferred data exceeds 64 words you must program multiple file to file moves to move different data sets to and from the block-transfer files.

6.3.1 PLC-2 Processor Program (continued)

Refer to figure 6.1 for the sample ladder logic and figure 6.2 for the corresponding BASIC program. The values shown in figure 6.2 are for demonstration purposes only. Use the program shown in figure 6.2 for all PLC-2, PLC-3 and PLC-5 processor ladder logic programs shown in this chapter. Figure 6.3 is an actual sample program.

Figure 6.1
Sample PLC-2 Family Ladder Logic



6.3.1.1 Rung Description

Rungs 1 and 2 – The first two rungs of the sample program toggle the requests for block-transfer-writes (BTW) and block-transfer-reads (BTR). The interlocks shown do not allow a BTR and BTW instruction to enable at the same time.

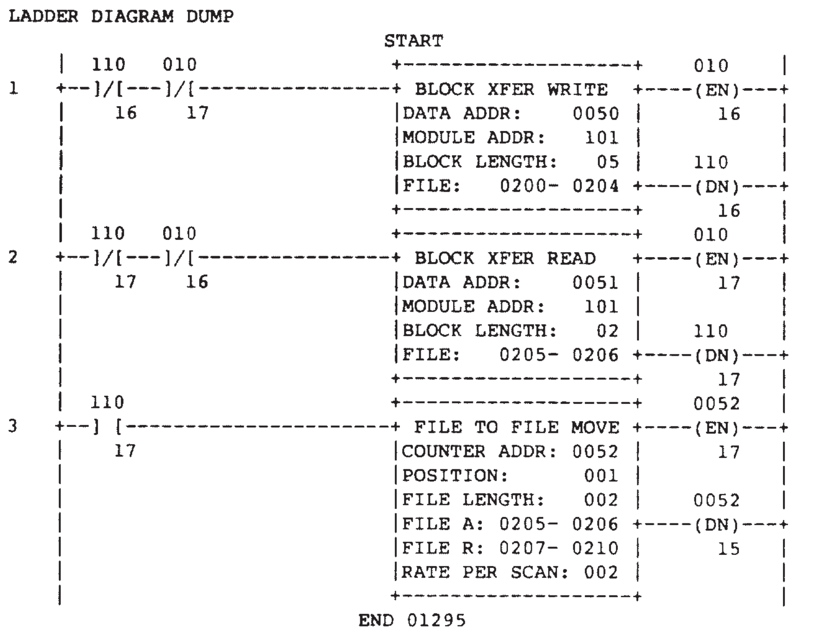
Rung 3 – When a BTR successfully completes, its done bit sets, enabling the file-to-file move instruction. The file-to-file move instruction (FFM) moves the BTR data file (File CCC-DDD) into a storage data file (EEE-FFF). This prevents the programmable controller from using invalid data if a block-transfer communication fault occurs.

6.3.1 PLC-2 Processor Program (continued)

Figure 6.2
Sample BASIC Module Program

```
>5     DIM A(10)
>10    REM SET BTW LENGTH TO 10 WORDS
>20    PUSH 10: CALL 4
>30    REM SET BTR LENGTH TO 2 WORDS
>40    PUSH 2: CALL 5
>50    REM READ THE BTW BUFFER
>60    CALL 6
>70    REM CONVERT DATA FROM 3-DIGIT SIGNED BCD TO DB FORMAT
>80    FOR I=1 TO 10 DO
>90    PUSH(I): CALL 10: POP A(I)
>100   NEXT I
>110   REM DO A CALCULATION
>120   T=A(1)+A(2)+A(3)+A(4)+A(5)+A(6)+A(7)+A(8)+A(9)+A(10):V=T/10
>130   REM CONVERT DATA FROM DB FORMAT TO 3-DIGIT SIGNED BCD
>140   PUSH T: PUSH 1: CALL 20
>150   PUSH V: PUSH 2: CALL 20
>160   REM WRITE TO THE BTR BUFFER
>170   CALL 7
>180   REM CONTINUE TO BLOCK TRANSFER
>190   GOTO 60
>200   END
```

Figure 6.3
Sample PLC-2 Family Ladder Diagram



```
LADDER DIAGRAM DUMP
                                          START
     | 110   010                          +-------------------+    010     |
1    +--]/[---]/[-----------------+ BLOCK XFER WRITE  +----(EN)---+
     |    16    17                        |DATA ADDR:     0050 |       16   |
     |                                    |MODULE ADDR:    101 |            |
     |                                    |BLOCK LENGTH:    05 |     110    |
     |                                    |FILE:   0200- 0204 +----(DN)---+
     |                                    +-------------------+       16   |
     | 110   010                          +-------------------+    010     |
2    +--]/[---]/[-----------------+ BLOCK XFER READ   +----(EN)---+
     |    17    16                        |DATA ADDR:     0051 |       17   |
     |                                    |MODULE ADDR:    101 |            |
     |                                    |BLOCK LENGTH:    02 |     110    |
     |                                    |FILE:   0205- 0206 +----(DN)---+
     |                                    +-------------------+       17   |
     | 110                                +-------------------+    0052    |
3    +--] [-----------------------+ FILE TO FILE MOVE +----(EN)---+
     |    17                              |COUNTER ADDR: 0052 |       17   |
     |                                    |POSITION:      001 |            |
     |                                    |FILE LENGTH:   002 |    0052    |
     |                                    |FILE A: 0205- 0206 +----(DN)---+
     |                                    |FILE R: 0207- 0210 |       15   |
     |                                    |RATE PER SCAN: 002 |            |
     |                                    +-------------------+            |
                                        END 01295
```

15044

6.4 PLC-3 Family Processors

You can use the following ladder logic program with PLC-3 or PLC-3/10 processors. This program assumes that your application requires a single BTR and BTW to pass data between the processor and the BASIC Module (i.e. transfer of 64 words or less). If the transferred data exceeds 64 words you must program multiple file to file moves to move different data sets to and from the block-transfer files.

Refer to Figure 6.4 for the sample ladder logic and Figure 6.2 for the corresponding BASIC program. You can use the BASIC program with any processor. Values shown in the program are for demonstration purposes only. Figure 6.5 is an actual sample program.

Figure 6.4
Sample PLC-3 Family Ladder Logic -Single Data Set

```
   |                                                             |
   |                                                             |
   |     PLC-3                                                   |
   |      AC                   +--------------+  +--------------+ |
1  +-----| |-------------------+     XOR      +--+     XOR      +-+
   |     Power                 | A=BTW cntl   |  | A=BTR cntl   | |
   |     Loss                  | B=BTW cntl   |  | B=BTR cntl   | |
   |     Bit                   | R=BTW cntl   |  | R=BTR cntl   | |
   |                           +--------------+  +--------------+ |
   |                                                             |
   |                                                             |
   |     BTR                   +--------------+                  |
2  +-----| |------------+------+     BTW      +------------(   )----+
   |      DN            |      | R            |             LE     |
   |                    |      | G            |                    |
   |    +-------------+ |      | M            +------------(   )----+
   +----+ EQU         +-+      | Data         |             DN     |
   |    | A=BTW cntl  |        | Length       |                    |
   |    | B=BTR cntl  |        | Cntl         +------------(   )----+
   |    +-------------+        +--------------+             ER     |
   |                                                             |
   |    BTW                    +--------------+                  |
3  +-----| |-------------------+     BTR      +------------(   )----+
   |     DN                    | R            |             LE     |
   |                           | G            |                    |
   |                           | M            +------------(   )----+
   |                           | Data         |             DN     |
   |                           | Length       |                    |
   |                           | Cntl         +------------(   )----+
   |                           +--------------+             ER     |
   |                                                             |
```

15045

6.4 PLC-3 Family Processors (continued)

Figure 6.5
Sample PLC-3 Family Ladder Diagram

```
                        RUNG NUMBER RM1

    | S0003            +- XOR -----------+ +- XOR -----------+|
1   |--] [-------------+   A XOR B = R   +-+   A XOR B = R   +|
    |   03             | A : WB001:0030  | | A : WB001:0020  ||
    |                  | 0000000010000100| | 0000000000000000||
    |                  | B : WB001:0030  | | B : WB001:0020  ||
    |                  | 0000000010000100| | 0000000000000000||
    |                  | R : WB001:0030  | | R : WB001:0020  ||
    |                  | 0000000010000100| | 0000000000000000||
    |                  +-----------------+ +-----------------+|

                        RUNG NUMBER RM2

    | WB001:0020                   +- BTW ------------+ CNTL  |
2   |+----]   [----------+-----------+ BLOCK XFER WRITE +-(LE)--|
    ||        15         |           | RACK   :  002    |  02  |
    ||+- EQU ------------+|          | GROUP  :    1    | CNTL |
    |++     A = B        ++          | MODULE :  1=HIGH +-(DN) |
    | | A : WB001:0030  |            | DATA: FB002:0150 |  05  |
    | | 0000000010000100|            | LENGTH =      10 | CNTL |
    | | B:  WB001:0020  |            | CNTL: FB001:0030 +-(ER) |
    | | 0000000000000000|            +------------------+  03  |
    | |                 |                                      |
    | |                 |                                      |
    | +-----------------+

                        RUNG NUMBER RM3

    | WB001:0030                   +- BTR ------------+ CNTL  |
3   |-----]   [----------------------+ BLOCK XFER READ  +-(LE)--|
    |         05                     | RACK   :  002    |  12  |
    |                                | GROUP  :    1    | CNTL |
    |                                | MODULE :  1=HIGH +-(DN) |
    |                                | DATA: FB002:0220 |  15  |
    |                                | LENGTH =       2 | CNTL |
    |                                | CNTL: FB001:0020 +-(ER) |
    |                                +------------------+  13  |
```

15046

6.4.1 Rung Description for Sample PLC-3 Family Ladder Logic – Single Data Set

Rung 1 — Rung one is true only at power-up. It uses status word 3, bit 3 (the AC power loss bit of the PLC-3) to zero the control file of both the BTR and BTW.

Rungs 2 and 3 — During normal program execution the BTW and BTR instructions are alternately executed. The done bits of each instruction enable the next block-transfer instruction. The BTR and BTW control files must be different for the next block-transfer to occur.

The equal instruction is used at power-up. At power-up the BTR and BTW control files both equal zero. At power-up the BTW enables and block-transfers begin.

6.5 PLC-5 Family Processors

You can use the following ladder logic program with PLC-5 Family processors. This program assumes that your application requires a single BTR and BTW to pass data between the processor and the BASIC Module (i.e. transfer of 64 words or less). If the transferred data exceeds 64 words you must program multiple file to file moves to move different data sets to and from the block-transfer files.

The PLC-5 block-transfer program is an alternating read/write program (i.e. at the completion of the BTW the BTR enables. At the completion of the BTR the BTW enables). The processor checks data validity before accepting read data and sets one enable bit at a time. Figure 6.6 is a generic sample block-transfer program for a PLC-5 family processor. Figure 6.7 is an actual sample program.

6.5 PLC-5 Family Processors (continued)

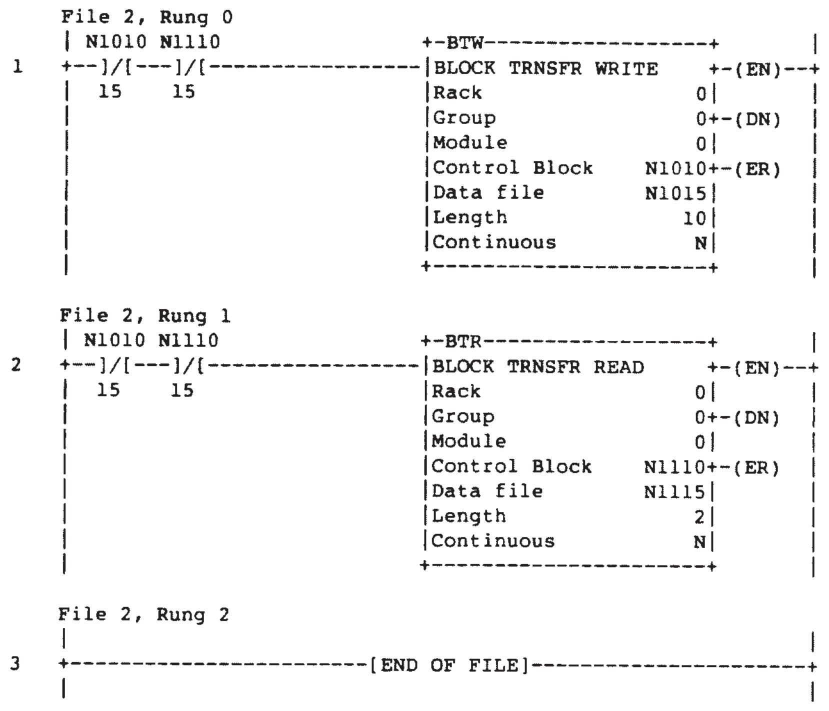
Figure 6.6
Sample PLC-5 Family Ladder Logic

```
     |                                                       |
     |   BTW   BTR                +--------------------+       |
1    +---|/|---|/|----------------+        BTW         +-------------+
     |    EN    EN                |Control Block  xxx |       |
     |                            |Data File      yyy |       |
     |                            |                    |       |
     |                            |Continuous     no  |       |
     |                            +--------------------+       |
     |                                                       |
     |   BTW   BTR                +--------------------+       |
2    +---|/|---|/|----------------+        BTR         +-------------+
     |    EN    EN                |Control Block  zzz |       |
     |                            |Data File      aaa |       |
     |                            |                    |       |
     |                            |Continuous     no  |       |
     |                            +--------------------+       |
     |                                                       |
```

15047

6.5 PLC-5 Family Processors (continued)

Figure 6.7
Sample PLC-5 Family Ladder Logic



```
     File 2, Rung 0
     | N1010 N1110                      +-BTW------------------+       |
1    +--]/[---]/[-----------------------|BLOCK TRNSFR WRITE    +-(EN)--+
     |  15    15                        |Rack                 0|       |
     |                                  |Group                0+-(DN)  |
     |                                  |Module               0|       |
     |                                  |Control Block    N1010+-(ER)  |
     |                                  |Data file        N1015|       |
     |                                  |Length              10|       |
     |                                  |Continuous           N|       |
     |                                  +----------------------+       |

     File 2, Rung 1
     | N1010 N1110                      +-BTR------------------+       |
2    +--]/[---]/[-----------------------|BLOCK TRNSFR READ     +-(EN)--+
     |  15    15                        |Rack                 0|       |
     |                                  |Group                0+-(DN)  |
     |                                  |Module               0|       |
     |                                  |Control Block    N1110+-(ER)  |
     |                                  |Data file        N1115|       |
     |                                  |Length               2|       |
     |                                  |Continuous           N|       |
     |                                  +----------------------+       |

     File 2, Rung 2
     |                                                                 |
3    +------------------------[END OF FILE]----------------------------+
     |                                                                 |
```

15048

6.5.1 Rung Description for Sample PLC-5 Family Ladder Logic

Rungs 1 and 2 – Rungs 1 and 2 execute the BTR and BTW instructions alternately. When the BTR completes the BTW enables immediately following the BTR scan.

Important: Do not select the continuous mode when using bidirectional block-transfer. Continuous mode does not allow use of the status bits in the block-transfer instructions.

Important: Set the block-transfer-write timeout bit (control block, word 0, bit 08) to minimize the impact of the block-transfer instructions on the program scan time. See the following Section 6.6, “Block-Transfer Programming Tips” for more information.

6.6. Block-Transfer Programming Tips

1. The block lengths PUSHed for CALLs 4 and 5 must equal the corresponding lengths on your BTW/BTR instructions in the processor.
2. If a BTW appears first in your ladder logic, put CALLs 3 or 6 first in your BASIC program. If a BTR appears first in your ladder logic, put CALLs 2 or 7 first in your BASIC program.
3. Set the PLC-5 block-transfer-write timeout bit (block-transfer control block, word 0 bit 8) to eliminate excessive PLC-5 scan times. When the timeout bit sets, the processor attempts two DB block-transfers before generating a block-transfer error. The error condition resets the enable bit and restarts the block-transfer in our program example, figure 6.7.
4. If your application requires bidirectional block-transfers, you can use CALL 6 or 3 and CALL 7 or 2 as necessary if:
   - you use an equal number of each type.
   - you alternate their use (e.g. CALL 6, CALL 7, CALL 6, CALL 7)You can put the calls anywhere in the program. They can occur at any time interval.
5. If your application requires a one way block-transfer (all write-block-transfers or all read-block-transfers, use only the associated CALLs (4, and 3 or 6; 5, and 2 or 7).

Data Types

7.1 Chapter Objectives

This chapter describes the data types and formats used by the BASIC Module Data Conversion CALL routines. After reading this chapter you should be able to interpret and manipulate the data values generated by your module.

7.2 Output Data Types

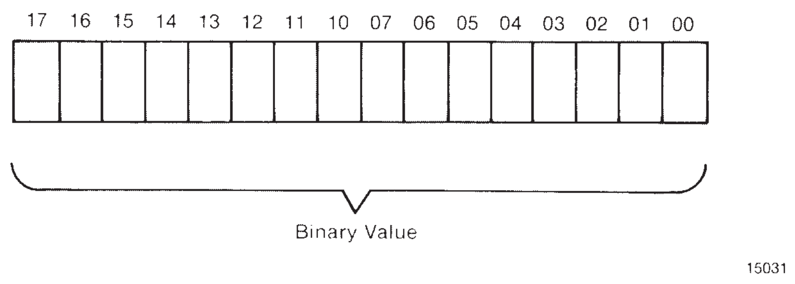
Converted data is exchanged with programmable controllers using block-transfers. You can generate the following data types with the BASIC Module:

- 16-bit binary (XXXX)
- 3-digit, signed, fixed decimal BCD (± XXX.)
- 4-digit, unsigned, fixed decimal BCD (XXXX.)
- 4-digit, signed, octal (± XXXX)
- 6-digit, signed, fixed decimal BCD (± XXXXXX.)
- 3.3-digit, signed, fixed decimal BCD (± XXX.XXX)

7.2.1 16-bit Binary (4 Hex Digits)

This value requires one word of the processor data table. The data is represented by 16 straight binary bits (figure 7.1). The value ranges from 0 to 65,535. No sign, overflow or underflow bits are affected or decoded. If you use a value larger than 65,535 or a negative number you get a BAD ARGUMENT error.

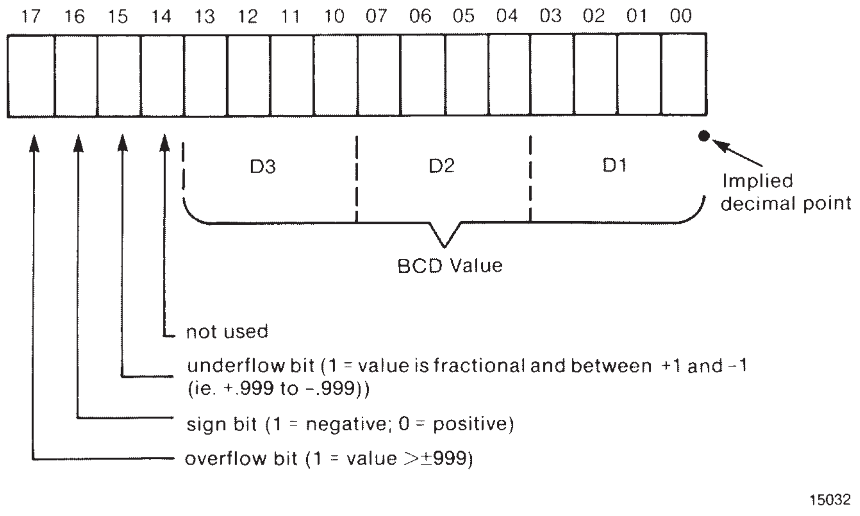
Figure 7.1
16 Bit Binary Word (4 digit hex)



7.2.2 3-digit, Signed, Fixed Decimal BCD

This value requires one word of the processor data table. The data is represented by a 3-digit binary coded decimal integer (figure 7.2). Overflow, underflow and sign are also indicated. An underflow or overflow condition sets the appropriate bit and a value of 000 is returned. The value ranges from -999 to +999. Fractional portions of any number used with the routine are truncated.

Figure 7.2
Truncated 3-Digit BCD Integer

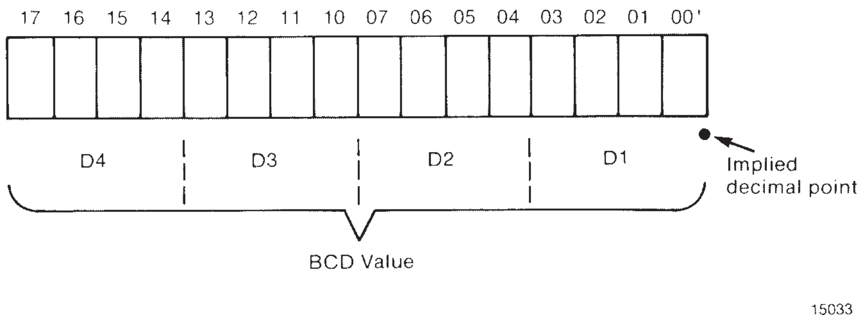

17 16 15 14 13 12 11 10 07 06 05 04 03 02 01 00
D3
D2
D1
Implied decimal point
BCD Value
not used
underflow bit (1 = value is fractional and between +1 and -1 (ie. +.999 to -.999))
sign bit (1 = negative; 0 = positive)
overflow bit (1 = value >±999)
15032

7.2.3 4-digit, Unsigned, Fixed Decimal BCD

This value requires one word of the processor data table. The data is represented by a 4-digit BCD integer (figure 7.3). The value ranges from 0-9999. There is no indication of sign, underflow or overflow. However, if a value of greater than 9999 is converted, the value reported is 0000. Fractional portions of any number used with the routine are truncated.

7.2.3 4-digit, Unsigned, Fixed Decimal BCD (continued)

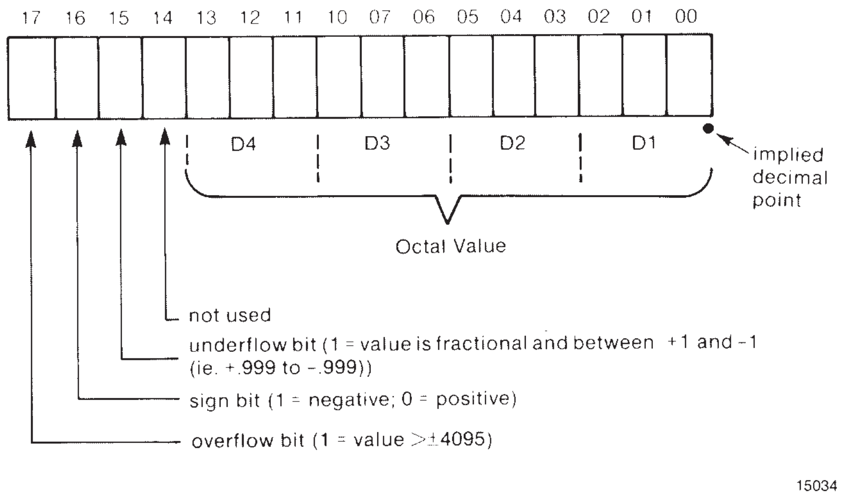
Figure 7.3
Truncated 4-Digit BCD Integer



7.2.4 4-digit, Signed, Octal

This value requires one word of the processor data table. The data is represented by a 4-digit octal integer (figure 7.4). The value ranges from ± 7777 8 (± 4095). Overflow, underflow and sign are also indicated. If an overflow or underflow condition exists, the appropriate bit is set and the value of 0000 is reported. Fractional portions of any number used in this routine are truncated.

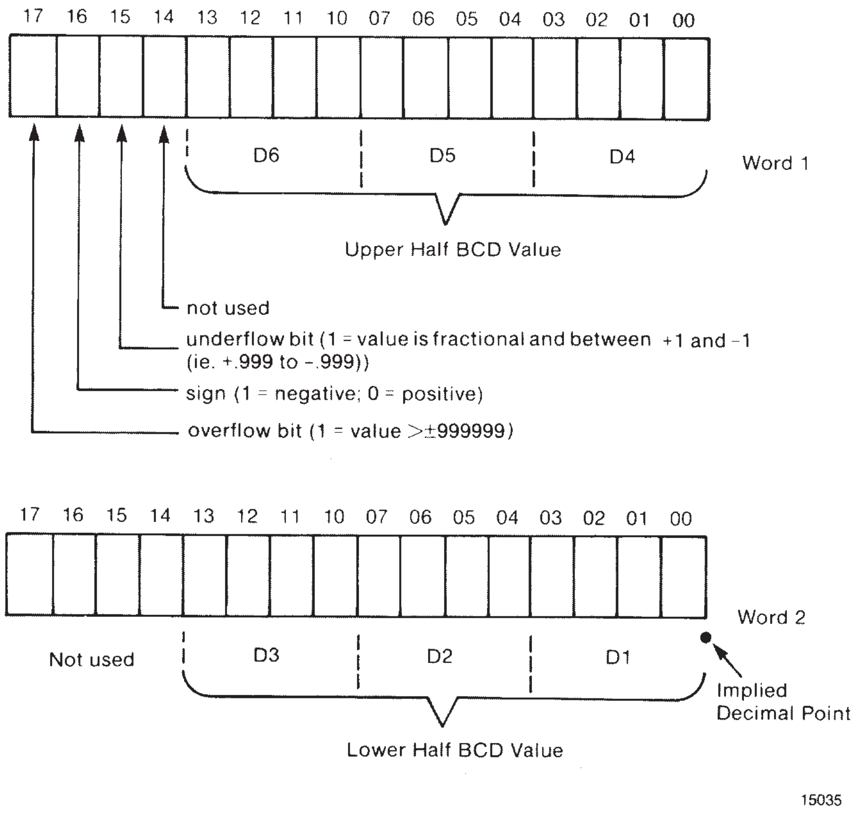
Figure 7.4
Truncated 4-Digit Octal Integer


17 16 15 14 13 12 11 10 07 06 05 04 03 02 01 00
D4
D3
D2
D1
implied decimal point
Octal Value
not used
underflow bit (1 = value is fractional and between +1 and -1 (ie. +.999 to -.999))
sign bit (1 = negative; 0 = positive)
overflow bit (1 = value >±4095)
15034

7.2.5 6-digit, Signed, Fixed Decimal BCD

This value requires two words of the processor data table. The first word contains overflow, underflow and sign data and the three most significant digits of the 6-digit BCD integer. The second word contains the lower three digits of the value (figure 7.5). The value ranges from -999999 to +99999. If an overflow or underflow condition exists, the appropriate bit is set and a value of 000000 is reported. Fractional portions of any number used with this routine are truncated.

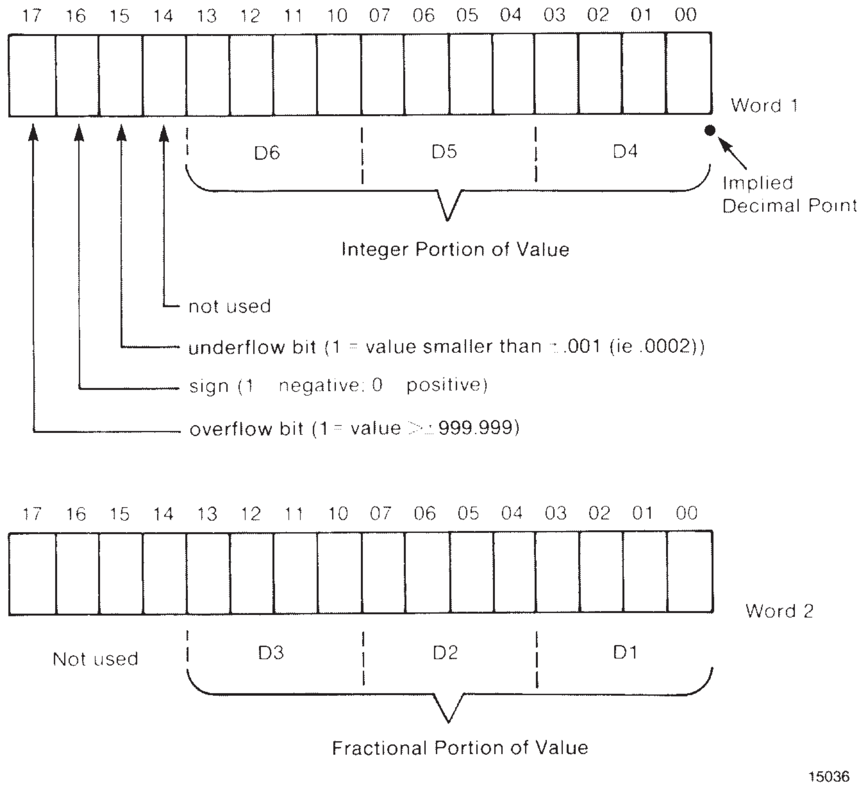
Figure 7.5
Truncated 6-Digit BCD Integer



7.2.6 3.3-digit, Signed, Fixed Decimal BCD

This value requires two words of the processor data table. The first word contains the overflow, underflow, sign data and the three most significant digits of the value. The second word contains the lower three digits of the value (figure 7.6). The value ranges from -999.999 to +999.999. If an overflow or underflow condition exists, a value of 000.000 is reported and the appropriate bit is set. Any digits more than 3 places to the right of the decimal point are truncated.

Figure 7.6
Truncated 3.3-Digit BCD



7.3 Input Data Types

The BASIC Module interfaces with the PLC-2, PLC-3 and PLC-5 family processors. You can send the following data types to the BASIC Module types to the BASIC Module:

- 16-bit binary (4 Hex digits) (XXXX)
- 3-digit, signed, fixed decimal BCD (± XXX.)
- 4-digit, unsigned, fixed decimal BCD (XXXX.)
- 4-digit, signed, octal (± XXXX.)
- 6-digit, signed, fixed decimal BCD (± XXXXXX.)

These data formats are the same as those described under ”Output Data Types” except for 3.3-digit BCD. Refer to the above descriptions.

The BASIC Module converts the data looking at the sign bit when applicable. Refer to the programming manual for your processor for the proper data formats.

Editing A Procedure

8.2 Chapter Objectives

After reading this chapter you should be able to make corrections or modifications to your BASIC programs using the editing features presented.

8.2 Entering the Edit Mode

To invoke the edit mode, type [EDIT] and the line number of the RAM program line to edit.

For example:

```
>EDIT 10.
```

The following features are available in the edit mode.

- right/left cursor control
- replace a character
- insert a character
- delete a character
- retype a line

8.3 Editing Commands/Features

Use the following editing commands to make corrections or modifications to your BASIC program in RAM.

8.3.1 Move

The move feature provides right/left cursor control. The space bar moves the cursor one space to the right. The [RUB OUT](DELETE) key moves the cursor one space to the left.

8.3.2 Replace

The replace feature allows you to replace the character at the cursor position. Type the new character over the previous one.

8.3.3 Insert

Invoke the insert command by typing [CTRL]A. This command inserts text at the cursor position. You must type a second [CTRL]A to terminate the insert.

Important: When you use insert, all text to the right of the cursor disappears until you type the second [CTRL]A. Total line length is 79 characters.

8.3.4 Delete

Invoke the delete command by typing [CTRL]D. This command deletes the character at the cursor position.

8.3.5 Retype

Invoke the retype command by typing the [RETURN] key. This feature retypes the line and initializes the cursor to the first character.

8.3.6 Exits

Invoke the exit command by typing [CTRL]Q or [CTRL]C.[CTRL]Q exits the editor and replaces the old line with the edited line. [CTRL]C exits the editor with no changes made to the line.

8.3.7 Renumber

Invoke the renumber command by typing any of the following commands:

- REN — begins at the start of the program and continues through the end of the program. The new line numbers begin at 10 and increment by 10.
- REN[NUM] — begins at the start of the program and continues through the end of the program. The new line numbers begin at 10 and increment by NUM.

8.3.7 Renumber (continued)

- REN[NUM1],[NUM2] — begins at the start of the program and continues through the end of the program. The new line numbers begin with NUM1 and increment by NUM2.
- REN[NUM1],[NUM2],[NUM3] — begins at NUM2 and continues through the end of the program. The new line numbers begin with NUM1 and increment by NUM3.

Important: The renumber command updates the destination of GOSUB, GOTO, ON ERR, ON TIME and ON GOTO statements.

If the target line number does not exist, or if there is insufficient memory to complete the task, no lines are changed and the message “RENUMBER ERROR” appears on the console screen.

Important: Because the renumber command uses the same RAM for renumbering as it does for variable and program storage, available RAM may be insufficient in large programs. We recommend that you renumber your program periodically during development. Do not wait until it is completed.

8.4 Editing a Simple Procedure

The following example shows you how to edit a simple procedure.

Example:

When the screen shows	You do this
LIST 10 REM 20 FOR I = 1 TO 6 30 PRINT I 40 NEXT I READY >	
	Type EDIT 20 then [RETURN]
EDIT 20 20 for I = 1 TO 6	
	Press the space bar 18 times to move the cursor to 6 (MOVE right feature). Type 9 to change 6 to 9 (REPLACE feature) Press space bar once, type STEP, press space bar once, type 2 Press [CTRL]A to exit the insert Press [CTRL]Q to exit the editor with the changes accepted
READY	
	Type LIST then [RETURN]
>LIST 10 REM 20 FOR I = 1 to 9 STEP 2 30 PRINT I 40 NEXT I READY >	

Error Messages and Anomalies

9.1 Chapter Objectives

After reading this chapter you should be familiar with the module's error messages and anomalies.

9.2 Error Messages from BASIC

When BASIC is in the RUN mode the format of the ERROR messages is as follows:

```
ERROR: XXX – IN LINE YYY

YYY BASIC STATEMENT
 ------------  X
```

Where XXX is the ERROR TYPE and YYY is the line number of the program in which the error occurred. A specific example is:

```
ERROR: BAD SYNTAX – IN LINE 10

10 PRINT 34*21*
 ------------  X
```

The X shows approximately where the ERROR occurred in the line number. The specific location of the X may be off by one or two characters or expressions depending on the type of error and where the error occurred in the program. If an ERROR occurs in the COMMAND MODE only the ERROR TYPE is printed out, not the line number. The ERROR TYPES are as follows:

A-STACK — An A-STACK (ARGUMENT STACK) error occurs when the argument stack pointer is forced "out of bounds". An "out of bounds" condition occurs if:

- you overflow the argument stack by PUSHing too many expressions onto the stack.
- you attempt to POP data off the stack when no data is present.

ARITH. OVERFLOW — An ARITH. OVERFLOW occurs when an arithmetic operation exceeds the upper limit of a module floating point number. The largest floating point number in the BASIC Module is +/–.99999999E+127. For example, 1E+70*1E+70 causes an ARITH. OVERFLOW error.

9.2 Error Messages from BASIC (continued)

ARITH. UNDERFLOW — An ARITH. UNDERFLOW occurs when an arithmetic operation exceeds the lower limit of a module floating point number. The smallest floating point number in the BASIC Module is +/–lE–127. For example, 1E–80/1E+80 causes an ARITH. UNDERFLOW error.

ARRAY SIZE — An ARRAY SIZE error occurs if an array is dimensioned by a DIM statement and you attempt to access a variable that is outside of the dimensioned bounds.

Example:

```
>DIM A(10)
>Print A(11)

ERROR: ARRAY SIZE
READY
```

BAD ARGUMENT — A BAD ARGUMENT error occurs when the argument of an operator is not within the limits of the operator. For example, SQR(–12) generates a BAD ARGUMENT error because the value of the SQR argument is limited to positive numbers.

BAD SYNTAX — A BAD SYNTAX error occurs when either an invalid BASIC Module command, statement or operator is entered and BASIC cannot process the entry. Check to make sure that all entries are correct.

C-STACK — A C-STACK (CONTROL STACK) error occurs if:

- the control stack pointer is forced “out of bounds”.
- you attempt to use more control stack than is available in the module.
- you execute a RETURN before a GOSUB, a WHILE or UNTIL before a DO, or a NEXT before a FOR.
- you jump out of loop structures such as DO WHILE.

CAN’T CONTINUE — A CAN’T CONTINUE error appears if:

- you edit the program after halting execution and then enter the CONT command.
- you enter CTRL C while in a call routine.

You can halt program execution by either entering CTRL C or by executing a STOP statement. Normally, program execution continues after entering the CONT command. You must enter CTRL C during program execution or you must execute a STOP statement before the CONT command can work.

DIVIDE BY ZERO — A DIVIDE BY ZERO error occurs if you attempt to divide by zero (12/0).

9.2 Error Messages from BASIC (continued)

EXTRA IGNORED — Error occurs when an INPUT statement requiring numeric data, receives numeric data followed by letters. Letters are ignored. Error also occurs from CALL 61.

MEMORY ALLOCATION — A MEMORY ALLOCATION error occurs when:

- user memory (RAM) is full.
- BASIC cannot determine memory bounds because the system control value MTOP is altered.
- RAM contains an incomplete program file.
- you attempt to access STRINGS that are “outside” the defined string limits.

NO DATA — A NO DATA message occurs if a READ STATEMENT is executed and no DATA STATEMENT exists or all DATA was read and a RESTORE instruction was not executed. The message ERROR: NO DATA – IN LINE XXX is printed to the console device.

PROGRAMMING — If an error occurs while the BASIC Module is programming an EPROM, a PROGRAMMING error occurs. An error during programming destroys the EPROM file structure. You cannot save any more programs on that particular EPROM once a PROGRAMMING error occurs. If the EPROM size is exceeded, the previously stored program may be partially altered.

9.3 Error Messages from CALL Routines

Your module generates the following messages when an error occurs while trying to execute a CALL routine.

9.3.1 Data Conversion CALL Error Messages

NEGATIVE VALUES NOT VALID — This error occurs when you attempt to convert a negative number with CALL 21 or 27.

9.3.2 Peripheral Port Support CALL Error Messages

CHECKSUM ERROR FROM RECORDER — This error occurs when bad data is received from the tape while executing CALLS 33, 34 or 39. You should check for correct cable connections and baud rate. Also check your tape cartridge.

9.3.2 Peripheral Port Support CALL Error Messages (continued)

IN ROM — The IN ROM message displays if you attempt to load a ROM program to tape with CALL 32 or 38. You should transfer the ROM program to RAM and then load the program to tape.

INVALID INPUT DATA — This error occurs when you enter an invalid value when using CALL 30.

INVALID VALUE PUSHED — This error occurs when you enter a value other then 0, 1 or 2 when using CALL 37.

LOAD/SAVE ABORT — This error occurs when you execute a CTRL C from any tape CALL (32, 33, 34, 38 or 39).

NO BASIC PROGRAM EXIST — This error occurs when the BASIC Module is in RAM mode with no program in RAM and you attempt to execute a CALL 32 or 38. You should enter a program in RAM or XFER a ROM program to RAM prior to loading to tape with CALL 32 or 38.

9.3.3 Wall Clock CALL Error Messages

INSUFFICIENT NUMBER OF STRING CHARACTERS ALLOCATED — This error occurs if you attempt to execute a CALL 43, 45 or 52 and a string length of 18, 8 or 9, respectively, is not allocated during string allocation.

INVALID DATE/TIME PUSHED — This error occurs when you enter an invalid value for the date and/or time when using CALL 40 and 41.

NUMBER BYTES/STRING EXCEED 254 — This error occurs when using CALL 43, 45 or 52 and the STRING X,X command allocates more characters per string than is allowed.

Example:

```
10 STRING 1000,300
```

INVALID NUMBER PUSHED — This error occurs when you push an invalid string value or day of week value using CALL 42, 43 and 52.

9.3.4 String Support CALL Error Messages

STRING# NOT ALLOCATED — This error occurs if you attempt to access a string that is outside the allocated string memory when using CALLs 60, 61, 64, 65, 66, 67, or 68.

Example:

```
>10 STRING 100,9              REM 10 STRINGS ALLOCATED$
                              (0)–$(9)
>20 PUSH 5,12                 REM REPEAT CHAR 5 TIMES
                              IN$(12)
>30 CALL 60
>RUN
```

ERROR — STRING # NOT ALLOCATED

Error occurs because STRING 12 is outside the area reserved for strings.

#BYTES/STRING EXCEED 254 — This error occurs if the STRING X,X command allocates more characters per string than is allowed using CALL 62.

Example:

```
>10 STRING 1000,300
```

INSUFFICIENT NUMBER OF STRING CHARACTERS This error occurs if you do not use the required minimum string lengths when using CALL 62.

BAD # PUSHED — This error occurs if the string position pointer is zero (invalid position) using CALL 66.

INSUFFICIENT STRING SIZE — This error occurs if the resulting string cannot hold all required characters when using CALLs 61 or 66.

Example:

```
>10 STRING 100,9 REM MAX OF 9 CHR'S/STRING
>20 $(0)="01234567"
>30 $(1)="890"
```

If you attempt to insert or concatenate, an error occurs because the resulting string requires 11 characters.

9.3.4 String Support CALL Error Messages (continued)

BAD POSITION— This error occurs if you attempt to access a string position that is beyond the declared length of the string when using CALL 66.

Example:

```
>10 STRING 100,9
>20 $(0)="1234"
>30 $(1)="56"
>40 PUSH 6    REM INVALID POSITION OF $(0)
>50 PUSH 1    REM $(1)
>60 PUSH 0    REM $(0)
>70 CALL 66  REM INSERT $(1) INTO $(0) @ POS 6
```

BAD POSITION error results because position 6 is outside of the declared string.

EXTRA IGNORED — This error occurs when the resulting string cannot hold all the characters when using CALL 61. Similar to insufficient string size error. Extra characters are lost.

Input — An input statement requiring numeric data, received numeric data followed by letters. The letters are ignored.

Example:

```
Input A
```

Entering 1.23AB causes this error message. The program continues to run.

9.3.5 Memory Support CALL Error Messages

INVALID MTOP ADDRESS ENTERED — This error occurs when you select an invalid RAM location for a new MTOP value when using CALL 77.

PROGRAM NOT FOUND — This error occurs if a program number higher than 255 is PUSHed when using CALL 71 or 72 or if the program is not found.

9.3.6 Miscellaneous CALL Error Messages

INVALID BAUD RATE ENTERED — This error occurs when a baud rate other than 300, 600, 1200, 2400, 4800, 9600 or 19.2K bps is PUSHed using CALL 78.

INCOMPLETE ROM PROGRAM FOUND — This error occurs when CALL 81 detects an incomplete program in the EPROM. You can burn no additional programs onto this PROM. All earlier programs are still accessible.

NO PROGRAM FOUND BUT THE PROM IS NOT BLANK — ×This error occurs if miscellaneous data is found on a “blank” PROM using CALL 81. You should clear the PROM before using it.

NEGATIVE VALUE NOT VALID — ×This error occurs if you attempt to convert a negative number using CALL 21.

9.4 Anomalies

Anomalies are deviations from the normal. Anomalies in the BASIC Module can occur as the module compacts or tokenizes the BASIC program. The known anomalies and cautions are as follows:

1. When using the variable H after a line number, put a space between the line number and the H. If you do not, the program assumes that the line number is a HEX number.

   Examples:

Wrong	**Right**
>20H=10	>20 H=10
>LIST	>LIST
32 =10	20 H=10

9.4 Anomalies (continued)

2. When using the variable I before an ELSE statement, put a space between the I and the ELSE statement. If you do not, the program assumes that the IE portion of IELSE is the special function operator IE.

   This error may or may not yield a BAD SYNTAX — IN LINE XXX error message, depending on the particular program in which it is used.

   Examples:

   Wrong

   ```
   >20 IF I >10 THEN PRINT IELSE 100
   >LIST
   20          IF I >10 THEN      PRINT I ELSE 100
   ```

   Right

   ```
   >20         IF I>10 THEN       PRINT I ELSE 100
   >LIST
   20          IF I >10 THEN      PRINT I ELSE 100
   ```

3. Do not place a space character inside the ASC() operator. A statement like PRINT ASC() yields a BAD SYNTAX ERROR. You can put spaces in strings, however, allowing the following statement to work properly:

   ```
   LET $(1) >“HELLO, HOW ARE YOU”
   ```

   ASC() yields an error because the module eliminates all spaces when a line is processed. ASC() is stored as ASC() and the module interprets this as an error.

4. Do not use the following one letter variables: B, F, R. Unpredictable operation could result.

5. Do not use the following two letter variables: CR, DO, lE, IF, IP, ON, PI, SP, TO, UI and UO.

6. When using an INPUT statement to enter data you must be sure to enter valid data. If you enter invalid data you see the prompt “TRY AGAIN”. This disrupts the screen layout.

7. SQR(M–M2) gives a bad argument if M=O.

8. ONTIME does not interrupt CALL routines, INPUT statements or PRINT# statements waiting for handshaking (XON, CTS, DCD) to become true. ONTIME is a polling mechanism which is checked after each line of BASIC is completed. End of line is either a (CR) or (:).

9.4 Anomalies (continued)

9. If you use a VT100 terminal, the BASIC Module can miss an XON character sent by your terminal when you enable software handshaking and use a 19.2K baud rate on the module's program port. You must type CTRL Q to resume.
10. If you use a CTRL C to abort LIST# or PRINT# to a peripheral device, the BASIC Module no longer transmits on the program port (only at 9600 or 19.2 K baud). You can correct the problem by deleting any line. The line deleted need not actually exist in the program.
11. Illegal CALL numbers above 128 are not trapped and cause the micro to jump into code memory at the address specified. This can cause the module to get "lost".
12. The BASIC Module does not save the EPROM stored baud rate.

    Example:

    The module is powered up after a CALL 73 is issued and a valid baud rate is previously stored in EPROM using a PROG1.

    If the module is powered down and then up, it is powered up at 1200 baud.
13. The renumber routine does not renumber a program if there is insufficient RAM left or if a GOTO or GOSUB exists and the target line number does not. Error reporting does not indicate the cause, only that an error occurred. We recommend renumbering the program in sections and not to renumber a program greater than 9 K.
14. When editing a line, an excessive line length may cause the terminal to issue a CTRL S. A CTRL Q causes termination of the edit. You must retype the complete line.
15. The BASIC Module updates the wall clock for Daylight Savings Time. This occurs on the last Sunday in April and October if the Day of Week is set properly (CALL 42).

Quick Reference Guide

Mnemonic	Page	Description	Example
ABS( )	5–45	ABSOLUTE VALUE	ABS(–3)
ASC( )	5–72	RETURNS INTEGER VALUE OF ASCII CHARACTER	P.ASC(A)
ATN( )	5–47	RETURNS ARCTANGENT OF ARGUMENT	ATN(1)
CALL	5–16	CALL APPLICATION PROGRAM	CALL 10
CHR( )	5–74	COUNTS VALUE CONVERTED ASCII CHARACTER	P.CHR(65)
CLEAR	5–16	CLEARS VARIABLES, INTERRUPTS & STRINGS	CLEAR
CLEARI	5–16	CLEAR INTERRUPTS	CLEARI
CLOCK0	5–17	DISABLE REAL TIME CLOCK	CLOCK0
CLOCK1	5–17	ENABLE REAL TIME CLOCK	CLOCK1
CONT	5–7	CONTINUE AFTER A STOP OR CONTROL-C	CONT
CONTROL C	5–9	STOP EXECUTION & RETURN TO COMMAND MODE	CTRL C
CONTROL S	5–10	INTERRUPT A LIST COMMAND	CTRL S
CONTROL Q	5–10	RESTART A LIST AFTER CONTROL S	CTRL Q
COS( )	5–47	RETURNS THE COSINE OF ARGUMENT	CPS(0)
DATA	5–18	DATA TO BE READ BY READ STATEMENT	DATA 100
DIM	5–19	ALLOCATE MEMORY FOR ARRAY VARIABLES	DIM A(20)
DO	5–19	SET UP LOOP FOR WHILE OR UNTIL	DO
END	5–22	TERMINATE PROGRAM EXECUTION	END
EXP( )	5–46	“e” (2.7182818) TO THE X	EXP(10)
FOR-TO (STEP)	5–22	SET UP FOR NEXT LOOP	FOR A=1 TO 5
GET	5–50	READ CONSOLE	P.GET
GOSUB	5–23	EXECUTE SUBROUTINE	GOSUB 1000
GOTO	5–24	GOTO PROGRAM LINE NUMBER	GOTO 5000
IF-THEN-ELSE	5–25	CONDITIONAL TEST	IF A < C THEN A=0
INPUT	5–26	INPUT A STRING OR VARIABLE	INPUT A
INT( )	6–45	INTEGER	INT(3.2)
LD@	5–28	LOAD VARIABLE	LD@ 14335
LEN	5–52	READ THE NUMBER OF BYTES OF MEMORY IN THE CURRENT SELECTED PROGRAM	PRINT LEN
LET	5–29	ASSIGN A VARIABLE OR STRING A VALUE (LET IS OPTIONAL)	LET A=10
LIST	5–7	LIST PROGRAM TO THE CONSOLE DEVICE	LIST LIST 10–50
LIST#	5–8	LIST PROGRAM TO SERIAL PRINTER	LIST# LIST# 50
LOG( )	5–46	NATURAL LOG	LOG(10)
MTOP	5–52	READ THE LAST VALID MEMORY ADDRESS	PRINT MTOP
NEW	5–9	ERASE THE PROGRAM STORED IN RAM	NEW
NEXT	5–22	TEST FOR-NEXT LOOP CONDITION	NEXT A
NOT( )	5–45	ONE’S COMPLEMENT	NOT(0)
NULL	5–9	SET NULL COUNT AFTER CARRIAGE RETURN-LINE FEED	NULL NULL 4
ONERR	5–30	ONERR OR GOTO LINE NUMBER	ONERR 1000
ON GOTO	5–25	CONDITIONAL GOTO	ON A GOTO 5,20
ON GOSUB	5–25	CONDITIONAL GOSUB	ON A GOSUB 2,6
ONTIME	5–31	GENERATE AN INTERRUPT WHEN TIME IS EQUAL TO OR GREATER THAN ONTIME ARGUMENT-LINE NUMBER IS AFTER COMMA	ONTIME 10, 1000

Mnemonic	Page	Description	Example
PH0	5–37	PRINT HEX MODE WITH ZERO SUPPRESSION	PH0.A
PH1	5–37	PRINT HEX MODE WITH NO ZERO SUPPRESSION	PH1.A
PH0.#	5–37	PH0. TO LINE PRINTER	PH0.#A
PH1.#	5–37	PH1.# TO LINE PRINTER	PH1.#A
PI	5–46	PI – 3.1415926	PI
POP	5–38	POP ARGUMENT STACK TO VARIABLES	POP A,C,D
PRINT	5–32	PRINT VARIABLES, STRINGS OR LITERALS P, IS SHORTHAND FOR PRINT	PRINT A
PRINT#	5–36	PRINT TO SOFTWARE SERIAL PORT	PRINT# A
PRINT CR	5–33	PRINT I, CR	
PRINT SPC(5)	5–33	PRINT “A”, SPC(5), “B”	A....B
PRINT TAB(#)	5–33	PRINT TAB(5), “x”	x
PRINT USING (Fx)	5–34	PRINT USING (F3), 1,2	1. .00E0 2.00E0
PRINT USING(#.#)	5–35	PRINT USING (##.##), 1,2	1.002.00
PROG	5–12	SAVE THE CURRENT PROGRAM IN EPROM	PROG
PROG1	5–14	SAVE BAUD RATE INFORMATION IN EPROM	PROG1
PROG2	5–14	SAVE BAUD RATE INFORMATION IN EPROM AND EXECUTE PROGRAM AFTER RESET	PROG2
PUSH	5–37	PUSH EXPRESSIONS ON ARGUMENT STACK	PUSH10,A
RAM	5–10	EVOKE RAM MODE, CURRENT PROGRAM IN READ/WRITE MEMORY	RAM
READ	5–18	READ DATA IN DATA STATEMENT	READ A
REM	5–40	REMARK	REM DONE
RESTORE	5–18	RESTORE READ POINTER	RESTORE
RETI	5–41	RETURN FROM INTERRUPT	RETI
RETURN	5–23	RETURN FROM SUBROUTINE	RETURN
RND	5–46	RANDOM NUMBER	RND
ROM #	5–10	EVOKE ROM MODE, EPROM PROGRAM #, DEFAULT TO ROM1	ROM ROM3
RUN	5–5	EXECUTE A PROGRAM	RUN
SGN	5–45	SIGN	SGN (–5)
SIN( )	5–46	RETURNS THE SINE OF ARGUMENT	SIN(3.14)
SQR( )	5–45	SQUARE ROOT	SQR(100)
ST@	5–41	STORE VARIABLE	ST@ 14335
STOP	5–41	BREAK PROGRAM EXECUTION	STOP
STRING #,#	5–42	ALLOCATE MEMORY FOR STRINGS # BYTES TO ALLOCATE, # BYTES/STRING	STRING 50,10
TAN( )	5–47	RETURNS THE TANGENT OF THE ARGUMENT	TAN(0)
TIME	5–50	RETRIEVE AND/OR ASSIGN REAL TIME CLOCK VALUE	PRINT TIME TIME=0
UNTIL	5–5	TEST DO LOOP CONDITION	UNTIL A=10
WHILE	5–5	TEST DO LOOP CONDITION	WHILE A=C
XFER	5–12	TRANSFER A PROGRAM FROM ROM/EPROM TO RAM	XFER
+	5–43	ADDITION	1+1
/	5–43	DIVISION	10/2
**	5–43	EXPONENTIATION	2**4
*	5–43	MULTIPLICATION	4*2
–	5–43	SUBTRACTION	8–4
.AND.	5–43	LOGICAL AND	10,AND.5
.OR.	5–43	LOGIC OR	2.OR.1
.XOR.	5–43	LOGICAL EXCLUSIVE OR	3.XOR.2

Appendix B

Decimal/Hexadecimal/Octal/ASCII Conversion Table

Column 1				Column 2				Column 3				Column 4			
DEC	HEX	OCT	ASC	DEC	HEX	OCT	ASC	DEC	HEX	OCT	ASC	DEC	HEX	OCT	ASC
00	00	000	NUL	32	20	040	SP	64	40	100	@	96	60	140	\
01	01	001	SOH	33	21	041	!	65	41	101	A	97	61	141	a
02	02	002	STX	34	22	042	″	66	42	102	B	98	62	142	b
03	03	003	ETX	35	23	043	#	67	43	103	C	99	63	143	c
04	04	004	EOT	36	24	044	$	68	44	104	D	100	64	144	d
05	05	005	ENQ	37	25	045	%	69	45	105	E	101	65	145	e
06	06	006	ACK	38	26	046	&	70	46	106	F	102	66	146	f
07	07	007	BEL	39	27	047	′	71	47	107	G	103	67	147	g
08	08	010	BS	40	28	050	(	72	48	110	H	104	68	150	h
09	09	011	HT	41	29	051	)	73	49	111	I	105	69	151	i
10	0A	012	LF	42	2A	052	*	74	4A	112	J	106	6A	152	j
11	0B	013	VT	43	2B	053	+	75	4B	113	K	107	6B	154	k
12	0C	014	FF	44	2C	054	’	76	4C	114	L	108	6C	154	l
13	0D	015	CR	45	2D	055	–	77	4D	115	M	109	ED	155	m
14	0E	016	S0	46	2E	056	.	78	4E	116	N	110	6E	156	n
15	0F	017	SI	47	2F	057	/	79	4F	117	O	111	6F	157	o
16	10	020	DLE	48	30	060	0	80	50	120	P	112	70	160	p
17	11	021	DC1	49	31	061	1	81	51	121	Q	113	71	161	q
18	12	022	DC2	50	32	062	2	82	52	122	R	114	72	162	r
19	13	023	DC3	51	33	063	3	83	53	123	S	115	73	163	s
20	14	024	DC4	52	34	064	4	84	54	124	T	116	74	164	t
21	15	025	NAK	53	35	065	5	85	55	125	U	117	75	165	u
22	16	026	SYN	54	36	066	6	86	56	126	V	118	76	166	v
23	17	027	ETB	55	37	067	7	87	57	127	W	119	77	167	w
24	18	030	CAN	56	38	070	8	88	58	130	X	120	78	170	x
25	19	031	EM	57	39	071	9	89	59	131	Y	121	79	171	y
26	1A	032	SUB	58	3A	072	:	90	5A	132	Z	122	7A	172	z
27	1B	033	ESC	59	3B	073	;	91	5B	133	[	123	7B	173	{
28	1C	034	FS	60	3C	074	<	92	5C	134	\	124	7C	174	.
29	1D	035	GS	61	3D	075	=	93	5D	135	]	125	7D	175	}
30	1E	036	RS	62	3E	076	>	94	5E	136	^	126	7E	176	~
31	1F	037	US	63	3F	077	?	95	5F	137	_	127	7F	177	DEL

Basic Module Programming Hints

BASIC Module Programming Hints

These programming hints can help you to properly program your module to increase module performance.

1. Always define strings first.
2. Always dimension arrays after defining strings.
3. Define the most used variables first. You can use 0 values until you assign real values.
4. When doing math, save intermediate values rather than recalculate.
5. Place the most used subroutines near the beginning of the program.
6. Straight through code executes faster, but uses more memory.
7. Put multiple statements on a line, after the program has been debugged.
8. Comments use space and slow program execution. After the program is debugged save a fully commented copy on tape or spare ERROM and remove comments.

Rockwell Automation

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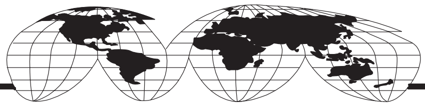

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